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CONTENTS

Research Papers

A STUDY ON QUALITY OF WORK LIFE AND JOB PERFORMANCE OF EMPLOYEES IN AUTOMOBILE INDUSTRY IN CHENNAI

K. S. BALAJI AND S. RAJAMOHAN

ABSTRACT
Quality of work life is including wide range of components that are influencing performance of employees and development of capabilities of human resources. All business organizations are adopting various programmes and methods in order to improve quality of work life of their employees with the objective of reaching their goals. The results reveals that male employees, employees belonging to 36 – 40 years of age, employees with under graduation, employees holding 7 – 9 years of working experience and employees in monthly salary group of Rs.30,001 – Rs.40,000 are having better quality of work life in automobile industry. Significant difference is there amongst profile of employees of automobile industry and their quality of work life. The quality of work life of employees is significantly, positively and highly related their job performance in automobile industry. Therefore, automobile companies should give adequate salary for their employees and they must give adequate opportunities for personal development of employees. Further, automobile companies must ensure job security to employees for minimum period based on their job performance.

Keywords: Automobile Industry, Employees, Job Performance, Quality of Work Life

1. INTRODUCTION
Quality of work life comprises of various aspects of work environment which facilitates the development of human resources in all types of business organizations effectually (Hoque and Rahman, 1997). Quality of work life is including wide range of components that are influencing performance of employees and development of capabilities of human resources (Considine and Callus, 2001). Quality of work life is essential for professional development of employees the organizations and it is helping for the growth of organizations and their reputation (Mensah and Lebbaeus, 2013). Quality of work life is an inclusive programme that enhances satisfaction of employees associated with their works and it is encouraging employees to do their job efficiently and attain their personal objectives also (Vijaimadhavan and Raju, 2013).

All business organizations are adopting various programmes and methods in order to improve quality of work life of their employees with the objective of reaching their goals (Gayathiri and Ramakrishnan, 2013) and it is largely supporting employees to fulfill their desires in their jobs and is highly contributing to the performance and success of business organizations (Pugalendhi et al 2011). Quality of work life is very important for employees working in automobile industry due to its nature of job, working condition, competitive working atmosphere, workload and technological advancements and it is also related with their job performance, satisfaction and commitment. Thus, it is imperative to study quality of work life and job performance of employees in automobile industry.

2. REVIEW OF RELATED LITERATURE
Jeyarathnam and Malarvizhi (2011) found that job autonomy, work atmosphere, safety, working conditions, security for job and inter personal with colleagues were elements of quality of work life of employees and it had positive influence on their job performance.

Ouppara and Victoria (2012) concluded that safe working atmosphere, fair and adequate compensation, job security, development of human capabilities and social integration were components of quality of work life of employees.

Rathamani and Ramchandra (2013) revealed that opportunities for career development, working atmosphere, autonomy in job and encouragement were elements of quality of work life among employees and it was positively and significantly related with their job performance.

Rubel and Kee (2014) indicated that work atmosphere, features of job, compensation and incentives, chances for development of careers, support of supervisors and motivation were the important constituents of quality of work life of employee and they were positively affecting job performance of employees.

Haque et al (2015) showed that health working conditions, compensation, growth of career, nature of job and workload and decision making power were elements of quality of work life of employees and they had positive impact on performance of employees.

Jayaraman (2016) found that timings, security for job, policies and procedures, opportunities for development, pay, decision making, readdressing grievances, recognition, break time and communication were the important components of quality of work life of employees.

Tripathy (2017) concluded that features of job, economic and social aspects of job, working atmosphere, effectiveness of management and socialization were components of quality of work life of employees and they had positive and significant influence on job performance of employees.

Nagesh (2018) revealed that flexible working hours and shifts, job security, effective communication, rewards and recognition, career and personal development and good compensation were elements of quality of work life of employees and they were significantly and positively impacting job performance among employees.

Daniel (2019) indicated that job design and enrichment, autonomy in work, career growth, job security, organizational justice, flexible work schedule and participation of employees were elements of quality of work life of employees. Quality work life was positively and significantly related to employee job performance which in turn affected the organizational performance.

Dhivya (2020) showed that safe and healthy working condition, adequate and fair compensation, work and total life space, opportunities for development and social relevance of work life were major constituents of quality of work life of employees.

Narayana (2021) found that adequate and fair compensation, social integration, opportunities for development, constitutionalism, work and total life space, safe and healthy working condition and social relevance of work life were elements of quality of work life of employee and it was positively related with performance of employees.

3. OBJECTIVES OF THE STUDY

i) To study quality of work life of employees in automobile industry.

ii) To scrutinize difference amongst profile of employees of automobile industry and their quality of work life.

iii) To examine relation amongst quality of work life of employees and their job performance in automobile industry.

4. METHODOLOGY

The present study is carried out in Chennai. Employees working in automobile industry are randomly chosen and data are collected from 300 employees working in automobile industry by using structured questionnaire. Percentages are used to understand profile of employees of automobile industry. Mean and standard deviation are computed to study quality of work life of employees in automobile industry. t-test and ANOVA test are employed to scrutinize difference amongst profile of employees of automobile industry and their quality of work life. Correlation analysis is carried out to examine relation amongst quality of work life of employees and their job performance in automobile industry.

5. RESULTS

5.1. Profile of Employees of Automobile Industry

The profile of employees of automobile industry is shown in Table-1. The results show that 61.67 per cent of them are males, while, 38.22 per cent of them are females and 37.00 per cent of them are belonging to 31 – 35 years of age, while, 10.67 per cent of them are belonging to 21 – 25 years of age. The results indicate that 39.67 per cent of them are under graduates, while, 24.33 per cent of them are post graduates and 40.66 per cent of them are holding 4 – 6 years of working experience, while, 25.67 per cent of them are holding 1 – 3 years of working experience and 34.67 per cent of them are in monthly salary group of Rs.40,001 – Rs.50,000, while, 15.00 per cent of them are in monthly salary group of above Rs.50,000.

Table- 1. Profile of Employees of Automobile Industry

Profile	Number (n = 300)	Percentage
Gender		
Male	185	61.67
Female	115	38.22
Age		
21 – 25 Years	32	10.67
26 – 30 Years	99	33.00

31 – 35 Years	111	37.00
36 – 40 Years	58	19.33
Education		
Diploma	108	36.00
Under Graduation	119	39.67
Post Graduation	73	24.33
Working Experience		
1 – 3 Years	77	25.67
4 – 6 Years	122	40.66
7 – 9 Years	101	33.67
Monthly Salary		
Below Rs.30,000	60	20.00
Rs.30,001 – Rs.40,000	91	30.33
Rs.40,001 – Rs.50,000	104	34.67
Above Rs.50,000	45	15.00

5.2. Quality of Work Life of Employees in Automobile Industry

The quality of work life of employees in automobile industry is shown in Table-2.

Table-2. Quality of Work Life of Employees in Automobile Industry

Quality of Work Life	Mean	Standard Deviation
My automobile company is giving adequate salary for their employees	3.35	0.87
My automobile company is providing good incentives to employees	3.75	0.97
My automobile company is giving healthy work atmosphere	3.83	0.94
My automobile company is providing safety to employees	3.91	0.90
My automobile company is giving adequate opportunities for personal development of employees	3.31	0.49
My automobile company is helping employees for their professional growth	3.88	0.73
My automobile company is addressing issues of employees efficiently	3.62	1.04
My automobile company is encouraging team work and cooperation among employees	3.93	0.96
My automobile company is ensuring job security for employees	3.29	1.08
My automobile company is providing sufficient facilities to employees	3.85	0.89

The employees of automobile industry are agreed with their automobile company is providing good incentives to employees, their automobile company is giving healthy work atmosphere, their automobile company is providing safety to employees, their automobile company is helping employees for their professional growth, their automobile company is addressing issues of employees efficiently, their automobile company is encouraging team work and cooperation among employees and their automobile company is providing sufficient facilities to employees, while, they are neutral with their automobile company is giving adequate salary for their employees, their automobile company is giving adequate opportunities for personal development of employees and their automobile company is ensuring job security for employees.

5.3. Profile of Employees of Automobile Industry and their Quality of Work Life

The relation amongst profile of employees of automobile industry and their quality of work life is shown below as.

5.3.1. Gender of Employees and Quality of Work Life

The relation amongst gender of employees and their quality of work life in automobile industry is shown in Table-3.

Table-3. Gender of Employees and Quality of Work Life

Gender	N	Mean	Standard Deviation	t-Value	Sig.
Male	185	37.89	3.69	3.996	.000
Female	115	35.45	3.78		
Eta Squared			0.013		

Mean value of quality of work life in automobile industry is 37.89 for male employees and it is 35.45 for female employees and it explicates that male employees are having better quality of work life in automobile industry than female employees.

The t-value is 3.996 and it reveals that significant difference is there amongst gender of employees and their quality of work life in automobile industry in one per cent level. The eta squared value is 0.013 implying that the effect size is small and it shows that the actual difference in mean values between groups is small.

5.3.2. Age of Employees and Quality of Work Life
The relation amongst age of employees and their quality of work life in automobile industry is shown in Table-4.

Table- 4. Age of Employees and Quality of Work Life

Age	N	Mean	Standard Deviation	F-Value	Sig.
21 – 25 Years	32	36.66	3.75		
26 – 30 Years	99	38.18	4.10	10.782	.000
31 – 35 Years	111	36.42	3.63		
36 – 40 Years	58	35.55	3.22		
Eta Squared			0.027		

Mean value of quality of work life in automobile industry is varying from 38.18 for employees belonging to 26 – 30 years of age to 35.55 or employees belonging to 36 – 40 years of age and it explicates that employees belonging to 26 – 30 years of age are having better quality of work life in automobile industry than other ages.

The F-value is 10.782 and it reveals that significant difference is there amongst age of employees and their quality of work life in automobile industry in one per cent level. The eta squared value is 0.027 implying that the effect size is small and it shows that the actual difference in mean values between groups is small.

5.3.3. Education of Employees and Quality of Work Life
The relation amongst education of employees and their quality of work life in automobile industry is shown in Table-5.

Table- 5. Education of Employees and Quality of Work Life

Education	N	Mean	Standard Deviation	F-Value	Sig.
Diploma	108	35.38	3.14		
Under Graduation	119	37.90	3.99	13.094	.000
Post Graduation	73	36.96	3.51		
Eta Squared			0.036		

Mean value of quality of work life in automobile industry is varying from 37.90 for employees with under graduation to 35.38 for employees with diploma and it explicates that employees with under graduation are having better quality of work life in automobile industry than other educations.

The F-value is 13.094 and it reveals that significant difference is there amongst education of employees and their quality of work life in automobile industry in one per cent level. The eta squared value is 0.036 implying that the effect size is small and it shows that the actual difference in mean values between groups is small.

5.3.4. Working Experience of Employees and Quality of Work Life
The relation amongst working experience of employees and their quality of work life in automobile industry is shown in Table-6.

Table- 6. Working Experience of Employees and Quality of Work Life

Working Experience	N	Mean	Standard Deviation	F-Value	Sig.
1 – 3 Years	77	35.75	3.17		
4 – 6 Years	122	36.46	4.16	11.549	.000
7 – 9 Years	101	38.02	3.59		
Eta Squared			0.042		

Mean value of quality of work life in automobile industry is varying from 38.02 for employees holding 7 – 9 years of working experience to 35.75 for employees holding 1 – 3 years of working experience and it explicates that employees holding 7 – 9 years of working experience are having better quality of work life in automobile industry than other working experiences.

The F-value is 11.549 and it reveals that significant difference is there amongst working experience of employees and their quality of work life in automobile industry in one per cent level. The eta squared value is 0.042 implying that the effect size is small and it shows that the actual difference in mean values between groups is small.

5.3.5. Monthly Salary of Employees and Quality of Work Life

The relation amongst monthly salary of employees and their quality of work life in automobile industry is shown in Table-7.

Table-7. Monthly Salary of Employees and Quality of Work Life

Monthly Salary	N	Mean	Standard Deviation	F-Value	Sig.
Below Rs.30,000	60	37.15	3.65		
Rs.30,001 – Rs.40,000	91	38.22	3.59	8.653	.000
Rs.40,001 – Rs.50,000	104	36.18	3.78		
Above Rs.50,000	45	35.40	3.89		
Eta Squared	0.039				

Mean value of quality of work life in automobile industry is varying from 38.22 for employees in monthly salary group of Rs.30,001 – Rs.40,000 to 35.40 for employees in monthly salary group of above Rs.50,000 and it explicates that employees in monthly salary group of Rs.30,001 – Rs.40,000 are having better quality of work life in automobile industry than other monthly salary groups.

The F-value is 8.653 and it reveals that significant difference is there amongst monthly salary of employees and their quality of work life in automobile industry in one per cent level. The eta squared value is 0.039 implying that the effect size is small and it shows that the actual difference in mean values between groups is small.

5.4. Relation amongst Quality of Work Life of Employees and their Job Performance in Automobile Industry

The correlation analysis is carried out to examine relation amongst quality of work life of employees and their job performance in automobile industry and the result is shown inTable-8.

Table- 8. Quality of Work Life of Employees and their Job Performance in Automobile Industry

Particulars	Correlation Coefficient
Quality of Work Life of Employees and their Job Performance in Automobile Industry	0.66

The correlation coefficient amongst quality of work life of employees and their job performance in automobile industry is 0.66 and it clarifies that they are positively, significantly and highly related with other in one per cent level

6. CONCLUSION

The above results reveals that male employees, employees belonging to 36 – 40 years of age, employees with under graduation, employees holding 7 – 9 years of working experience and employees in monthly salary group of Rs.30,001 – Rs.40,000 are having better quality of work life in automobile industry. Significant difference is there amongst profile of employees of automobile industry and their quality of work life. The quality of work life of employees is significantly, positively and highly related their job performance in automobile industry. Therefore, automobile companies should give adequate salary for their employees and they must give adequate opportunities for personal development of employees. Further, automobile companies must ensure job security to employees for minimum period based on their job performance.

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EFFECT OF INSULIN WITH OTHER HYPOGLYCEMIC AGENTS AND MULTIVITAMIN CONSUMPTION ON DIABETES PROGRESSION

VEERAVENTHAN VETRISELVAM, AIYAVU CHINNAIYAN, DANIEL A. GIDEON, SIVAKUMAR KRISHNAMOORTHI AND NETHAJI SHANMUGAM

ABSTRACT
The aim of this study was to assess the long-term effect of insulin administration (3 years) with other hypoglycemic agents (OHA) and multivitamins (MV) on the glycemic index and diabetic progression. An equal number of male and female (n = 11/group) subjects who had diabetes for more than 5 years were selected and enrolled in this study. All subjects were consuming multivitamins with three hypoglycemic drugs (a combination of metformin, Glimepiride and Voglibase) only or with insulin divided into groups. Blood samples were collected, and clinical analyses were performed to determine fasting (FBS), postprandial blood glucose (PPBS), glycosylated hemoglobin (HbA1c), and body mass index (BMI). Each parameter was analyzed for pre and post-study periods to determine the changes during the study period, and a gender-based analysis was also performed to examine the effects on a gender basis. Though we observed an increasing trend in FBS, and HbA1c levels in both groups compared to their basal (pre-study) levels, these changes were not significant. There was no change in PPBS at baseline as well as post-study. While BMI was not changed significantly compared to its baseline, BMI was significantly (P<0.05) changed in both the groups of female participants only due to the higher dysglycemia risk in South Asian women. From these results, we concluded that long-term insulin administration with MV and OHA has less effect on controlling the glycemic index in subjects with chronic diabetes. However, our results warrant a long-term and large-scale randomized study.

Keywords: Diabetes mellitus; multi-vitamin; Insulin; HbA1c; hypoglycemic

1. INTRODUCTION

Diabetes is an incurable metabolic disorder (Karamanou et al. 2016; Blasi 2016) and is linked to diminished life expectancy, which stems from significant morbidity arising from diabetes-associated micro/macro-vascular complications (Dregan et al. 2014; Viigimaa et al. 2020). Brown et al. (2016) found that patients with diabetes mellitus have a significantly reduced quality of life (Rubin and Peyrot 1999); moreover, patients require lifelong pharmaceutical management of the disease by taking antidiabetic (antihyperglycemic) medications (Brown et al. 2016). Multiple genetic alterations/mutations have also been known to cause diabetes mellitus (Groop and Pociot 2014; O'Connor et al. 2022; Støy et al. 2021), however, it is not caused solely by genetic abnormalities. Numerous pathogenesis processes are known to cause pancreatic beta cells' destruction, leading to insulin insufficiency and the prevalence of metabolic dysfunction (Marasco and Linnemann 2018). This subsequently causes insulin resistance, which ensues for manifold reasons such as lack of insulin, mutations of the insulin gene or the gene coding for the insulin receptor, mutations of the glucose transporter (GLUT) genes responsible for insulin-mediated glucose uptake, or decreased insulin action (Støy et al. 2021). Diabetes affects carbohydrate, fatty acid, and protein metabolism because insulin action is impaired.

Oral hypoglycemic agents (OHA) are anti-diabetic medications that address the problem of hyperglycemia. Several types of OHAs are used for the treatment of hyperglycemia, namely biguanides, sulfonylureas, α-glucosidase inhibitors, thiazolidinediones, and incretin analogs/agonists (Song 2016). Most diabetic patients' hyperglycemic levels are managed with any one of the drugs for a couple of years. However, chronic consumption requires a high concentration or combination of other hypoglycemic drugs or insulin (Cheng and Fantus 2005). Diabetes mellitus (due to impaired insulin sensitivity) can cause immune system dysfunction in humans (Rahman et al. 2021; Sty et al. 2021).When the pancreas does not secrete insulin normally and/or insulin levels are low, pharmacological management of hyperglycemia does not work. Exogenous insulin from porcine or humulin is administered to diabetic patients to manage hyperglycemia (Inzucchi et al. 2015).

Several decades of research documented that chronic oxidative stress is known to be the cause of diabetic-associated complications, and antioxidant supplementation is thought to compensate for the oxidative stress. Bouayed and Bohn (2010))and Polyak et al. (2018) believe that exogenous antioxidant supplementation can compensate for oxidative stress. Supplementation or endogenous activation of antioxidants can suppress the severity of diabetes mellitus (Bouayed and Bohn 2010; Polyak et al. 2018).For several decades, clinical trials of antioxidants have been inconclusive as mixed effects have been observed; a few clinical trials have revealed

that antioxidants may also impede normal redoxfunctions of cells and might further complicate diabetes management(A and A 2018; Ahmad and Leake 2018; Chiabrando et al. 2002; Levy, Blum, and Levy 2009; Steinhubl 2008; Violi et al. 2004).

Although single or multiple oral hypoglycemic agents (OHA) with insulin are effective in managing glycemic control, the effect of OHA with insulin and multivitamins on diabetes progression is unknown.In this study, we aimed to assess the impact of insulin administration on glycemic management in diabetic subjects with other antihyperglycemic and multivitamin drugs for a minimum period of 3 years between 2014 and 2018. Diabetic subjects consumed 3 hypoglycemic drugs (a combination of metformin, Glimepiride, and Voglibase tablet) with multivitamin supplements to determine the basic glycemic index management over the years to find whether insulin supplements had the potential to slow down diabetes progression.

2. MATERIALS AND METHODS

Diabetic patients (n=50) who had diabetes for more than 5 years and were regularly consuming (prescribed & non-prescribed) multivitamin supplements (Table-1) from 2014 to 2018 in Tamil Nadu, India (South region) were approached to get their informed consent to assess their medical records from Karunya Sugalaya Diabetic Care & Research Centre in Kumbakonam, Tamil Nadu. Informed consent was obtained from all the patients, and enrolled patients were notified. Samples were collected, processed, and clinical analyses were performed in Karunya Sugalaya Diabetic Care & Research Centre in Kumbakonam, Tamil Nadu. The inclusion and exclusion criteria of the diabetic subjects were followed as described in Figure-1. Only 22 subjects were included in this study, and the age of the patients ranged from 45 to 80. The distribution of subjects was 1:1 for males: females. Body mass index (BMI), fasting (FBG), and postprandial blood glucose (PPBG) levels, and HbA1c, levels were extracted from the database and used for this study. This study was approved by the Bharathidasan University Institution bioethical committee (IEC; DM/2014/101/47).

Composition of vitamins/cofactors	Per serving (per tablet)
VITAMINS	
Vitamin A (as Acetate)	2500 IU
Vitamin E (Tocopherol)	10 IU
Vitamin K	10 mcg
Vitamin D3 (Cholecalciferol)	200 IU
Vitamin B1 (Thiamine Mononitrate)	2 mg
Vitamin B2 (Riboflavin)	3mg
Vitamin B6 (Pyridoxie Hydrochloride)	1.5mg
Niacinamide	26mg
Vitamin C (Ascorbic Acid)	50mg
Vitamin B12 (Cyanocobalamin)	1mcg
Folic Acid	0.3mg
Calcium Pantothenate	5mg
Biotin	30mcg
MINERALS:	
Zinc (as zinc sulphate Monohydrate)	15mg
Iodine (as potassium iodide)	0.15mg
Ferrous fumarate equ. To Iron	9mg
Magnesium(as Magnesium oxide)	100mg
Manganese (as Managanese sulphate monohydrate)	2.5mg
Copper (as Cupric Oxide)	2mg
Calcium (as Dibasic calcium Phosphate)	162mg
Phosphorous	125mg
Potassium (as Potassium Chloride)	40mg
Chloride	36.3mg
Chromium (as Chromium Chloride)	100mcg
Selenium (as selenium silicate)	25mcg
Nickel (Nickel sulphate)	5mcg
Silica (as colloidal silicon Dioxide)	10mcg
Vanadium	10mcg
Molybdenum(as Sodium Molybdenum)	100mcg

Table-1. Composition of multivitamin tablets

Figure-1. Criteria for study subject selection
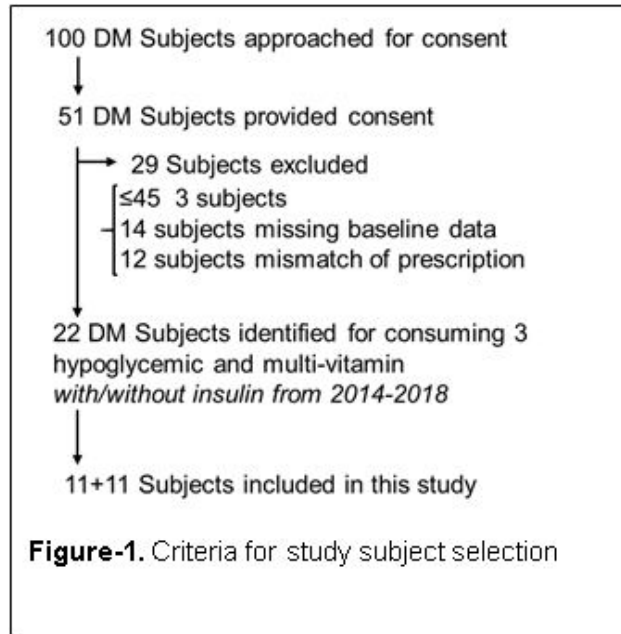
STATISTICAL ANALYSIS

Statistical analyses were used for the calculation of mean and SEM. All values are represented as mean ± SEM. The P-value < 0.05 (P < 0.05) was considered statistically significant. All statistical analyses were performed using the Graph pad prism. One-way ANOVA (analysis of variance) was performed to find the difference in statistical significance between the means of two or more groups.The P-values for ANOVA analyses are given in the respective results wherever ANOVA was performed.

3. RESULTS

3.1 Characteristics of the Study Participants:

At baseline, there was no statistical significance observed in blood glucose (FBS & PPBG), age, BMI among the group participants. However, we observed differences in HbA1c levels but they were not statistically significant. We included two patients with higher age in the drug-only group to match the gender association of patients with an equal number and also to achieve the total number of participants per group to a minimum of 10. The mean age of participants for the drug-only group was 60.27±3.0, whereas the drug+Insulin group was 55.18±1.73. In each group, we included 5 males and 6 females. The average age of males and females in the drug-only group was 64.20±4.90, 57±3.51 respectively and in the drug+Insulin group was 58.60±2.42, 52.33±1.89 (Figure 2A-B.)

Figure-2. Ages of the study participants. (A) Comparison of ages between two groups of subjects included. (B) Bar graph illustrating the ages of males and females separately in each group.
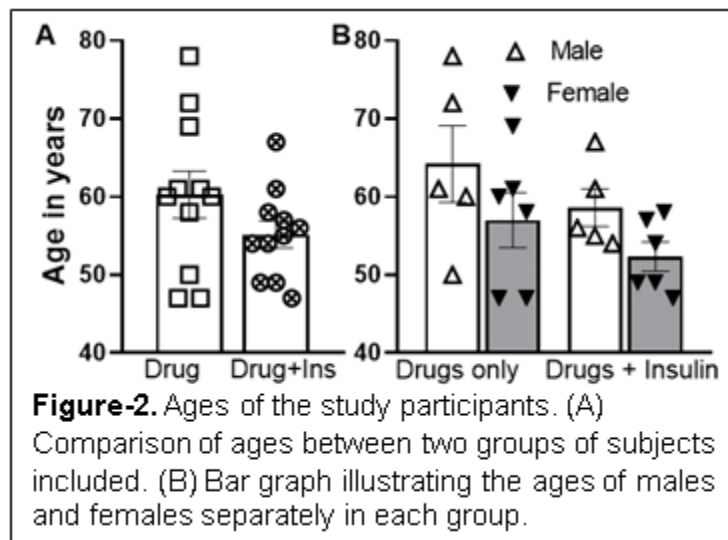
3.2 Fasting and Postprandialblood Glucose Levels

First, we analyzed the changes in FBS and PPBS to determine whether prolonged intake of multi-vitamins with hypoglycemic drugs alone and/or insulin preserves blood glucose levels in study subjects. We observed an

increasing trend in the FBS levels of participants in the drug-only group. However, this change was not statistically significant within the group as well as the gender (Figure-3A-B). Next, we analyzed the pre and post-treatment changes in PPBS levels between the groups and also gender. No significant differences were seen in PPBS levels during pre and post-study times (Figure 4A). Our gender-based comparison also showed no changes within the groups or between the genders. Although we observed a decrease in the PPBS levels in both groups' males, these changes were not statistically significant (Figure 4B). Overall, the results suggested that there were no significant changes observed in the blood glucose levels (FBS/PPBS) in subjects who consumed hypoglycemic drugs only or hypoglycemic drugs with the insulin-treated group during the study period.
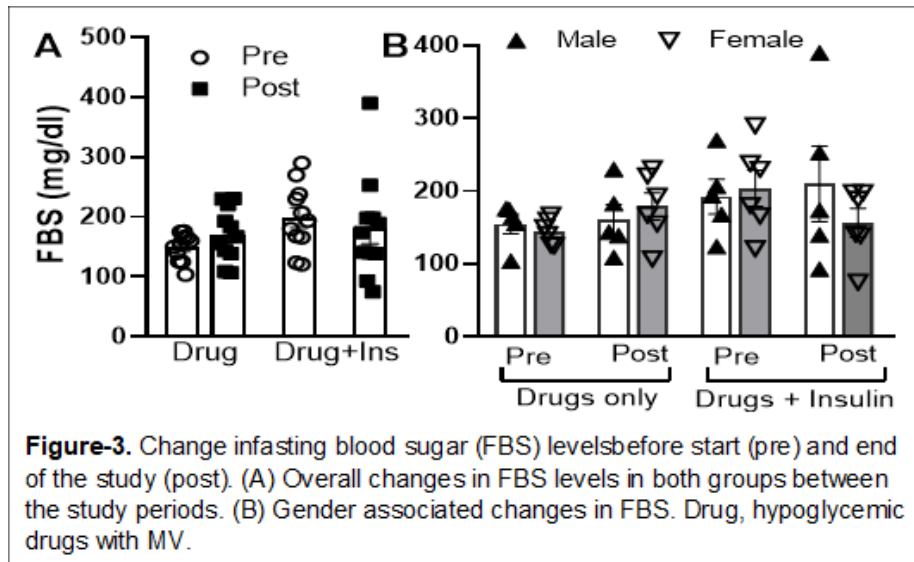
Figure-3. Change infasting blood sugar (FBS) levelsbefore start (pre) and end of the study (post). (A) Overall changes in FBS levels in both groups between the study periods. (B) Gender associated changes in FBS. Drug, hypoglycemic drugs with MV.
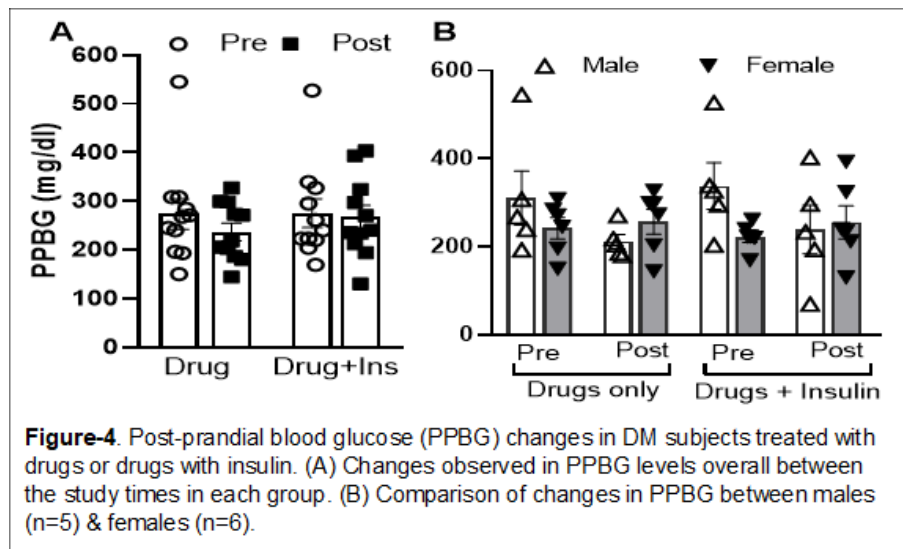
Figure-4. Post-prandial blood glucose (PPBG) changes in DM subjects treated with drugs or drugs with insulin. (A) Changes observed in PPBG levels overall between the study times in each group. (B) Comparison of changes in PPBG between males (n=5) & females (n=6).

3.3 HBA1C levels

Although no significant changes were observed in blood glucose levels, next, we assessed the HbA1c levels in study subjects to determine whether chronic multivitamin consumption with hypoglycemic drugs alone or insulin stabilizes HbA1c levels in the study subjects. Interestingly, both groups showed an increasing trend in HbA1c levels during the post-study period compared to baseline (pre) values (Figure-5A). However, these changes were not statistically significant. Further, our gender-based analysis also revealed that both genders in the drug + insulin receiving group showed an increase in HbA1c levels. However, we didn't observe any statistically significant differences within/between the genders (Figure-5B).

3.4 Body mass Index

As subjects with persistent elevation of blood glucose and HbA1c levels might gain body weight, we next measured the body mass index in both groups. In these subjects, neither the drug alone nor the drug plus insulin administration had no effect on BMI over time (Figure-6A).Further, our gender-based analysis revealed that both the groups' ~50% of female subjects showed a statistically significant increase in BMI (p < 0.05), however, we didn't observe any changes in male groups (Figure-6B).
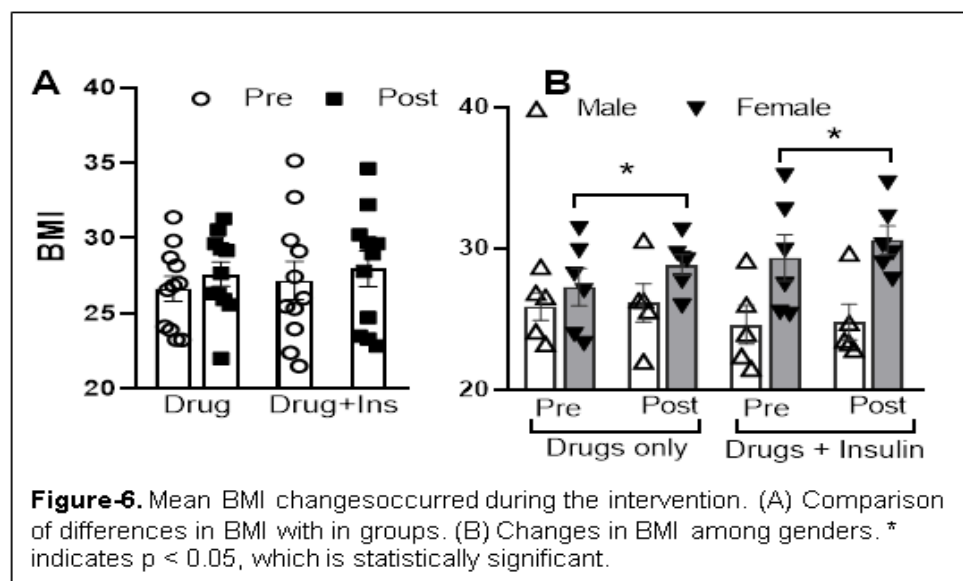
Figure-6. Mean BMI changes occurred during the intervention. (A) Comparison of differences in BMI with in groups. (B) Changes in BMI among genders. * indicates p < 0.05, which is statistically significant.

4. DISCUSSION

Chronic diabetes mellitus associated with oxidative stress causes microvascular complications such as diabetic neuropathy, nephropathy, and retinopathy as well as macromolecular damages such as protein carbonylation, protein glycation, lipid peroxidation, etc., leading to several macro-vascular complications. Multivitamins have been reported as antioxidants and are assumed to suppress oxidative stress and its associated damage. While multivitamin consumption is not required for healthy subjects, it may be needed for aged individuals (Atkinson 2011) and patients with diseases like diabetes, myocardial infarction, and other complications (Grodstein et al. 2013). Although several decades of preclinical research supported the beneficial effects of antioxidants (Polyak et al. 2018); previous clinical trials indicated that prolonged antioxidant consumption is not beneficial, and a few studies reported its harmful effects (A and A 2018; Ahmad and Leake 2018; Bouayed and Bohn 2010; Chiabrando et al. 2002; Grodstein et al. 2013; Levy, Blum, and Levy 2009; Steinhubl 2008; Violi et al. 2004). Regular use of these hypoglycemic drugs or insulin administration has been shown to have a significant hypoglycemic index, and a combination of these drugs alone may be effective in lowering blood glucose levels for a limited time (1 year) (Cheng and Fantus 2005). However, it is unclear whether chronic use of these hypoglycemic drugs (3 years) in conjunction with multivitamin consumption of diabetic management in this south Indian population. Simultaneous consumption of multivitamins with hypoglycemic drugs alone and with insulin is predicted to decrease blood glucose and HbA1C levels. In this preliminary study, we have focused on the impact of multivitamin intake with a combination of hypoglycemic drugs and/or insulin to determine the basic diabetic profiles of these specific subjects in the South Indian population. Although we observed changes in FBS, PPBS, and HbA1c levels in both drugs alone and drug + insulin groups (Figure 3-5), these observations were not significant, suggesting that these subjects showed a steady rise in glycemic index (both glucose and HbA1C levels) trend to develop other vulnerable complications (Bennett et al., 2007). However, antioxidant intake combined with these hypoglycemic drugs and insulin was not successful in halting the progression of diabetes and its complications.

Diabetes mellitus is caused by both decreased insulin production and insulin sensitivity, leading to hyperlipidemia and resulting in insulin resistance and obesity (Ferris and Kahn 2016). Long-term exercise or other methods for lowering BMI and increasing insulin sensitivity (Bird and Hawley 2016; Schenk et al. 2009). Persistent increases in HbA1c levels (>7.5) accompanied by elevated BMI (>25) exacerbate insulin resistance and other associated complications. Our study results showed that ~50% of patients with higher HbA1c levels and BMI (>27) were prescribed medium to high doses of insulin to control their glycaemic status. However, their glycemic profiles were also higher, which was not significant.

This study has several limitations, including a small number of subjects with long-duration diabetes. Although gender and age matches were followed for the participation of subjects, the duration of diabetes was not considered in either group. Additionally, while the dosage of three drugs was the same among participants, the insulin dosage for each participant was different, which might be one of the causes of poor blood glucose and HbA1c outcomes. Further study is needed with a controlled age of diabetes and an equal age of participants to determine the impact of insulin administration with multivitamins and other hypoglycemic drugs. Although

several studies have determined the long-term effects of hypoglycemic drugs, insulin, and multivitamins separately in diabetic subjects, our study determined the combined effect on south Indian diabetic subjects.

In summary, our findings indicate that prolonged multivitamin consumption with hypoglycemic drugs and/or insulin had less effect on blood glucose, BMI, and HbA1c levels in both genders with chronic diabetes (>5 years). However, female subjects showed significantly increased BMI, which may be due to higher dysglycemia risk in women in South Asia.

CONFLICT OF INTEREST
The authors declare that they have no conflict of interest.

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A STUDY ON PROMOTIONAL STRATEGIES ADOPTED BY CORPORATE HOSPITALS IN BENGALURU CITY

MARIA ALEXINA VINOTHA RAJAN AND A. MEGALA

ABSTRACT
Promotional strategies are a tactic for hospitals, healthcare networks, physical circumstance practitioners, caregivers, healthcare providers, and healthcare promotion executives. It's also understood to include health improvement by empowering cases, cousins, and workers in the enhancement of their health-related physical, internal and social well-being. Hospitals engage in recreation an imperative part in promoting health, precluding complaints, and furnishing recuperation services. Commercial hospitals can be distinct from clandestine for-profit hospitals as contrasting to plentiful hospital donations for general or specialist tertiary position care. They're different from other hospitals because of their private commercial limited status. It's used to describe everything from a managed care association to a croaker association to a sanitarium- run association. Health creation measures concentrate on both individualities and the conduct of individualities to help and reduce ill-health and ameliorate good. Health in this environment not only refers to the traditional. The healthcare delivery request in India is anticipated to be further than double within the coming decade. India is witnessing a period where new hospitals are being erected at a pace like no way ahead. There are instigative challenges that these hospitals are facing while they're being commissioned. One grueling task that every sanitarium, new or old, small or big, is facing moment is the task of marketing itself. With adding competition, healthcare marketing is witnessing a changeover from tune bringer dominance to service campaigners' preference. A study was thus accepted to appreciate probe the case satisfaction of commercial hospitals and the promotional strategy espoused by commercial hospitals.

Keywords: Hospitals, Promotional, Marketing, Corporate

INTRODUCTION
In utmost of developed countries at the global position, the healthcare assiduity accounts for nearly 10 of their Gross Domestic Product **(World Health Organization, Report 2012).** There's a symbol in the current period as the population is roaring, the preface of new technologies, and the services and benefits (cases are being well informed) offered by the healthcare assiduity. There's a need for reliance on other expert services piecemeal for medical professionals like medical abstracts, lab sidekicks, IT help, deals & marketing professionals, testers, quality assurance help, etc. Healthcare isn't only limited to hospitals but also includes medical bias and outfit, pharma, insurance, biotechnology, alternate drug, medical apparel, etc. which are growing at a faster pace. Promotion and communication strategy are crucial factors of the services marketing blend strategy by which hospitals can communicate their health services to guests (**Lovelock**).

The sanitarium's directors must first examine guests' requirements in the terrain it serves and choose the communication tools that suit the terrain, grounded on profit and growth eventuality given sanitarium coffers and objects. Promotion can give an occasion for associations to separate themselves in commercial and brand situations. A service creation strategy has some factors that are known as the " promotional blend" (Harrison,) **Sreenivas, T., Srinivasarao, B., Srinivasa Rao, U., & India, A. (2013).** evaluates the innovative marketing strategies espoused by commercial hospitals to vend their services and tries to explore the Marketing process explained with the help of 7P's i.e. Product, Price, Place, Promotion, People, Physical Substantiation, and Process in sample hospitals that run under different commercial superintendence. The healthcare request size is anticipated to reach US \$280 billion by 2020. **(World Bank, 2012).** There's a remarkable rise in spending on the nation's GDP. There's a huge eventuality for the Indian healthcare request and also Government has been introducing numerous programs to get the healthcare service to the coming position. India is arising as a new destination for serving healthcare installations considering its low cost and advanced technologies used by foreign medical excursionists.

REVIEW OF LITERATURE
Pharmaceutical creation is "all instructional and conclusive conditioning by manufacturers and distributors, the effect of which is to induce the tradition, force, purchase and/ or use of medicinal medicines" **(WHO 1988). Van Doren, D.C., Fechner, D.L., & Green-Adelsberger, K. (2000).** This eventuality for exposure has dramatic counteraccusations for any business considering the Internet as a promotional vehicle. Internet spots,

where druggies may bandy their passions about companies and products, allow increased scrutiny of all aspects of the business. However, brand equity is vulnerable to corrosion, If companies don't deal effectively with this scrutiny. Thus, all contingencies essential in promotional sweats on the Internet must be counted precisely.

Medicines have an important part in healthcare in the treatment of a large range of health conditions, relief of worrisome symptoms, and forestallment of unborn ill-health. Numerous factors impact the quality and felicitousness of drug use. **Abreu, R., David, F., & Crowther, D. (2005).** The authors trust that, as multifaceted establishments, hospices necessary dishonorable their disclosure police transparency to allow affected role to identify their locations that should be ambitious mainly by CSR as a public service and not by the financial viewpoint of a commercial.

Holden, C. (2005). This work of art presents the consequences of a disquisition conditioning. Companies included in Fortune magazine's 'G500' list of pots (by deals) were anatomized for health-related conditioning. Any drug use has the implicit to lead to both health benefits and damages. Interventions to ameliorate the quality of drug use end to maximize implicit benefits and minimize the eventuality of detriment **(Schiff 2011),** as well as support a cost-effective approach to watch **(Aronson 2012).**

Chen, C. B., & Kao, P.L. (2012) This paper expects to understand consumer preferences regarding consumers creation styles which promotional styles produce further fidelity among consumers, and studies on sanitarium marketing practices from consumers from different backgrounds consumers. Grounded on the issues of the disquisition, the following three specific results were attained (1) The top six marketing-related ways impacting consumers' choice of hospitals are free medical discussion, referral by musketeers and cousins, free clinic treatments, the mailing of clinic schedules to implicit guests, Television news exposure, and furnishing education in public health and hygiene. (2). The top styles of creation, yielding the loftiest consumer fidelity are (in order of significance) high prevalence of referral by musketeers and cousins; Television exposure; free medical discussion; free clinic treatments; and furnishing education in public health and hygiene. (3) Gender and age are factors that significantly impact consumer preferences related to promotional conditioning.

Bobeica Ana Maria (2013) In this study of academic exploration, the experimenter has suggested " marketing plan in the healthcare assiduity" analyses the healthcare requests to gain better results serve on internal association structure which shows the direct connection between marketing strategy, creative strategy.

Al-Qarni, A. A., Alsharqi, O. Z., Qalai, D. A., & Kadi, N. (2013) This exploration aims to probe the impact of the marketing blend strategy of the secluded zone sanatorium. **Azad, M. (2017)** to dissect the current request position of baby wipes baby care product). To understand the request position this analysis is conducted in two different stages. One testing the client " s comprehension towards baby wipes products grounded on the suppositions and the alternate bone is collecting information from the request (medicinal shops) to dissect the monthly deals, request share, and different SKU parts of different brands of wipes. Despite assaying, this report also gives Pharmaceutical product creation constantly reflects this pressure between marketable and health precedences, as promoted drugs don't always represent advances in patient care **Greenway 2017; Lexchin 2017**. A pressure exists between marketable pressures on pharmaceutical manufacturers to expand deals of newer patent products and the need for judicious use of the most cost-effective available druthers Alves2018. The extent and types of relations prescribes have expanded, with non-supervisory norms not completely reflecting the range of current promotional conditioning **Parker 2018**.

Bennington, L. (2010) This review draws jointly the theoretical and experiential writing from mutually the profitable and healthcare domination literature to resolve the state of information that can with assurance produce a supremacy structure. It concludes by suggesting with the intention of further theoretical work and investigation are required and that the focus of both requirements is to be broader to receive keen financial credit for the complexity of the sector.

OBJECTIVES OF THE STUDY

1. To understand the study area the promotional strategies incorporate hospitals in Bangalore city.

2. To inquire about the satisfaction level of the patients in commercial hospitals

3. To measure the consumer prospects taken by corporate hospitals in Bangalore city.

4. To offer possible suggestions for the study.

METHODOLOGY

A quantitative approach was used to gain a comprehensive picture of the issues in question in this exploration. The current exploration used questionnaire ways to collect the primary data. The exploration questionnaire was

designed grounded on the former empirical workshop of literature. The exploration questionnaire was used as the primary data collection system. The factors of the Promotional and sanitarium performance videlicet (patient satisfaction) will be measured from a 5 (SA) to 1 (SDA). Secondary data was collected from the magazines, news, reviews, etc., The total population slice was 900. The sample size was 270. A commensurate arbitrary slice was used in the study.

FINDINGS AND DISCUSSION
Table-1. The results demonstrate that 52.2% of them are in the male category, while, 47.8% of them are in the female category, 14.1% of them are falling into 19 – 29 years, while, 20.7% of them are falling into the 30-39 years, 34.4% of them are falling into the 40-49 years, and above 60 years is 30%. Position of General Directors is 18.5%, Medical Manager position is 20%, Administrative Manager is 11.9%, Medical Departments are 20%, Manager Out-Patient Manager is holding 19% Patients are 10%. 51% of them are under graduation, while, 27.8% of them are PG.

Table 1: Report of the Respondents

Variable	Classification of the Variables	Occurrence	%
Gender	Male	141	52.2
	Female	129	47.8
Age	19-29	38	14.1
	30-39	56	20.7
	40-59	93	34.4
	above 60	83	30.7
Position	General Director	50	18.5
	Medical Manager	54	20.0
	Administrative Manager	32	11.9
	Medical Departments Manager	55	20.4
	Out-Patient Manager	52	19.3
	Patients	27	10.0
Qualification	Diploma	56	20.7
	Graduate	139	51.5
	Post Graduate	75	27.8
Academic Background	Medical	166	61.5
	Administrative	104	38.5
Year of Experience	<5 years	68	25.2
	6-10 years	153	56.7
	11-15 years	46	17.0
	16-20 years	3	1.1
How many employees are working	Below 10 employees	63	23.3
	11-25 employees	159	58.9
	26 -50 employees	48	17.8
Marital Status	Single	127	47.0
	Married	143	53.0
Monthly salary	>10,000	69	25.6
	10,001 - 25,000	41	15.2
	25,000 - 50,000	98	36.3
	50,001 – 1,00,000	40	14.8
	More than 1,00,000	22	8.1

Strategies Followed by the Corporate Hospitals in Bangalore City
The strategies followed by the corporate hospitals in Bangalore city are given in Table-2.

Table 2: Promotional Strategies in Corporate Hospitals

Strategies	Mean	Standard Deviation
Advertising to Boost Online Visibility	3.88	1.476
Use Social Media	2.29	.956
Associated with Patients from beginning to end	2.69	1.542
Use Message app	3.50	1.055
Get Patients' Feedback	2.55	.996

Table 2 represents the Advertising to boost online visibility (1.4 SD), Use Social Media (0.9), Stay Connected (1.5), Use Message apps (1), Get Patients' Feedback (0.9).

Measure of Consumer Expectations of Corporate Hospitals in Bangalore City
The evaluation of end-user prospects of corporate hospitals in Bangalore city is given in Table-3.

Table 3: Consumer Expectations for Measures to be taken by Hospitals

Expectations	Mean	Std. Deviation
Use of individual caring apparatus	3.87	1.479
Sanitization chambers and thermal screening	2.13	.700
Disposable mask / gloves	2.57	1.501
disinfection	3.41	1.044
Separate fever clinics	2.55	.996
Digital/ paperless way	3.97	1.423
Social distancing in OPD / waiting areas	2.15	.737
Separate/unconnected air conditioning systems	2.61	1.513
Robots	3.49	1.037

Table 3 stand for the Use of individual caring apparatus (1.4), Sanitization chambers and thermal screening (0.7) Disposable mask / gloves (1.5), disinfection (1), Separate fever clinics (0.9), Digital / paperless way (1.4), Social distancing in OPD / waiting areas (0.7), Separate/unconnected air conditioning systems (1.5), Robots (1).

Patient Satisfaction in Feasible Hospitals in Bangalore City
Patient satisfaction in commercial hospitals in Bangalore city is given in Table-4.

Table 4: Patient Satisfaction in Corporate Hospitals

Satisfaction	Mean	Standard Deviation
Bargain danger of negligence suit	2.56	1.007
Increased personal	3.96	1.423
Improved patient retention	2.13	.700
Increased professional satisfaction	2.86	1.597

Table 4 represents the stratification of the corporate hospitals the facts are Bargain danger of negligence suit, Increased personal, Improved patient retention, and Increased professional satisfaction.

HYPOTHESIS
There is no substantial disparity between the positions of the respondents and the promotional strategies of the corporate hospitals. Promotional strategies are Advertising to Increase Online Visibility, Use Social Media, being Associated with Patients from beginning to end, Use Message apps, and Get Patients' Feedback.

Table 5: Promotional Strategies of Corporate Hospitals

ANOVA						
Promotional Strategies		**Sum of Squares**	**Degrees of Freedom**	**Mean Square**	**F-Value**	**Sig.**
Advertising to Increase Online Visibility	Between Groups	31.505	5	6.301	2.999	**.012**
	Within Groups	554.702	264	2.101		
	Total	586.207	269	--		
Use Social Media	Between Groups	39.970	5	7.994	4.656	**.000**
	Within Groups	453.293	264	1.717		
	Total	493.263	269	--		
Associated with Patients from beginning to end	Between Groups	77.457	5	15.491	7.272	**.000**
	Within Groups	562.410	264	2.130		
	Total	639.867	269	--		
Use Message app	Between Groups	14.098	5	2.820	3.662	**.003**
	Within Groups	203.269	264	.770		

	Total	217.367	269	--			
Get Patients Feedback	Between Groups	7.303	5	1.461	1.486	.195
	Within Groups	259.471	264	.983		
	Total	266.774	269	--		

*Significant at 0.05% level

From the above table, Promotional strategies are Advertising to Increase Online Visibility, Use Social Media, Stay Connected with Patients Through Email, Use Message apps, and Get Patients' Feedback. All four factors are significant. Expect only one factor does not significant. Therefore the significant value is less than that of the p-value of 0.05. the hypothesis is rejected.

Table 6: Satisfaction Level of Patients Incorporating Hospitals

Satisfaction	Mean	Rank
Bargain danger of negligence suit	2.56	II
Increased personal	3.96	I
Improved patient retention	2.13	IV
Increased professional satisfaction	2.86	III

Table 6 represents the incorporation of hospital satisfaction levels Reduced risk of negligence suits, Increased personal and professional satisfaction, Improved patient retention, and Increased personal and professional satisfaction. Rank I represents the Increased personal and professional satisfaction, Rank II represents the Reduced risk of malpractice suits, Rank III represents the Improved patient retention, and Rank IV represents the Increased professional satisfaction.

HYPOTHESIS
There is no correspondence flanked by the outline of the respondents to measure the level of consumer expectations. G-Gender, C1-Use of individual caring apparatus, C2-Sanitization chambers and thermal screening, C3 -Disposable mask / gloves, C4-disinfection, C5-Separate fever clinics, C6- Digital / paperless way, C7-Social distancing in OPD / waiting areas, C8-Separate / unconnected air conditioning systems, C9-Robots.

Correlations											
		G	C1	C2	C3	C4	C5	C6	C7	C8	C9
G	Pearson Correlation	1									
	Sig. (2-tailed)										
	N	270									
C1	Pearson Correlation	-.202**	1								
	Sig. (2-tailed)	**.001**									
	N	270	270								
C2	Pearson Correlation	.199**	.124*	1							
	Sig. (2-tailed)	**.001**	**.042**								
	N	270	270	270							
C3	Pearson Correlation	-.008	.375**	.183**	1						
	Sig. (2-tailed)	.898	**.000**	**.003**							
	N	270	270	270	270						
C4	Pearson Correlation	-.068	.275**	.057	.088	1					
	Sig. (2-tailed)	.266	**.000**	.353	.148						
	N	270	270	270	270	270					
C5	Pearson Correlation	.110	-.032	-.377**	.022	.166**	1				
	Sig. (2-tailed)	**.070**	.600	**.000**	.714	**.006**					
	N	270	270	270	270	270	270				
C6	Pearson Correlation	-.150*	.915**	.116	.326**	.214**	.018	1			
	Sig. (2-tailed)	**.014**	**.000**	**.056**	**.000**	**.000**	.765				
	N	270	270	270	270	270	270	270			
C7	Pearson Correlation	.200**	.079	.930**	.162**	.003	-.375**	.069	1		

	Sig. (2-tailed)	**.001**	.195	**.000**	**.008**	.956	**.000**	.262		
	N	270	270	270	270	270	270	270	270	
C8	Pearson Correlation	.023	.315**	.176**	.961**	.057	.045	.344**	.155*	1
	Sig. (2-tailed)	.707	**.000**	**.004**	**.000**	.348	.458	**.000**	**.011**	
	N	270	270	270	270	270	270	270	270	270
C9	Pearson Correlation	-.043	.182**	.012	.064	.880**	.162**	.172**	.036	.030	1
	Sig. (2-tailed)	.477	.003	.842	.296	**.000**	**.007**	**.005**	.554	.619	
	N	270	270	270	270	270	270	270	270	270	270

SUGGESTIONS

The best ways to ensure stable pleasure in communal hospitals the factors are to Make Processes Simple, **Improve communication with patients, Optimize the appointment process, and Simplify the billing process.** Promotional strategies to improve the to Use consistent healthcare branding, Keep promotions simple, Improve employee engagement, and Leverage innovative technology, Increases operational efficiency.

CONCLUSION

This cram was meant to appraise the various Promotional strategies used, to analyze the patient stratifications in corporate hospitals in the healthcare services industry. Promotional strategies have proven to be very important, especially since the purpose of any organization is to make profits and increase clientele bases. This study reviewed the relevant literature on the value of promotion strategy in the hospitals included in the study. A promotional strategy is a necessary strategy in service organizations to ensure these organizations' success. It is vital to market the hospitals in the target market and acts whole corporate hospital or with coordination in dealing with hospital routine-considered by patient satisfaction. These are the factors that the hospital is attempting to win via the promotional strategy application and the services delivered. The framework suggests that promotional strategy as a core construct in this research receives its vital role through the effect of promoting strategy on corporate hospital recital deliberate by enduring fulfillment. As a result, this study argues that the promotional strategy is a mediating factor that relies on business hospice feat measured make the most of patient satisfaction.

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THE EFFECTS OF STOKES DRAG ON THE RESONANT MOTION OF MARS IN THE SUN-EARTH SYSTEM

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ABSTRACT

This paper deals with effect of resonance on the motion of mars in the Sun-Earth system due to stokes drag by using Beauge's and Ferrz-Mellow's model (1992). In presence of Stokes drag applied on both earth and mars there are seven resonant points $1:1, 2:1, 3:1, 1:2, 2:3, 3:2$ and $4:3$ have been found whereas two resonant points $1:1$ and $2:1$ are also found due to Stokes drag applied on mars only. Also, amplitude and time period have been discussed at all the resonant points.

Keywords: Resonance, Stokes drag, Amplitude and time period.

1. INTRODUCTION

Many authors had studied three-body problem and restricted three-body problem under different perturbations. The mechanism of dissipation in solar dynamics is multi-dimensional. The gravitational dissipative force due to solar radiation incident on particles is the Poynting-Robertson (PR) drag. The non-gravitational dissipative force due to gas nebula moving in solar space is known as Stokes drag which is proportional to the velocity of particle with respect to gas and valid for low Renold number $R_e < 10$. The particular case of Stokes drag is the linear drag. Also there is another important effect of dissipation is called Epstein drag which is proportional to the square of the relative velocity and is valid for high Reynold numbers $R_e > 10^3$. The radiation pressure, the Doppler's shift of incident radiation had been discussed by Poynting (1903) and Robertson (1937). The effect of radiation pressure of sun on artificial satellite has been studied by Brouwer (1963) The problem of resonance plays an important role in our solar system dynamics. Resonance may be described as a set of cases in which the periods of revolutions are in the ratio of two small integers, which are usually manifested by the appearance of small divisors, when integrating the equation of the motion. Hughes (1980) studied earth satellite orbit resonant with respect to lunisolar gravity and direct solar radiation pressure with particular reference to those resonances, the occurrence of which is dependent only on the satellite's orbital inclination. Weidenchilling and Devis (1985) discovered the behavior of resonance trapping in a gasrich scenario. Patterson (1987) extended W-D's work to resonances of any order and showed how planetary embryous could have formed at two-body external resonances by accretion of infinitesimals caught in these orbits. Bhatnagar and Mehra (1986) examined the motion of a satellite by taking gravitational forces of the Moon, the Earth and the Sun (with radiation pressure). Ferraz-Mellow (1992) studied "averaging of the elliptic asteroidal problem with a Stokes drag" and with the assistance of Beauge (1993) studied "resonance trapping and Stokes drag dissipation in the primordial solar Nebula. Celletti and Stefanelli (2011) have shown that the semi major axis decreases often due to dissipation and consequently the collision takes place between one of the primaries and minor bodies. Quasles et al. (2012) has studied the resonances for co-planar CR3BP for the mass ratio between 0.10 and 0.15 and used the method of maximum Lyaponav exponent to locate the resonances. They showed that for high value of resonance, orbital stability is ensured where single resonance is present. Sushil et al. (2013) worked on resonance in a geocentric satellite due to Earth's equatorial ellipticity and analyzed the effects on amplitude and time period of oscillation on Γ (angle measured from the minor axis of the Earth's equatorial ellipse to the projection of the moon on the plane of equator) and on the other orbital elements of the satellite. Rosemary (2013) has given detailed description of the perturbation theory to determine the location of resonance based on approximations to a harmonic oscillation. Charanpreet Kaur et al. (2018) worked on resonance in the motion of geocentric satellite due to PR-drag. Charanpreet kaur et al. (2019) have discussed the "Resonance" in the motion of geocentric satellite due to PR-drag and equatorial ellipticity of the Earth. Presently we have proposed to extend the work of Sushil et al (2013) and Charanpreet Kour et al (2019) by considering the effect of resonance on the motion of mars in presence of Stokes drag in the Sun-Earth system defined by Ferraz-Mellow (1992).

2. EQUATION OF MOTION

Considering the inertial frame (E, X_0Y_0Z) with the earth E at the origin and a rotating frame (E, XYZ) relative to inertial one, where EX_0 passes through the vernal equinox γ . Let $\hat{i}_0, \hat{j}_0$ and $\hat{i}, \hat{j}$ be the unit

vectors along the axes of the inertial and rotating frame with the common unit vector $\hat{k}$ along OZ (not seen in the figure) . Let $\overrightarrow{EM} = \vec{r}$ be the position vector of the mars M and $\overrightarrow{ES} = -\vec{\rho}$ be the position vector of the sun S relative to the earth E and $\overrightarrow{SM} = \vec{R}$. Let m, m_1 and m_2 be the masses of the sun, earth and mars respectively.

$$\vec{F}_{SM} = -\frac{Gmm_2}{R^3}\vec{R}, \ \ \vec{F}_{EM} = -\frac{Gm_1m_2}{r^3}\vec{r}, \ \ \vec{F}_{SE} = -\frac{Gmm_1}{\rho^3}\vec{\rho}, \ \ \vec{F}_{ME} = \frac{Gm_1m_2}{r^3}\vec{r} \tag{1}$$

The force of Stokes drag due to collisions of the earth E and mars M with the gas molecules in the frame of proto planetary nebulas are given by

$$\vec{S}_{D_1} = -c_1 m_1 \left[\dot{\vec{\rho}} - (1 - \lambda_1 \Omega_1)\vec{\rho} \times \hat{k} \right] \tag{2}$$

$$\vec{S}_{D_2} = -c_2 m_2 \left[\dot{\vec{R}} - (1 - \lambda_2 \Omega_2)\vec{R} \times \hat{k} \right] \tag{3}$$

Where $c_1, c_2 \in [0,1]$ are the dissipative constant depending on several physical parameters (Beauge and Ferraz-Mellow 1993) like the viscosity of the gas, the radius of the earth and mars and the mass of the earth and mars, where $\Omega_1 = \Omega_1(\rho) = \rho^{-3/2}$ and $\Omega_2 = \Omega_2(R) = R^{-3/2}$ are the Keplerian angular velocities, $\lambda_1, \lambda_2 \in [0,1]$ are the ratio between gas and Keplerian velocities (Murrary 1994). Let $\vec{\omega}$ be the angular velocity of the rotating frame relative to the inertial frame and $\hat{i}$ be the unit vector along the direction of mars then the equation of motion of mars in rotating frame can be written as

$$\ddot{\vec{r}} = \frac{\partial^2 r}{\partial t^2}\hat{i} + 2\frac{\partial r}{\partial t}(\vec{\omega} \times \hat{i}) + r\left(\frac{\partial \vec{\omega}}{\partial t} \times \hat{i}\right) + r\left[(\vec{\omega} \Box \hat{i})\vec{\omega} - (\vec{\omega} \Box \vec{\omega})\hat{i}\right] \tag{4}$$

Let α be the angles of direction of the mars with the direction of vernal equinox then $\vec{\omega} = \dot{\alpha}\hat{k}$ and hence the Equation (4) reduced to

$$\frac{d^2\vec{r}}{dt^2} = \left(\frac{\partial^2 r}{\partial t^2} - r\dot{\alpha}^2\right)\hat{i} + \left(2\dot{\alpha}\frac{\partial r}{\partial t} + r\ddot{\alpha}\right)\hat{j} \tag{5}$$

where $\dot{\alpha}$ be the angular velocity of the mars relative to the earth.

In triangle EMS, we have $\ddot{\vec{r}} = \ddot{\vec{R}} - \ddot{\vec{\rho}}$ then by using Equations $(1), (2)$ & (3) one can find

$$\ddot{\vec{r}} = \frac{\vec{F}_{SM} + \vec{F}_{EM} + \vec{S}_{D_2}}{m_2} - \frac{\vec{F}_{SE} + \vec{F}_{ME} + \vec{S}_{D_1}}{m_1}$$

$$= -\frac{Gm}{R^3}\vec{R} - \frac{Gm_1}{r^3}\vec{r} - c_2\left[\dot{\vec{R}} - (1 - \lambda_2\Omega_2)\vec{R}\times\hat{k}\right] + \frac{Gm}{\rho^3}\vec{\rho} - \frac{Gm_2}{r^3}\vec{r} + c_1\left[\dot{\vec{\rho}} - (1 - \lambda_1\Omega_1)\vec{\rho}\times\hat{k}\right]$$

$$= -\frac{G(m_1 + m_2)}{r^3}\vec{r} + \dot{\beta}^2\vec{\rho} - \frac{Gm}{R^3}\vec{R} - c_2\left[\dot{\vec{R}} - (1 - \lambda_2\Omega_2)\vec{R}\times\hat{k}\right] + c_1\left[\dot{\vec{\rho}} - (1 - \lambda_1\Omega_1)\vec{\rho}\times\hat{k}\right] \quad \text{If } \hat{\rho}$$

be the unit vector along $\vec{\rho}$ and β is the angle of direction of the sun with the direction of vernal equinox, then $\hat{\rho} = \cos\beta\hat{i}_0 + \sin\beta\hat{j}_0$ and $\vec{r} = r\hat{i}$, $\vec{\rho} = \rho\hat{\rho}$ implies that

$$\ddot{\vec{r}} = -\frac{G(m_1 + m_2)}{r^2}\hat{i} + \dot{\beta}^2\rho\left(\cos\beta\hat{i}_0 + \sin\beta\hat{j}_0\right) - \frac{Gm}{R^3}\left(r\hat{i} + \rho\cos\beta\hat{i}_0 + \rho\sin\beta\hat{j}_0\right)$$

$$- c_2\left[\dot{\vec{R}} - (1 - \lambda_2\Omega_2)\vec{R}\times\hat{k}\right] + c_1\left[\dot{\vec{\rho}} - (1 - \lambda_1\Omega_1)\vec{\rho}\times\hat{k}\right] \tag{6}$$

Taking Scalar product of $\hat{i}$ with $(5)\,\&\,(6)$ and then that of $\hat{j}$ with $(5)\,\&\,(6)$ comparing the results one can find the equation of motion of the mars in polar form as

$$\frac{\partial^2 r}{\partial t^2} - r\dot{\alpha}^2 + \frac{G(m_1 + m_2)}{r^2} = \rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)\cos(\alpha - \beta) + c_1\left[\dot{\vec{\rho}}\square\hat{i} - (1 - \lambda_1\Omega_1)(\vec{\rho}\times\hat{k})\square\hat{i}\right]$$

$$- c_2\left[\dot{\vec{R}}\square\hat{i} - (1 - \lambda_2\Omega_2)(\vec{R}\times\hat{k})\square\hat{i}\right] - \frac{Gm}{R^3}r \tag{7}$$

$$\frac{\partial}{\partial t}(r^2\dot{\alpha}) = -\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)\rho r\sin(\alpha - \beta) + c_1 r\left[\dot{\vec{\rho}}\square\hat{j} - (1 - \lambda_1\Omega_1)(\vec{\rho}\times\hat{k})\square\hat{j}\right]$$

$$- c_2 r\left[\dot{\vec{R}}\square\hat{j} - (1 - \lambda_2\Omega_2)(\vec{R}\times\hat{k})\square\hat{j}\right] \tag{8}$$

These equations are not integrable, so we replace r and $\dot{\alpha}$ by their steady state value r_0 and $\dot{\alpha}_0$ by perturbation technique which can be introduced in Equations (7) and (8) as $\alpha = \dot{\alpha}_0 t$ and $\beta = \dot{\beta}t$. Thus from Equations (5) and (6) we get

$$\frac{d^2 r}{dt^2} - r\dot{\alpha}^2 + \frac{G(m_1 + m_2)}{r^2} = \rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)\cos(\dot{\alpha}_0 - \dot{\beta})t$$

$$+ c_1\left[\dot{\vec{\rho}}\square\hat{i} - (1 - \lambda_1\Omega_1)(\vec{\rho}\times\hat{k})\square\hat{i}\right] - c_2\left[\dot{\vec{R}}\square\hat{i} - (1 - \lambda_2\Omega_2)(\vec{R}\times\hat{k})\square\hat{i}\right] - \frac{Gm}{R^3}r_0 \tag{9}$$

$$\frac{d}{dt}(r^2\dot{\alpha}) = -\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)\rho r_0\sin(\dot{\alpha}_0 - \dot{\beta})t + c_1 r_0\left[\dot{\vec{\rho}}\square\hat{j} - (1 - \lambda_1\Omega_1)(\vec{\rho}\times\hat{k})\square\hat{j}\right]$$

$$- c_2 r_0\left[\dot{\vec{R}}\square\hat{j} - (1 - \lambda_2\Omega_2)(\vec{R}\times\hat{k})\square\hat{j}\right] \tag{10}$$

Now $\dot{\vec{R}} = \dfrac{d\vec{R}}{dt} = \dfrac{d}{dt}(\vec{r} + \vec{\rho})$

$$= \frac{\partial\vec{r}}{\partial t} + \vec{\omega}\times\vec{r} + \frac{d}{dt}(\rho\hat{\rho}) = \frac{\partial r}{\partial t}\hat{i} + \dot{\alpha}\hat{k}\times r\hat{i} + \rho\frac{d}{dt}\left(\cos\beta\hat{i}_0 + \sin\beta\hat{j}_0\right)$$

$$= \frac{\partial r}{\partial t}\hat{i} + \dot{\alpha}r\hat{j} + \rho\dot{\beta}\left[\sin(\alpha - \beta)\hat{i} + \cos(\alpha - \beta)\hat{j}\right]$$

At steady state, $\dot{\vec{R}} = \rho\dot{\beta}\sin(\dot{\alpha}_0 - \dot{\beta})t\hat{i} + \rho\dot{\beta}\cos(\dot{\alpha}_0 - \dot{\beta})t\hat{j} + \dot{\alpha}_0 r_0\hat{j} \tag{11}$

$$\dot{\vec{\rho}} = \frac{d\vec{\rho}}{dt} = \frac{d}{dt}(\rho\hat{\rho}) = \rho\frac{d\hat{\rho}}{dt} = \rho\frac{d}{dt}\left(\cos\beta\hat{i}_0 + \sin\beta\hat{j}_0\right) = \rho\left(-\sin\beta\dot{\beta}\hat{i}_0 + \cos\beta\dot{\beta}\hat{j}_0\right)$$

$$= \rho\dot{\beta}\left[-\sin\beta\left(\cos\alpha\hat{i} - \sin\alpha\hat{j}\right) + \cos\beta\left(\sin\alpha\hat{i} + \cos\alpha\hat{j}\right)\right]$$

$$= \rho\dot{\beta}\left[\left(\sin\alpha\cos\beta - \sin\beta\cos\alpha\right)\hat{i} + \left(\cos\alpha\cos\beta + \sin\alpha\sin\beta\right)\hat{j}\right]$$

$$= \rho\dot{\beta}\left[\sin(\alpha-\beta)\hat{i} + \cos(\alpha-\beta)\hat{j}\right]$$

At steady state $\therefore \dot{\vec{\rho}} = \rho\dot{\beta}\left[\sin(\dot{\alpha}_0 - \dot{\beta})t\hat{i} + \cos(\dot{\alpha}_0 - \dot{\beta})t\hat{j}\right]$

And $\Omega_2 = R^{-3/2} = \left[\rho^2 + r^2 - 2\rho r\cos(\alpha-\beta)\right]^{-3/4}$ $\left(\because \cos(\alpha-\beta) = \dfrac{\rho^2 + r^2 - R^2}{2\rho r}\right)$

$$= \left(\rho^2 + r^2\right)^{-3/4}\left[1 - \frac{2\rho r\cos(\alpha-\beta)}{\rho^2 + r^2}\right]^{-3/4}$$

$$= \rho^{-3/2}\left(1 - \frac{3r^2}{4\rho^2}\right)\left[1 - \frac{2r}{\rho}\left(1 - \frac{r^2}{\rho^2}\right)\cos(\alpha-\beta)\right]^{-3/4}$$

$$= \rho^{-3/2}\left(1 - \frac{3r^2}{4\rho^2}\right)\left[1 + \frac{3}{2}\frac{r}{\rho}\cos(\alpha-\beta) + \frac{21}{8}\frac{r^2}{\rho^2}\cos^2(\alpha-\beta) + \ldots\right]$$

$$= \rho^{-3/2}\left[1 + \frac{3}{2}\frac{r}{\rho}\cos(\alpha-\beta) + \frac{21}{16}\frac{r^2}{\rho^2}\{1 + \cos(2\alpha - 2\beta)\} - \frac{3r^2}{4\rho^2}\ldots\right]$$

$$= \rho^{-3/2}\left[1 + \frac{3}{2}\frac{r}{\rho}\cos(\alpha-\beta) + \frac{9}{16}\frac{r^2}{\rho^2} + \frac{21}{16}\frac{r^2}{\rho^2}\cos(2\alpha - 2\beta)\right]$$

$$\therefore \Omega_2 = \rho^{-3/2}\left[1 + \frac{3}{2}\frac{r}{\rho}\cos(\dot{\alpha}_0 - \dot{\beta})t + \frac{9}{16}\frac{r^2}{\rho^2} + \frac{21}{16}\frac{r^2}{\rho^2}\cos(2\dot{\alpha}_0 - 2\dot{\beta})t\right]$$

$$\Omega_1 = \rho^{-3/2}, \quad \Omega_2 = \rho^{-3/2}\left[1 + \frac{3}{2}\frac{r}{\rho}\cos(\dot{\alpha}_0 - \dot{\beta})t + \frac{9}{16}\frac{r^2}{\rho^2} + \frac{21}{16}\frac{r^2}{\rho^2}\cos(2\dot{\alpha}_0 - 2\dot{\beta})t\right] \quad (12)$$

By taking $r^2\dot{\alpha} = h$ (constant) and $r = 1/u$ for central orbit in Equation (9) we get

$$\frac{d^2u}{d^2\alpha} + u = \frac{G(m_1 + m_2)}{r_0^4\dot{\alpha}_0^2} - \rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)\frac{u^2}{\dot{\alpha}_0^2}\cos(\dot{\alpha}_0 - \dot{\beta})t - \frac{c_1u^2\rho}{\dot{\alpha}_0^2}\left(\dot{\beta} + 1 - \lambda_1\Omega_1\right)\sin(\dot{\alpha}_0 - \dot{\beta})t$$

$$+ \frac{c_2u^2\rho}{\dot{\alpha}_0^2}\left(\dot{\beta} + 1 - \lambda_2\Omega_2\right)\sin(\dot{\alpha}_0 - \dot{\beta})t + \frac{Gmr_0u^2}{R^3\dot{\alpha}_0^2} \quad (13)$$

Now $\left(\dot{\beta} + 1 - \lambda_1\Omega_1\right)\sin(\dot{\alpha}_0 - \dot{\beta})t = \left(\dot{\beta} + 1\right)\sin(\dot{\alpha}_0 - \dot{\beta})t - \lambda_1\rho^{-3/2}\sin(\dot{\alpha}_0 - \dot{\beta})t \quad (14)$

$$\left(\dot{\beta} + 1 - \lambda_2\Omega_2\right)\sin(\dot{\alpha}_0 - \dot{\beta})t = \left(\dot{\beta} + 1 - \lambda_2\rho^{-3/2}\right)\sin(\dot{\alpha}_0 - \dot{\beta})t - \frac{3}{4}\frac{\lambda_2 r}{\rho^{5/2}}\sin(2\dot{\alpha}_0 - 2\dot{\beta})t$$

$$+ \frac{3}{32}\frac{\lambda_2 r^2}{\rho^{7/2}}\sin(\dot{\alpha}_0 - \dot{\beta})t - \frac{21}{32}\frac{\lambda_2 r^2}{\rho^{7/2}}\sin(3\dot{\alpha}_0 - 3\dot{\beta})t \quad (15)$$

Collaboration of Equations (13), (14) and (15)

$$\therefore \frac{d^2 u}{d^2 \alpha} + u = \frac{G(m_1 + m_2)}{r_0^{\,4} \dot{\alpha}_0^2} - \rho \left(\dot{\beta}^2 - \frac{Gm}{R^3} \right) \frac{u^2}{\dot{\alpha}_0^2} \cos(\dot{\alpha}_0 - \dot{\beta}) t - \frac{c_1 \rho u^2}{\dot{\alpha}_0^2} \left(\dot{\beta} + 1 - \lambda_1 \rho^{-3/2} \right) \sin(\dot{\alpha}_0 - \dot{\beta}) t$$

$$+ \frac{c_2 \rho u^2}{\dot{\alpha}_0^2} \left[\begin{array}{c} \left(\dot{\beta} + 1 - \lambda_2 \rho^{-3/2} \right) \sin(\dot{\alpha}_0 - \dot{\beta}) t - \dfrac{3}{4} \dfrac{\lambda_2 r}{\rho^{5/2}} \sin(2\dot{\alpha}_0 - 2\dot{\beta}) t \\ + \dfrac{3}{32} \dfrac{\lambda_2 r^2}{\rho^{7/2}} \sin(\dot{\alpha}_0 - \dot{\beta}) t - \dfrac{21}{32} \dfrac{\lambda_2 r^2}{\rho^{7/2}} \sin(3\dot{\alpha}_0 - 3\dot{\beta}) t \end{array} \right] + \frac{Gmr_0 u^2}{R^3 \ddot{\alpha}_0^2} \tag{16}$$

3. RESONANCE IN THE MOTION OF THE SATELLITE

The complete solution of unperturbed system $\dfrac{d^2 u}{d^2 \alpha} + u = \dfrac{G(m_1 + m_2)}{r_0^{\,4} \dot{\alpha}_0^2}$ is given by

$$u = \sqrt{\frac{a^2 - b^2}{b^4}} \cos(\alpha - \psi) + \frac{G(m_1 + m_2)}{r_0^{\,4} \dot{\alpha}_0^2},$$

$$\Rightarrow \frac{h^2 u}{G(m_1 + m_2)} = 1 + \sqrt{\frac{a^2 - b^2}{b^4}} \frac{h^2}{G(m_1 + m_2)} \cos(\alpha - \psi)$$

where $h = r_0^{\,2} \dot{\alpha}_0$, $a \, \& \, b$ are the semi-major axis and semi-minor axis of the elliptic orbit of the mars and ψ be the constant of integration.

Thus $\dfrac{\ell}{r} = 1 + e \cos(\alpha - \psi)$ where e is some constant and $\ell = \dfrac{h^2}{G(m_1 + m_2)} = \dfrac{b^2}{a}$.

Considering $\alpha - \psi = \dot{\alpha}_0 t = nt$ (say), where n is the frequency of the mars and $(1 + e \cos nt)^{n_1} \approx 1 + n_1 e \cos nt$.

Hence by using frequency n and $\dfrac{d^2 u}{d^2 t} = \alpha_0^{\,2} \dfrac{d^2 u}{d^2 \alpha}$ in Equation (16)

the perturbed equation of motion of the mars becomes

$$\frac{d^2 u}{dt^2} + n^2 u = \frac{G(m_1 + m_2)}{r_0^{\,4}} - \rho \left(\dot{\beta}^2 - \frac{Gm}{R^3} \right) \left(\frac{1 + 2e \cos nt}{a^2 (1 - e^2)^2} \right) \cos(n - \dot{\beta}) t$$

$$+ \rho \left[(c_2 - c_1)(\dot{\beta} + 1) + (\lambda_1 c_1 - \lambda_2 c_2) \rho^{-3/2} \right] \left(\frac{1 + 2e \cos nt}{a^2 (1 - e^2)^2} \right) \sin(n - \dot{\beta}) t$$

$$- \frac{3}{4} \frac{c_2 \lambda_2}{\rho^{3/2}} \left(\frac{1 + e \cos nt}{a(1 - e^2)} \right) \sin(2n - 2\dot{\beta}) t + \frac{3}{32} \frac{c_2 \lambda_2}{\rho^{5/2}} \sin(n - \dot{\beta}) t$$

$$- \frac{21}{32} \frac{c_2 \lambda_2}{\rho^{5/2}} \sin(3n - 3\dot{\beta}) t + \frac{Gmr_0}{R^3} \left(\frac{1 + 2e \cos nt}{a^2 (1 - e^2)^2} \right)$$

$$\Rightarrow \frac{d^2u}{dt^2} + n^2u = \left[\frac{G(m_1+m_2)}{r_0^{\ 4}} + \frac{Gmr_0}{R^3a^2(1-e^2)^2}\right] + \frac{2Gme}{a^2(1-e^2)^2}\cos nt - \frac{\rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)e}{a^2(1-e^2)^2}\cos\dot{\beta}t$$

$$-\frac{\rho e\left[(c_2-c_1)(\dot{\beta}+1)+(\lambda_1c_1-\lambda_2c_2)\rho^{-3/2}\right]}{a^2(1-e^2)^2}\sin\dot{\beta}t - \frac{\rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)}{a^2(1-e^2)^2}\cos(n-\dot{\beta})t$$

$$+\left[\frac{\rho\left[(c_2-c_1)(\dot{\beta}+1)+(\lambda_1c_1-\lambda_2c_2)\rho^{-3/2}\right]}{a^2(1-e^2)^2} + \frac{3}{32}\frac{c_2\lambda_2}{\rho^{5/2}}\right]\sin(n-\dot{\beta})t - \frac{\rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)e}{a^2(1-e^2)^2}\cos(2n-\dot{\beta})t$$

$$+\frac{\rho e\left[(c_2-c_1)(\dot{\beta}+1)+(\lambda_1c_1-\lambda_2c_2)\rho^{-3/2}\right]}{a^2(1-e^2)^2}\sin(2n-\dot{\beta})t - \frac{3c_2\lambda_2e}{8\rho^{3/2}a(1-e^2)}\sin(n-2\dot{\beta})$$

$$-\frac{3c_2\lambda_2}{4\rho^{3/2}a(1-e^2)}\sin(2n-2\dot{\beta})t - \frac{3c_2\lambda_2e}{8\rho^{3/2}a(1-e^2)}\sin(3n-2\dot{\beta})t - \frac{21}{32}\frac{c_2\lambda_2}{\rho^{5/2}}\sin(3n-3\dot{\beta})t$$

$$\therefore \frac{d^2u}{dt^2} + n^2u = K_1 + K_2\cos nt + K_3\cos\dot{\beta}t + K_4\sin\dot{\beta}t + K_5\cos(n-\dot{\beta})t + K_6\sin(n-\dot{\beta})t$$

$$+ K_7\cos(2n-\dot{\beta})t + K_8\sin(2n-\dot{\beta})t + K_9\sin(n-2\dot{\beta}) + K_{10}\sin(2n-2\dot{\beta})t$$

$$+ K_{11}\sin(3n-2\dot{\beta})t + K_{12}\sin(3n-3\dot{\beta})t \qquad (17)$$

Where

$$K_1 = \left[\frac{G(m_1+m_2)}{r_0^{\ 4}} + \frac{Gmr_0}{R^3a^2(1-e^2)^2}\right]$$

$$K_7 = -\frac{\rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)e}{a^2(1-e^2)^2} = K_3$$

$$K_2 = \frac{2Gme}{a^2(1-e^2)^2}$$

$$K_8 = \frac{\rho e\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1c_1-\lambda_2c_2)\rho^{-3/2}\end{matrix}\right]}{a^2(1-e^2)^2} = -K_4$$

$$K_3 = -\frac{\rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)e}{a^2(1-e^2)^2}$$

$$K_9 = -\frac{3c_2\lambda_2e}{8\rho^{3/2}a(1-e^2)}$$

$$K_4 = -\frac{\rho e\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1c_1-\lambda_2c_2)\rho^{-3/2}\end{matrix}\right]}{a^2(1-e^2)^2}$$

$$K_{10} = -\frac{3c_2\lambda_2}{4\rho^{3/2}a(1-e^2)}$$

$$K_5 = -\frac{\rho\left(\dot{\beta}^2 - \frac{Gm}{R^3}\right)}{a^2(1-e^2)^2}$$

$$K_{11} = -\frac{3c_2\lambda_2e}{8\rho^{3/2}a(1-e^2)} = K_9$$

$$K_6 = \left[\frac{\rho\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1c_1-\lambda_2c_2)\rho^{-3/2}\end{matrix}\right]}{a^2(1-e^2)^2} + \frac{3}{32}\frac{c_2\lambda_2}{\rho^{5/2}}\right]$$

$$K_{12} = -\frac{21}{32}\frac{c_2\lambda_2}{\rho^{5/2}}$$

The solution of Equation (17) is given by

$$u = K\cos\left(nt - \in_1\right) + \frac{K_1}{n^2} + \frac{K_2 t\cos nt}{2n} + \frac{K_3\cos\dot\beta t}{n^2 - \dot\beta^2} + \frac{K_4\sin\dot\beta t}{n^2 - \dot\beta^2} + \frac{K_5\cos\left(n - \dot\beta\right)t}{n^2 - \left(n - \dot\beta\right)^2} + \frac{K_6\sin\left(n - \dot\beta\right)t}{n^2 - \left(n - \dot\beta\right)^2}$$

$$+ \frac{K_7\cos\left(2n - \dot\beta\right)t}{n^2 - \left(2n - \dot\beta\right)^2} + \frac{K_8\sin\left(2n - \dot\beta\right)t}{n^2 - \left(2n - \dot\beta\right)^2} + \frac{K_9\sin\left(n - 2\dot\beta\right)}{n^2 - \left(n - 2\dot\beta\right)^2} + \frac{K_{10}\sin\left(2n - 2\dot\beta\right)t}{n^2 - \left(2n - 2\dot\beta\right)^2}$$

$$+ \frac{K_{11}\sin\left(3n - 2\dot\beta\right)t}{n^2 - \left(3n - 2\dot\beta\right)^2} + \frac{K_{12}\sin\left(3n - 3\dot\beta\right)t}{n^2 - \left(3n - 3\dot\beta\right)^2} \qquad (18)$$

Where $\in_1$ is the integrability constant angle.

On vanishing the denominator of any one term of equation (18) we get some points at which motion becomes indeterminate and hence the resonance occurs at these points. Thus, the resonances occur at the points where $n = \dot\beta,\ 2n = \dot\beta,\ 3n = \dot\beta,\ n = 2\dot\beta,\ 2n = 3\dot\beta,\ 3n = 2\dot\beta$ and $4n = 3\dot\beta$.

4. TIME PERIOD AND AMPLITUDE BY METHOD OF BROWN AND SHOOK

The solution of equation (17) given in equation (18) is periodic and same as one case of Brown and Shook (1933), so we follow the same method to determine time period and amplitude at $2n = 3\dot\beta$.

The solution of unperturbed equation of motion $\dfrac{d^2 u}{dt^2} + n^2 u = 0$ is given by $u = \xi\sin l$ \qquad (19)

where $l = nt + \in,\ n = \dfrac{\sqrt{v}}{\xi} = a\ function\ of\ \xi.\ v,\ \xi,\ \in$ are arbitrary constants.

As we are finding out amplitude and time period at resonant at the point $2n = 3\dot\beta$, hence equation (17) can be reduced to

$$\frac{d^2 u}{dt^2} + n^2 u = K_{12}\sin\left(3n - 3\dot\beta\right)t = L\bar{A}\sin\left(3n - 3\dot\beta\right)t \text{ where } L = \frac{21 c_2\lambda_2}{32\rho^{5/2}},\ \bar{A} = -1$$

Thus, the above equation can be written as $\qquad \dfrac{d^2 u}{dt^2} + n^2 u = L\phi'$ \qquad (20)

where $\phi' = \dfrac{\partial\phi}{\partial u} = \bar{A}\sin\left(3n - 3\dot\beta\right)t$ \qquad (21)

Thus $\phi = \dfrac{\bar{A}\xi}{2}\left\{\cos\left[\left(3n - 3\dot\beta\right)t - l\right] - \cos\left[\left(3n - 3\dot\beta\right)t + l\right]\right\}$ \qquad (22) As $u = \xi\sin l = u(l, \xi)$ is a function of two independent variables l and ξ, so

$$\frac{\partial u}{\partial l} = \xi\cos l \Rightarrow n^2\frac{\partial^2 u}{\partial l^2} + n^2 u = 0 \qquad (23)$$

and so $\dfrac{du}{dt} = \dfrac{\partial u}{\partial l}\dfrac{dl}{dt} + \dfrac{\partial u}{\partial\xi}\dfrac{d\xi}{dt} = n\dfrac{\partial u}{\partial l}$ \qquad (24)

Since t can be expressed in terms of l, ξ, n then (24) hence

$$\frac{d^2 u}{dt^2} = \frac{d}{dt}\left(\frac{du}{dt}\right) = \frac{d}{dt}\left(n\frac{\partial u}{\partial l}\right) = n\frac{\partial^2 u}{\partial l^2}\frac{dl}{dt} + \frac{\partial}{\partial\xi}\left(n\frac{\partial u}{\partial l}\right)\frac{d\xi}{dt} \qquad (25)$$

The combination of Equation $(20),(23)\&(25)$ yields

$$n\frac{\partial^2 u}{\partial l^2}\left(\frac{dl}{dt}-n\right)+\frac{\partial}{\partial\xi}\left(n\frac{\partial u}{\partial l}\right)\frac{d\xi}{dt}=L\phi' \qquad (26)$$

Solving Equations (24) and (25), we get

$$\frac{d\xi}{dt}=\frac{L}{\chi}\frac{\partial u}{\partial l}\phi'=\frac{L}{\chi}\frac{\partial\phi}{\partial l} \qquad (27)$$

and $\quad\dfrac{dl}{dt}=n-\dfrac{L}{\chi}\dfrac{\partial u}{\partial\xi}\phi'=n-\dfrac{L}{\chi}\dfrac{\partial\phi}{\partial\xi} \qquad (28)$

Where $\chi=\dfrac{\partial u}{\partial l}\dfrac{\partial}{\partial\xi}\left(n\dfrac{\partial u}{\partial l}\right)-n\dfrac{\partial^2 u}{\partial l^2}\dfrac{\partial u}{\partial\xi}=A\ function\ of\ \xi\ only \qquad (29)$

Since n,χ are function of ξ only, we can put (27) and (28) into canonical form with new variables υ and σ defined by $d\upsilon=\chi d\xi,\quad d\sigma=-nd\upsilon=-n\chi d\xi \qquad (30)$

Also (30) can be put in the form

$$\frac{d\upsilon}{dt}=\frac{\partial}{\partial l}(\sigma+L\phi),\ \frac{dl}{dt}=-\frac{\partial}{\partial\upsilon}(\sigma+L\phi) \qquad (31)$$

By differentiating Equation (28) with respective to t and using $(27)\&(28)$, one can find

$$\frac{d^2 l}{dt^2}=\frac{L}{\chi}\left(\frac{\partial n}{\partial\xi}\frac{\partial\phi}{\partial l}-n\frac{\partial^2\phi}{\partial l\partial\xi}-\frac{\partial^2\phi}{\partial\xi\partial t}\right)+\frac{L^2}{\chi^2}\left[\frac{\partial^2\phi}{\partial l\partial\xi}\frac{\partial\phi}{\partial\xi}-\chi\frac{\partial}{\partial\xi}\left(\frac{1}{\chi}\frac{\partial\phi}{\partial\xi}\right)\frac{\partial\phi}{\partial l}\right] \qquad (32)$$

Since L^2 is a factor of the last term of equation (32) hence for the first approximation it may be neglected in general. in equation $(22),l$ and t are present in ϕ and ϕ is expresse d as the difference of periodic terms with argument $l'=l-(3n-3\dot\beta)t$ so in our case, the effected term is given by

$$\phi=\frac{\overline{A}\xi}{2}\cos\left[(3n-3\dot\beta)t-l\right]=\frac{\overline{A}\xi}{2}\cos l' \qquad (33)$$

As $l=l'+(3n-3\dot\beta)t$ so differentiating twice with respect to t, we get

$$\frac{d^2 l}{dt^2}=\frac{d^2 l'}{dt^2}+\frac{L}{\chi}\frac{\partial}{\partial\xi}(3n-3\dot\beta)\frac{\partial\phi}{\partial l'} \qquad (34)$$

By introducing Equations $(33)\&(34)$ in Equation (32) we get

$$\frac{d^2 l'}{dt^2}-(3\dot\beta-2n)^2\frac{L}{2\chi}\frac{\partial}{\partial\xi}\left[\frac{\overline{A}\xi\sin l'}{(3\dot\beta-2n)}\right]=0 \qquad (35)$$

For the first approximation, we put $\xi=\xi_0\ ,n=n_0\ ,\chi=\chi_0$ (all are constants), then Equation (35) reduced to

$$\frac{d^2 l'}{dt^2} - \left(3\dot{\beta} - 2n_0\right)^2 \frac{L}{2\chi_0} \left[\frac{\partial}{\partial \xi}\left(\frac{\overline{A}\xi}{3\dot{\beta} - 2n}\right)\right]_0 \sin l' = 0 \qquad (36)$$

If the oscillation be small, the Equation (36) takes the form

$$\frac{d^2 l'}{dt^2} - \left(3\dot{\beta} - 2n_0\right)^2 \frac{L}{2\chi_0} \left[\frac{\partial}{\partial \xi}\left(\frac{\overline{A}\xi}{3\dot{\beta} - 2n}\right)\right]_0 l' = 0$$

i.e. $\qquad \dfrac{d^2 l'}{dt^2} + p^2 l' = 0 \qquad\qquad (37)$

where $p^2 = \left| -\left(3\dot{\beta} - 2n_0\right)^2 \dfrac{L}{2\chi_0} \left[\dfrac{\partial}{\partial \xi}\left(\dfrac{\overline{A}\xi}{3\dot{\beta} - 2n}\right)\right]_0 \right|$

$$= \left| \left(3\dot{\beta} - 2n_0\right)^2 \frac{L}{2\chi_0} \frac{\left\{3\dot{\beta} - 2n - \dfrac{2\sqrt{v}}{\xi}\right\}_0}{\left(3\dot{\beta} - 2n_0\right)^2} \right|$$

$$= \frac{L}{2\chi_0} \frac{2\sqrt{v}}{\xi_0} \qquad \left(\because 2n_0 = 3\dot{\beta}\right)$$

so, $p = \sqrt{\dfrac{L}{2}} \sqrt{\dfrac{2\sqrt{v}}{\chi_0 \xi_0}} \quad p = \sqrt{\dfrac{21 c_2 \lambda_2}{64 \rho^{5/2}}} \sqrt{\dfrac{2\sqrt{v}}{\chi_0 \xi_0}} \qquad (38)$

Now let us find $\chi_0 = \left(\chi\right)_0$, for which we have $u = \xi \sin l = \xi \cos\left(l - \pi/2\right)$

Using previous Equations and escaping intervening simple calculation one can find $\chi = \sqrt{v} \cos^2\left(l - \pi/2\right)$

Thus $\chi_0 = \sqrt{v} \cos^2\left(\dfrac{3\beta}{2} + \in_0 - \dfrac{\pi}{2}\right) \qquad (39)$

Also, the solution of Equation (37) is given by $l' = A_8 \sin\left(pt + \Im_0\right)$, where $A_8 = \dfrac{\sqrt{v_1}}{p}, v_0, \Im_0$ are constant of integration. Thus l can be given by

$$l = l' + \left(3n - 3\dot{\beta}\right)t = \left(3n - 3\dot{\beta}\right)t + A_8 \sin\left(pt + \Im_0\right) \qquad (40) \text{ Differentiating} \qquad \phi$$

partially with respect to l and introducing l' we get $\dfrac{\partial \phi}{\partial l} = -\dfrac{1}{2}\xi \overline{A} A_8 \sin\left(pt + \Im_0\right)$

Thus, from equation (27) we get $\dfrac{d\xi}{dt} = -\dfrac{L\overline{A}}{2}\left[\dfrac{\xi}{\chi}\right]_0 A_8 \sin\left(pt + \Im_0\right)$

Integral of this given by $\xi = \xi_0 + \dfrac{L\overline{A}}{2}\left[\dfrac{\xi}{\chi}\right]_0 \dfrac{A_8}{p}\cos\left(pt + \Im_0\right) \qquad (41)$

where ξ_0 is determined from $2n_0 = 3\dot{\beta}$ as n_0 is a known function of ξ_0.

The amplitude A_8 and time period T_8 and given by $A_8 = \dfrac{\sqrt{v_1}}{p}$ and $T_8 = \dfrac{2\pi}{p}$

Where, $p = \sqrt{\dfrac{21c_2\lambda_2}{64\rho^{5/2}}} \sqrt{\dfrac{2}{\cos^2\left(\dfrac{3\beta}{2} + \in_0 - \dfrac{\pi}{2}\right)\dfrac{\sqrt{v}}{n_0}}}$

Choosing of integration $v = 4, v_1 = 1, \in_0 = \pi/2$ gives $\quad p = \dfrac{\sqrt{21c_2\lambda_2 n_0}}{\sqrt{2}\sqrt{32\rho^{5/2}} \cos\left(\dfrac{3\beta}{2}\right)}$ (42)

Thus, we get $A_8 = \dfrac{\sqrt{v_1}}{p} = \dfrac{1}{p} = \dfrac{8\rho^{5/4}\cos\left(\dfrac{3\beta}{2}\right)}{\sqrt{21c_2\lambda_2 n_0}}$ (43)

and $T_8 = \dfrac{2\pi}{p} = \dfrac{8\rho^{5/4}\cos\left(\dfrac{3\beta}{2}\right)}{\sqrt{21c_2\lambda_2 n_0}}$ (44)

5. GENERALIZATION OF AMPLITUDE AND TIME PERIOD:

In general, if resonance at $m_1 n = m_2\dot{\beta}$ where $m_1, m_2 \in N$ then the resulting equation is of the form

$\dfrac{d^2u}{dt^2} + n^2u = L\phi'$ where $L = K_{n'}$ (Say) where $n' \in N$

Then by using above process and taking suitable value of v, v_1 and $\in_0$ we get the general formula for amplitude

A and time period T

$A = \dfrac{\sqrt{2}\cos\dfrac{m_2}{m_1}\beta}{\sqrt{|K_{n'}|n_0}} \quad \& \quad T = \dfrac{2\sqrt{2}\pi\cos\dfrac{m_2}{m_1}\beta}{\sqrt{|K_{n'}|n_0}}$ (45)

It is to be noted that any value of n' may or may not represent the corresponding values of $A \& T$.

Using the results of (45) the amplitude and time period at different resonant points.

The Table for Amplitude and Time Period at Different Resonant Points.

Resonant Point	Stokes drag applied on earth and mars			Stokes Drag applied on mars only		
	Amplitude	Time Period	n'	Amplitude	Time Period	n'
$n = \dot{\beta}$	A_1	T_1	4	A_4	T_4	9
$2n = \dot{\beta}$	A_2	T_2	6	A_7	T_7	11
$3n = \dot{\beta}$	A_3	T_3	8	–	–	–
$n = 2\dot{\beta}$	A_5	T_5	10	–	–	–
$2n = 3\dot{\beta}$	A_8	T_8	12	–	–	–
$3n = 2\dot{\beta}$	A_6	T_6	10	–	–	–
$4n = 3\dot{\beta}$	A_9	T_9	12	–	–	–

where

$$A_1 = \frac{\sqrt{2}a\left(1-e^2\right)\cos\beta}{\sqrt{\rho e\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1 c_1-\lambda_2 c_2)\rho^{-3/2}\end{matrix}\right]n_0}}$$

$$T_1 = \frac{2\sqrt{2}\pi a\left(1-e^2\right)\cos\beta}{\sqrt{\rho e\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1 c_1-\lambda_2 c_2)\rho^{-3/2}\end{matrix}\right]n_0}}$$

$$A_2 = \frac{8a\left(1-e^2\right)\rho^{5/4}\cos\dfrac{\beta}{2}}{\sqrt{\left\{\rho^{7/2}\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1 c_1-\lambda_2 c_2)\rho^{-3/2}\end{matrix}\right]n_0\\ +3c_2\lambda_2 a^2\left(1-e^2\right)^2\right.}}$$

$$T_2 = \frac{16\pi a\left(1-e^2\right)\rho^{5/4}\cos\dfrac{\beta}{2}}{\sqrt{\left\{\rho^{7/2}\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1 c_1-\lambda_2 c_2)\rho^{-3/2}\end{matrix}\right]n_0\\ +3c_2\lambda_2 a^2\left(1-e^2\right)^2\right.}}$$

$$A_3 = \frac{\sqrt{2}a\left(1-e^2\right)\cos\dfrac{\beta}{3}}{\sqrt{\rho e\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1 c_1-\lambda_2 c_2)\rho^{-3/2}\end{matrix}\right]n_0}}$$

$$T_3 = \frac{2\sqrt{2}\pi a\left(1-e^2\right)\cos\dfrac{\beta}{3}}{\sqrt{\rho e\left[\begin{matrix}(c_2-c_1)(\dot{\beta}+1)\\+(\lambda_1 c_1-\lambda_2 c_2)\rho^{-3/2}\end{matrix}\right]n_0}}$$

$$A_4 = \frac{4\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos\beta}{\sqrt{3c_2\lambda_2 e n_0}}$$

$$T_4 = \frac{8\pi\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos\beta}{\sqrt{3c_2\lambda_2 e n_0}}$$

$$A_5 = \frac{2\sqrt{2}\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos 2\beta}{\sqrt{3c_2\lambda_2 n_0}}$$

$$T_5 = \frac{4\sqrt{2}\pi\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos 2\beta}{\sqrt{3c_2\lambda_2 n_0}}$$

$$A_6 = \frac{2\sqrt{2}\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos\dfrac{2\beta}{3}}{\sqrt{3c_2\lambda_2 n_0}}$$

$$T_6 = \frac{4\sqrt{2}\pi\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos\dfrac{2\beta}{3}}{\sqrt{3c_2\lambda_2 n_0}}$$

$$A_7 = \frac{4\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos\dfrac{\beta}{2}}{\sqrt{3c_2\lambda_2 e n_0}}$$

$$T_7 = \frac{8\pi\rho^{3/4}\sqrt{a\left(1-e^2\right)}\cos\dfrac{\beta}{2}}{\sqrt{3c_2\lambda_2 e n_0}}$$

$$A_8 = \frac{8\rho^{5/4}\cos\dfrac{3\beta}{2}}{\sqrt{21c_2\lambda_2 n_0}}$$

$$T_8 = \frac{16\pi\rho^{5/4}\cos\dfrac{3\beta}{2}}{\sqrt{21c_2\lambda_2 n_0}}$$

$$A_9 = \frac{8\rho^{5/4}\cos\dfrac{3\beta}{4}}{\sqrt{21c_2\lambda_2 n_0}}$$

$$T_9 = \frac{16\pi\rho^{5/4}\cos\dfrac{3\beta}{4}}{\sqrt{21c_2\lambda_2 n_0}}$$

7. CONCLUSION

In section 1. of this manuscript; the review of literature has been cited from 1903 to till date. In section 2, the polar equations of motion of mars have been established in presence of stokes drag in rotating frame relative to the Earth. To reduce the chances of non-integrability of the equation of motion we have used perturbation technique by taking the steady state values of the position vector and angular velocity of mars. In section 3 we have solved first the unperturbed equation of motion. By using unperturbed solution as $\alpha - \psi = \dot{\alpha}_0 t = nt$, α - derivative of the solution has been reduced to time-derivative and hence established the integrable form of the perturbed equation of motion in (17) and the solution of perturbed equation of motion is established in Equation (18). By making denominator of any term from 4th to 13th to zero u becomes infinity and hence the motion of the satellite becomes indeterminate. Thus $n = \dot{\beta}, 2n = \dot{\beta}, 3n = \dot{\beta}, n = 2\dot{\beta}, 2n = 3\dot{\beta}, 3n = 2\dot{\beta}$ and $4n = 3\dot{\beta}$ are

the resonant points of our solution and hence $1:1, 2:1, 3:1, 1:2, 2:3, 3:2$ and $4:3$ are seven resonances of the problem. First two are due to the combined effect of Stokes drag applied on earth and mars and Stokes drag applied on mars only whereas last five are due to effect of Stokes drag applied on earth and mars. In section 4 we have established amplitude and time period of mars around the Earth corresponding to different seven resonances by using the method of Brown and Shooks (1933). In section 5 the formulas of amplitudes and time periods have been generalized by introducing three natural numbers $m_1, m_2, n' \in N$.

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HYBRID WAVELET-ARTIFICIAL NEURAL NETWORK BASED INTELLIGENT TECHNIQUE FOR ELECTRIC LOAD FORECASTING

SHAHIDA KHATOON, IBRAHEEM, PRITI AND MOHAMMAD SHAHID[*]

ABSTRACT

Load forecasting is one of the most important factors in power system planning and operation. To achieve higher profit margin, power companies required efficient and effective load forecasting. The limitations of traditional forecasting techniques have attracted the researchers to develop more precise and feasible techniques. With the introduction of artificial intelligent techniques, the possibility of obtaining accurate load forecasts increases This research paper proposes an intelligent forecasting technique for electric load based on hybrid Wavelet-Artificial Neural Network (W-ANN) integration. A comparative study was also performed on different Daubechies wavelets to achieve optimal solution.

Keywords: Wavelet Transform, Neural Networks, Load Forecasting, Power System, Soft Computing etc.

1. INTRODUCTION

Wavelet transform comes out to be a modern powerful tool for analysis of time series. It transforms series of load data into a set of patterns with different frequencies. This new filtered pattern shows an improved behaviour than actual series and can be forecasted with better accuracy. A Wavelet is considered to be a waveform of limited duration whose average comes out to be zero. If we compare the wavelet with sine wave then sine wave propagates from $+\infty$ to $-\infty$ on time hence infinite time duration. Also, wavelets are irregular and not symmetric whereas sine waves are smooth and periodic. Wavelet technique disintegrate a pattern in to shifted and scaled form of parent wavelet. It utilizes time-scale, rather than frequency scale. Therefore, it is suitable for catching trends, irregularity, periodicity and similarity.

As the name suggest wavelet is a small child of a wave whose time period is very small. It is important to choose parent wavelet for accurate analysis. For example, Haar Wavelet, Meyer, Coiflet, Morlet Daubechhies and many more. Wavelet transform is classified as continuous, discrete and fast wavelet transform. A fast wavelet transform converts any time series into low and high pass filters [1]. It decomposes the signals into 'approximations' (low frequency components) and 'details' (difference between two consecutive approximations). Approximations consist of trend component of any time series whereas details consist of quickly occurring components. Any 'n' level decomposition converts the original signal in to 'one' approximation component and 'n' details components. A wavelet function of type Daubechhies of order 'm' is known as dbm, which can be utilized as the parent wavelet.

For prediction wavelet transforms and neural network [2-4] has been widely used but it is not applied much for energy forecasting purpose. The paper presents a novel approach for forecasting load using hybrid model of wavelet transform and neural network. Because wavelet transform breaks the time series into various time scale elements. In this paper, the effectiveness of training of back propagation neural networks is explored, to which wavelet transformed data is fed to catch important information of time series. To form the aggregate forecast, each wavelet sub-series predictions are recombined using the linear reconstruction and superposition. The motive is to forecast future electric load accurately.

The remaining of the paper has been ordered as section 2 presents an overview of fundamental theories of ANN and Wavelet. Section 3 represents the proposed hybrid technique. Performance is evaluated in section 4 which provides results as well as discussions. Finally, Section 5 concludes the paper.

2. LITERATURE REVIEW

From last three decades load forecasting researchers are giving more attention to Artificial Intelligent Techniques. Literature shows the ability of prediction of conventional Artificial Neural Network.

For optimization and classification problem ANN [5-7] is a promising intelligent methodology. The concept of Artificial Neural Network was bringing by the pioneering work of Mc-Culloch & Pits [8] in 1943 when simplified artificial neuron was presented with basic logical properties. Rosenblatt [9] refined the concept with the use of perceptron model where a single layer or multilayer feed forward network was able to obtain weights only for linearly separable tasks. Artificial neural networks (ANN/NN) have been used in electric load prediction problem since 1992 [10].

Since the emergence of revolutionary work of Morlet and Grossman in 1980s [11] wavelet transform is attracting the researchers as a promising approach of investigating unusual conditions when past information comprises of scaling properties, instabilities, peaks etc. These conditions can be traced with multi resolution analysis (MRA) by Mallat, [12] Daubechies [13] introduces the orthogonal wavelets in early1990s. Since last three decades wavelet analysis is attracting the mathematicians and engineers and considered to be a nucleus of interest and ideas. Statistically, the basic concept of MRA is to characterize any wave signal as a combination of consecutive estimations, that are better versions of signal itself.

Wavelets transform can provide information in both time and frequency domain. Hence considered to be mathematical tools for analyzing time series in new way [14]. It proposed a wavelet neural network forecasting for which Morlet and Mexican hat wavelets has been applied to get the transfer function for activation. [15] utilizes Daubechies db2, db4 and db10 as activation for wavelet where temperature has been considered using multiple linear regressions. The result shown that proposed wavelet transform method can be used for short term load forecast. [16] added temperature data for better results. The most of the papers presented in [17-21] found to using wavelet techniques with not on real time data. Hence in this work a real time data is collected from a utility company of Greater Noida.

3. HYBRID WAVELET- ARTIFICIAL NEURAL NETWORK BASED LOAD FORECASTING MODEL

The proposed hybrid model for load forecasting is an integration of Wavelet transform and artificial neural network. Here wavelet transformation is used to disintegrate the given time series in different approximations and details. Then resultant wavelet elements have been applied for training ANN for forecasting. Finally, all these forecasted elements have been utilized to recreate 'upcoming' load.

Based on time horizon an electric load forecast is categorized as Long, Medium- and Short-term load forecast. Among all Short-term load forecast are most popular as time horizon is from few minutes to hours up to days. The purpose of short-term load forecasting is estimation of upcoming electric load provided past and current data [22].

Literature shows variety of load forecasting techniques. These load forecasting techniques are categorized as conventional and Soft Computing Techniques. Conventional techniques include basically statistical techniques e.g. regression, multiple regression, autoregressive integrated moving average. These techniques describe quantitative relationship between load and their influencing factors by utilizing historical load. These techniques focused on estimation of various coefficients leaving the nonlinear constant to make it inaccurate. Now with the advent of intelligent techniques e.g. fuzzy logic, artificial neural network and genetic algorithm accuracy of load forecasting has been improved as these can be able to handle nonlinear data also [23]. To draw the benefits of these techniques concept of integrated techniques has been raised where more than one technique are used in conjunction with other i.e. W-ANN.

The intelligent techniques such as artificial neural network and fuzzy logic are most widely applied techniques for forecasting. ANN is considered as a universal approximation tool. It has complex structure which takes large training time. If fuzzy concepts are introduced in ANN, the accuracy in forecasts improves but structural complexity remains there, because of that training time is still large.

Wavelet has been identified as a potential tool for electric load prediction. The wavelet transform decomposes and analyses time series signals successfully as follows:

1. Wavelet decomposition breaks a signal into different frequency components, called wavelet decomposition tree.

2. Wavelet decomposition can be done to get valuable information of any signal. Appropriate levels depending upon the function type can be selected to get optimum solution.

3. Wavelet decomposed units may be integrated into actual pattern without losing important features, and known as reconstruction or synthesis i.e.

$$
\begin{aligned}
S(t) &= AP_1(t) + DE_1(t) \\
&= AP_2(t) + DE_2(t) + DE_1(t) \\
&= AP_3(t) + DE_3(t) + DE_2(t) + DE_1(t) \\
&= AP_n(t) + DE_n(t) + DE_{n-1}(t) + \cdots + DE_1(t)
\end{aligned}
$$

Here an intelligent technique has been developed by combining ANN with wavelet transform to make integrated model. The developed model can be used for improving forecasting results. Using wavelet transform, historic electrical pattern is decomposed into lower and higher frequency component i.e. approximations and details as in Fig. 1. These disintegrated components are used for training of ANN forecasting model. Finally, these forecasted components are combined to get forecasted load. An integrated model shown in Fig. 2 using wavelet transform and ANN is developed to forecast the load. Load profile for actual and forecasted load has been analyzed considering different aspects. The implementation of the wavelet transform is done using MATLAB software. The ANN technique is applied on MATLAB and the various plots/graphs are drawn in MS Excel. It is followed by the estimation of errors with these methods used for load forecasting.
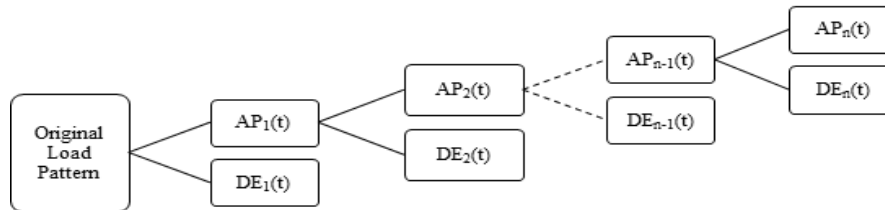
Fig 1: Wavelet Decomposition
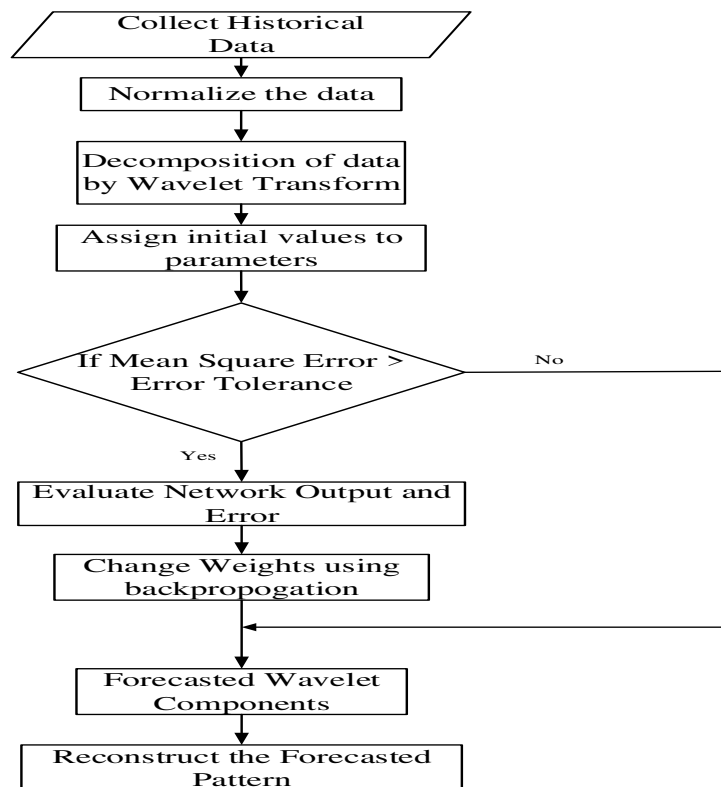
Fig 2: Flowchart of W-ANN Forecast Model

4. RESULTS AND DISCUSSIONS

the forecasting model is assessed on performance evaluation which is performed by computing the error found in a set on independent data. If training is done successfully, the model can be generalized, hence higher accuracy of prediction. Optimum performance of load forecasting model is decided by the performance indices which are established on the best possible values of forecasts. A number of such performance indices are used in practice, the most common are listed below:

(i) Mean Absolute Percentage Error (MAPE):

$$MAPE = \sum \frac{|Actual\ Value - Foreacsted\ Value|}{ActualValue} \times 100$$

(ii)Integral Absolute -Error criterion (IAE):

$$IAE = \sum |\text{Actual Value} - \text{Foreacsted Value}|$$

(iii) Integral of time multiplied error (ITAE):

$$ITAE = \sum t. |\text{Actual Value} - \text{Foreacsted Value}|$$

(iv) Integral Square Error (ISE):

$$ISE = \sum (\text{Actual Value} - \text{Forecasted Value})^2$$

(v) Integral of Time-multiplied Square Error (ITSE):

$$ITSE = \sum t. (\text{Actual Value} - \text{Forecasted Value})^2$$

Wavelet decomposition is used to breaks the time series in to approximations and details in each level. After that each approximation and detail is forecasted using ANN. finally wavelet reconstruction is used to forecast the load. Table 1- 10 shows results from different Daublechies wavelet. Table 1 compare the performance of db1 on levels 1 - 9 and result shows that error varies between 1.58% to 5.27% and among all level 2 and level 4 gives the best results. From Table 2 performance of db2 with the level variation from 1 to 9 is evaluated which shows that error range are from 1.62% to 2.05% where level 4 gives best results. From table 3 wavelet comparison of db3 is obtained where error varies from 1.41% minimum hence db3 seems be suitable for forecasting. Table 4 depicts the performance of wavelet db4 where error variation is from 1.57% to 1.92% and level 1 and 8 gives best results. Table 5 compare the result of db5 which shows the range of error from 1.4% to 1.83% where db5 level8 gives best result. Range of all performance indices is more than db3 hence db3 seems be suitable for forecasting. Table 6 depicts the results of wavelet 6 where variation error is from 1.63% to 2.07% where db 6 level 2 gives best results. Table 7 shows that db7 has variation of error from 1.45% to 1.7% with level 2 giving best performance. Table 8 and 9 compares the corresponding wavelets and finally from table 10 wavelet db3 is identified as suitable for load forecasting which shows all performance indices minimum.

Table 1. Performance of wavelet db1

Level	MAPE	IAE	ITAE	ISE	ITSE
1	4.98%	17.64838	218.6567	0.940002	11.73737
2	1.58%	6.019611	74.77839	0.126959	1.545342
3	1.95%	7.430596	91.66007	0.154546	1.84071
4	1.73%	6.436777	73.21268	0.178052	1.971454
5	2.08%	7.885556	89.53734	0.213027	2.248473
6	1.97%	7.246042	80.47219	0.219827	2.183175
7	2.05%	7.777577	90.86112	0.216553	2.251848
8	1.78%	6.829173	77.83604	0.185006	1.925083
9	5.27%	19.74725	240.2586	1.033712	12.26281

Table 2. Performance of wavelet db2

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.62%	5.587122	67.57949	0.101845	1.189468
2	1.67%	6.03182	72.0327	0.117343	1.355982
3	1.65%	6.545091	84.08898	0.133534	1.822444
4	1.54%	5.884094	73.59404	0.114593	1.494402
5	2.05%	7.626392	91.61304	0.142767	1.696572
6	1.67%	6.377937	78.00254	0.126075	1.593753
7	1.70%	6.366723	78.58303	0.115737	1.491787
8	1.78%	6.882879	89.57211	0.124984	1.723242
9	1.89%	7.391662	96.66507	0.143483	1.933318

Table 3. Performance of wavelet db3

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.41%	5.121307	63.8449	0.086365	1.076235
2	1.54%	5.535123	66.54032	0.101019	1.159438
3	1.80%	7.169294	92.02938	0.149718	2.014329
4	1.75%	6.89454	86.16256	0.137652	1.843768

5	1.77%	6.720977	79.03319	0.125287	1.50685
6	1.73%	6.717245	80.39977	0.121816	1.460757
7	1.75%	6.875741	85.34839	0.124342	1.567746
8	1.69%	6.574952	81.80775	0.115764	1.44155
9	1.70%	6.675139	83.44847	0.117589	1.466055

Table 4. Performance of wavelet db4

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.57%	6.079701	77.15305	0.107657	1.381942
2	1.72%	6.538529	79.9281	0.12237	1.456398
3	1.74%	6.764395	86.22896	0.142102	1.945934
4	1.98%	7.072738	85.76649	0.151964	1.785595
5	1.79%	6.56426	78.01402	0.137075	1.596396
6	1.92%	6.887544	81.61067	0.134416	1.511439
7	1.91%	7.007124	85.31703	0.126047	1.503785
8	1.72%	6.380358	78.64034	0.110762	1.353165
9	1.90%	6.968334	85.06754	0.130734	1.542013

Table 5. Performance of wavelet db5

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.57%	6.079701	77.15305	0.107657	1.381942
2	1.72%	6.538529	79.9281	0.12237	1.456398
3	1.74%	6.764395	86.22896	0.142102	1.945934
4	1.98%	7.072738	85.76649	0.151964	1.785595
5	1.79%	6.56426	78.01402	0.137075	1.596396
6	1.92%	6.887544	81.61067	0.134416	1.511439
7	1.91%	7.007124	85.31703	0.126047	1.503785
8	1.72%	6.380358	78.64034	0.110762	1.353165
9	1.90%	6.968334	85.06754	0.130734	1.542013

Table 6. Performance of wavelet db6

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.80%	6.7815	86.1348	0.1315	1.6667
2	1.63%	5.9874	73.01464	0.110308	1.266455
3	1.74%	6.8683	90.84352	0.1373	1.983
4	1.65%	6.2583	77.5335	0.1116	1.3622
5	1.95%	7.3548	90.626	0.1426	1.8164
6	1.91%	7.4467	95.2569	0.1432	1.8475
7	1.94%	7.2747	90.4645	0.134	1.6927
8	2.07%	7.9992	103.9824	0.1484	1.9964
9	2.01%	7.6544	99.1356	0.1392	1.8609

Table 7. Performance of wavelet db7

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.63%	6.046271	76.66458	0.121466	1.567384
2	1.49%	5.651176	69.61125	0.09934	1.148712
3	1.70%	6.866286	91.4652	0.140863	1.994964
4	1.52%	5.744581	72.23672	0.102637	1.278518
5	1.45%	5.512255	68.14752	0.101045	1.232557
6	1.48%	5.841831	71.11525	0.110744	1.323276
7	1.70%	6.869301	86.90814	0.118974	1.532624
8	1.65%	6.51304	81.93181	0.106696	1.365659
9	1.69%	6.672505	83.29354	0.108405	1.369176

Table 8. Performance of wavelet db8

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.63%	5.843555	72.87096	0.109905	1.346864
2	1.71%	6.469457	78.88329	0.133042	1.568468

3	1.74%	6.849182	86.9034	0.147288	2.027271
4	1.67%	6.402785	78.78269	0.119037	1.459667
5	1.74%	6.451763	80.6788	0.122012	1.484048
6	1.79%	6.66676	80.85444	0.119269	1.397127
7	1.91%	7.346527	92.41405	0.123269	1.575491
8	1.69%	6.533989	84.92506	0.109939	1.465006
9	1.80%	6.829615	87.4818	0.119163	1.532618

Table 9. Performance of wavelet db9

Level	MAPE	IAE	ITAE	ISE	ITSE
1	1.56%	5.387044	66.37236	0.108878	1.275827
2	1.60%	5.952357	73.41842	0.111153	1.341123
3	1.69%	6.708753	88.0656	0.132695	1.885626
4	1.68%	6.616391	82.10897	0.12717	1.601906
5	2.03%	7.697748	94.88159	0.148437	1.830766
6	1.80%	7.082779	90.64236	0.138532	1.770529
7	1.94%	7.550506	95.21421	0.132034	1.696529
8	1.71%	6.91347	89.43193	0.118775	1.593089
9	1.67%	6.676892	86.75266	0.114185	1.539132

Table 10. Comparative analysis on best performance of wavelets

Wavelet	Level	MAPE	IAE	ITAE	ISE
db1	2	1.58%	6.019611	74.77839	0.126959
db2	1	1.62%	5.587122	67.57949	0.101845
db3	1	1.41%	5.121307	63.8449	0.086365
db4	1	1.57%	6.079701	77.15305	0.107657
db5	8	1.40%	5.53	69.138	0.0862
db6	2	1.63%	5.9874	73.01464	0.110308
db7	5	1.45%	5.512255	68.14752	0.101045
db8	1	1.63%	5.843555	72.87096	0.109905
db9	1	1.56%	5.387044	66.37236	0.108878

This study shows that Wavelets db3 and db5 has less error but overall performance indices is low for wavelet db3 hence db3 is suitable for forecasting.

Electric load at any specific time is analyzed as linear combination of various frequency components. In this method Daubechies wavelets db1-db9 is applied for the decomposition of given electric data.

Fig. 3 represents load profile for one month. Fig. 4 depicts the comparison of actual and forecasted load pattern for any day. From this it is clear that variations in electric load consumption occur whole of the day on hourly basis. It is important that the maximum consumption of load occurs at 10 pm and early morning. Also, there is significant variation in peak of actual and forecasted load which is due to error. Although the predictions are not so accurate, still forecasts are almost following the actual load series. Fig. 5 represents the load profile of actual and forecasted load at midnight. It has been analyzed that the forecasted load pattern at midnight is following actual pattern. However, the overall forecasted load is almost on higher side. The error between the actual and forecasted load has been calculated on different parameter indices. Various techniques for prediction of load are available; moreover, no utility till date had been able to predict the load with accuracy.
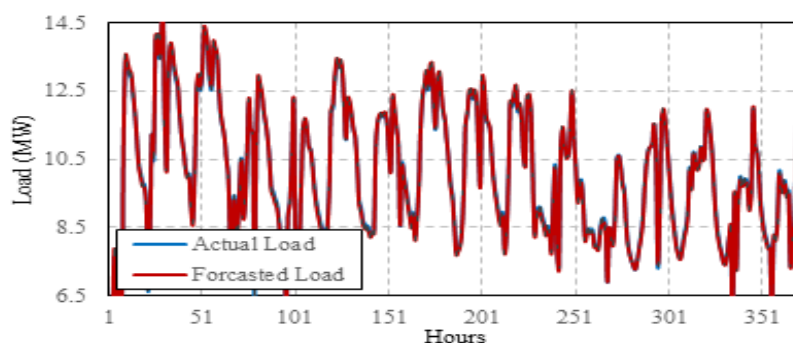
Fig 3: Load Profile using W-ANN Integration for 15 days
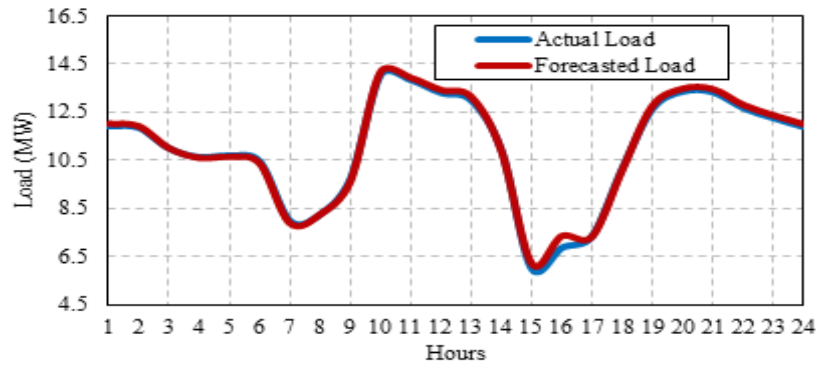
Fig 4: Comparision of Load on any Day using W-ANN Integration
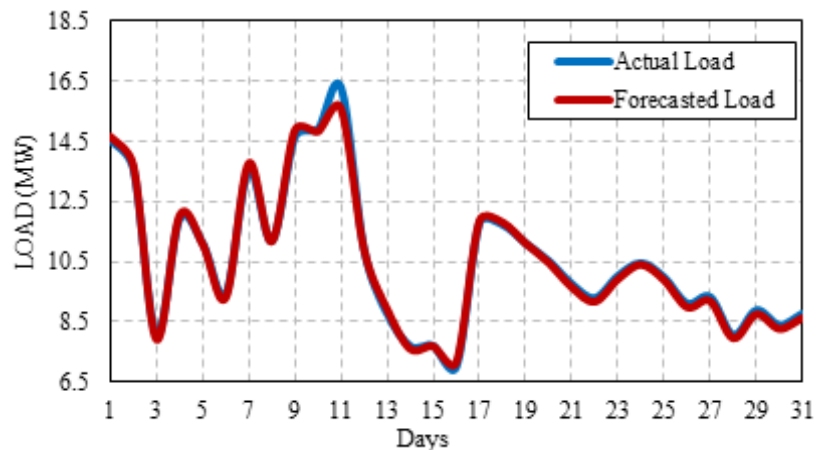
Fig 5: Comparison of Load at Midnight of one month using W-ANN Integration

5. CONCLUSIONS

This research work aims to propose an intelligent prediction technique for electric load. In this research work the computation of load forecasting has been done using real time data provided by a utility company of Gr. Noida, India. The research work presents the design of an intelligent technique of load forecasting using ANN and wavelet transformation. Wavelet functions from db1-db9 of all 9 levels are applied. The results have been compared based on different performance indices. Comparison of results shows that db3 wavelet along with ANN provides best results for load forecasting. It is also concluded that hybrid W-ANN based forecasting shows feasibility with less forecasting errors. The suggested integrated model captures the useful properties of artificial neural networks and wavelet transforms in time series and found to be accurate for real time data.

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IMPACT OF SEASONAL VARIATIONS ONHYDROCHEMICAL CHARACTERISTICS OF ARASALAR ESTUARY, KARAIKAL, SOUTHEAST COAST OF INDIA

N. JAKEER[*], S. ARUNADEVI AND R. SIVASAMANDY

ABSTRACT

The aim of the studies is aboutthe seasonal variation of Hydro chemical parameters in the Arasalar river estuary. All the Hydro chemical parameters such as salinity factor, pH concentration, total alkalinity nature, total level of suspended solids, maximum of dissolved oxygen and presence of nutrients including nitrate, nitrite, inorganic phosphate salt and reactive part of silicate concentration were studied during the period of two yearsfrom March 2019 – Feb.2021. The salinity factor varied from 22.7 % and 34.2 %, concentration of hydrogen ion varied between 7.84 and 9.02.The dissolved oxygen content showed the range from 7.17 to 5.19 ppm.Invariably total alkalinity recorded the range from 64 to 99 mg/l. Total suspended solids showed the range from 243.8 to 60.7 ppm.The concentration of nutrients viz. (2.42 -0.27ppm) and total phosphorus (7.84– 1.43ppm), the reactivepart of silicates (32.18–4.62ppm), ammonia (16.34 –7.3µm) showed remarkable variations independently.

Keywords: Hydro chemical parameters, Dissolved oxygen, Pre-monsoon, Nutrients, pH, SOP.

INTRODUCTION

Estuaries are the most important sources to the coastal or near shore ecosystem and physico -chemical characteristics may describe the quality of water for the study area.The estuarine and coastal areas by its virtue have complex and the dynamic aquatic environment[1].The investigationswere carried out on the same Hydro chemical features of several other southeast Indian estuaries and Uppanar estuary at regular time intervals[2].In the study area, which in quasi differences of all aquatic organisms are caused by Hydro chemicalparameters. The study area interpretationof seasonal variation in brackish water of estuarine rely on different Hydro chemicalkey factors such as pH level, salinity factor, dissolvancy of oxygen(DO) and micromolecular nutrientswhich includes nitrate,phosphate and silicate salts. The assessment of fertility level and productivity nature of any such ecological system requires a proper investigation on features related to metrological and hydrological aspects[3]. It was reported that anintensive research work has been carried out by number of researchers on the physical and chemical aspects of some geo-specific Indianestuaries **[4, 5, 6].** Seasonal variation of the study area interpretations to the Hydro chemicalparameters of coastal and brackish water in the various stations base were carried out on sea confluencepoint. The study area Arasalar estuary is found to be located at some 100 km far away from eastern part of Thanjavur district, Tamil Nadu state, India.Invariably the coupled response from anthropogenic activities and the domestic sewage wastages discharge practices into the estuarygreatly impaired thebiodiversity nature of the estuarine system.Some work on the Arasalar estuary has beenmade and articles were published on the Hydro chemicalcharacteristics; hence, an attempt was made to represent the interpretation work onHydro chemicalparameters at different seasonal variation of Arasalar estuary, southeast coast of India.

MATERIALS AND METHODS

Study Area

The Arasalar estuary study site is located in Karaikal region. (Lat.$10^0$92'54"N andLong.79^0.83'.80"E) of the Bay of Bengal sea, southeast coast ofIndia peninsula **(Fig 1)**. Seasonal samplings, such as monsoon, pre-monsoon, and post-monsoon, were conducted in the current study period from January 2019 to January 2021.

Sampling Area and Sampling Point

Surface and bottom water samples were taken from the Arasalar estuary area between January 2019 and January 2021 for the assessment and interpretation of hydro chemical parameters. Sampling points were fixed and the samples collected were designated as S_1, S_2 and S_3atsea conferencing point and 1 and 2 km away from sea.

Sample Collection

Water samples from surface and bottom were collected from the sampling pints,three locations (S_1,–S_3) and immediately transferred to plastic canes. Exposure to sources like light and temperature were avoided by sealing the containers and keeping at dark room atmosphere maintaining a steady temperature range of 4-10°C. The representative water sample taken from each study site area was subjected to chemical analysis, which includes

pH measurement, total suspended solids (TSS) content, total dissolved solids (TDS) content, turbidity level, and conductivity range.
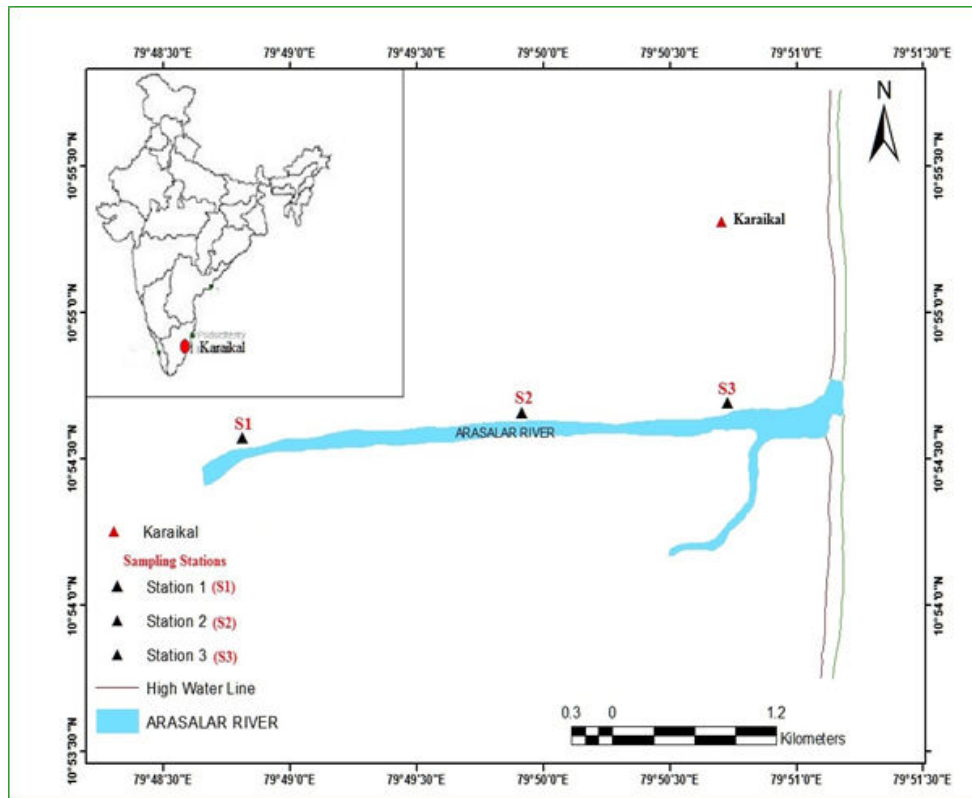
Figure 1: Depicts the map of study area along with different sampling points of Arasalar estuary.

Analysis of Hydro Chemical Parameters

The surface and bottom water samples were assessed for Hydro chemical parameters by using standard methods.i.e.instrumental analytical test of water quality parameters on samples were carry out such as temperature, chemical oxygen demand (COD), biological oxygen demand (BOD), pH level, turbidity level, demand of dissolved oxygen (DO), total organic content (TOC), conductivity range, total dissolved solid (TDS), total suspended solid (TSS),alkalinity, anionic part of salts like sulphate, nitrate, and phosphate.A portable pH meter was used to measure the pH of water in the field. In a cleaned double rinsed poly ethylene bottles the surface water was collected for nutrient analysis, kept it in and ice box and sent to the laboratory immediately. The water samples filtering process was carried out by using a Milliporefiltering system and further proceeded for total phosphorus,nitrate and silicate analysis as per the description of SOP**[7]**.

RESULTS AND DISCUSSION

Determination of Hydro Chemical Parameters

Estuaries has multidimensional, variable environments and frequently controlled by the action of estuarine flushing times **[8, 9]**. Annual and seasonal variation in physico- chemical parameters like temperature, pH, salinity, dissolved oxygen, phosphate, nitrate and silicate content at Arasalar estuarinesurface and bottom water were recorded for a period of 2 years from January 2019 to January 2021 **(Table1)**.The division of four seasons by IndianMeteorological Department such as post-monsoon period (January–March), summer period (April–June), Pre-monsoon period (July–September),and monsoon period (October–December) is just based on rainfall patterns.

The pH with a maximum value of 9.2 was recorded during the monsoon session 2020 and a minimum value of 7.84.Studies revealed that the cause for high pH value may be due to the photosynthetic activity as it is the bicarbonate degradation by carbonic anhydrase associated with photosynthesis**[10]**. The maximum value of 9.2 pH was observed at the station2 **(S$_2$)**during the monsoon 2020. It is undoubtedlybecause of the influence of routine photosynthetic action by phytoplankton, which in turn removes the gaseous dissolved carbon dioxide in the water body thereby increasing the level of pH**[11]**. Atstation 1 duringwinter (2021) season the highest value of electrical conductivity 62100 µS/cm was observed. The highest concentration 39123 ppm of total dissolved solid was recorded at station 1 and the lowest 25704 ppm at station 3. The salinity of Arasalar estuary varied

from 34.2 ppt – 23.7 ppt.The maximum salinity value of 34.2 pptwas recordedatstation 1,during the winter season of 2021. It was found that these values are coinciding with the low turnout of rainfall and higher evaporation rate of water[12].The concentration of dissolved oxygen was varied from 5.19 to 7.17 ppm, a minimum was observed in the winter season at station 1 (2021) and the maximum was recorded during post monsoon season at station 1 (2019), thelevel of dissolved oxygen in the natural water body mainly depends on the Hydro chemical and biochemical transformation occurring at surface levels [13]. In the present study, the observed value of dissolved oxygen concentration was low during pre- monsoon session and high during post monsoon period. The dissolved oxygen content and its fluctuation depends upon the photosynthetic effects, floods during monsoon and the wind turbulence[2]. The influx of organic sewage and the anthropogenic activities has raised the level of BOD in surface water to a high value of (2.52) at station 1 and considered under the class of contaminated stations. Furthermore, the surface water bearing a strong BOD demand, which may be attributable to the level of suspended organic materials from the discharge of wastewater. It was remarkably mentioned that the limit has been set for the biological oxygen demand by high photosynthetic action and frequent flushing property of estuary[14].

The total phosphorous (TP) with a maximum of (7.84 ppm) was recorded during monsoon 2019 at the station 3 and a minimum value of (1.43 ppm) was recorded during winter 2021. The possible cause of increased TP in water body are mainly from rainfall, land runoff, leaching of rocks and surplus supply of phosphorous enriched sediments from the nearby connecting tributaries[15]. The higher alkalinity (243.8 ppm) of the Arasalar estuary was recorded atstation 3, and lowest 60.7 ppm was recorded at station 2. The nitrate concentration in the present study is within the range of $N-NO_3^-$ (0.29 –2.42ppm) reported in the year of 2021 and 2019.The silicate concentration was varied from 4.62 to 32.18 ppm.The oxidation of NH_3 into NO_2 caused due to the digenetic decomposition of estuarine sediment rich in organic matter is continuously released into the aquatic environment[16].**Fig 2**showsthe annual pattern of seasonal variation of Hydro chemical parameters of the Arasalar estuary,comparatively the nitrate value are lower during the study period.A report has beenfiled on Kadinamkulam estuary and concluded that the combination of higher nitrate content concomitant with low nitrite values are the result of nitrification process[17].The inorganic phosphate was recorded from 0.13 to 0.46. The minimum value was recorded during the post monsoon (2019) at station1and the maximum value was recorded during the monsoon (2020) at station 3.

(EC –Electrical Conductivity, TDS-Total Dissolved solids, DO-Dissolved Oxygen, BOD - Biological Oxygen Demand, TH -Total Hardness ,TA -Total Alkalinity, TN-Total Nitrogen, TP-Total Phosphorus, HCO_3 –Bicarbonate, CO_3 –Carbonate, Cl- Chloride, NH_4-Ammonia,NO_3-Nitrate, PO_4 – Phosphate H_4SIO_4-Silicate)

Table 1: Shows the seasonal variation of Hydro chemicalparameters of theArasalar estuary water samples.

Seasons/Year	Stations	pH	EC µS/cm	TDS ppm	S ppt	DO ppm	BOD ppm	TA ppm	TH ppm	TN µm	TP µm	Ca^{2+} ppm	Mg^{2+} ppm	HCO_3^- ppm	(CO_3) ppm	Cl^- ppm	SO_4^{2-} ppm	NH_4 µm	$N-NO_3^-$ ppm	PO_4 ppm	H_4SiO_4 ppm
Monsoon(2019)	Station 1	8.26	53000	33390	30.6	6.98	1.6	85.1	1200	126.8	4.66	480	720	67.1	18	16838.7	1945.6	10.66	0.8	0.16	29.36
	Station 2	8.14	49400	31122	28.7	6.34	1.4	72.9	1096	136.4	6.22	400	696	54.9	18	9217	126.8	9.84	2.42	0.24	10.98
	Station 3	7.84	45600	28728	25.9	6.06	1.4	73	1120	142.2	7.84	280	840	61	12	8153.5	98.4	8.42	1.58	0.3	8.72
Premonsoon(2019)	Station 1	8.18	48600	30618	28.4	6.47	1.4	121.6	920	57.95	2.24	320	600	97.6	24	13293.7	1156.28	8.98	0.38	0.15	20.82
	Station 2	8.06	43400	27342	25.6	6.58	0.51	97.3	768	71.76	1.98	240	528	79.3	18	6203.7	81.62	7.66	0.94	0.18	6.14
	Station 3	8.12	40800	25704	23.7	5.8	0.11	127.8	704	88.39	2.24	200	504	109.8	18	5140.2	66.86	9.34	0.81	0.21	4.62
Post monsoon(2019)	Station 1	8.23	51600	32508	32.2	7.17	1.1	72.8	1072	87.21	2.93	400	672	48.8	24	15598.2	1372.82	7.3	0.66	0.13	26.47
	Station 2	8.83	46300	29169	30.6	6.63	1.6	60.7	944	101.46	3.55	320	624	42.7	18	7946.5	112.64	8.68	1.84	0.19	7.32
	Station 3	8.92	43800	27594	29.1	5.74	0.9	72.8	1032	129.6	5.32	240	792	48.8	24	6334.5	84.52	7.51	1.16	0.22	5.39
Monsoon(2020)	Station 1	8.43	60500	38115	32.2	5.73	2.14	158.4	1363	130.81	4.51	480	883	146.4	12	18433.75	2121.48	16.34	0.69	0.29	32.07
	Station 2	9.02	56500	35595	27.5	6.63	1.25	133.9	1275	135.5	6.07	440	835	115.9	14	11373.75	115.56	11.91	2.12	0.33	14.12
	Station 3	8.47	50600	31878	24.9	6.42	1.09	164.6	1203	137.35	7.69	320	883	158.6	10	9263.5	94.28	12.79	1.42	0.46	11.55
Premonsoon(2020)	Station 1	8.3	59100	37233	33.8	6.94	2.46	146.1	1264	67.54	3.06	400	864	128.1	18	17193.25	1548.6	12.98	0.48	0.24	32.18
	Station 2	8.17	53400	33642	29.4	6.44	1.96	121.7	1128	86.44	2.4	360	768	103.7	18	10103.25	101.4	10.72	1.44	0.28	10.46
	Station 3	7.95	48800	30744	28.1	6.62	1.5	164.4	928	99.12	1.84	280	648	146.4	18	7444.5	80.4	10.88	0.98	0.38	8.22
Post monsoon(2020)	Station 1	8.44	54600	34398	32.4	6.44	1.98	127.8	1168	62.48	2.66	400	768	109.8	18	15420.7	1284.2	10.42	0.4	0.19	26.84
	Station 2	8.10	49200	30996	28.9	6.18	1.62	97.4	968	80.14	2.02	320	648	85.4	12	8153.5	90.4	9.12	1.12	0.22	8.14
	Station 3	8.02	47800	30114	27.8	6.14	1.24	152.2	856	96.42	1.58	280	576	134.2	18	6025.5	76.2	8.46	0.78	0.25	6.94
Winter (2021)	Station 1	8.61	62100	39123	34.2	5.19	2.52	201.1	1331	66.49	2.51	400	931	189.1	11	17015.75	1460.18	16.1	0.29	0.32	29.55
	Station 2	8.98	56300	35469	27.7	6.47	1.47	158.4	1147	79.24	1.87	360	787	146.4	13	10310.25	80.16	11.19	0.82	0.31	11.28
	Station 3	8.65	52800	33264	26.8	6.54	0.93	243.8	939	91.57	1.43	320	619	231.8	10	7136.5	72.16	12.83	0.62	0.41	9.77
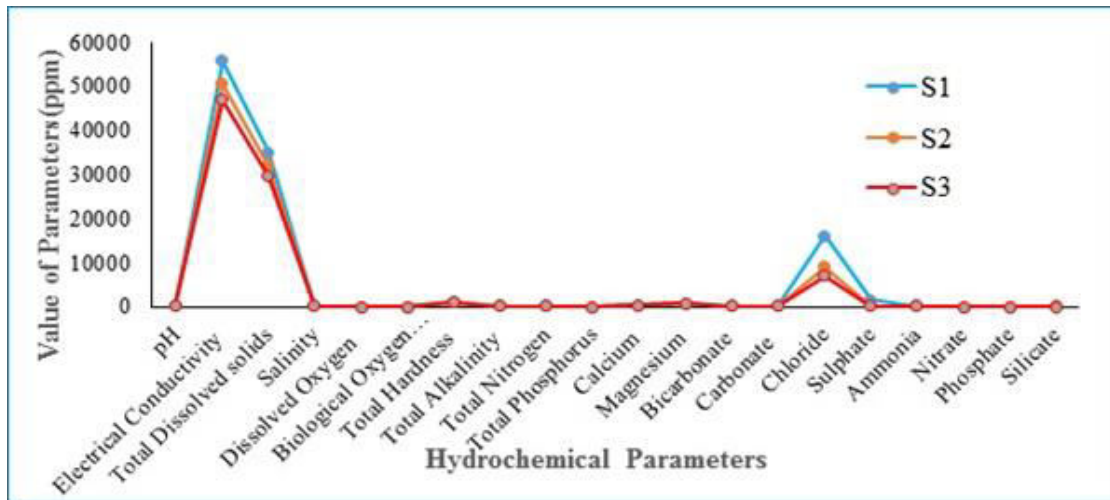
Fig 2: Showsannual seasonal variation ofHydro chemical parameters

In their findings the finalized values arenegatively correlated which may be due to desorption of phosphate in high salinity[18]. Magnesium concentration was found to be the highest as 931 ppm at station1 during winter session 2021 and the lowest as 504 ppm in station 3 at pre-monsoon 2019.The highest and lowest was obtained from station 1 and 3 were 480 ppm and 200 ppm respectively **(Table 1)**. The concentration of ammonia is comparatively higher during post monsoon period of 2019, then the same was found during the pre-monsoon and summer. The possible source of supply of ammonia is from the localized anthropogenic activities and its input into the water body rather than river run-off water[19].The concentration of total nitrogen content (TN) is higher during the monsoon period which may be attributed to the degradation of organic matter under debris, the disintegration of industrial effluents wastages, and the disposal of surficial organic wastes. The highest and lowest concentration of sulphate was recorded in the Station1during monsoon 2020(2121.48 ppm) and station 3 (66.86 ppm) respectively **(Table 1)**.

STATISTICAL ANALYSIS
Table 3 shows how the effect of each evaluated parameters statistically analyzed as well as the F test and its significance values. The calculated F value were observed in the range of 9.642-45.622 which were less than F critical value of 3.328 for a stated level of confidence (typically 95%), which proves that the difference being tested is statistically significant at 95% confidence level[20].The correlation matrix values have been processed and developed by the SPSS ver. 20 software and the values are interpreted **(Table 2)**. The Table shows that all of the parameters have a strong positive association that is statistically meaningful at the 0.01 level.

(EC –Electrical Conductivity, TDS-Total Dissolved Solids, DO-Dissolved Oxygen BOD - Biological Oxygen Demand TH -Total Hardness TA -Total Alkalinity TN-Total Nitrogen TP-Total Phosphorus HCO_3 - Bicarbonate CO_3 –Carbonate Cl- Chloride NH_4-Ammonia NO_3-Nitrate PO_4 – Phosphate, H_4SiO_4-Silicate)

Table 2: Correlation coefficient ofHydro chemicalparameters in surface water of Arasalar estuary

pH	EC	TDS	Salinity	DO	BOD	TH	TA	TN	TP	Ca	Mg	HCO₃	CO₃	Cl	SO₄	NH₄	NO₃	PO₄	H₄SiO₄
1																			
-0.0491	1																		
-0.0491	1	1																	
-0.1705	0.9925	0.9925	1																
0.7633	0.6078	0.6078	0.5065	1															
-0.1283	0.9968	0.9968	0.9991	0.5429	1														
-0.0860	0.9993	0.9993	0.9964	0.5781	0.9991	1													
-0.9547	-0.2503	-0.2503	-0.1304	-0.9209	-0.1727	-0.2144	1												
-0.0357	-0.9964	-0.9964	-0.9786	-0.6729	-0.9865	-0.9926	0.3315	1											
-0.3337	-0.9252	-0.9252	-0.8720	-0.8637	-0.8921	-0.9105	0.5991	0.9540	1										
0.0910	0.9902	0.9902	0.9657	0.7129	0.9759	0.9843	-0.3833	-0.9985	-0.9692	1									
-0.3006	0.9674	0.9674	0.9910	0.3868	0.9844	0.9761	0.0031	-0.9424	-0.7988	0.9224	1								
-0.9322	-0.3157	-0.3157	-0.1976	-0.9453	-0.2394	-0.2804	0.9977	0.3949	0.6522	-0.4453	-0.0649	1							
-0.4169	0.9283	0.9283	0.9667	0.2691	0.9549	0.9414	0.1275	-0.8935	-0.7178	0.8672	0.9922	0.0597	1						
-0.2646	0.9762	0.9762	0.9954	0.4212	0.9903	0.9835	-0.0344	-0.9543	-0.8208	0.9363	0.9993	-0.1024	0.9869	1					
-0.4493	0.9144	0.9144	0.9569	0.2342	0.9436	0.9287	0.1631	-0.8768	-0.6922	0.8487	0.9871	0.0956	0.9994	0.9804	1				
-0.6348	0.8029	0.8029	0.8696	0.0147	0.8477	0.8244	0.3761	-0.7496	-0.5166	0.7117	0.9278	0.3121	0.9670	0.9131	0.9755	1			
0.8081	-0.6280	-0.6280	-0.7182	0.2362	-0.6878	-0.6563	-0.5962	0.5598	0.2857	-0.5130	-0.8047	-0.5402	-0.8723	-0.7818	-0.8893	-0.9681	1		
-0.2431	-0.9569	-0.9569	-0.9144	-0.8122	-0.9308	-0.9455	0.5207	0.9781	0.9955	-0.9881	-0.8521	0.5776	-0.7804	-0.8711	-0.7573	-0.5952	0.3750	1	
-0.3822	0.9418	0.9418	0.9757	0.3054	0.9655	0.9535	0.0898	-0.9099	-0.7436	0.8855	0.9962	0.0218	0.9993	0.9923	0.9973	0.9566	-0.8532	-0.8035	1

Parameters	Sum of Squares	df	Mean Square	F	Significance
TN					
Between Groups	56.8246734	1	56.8246734	45.62264852	1.87
Within Groups	23.66519327	19	1.245536488		
Total	80.48986667	20			
TP					
Between Groups	4560.504732	1	4560.504732	0.751101835	0.397
Within Groups	115363.3048	19	6071.752884		
Total	119923.8095	20			
Calcium					
Between Groups	98500.74424	1	98500.74424	8.790007512	0.008
Within Groups	212913.8272	19	11205.9909		
Total	311414.5714	20			
Magnesium					
Between Groups	2374.656892	1	2374.656892	0.959146832	0.340
Within Groups	47040.22311	19	2475.801216		
Total	49414.88	20			
Bicarbonate					
Between Groups	149.1152108	1	149.1152108	11.99879043	0.003
Within Groups	236.1228844	19	12.42752023		
Total	385.2380952	20			
Carbonate					
Between Groups	1895.226078	1	1895.226078	9.6416605	0.992
Within Groups	373476112	19	19656637.47		
Total	373478007.2	20			
Sulphate					
Between Groups	26.36723351	1	26.36723351	4.839129835	0.040
Within Groups	103.5263474	19	5.448755129		
Total	129.893581	20			
Nitrate					
Between Groups	0.004653803	1	0.004653803	0.597664897	0.449
Within Groups	0.147946197	19	0.007786642		
Total	0.1526	20			

Parameters	Sum of Squares	df	Mean Square	F	Significance
pH					
Between Groups	0.31726	1	0.317256023	2.839682309	0.108
Within Groups	2.12272	19	0.111722365		
Total	2.43998	20			
EC					
Between Groups	654932381	1	654932381	5.107447807	4.75
Within Groups	2.4364	19	1.2823		
Total	654932381	20			
TDS					
Between Groups	121003058.1	1	121003058.1	16.54717618	0.001
Within Groups	138939603.9	19	7312610.73		
Total	259942662	20			
Salinity					
Between Groups	0.007539496	1	0.007539496	0.000836782	0.977
Within Groups	162.1819605	18	9.010108917		
Total	162.1895	19			
DO					
Between Groups	0.068097156	1	0.068097156	0.181450405	0.675
Within Groups	6.755282844	18	0.375293491		
Total	6.82338	19			
BOD					
Between Groups	1660.568083	1	1660.568083	0.725600853	0.406
Within Groups	41193.75742	18	2288.542079		
Total	42854.3255	19			
TA					
Between Groups	26657.56586	1	26657.56586	0.794785221	0.384
Within Groups	603730.6341	18	33540.59079		
Total	630388.2	19			

Fig 3: ANOVA analysis of Hydro chemical parameters at thestudy area.

CONCLUSION

The variations in Hydro chemicalparameters along the Arasalar estuary, southeast coast of India were attempted to present in the present day study. The Hydro chemicalparameters of estuarine water, on either hand, were not very variable. The natural development and productivity of marine organisms are influenced by fluctuations in Hydro chemicalparameters.The seasonal variation inHydro chemicalparameters depends on rainy seasons and also other sources of freshwater. The biological behavior and productivity of aquatic species are influenced by changes in Hydro chemicalparameters.

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H - FUZZY SOFT INTERIOR EUCLIDEAN IDEAL OVER ORDERED Γ- SEMIRING

N. SARALA[*] AND S. DHAYALNITHI

ABSTRACT

In this paper aims to the notion of fuzzy soft interior ideal over ordered Γ- semiring to H- fuzzy soft interior Euclidean ideal over ordered Γ- semiring has been introduced and study the basic of some necessary definition on binary operations, compatible relations, union, intersection, sub semiring of ordered Γ- semiring, left (right) ideal of an ordered Γ- semiring, null soft set , Γ- semiring and ordered Γ- semiring, fuzzy soft Γ- semiring, fuzzy soft ideal fuzzy soft interior ideal and definition for H- fuzzy soft interior Euclidean ideal and some of their algebraical theorems ,that is the theorems are intersection oy f two H- fuzzy soft interior Euclidean ideal over ordered Γ- semiring is also a H- fuzzy soft interior Euclidean ideal over ordered Γ- semiring , union of two H- fuzzy soft interior Euclidean ideal over ordered Γ- semiring is also a H- fuzzy soft interior Euclidean ideal over ordered Γ- semiring, and also AND,OR operations are H-fuzzy soft interior Euclidean ideal over ordered Γ- semiring, hesitant normal fuzzy soft interior Euclidean ideal over ordered Γ- semiring, H- fuzzy soft translation is an interior Euclidean ideal over ordered Γ-semiring ,H- fuzzy soft multiplication is an interior Euclidean ideals are proved.

Keywords: Ordered Γ- semiring, fuzzy soft ideal, fuzzy soft Γ- semiring, fuzzy soft interior ideal, H- fuzzy soft interior Euclidean ideal.

1. INTRODUCTION

The real-life problems in environmental engineering economics, medical science and many other fields are complicated, these problems are solved by the classical methods but the uncertainties are present in these problems. Molodtsov [17] firstly proposed a new mathematical tool named soft set theory to deal with uncertainty and imprecision. This theory has been demonstrated to be a useful tool in many applicators such as decision making, measurement theory and game theory. The notion of Γ- semiring was introduced by Murali Krishna [19;20] not only generalizes the notion of semiring and Γ- ring but also the notion of ternary semiring. Agargun and Ersoy [3] introduced by About Euclidean rings. Agargun and Fletches [5] introduced Euclidean rings.Agargun [2] introduced on Euclidean rings. Agargun and Ersoy[4] introduced by Fuzzy Euclidean ideals . Marapureddy and Muralikrishna Rao [15] introduced by fuzzy soft ideal,fuzzy soft Bi-idea, fuzzy soft quasi - ideal and fuzzy soft interior ideal over ordered Γ- semiring .Torra [26] introduced hesitant fuzzy soft sset. Xia and Xu [28] introduced hesitant fuzzy aggregation in decision making. Torra and Narukawa [27] introduced On hesitant fuzzy soft sets and decision

This paper is organized as follows: In section 2, some basic definitions. In section 3,the definition of H- fuzzy soft interior Euclidean ideal over ordered Γ- semiring and some theorems are studied.

2. PRELIMINARIES

Definition 2.1

A set M together with two associative binary operations called addition and multiplication will be called semiring provided

(i)   Addition is a commutative operation

(ii) There exists $0 \in M$ such that $x + 0 = x\ and\ x \cdot 0 = 0 \cdot x = 0$ for each $x \in M$

(iii) Multiplication distributes over addition both from the left and from the right

Definition 2.2

Let $(M, +)$ and $(\Gamma, +)$ be commutative semigroups. Then we call M as a Γ -semiring ,if there exists a mapping $M \times \Gamma \times M \to M$ written as (x, α, y) as $x\alpha y$ such that it satisfies the following axioms for all $x, y, z \in M$ and $\alpha, \beta \in \Gamma$

(i) $x\alpha(y + z) = x\alpha y + x\alpha z$

(ii) $(x + y)\alpha z = x\alpha z + y\alpha z$

(iii) $x(\alpha + \beta)y = x\alpha y + x\beta y$

(iv) $x\alpha(y\beta z) = (x\alpha y)\beta z$

Definition 2.3

A Γ –semiring M is called an ordered Γ –semiring if it admits a compatible relation $\leq$. (i.e)$\leq$ is a partial ordering on M satisfying the following conditions. If $a \leq b$ and $c \leq d$ then

(i) $a + c \leq b + d$

(ii) $a\alpha c \leq b\alpha d$

(iii) $c\alpha a \leq d\alpha b$ for all $a, b, c, d \in M, \alpha \in \Gamma$.

Example 2.4

Let $M = [0,1]$, $\Gamma = N, +$,binary operations be defined as $x + y = max\{x, y\}$ and ternary operation be defined as $x\gamma y = min\{x, \gamma, y\}$, for all $x, y \in M, \gamma \in \Gamma$.Then M is an ordered Γ –semiring with respect to usual ordering

Definition 2.5

Let M be an ordered Γ –semiring and A be a non-empty subset of M.A is called a Γ –sub semiring of ordered Γ –semiring M if A is a sub –semigroup of $(M, +)$ and $A\Gamma A \subseteq A$

Definition 2.6

Let M be an ordered Γ –semiring. A non empty subset A of M is called a left (right) ideal of an ordered Γ –semiring M if A is closed under addition and $M\Gamma A \subseteq A$ $(A\Gamma M \subseteq A)$ and for any $a \in M, b \in A, a \leq b$ then $a \in A$. A is called an ideal of M if it is both a left ideals and a right ideal.

Definition 2.7

A fuzzy subset $\mu: M \to [0,1]$ is non –empty if μ is not the constant function.

Definition 2.8

For any two fuzzy subsets λ and μ of M , $\lambda \subseteq \mu$ means $\lambda(x) \leq \mu(x)$ $for all$ $x \in M$

Definition 2.9

Let U be an initial universe set and E be the set of parameters. let $P(U)$ denotes the power set of U.A pair (f, E) is called soft set over U where f is a mapping given by $f: E \to P(U)$.

Definition 2.10

For a soft set (f, A), the set $\{x \in A|\ f(x) \neq \emptyset\}$ is called support of (f, A), denoted by sup (f, A). If sup$(f, A)\neq \emptyset$ then (f, A) is called a non null soft set.s

Definition 2.11

Let U be an initial universe set and E be the set of parameters and $A \subseteq E$.A pair (f, A) is called fuzzy soft set over U where f is a mapping given by $f: A \to I^U$ where I^Udenotes the collection of all fuzzy subsets of U.

Definition 2.12

Let (f, A), (g, B) be fuzzy soft sets over U. then (f, A) is said to be fuzzy soft subset of (g, B) denoted by $(f, A) \subseteq (g, B)$ if $A \subseteq B$ and $f(a) \subseteq g(a) for\ all\ a \in A$

3. H -FUZZY SOFT INTERIOR EUCLIDEAN IDEAL OVER ORDERED Γ- SEMIRING

Definition 3.1

Let M be an ordered Γ - semiring; E be a parameter set and A $\subseteq$ E.let f be a mapping given by$f: A \to [0,1]^M$ where $[0,1]^M$ denotes the collection of all fuzzy subsets of M .Then (f, A) is called a hesitant fuzzy soft interior Euclidean ideal over M if and only if for each $a \in A$,the corresponding fuzzy subset f_a: M $\to$ [0,1] is a fuzzy interior ideal of M

i.e;

(i) $f_a[(x_1 - d_1y_1) - (x_2 - d_2y_2)] \geq min\{f_a(y_1); f_a(y_2)\}$

(ii) $f_a[(x_1 - d_1y_1)\alpha(x_2 - d_2y_2)\beta(x_3 - d_3y_3)] \geq min\{f_a(y_2)\}$

(iii)$(x_1 - d_1y_1) \leq (x_2 - d_2y_2) \Rightarrow f_a(y_1) \geq f_a(y_2)$ $\forall x_1, x_2, x_3, y_1, y_2, y_3, d_1, d_2, d_3 \in M$ $\alpha, \beta \in \Gamma$

Theorem 3.2

Let (f, A) and (g, B) be H- fuzzy soft interior Euclidean ideals over ordered Γ – semiring M.Then $(f, A) \cap (g, B)$ is a H- fuzzy soft interior Euclidean ideal over M.

Proof

By definition, we have $(f, A) \cap (g, B) = (h, C)$ where $C = A \cup B$

$Case(i)$: If $c \in A \backslash B$, $h_c = f_c$. Then h_c is a H- fuzzy soft Euclidean interior ideal of M .Since (f, A) is a H- fuzzy soft interior Euclidean ideal over M.

Case (ii): If $c \in B \backslash A$ then $h_c = g_c$. Therefore h_c is a H- fuzzy soft interior Euclidean ideal of M .Since (g, B) is a H- fuzzy soft interior Euclidean ideal over M.

Case (iii): If $c \in A \cap B$ and $x_1, x_2, x_3, y_1, y_2, y_3, d_1, d_2, d_3 \in M$, $\alpha, \beta \in \Gamma$ then $h_c = f_c \cap g_c$ and

$$h_c[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)] = min\{f_c[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)], g_c[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)]\}$$

$$\geq min\{min\{f_c(y_1), f_c(y_2)\}, min\{g_c(y_1), g_c(y_2)\}\}$$

$$= min\{min\{f_c(y_1), g_c(y_1)\}, min\{f_c(y_2), g_c(y_2)\}\}$$

$= min\{f_c \cap g_c(y_1), f_c \cap g_c(y_2)\}$

$= min\{h_c(y_1), h_c(y_2)\}$

And

$$h_c[(x_1 - d_1 y_1)\alpha(x_3 - d_3 y_3)\beta(x_2 - d_2 y_2)]$$

$$= min\{f_c[(x_1 - d_1 y_1)\alpha(x_3 - d_3 y_3)\beta(x_2 - d_2 y_2)], g_c[(x_1 - d_1 y_1)\alpha(x_3 - d_3 y_3)\beta(x_2 - d_2 y_2)]\}$$

$\geq min\{f_c(x_3 - d_3 y_3), g_c(x_3 - d_3 y_3)\}$

$= min\{f_c(y_3), g_c(y_3)\}$

$= f_c \cap g_c(y_3)$

$= h_c(y_3)$

Let $x_1, x_2, y_1, y_2, d_1, d_2 \in M$ and $(x_1 - d_1 y_1) \leq (x_2 - d_2 y_2)$. Then

$$f_c(y_1) \geq f_c(y_2), g_c(y_1) \geq g_c(y_2)$$

$\Rightarrow min\{f_c(y_1), g_c(y_1)\} \geq min\{f_c(y_2), g_c(y_2)\}$

$\Rightarrow f_c(y_1) \cap g_c(y_1) \geq f_c(y_2) \cap g_c(y_2)$

$$\Rightarrow h_c(y_1) \geq h_c(y_2)$$

Hence h_c is a H- fuzzy soft interior Euclidean ideal over M. Thus $(f, A) \cap (g, B)$ is a H- fuzzy soft interior Euclidean ideal over M.

Theorem 3.3

Let (f, A) and (g, B) be two H- fuzzy soft interior Euclidean ideals over ordered Γ – semiring M. Then $(f, A) \cup (g, B)$ is a H- fuzzy soft interior Euclidean ideal over M.

Proof

By definition, we have $(f, A) \cup (g, B) = (h, C)$ where $C = A \cup B$

$$h_c = \{f_c \ if \ c \in A \backslash B, g_c \ if \ c \in B \backslash A, f_c \cup g_c \ if \ c \in A \cap B$$

Case(i): If $c \in A \backslash B$, $h_c = f_c$. Then h_c is a H- fuzzy soft interior Euclidean ideal of M .Since (f, A) is a H- fuzzy soft interior Euclidean ideal over M.

Case (ii): If $c \in B \backslash A$ then $h_c = g_c$. Then h_c is a H- fuzzy soft interior Euclidean ideal of M .Since (g, B) is a H- fuzzy soft interior Euclidean ideal over M.

Case (iii): If $c \in A \cap B$ and $x_1, x_2, x_3, y_1, y_2, y_3, d_1, d_2, d_3 \in M$, $\alpha, \beta \in \Gamma$, $h_c = f_c \cup g_c$ and

$$h_c[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)] = max\{f_c[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)], g_c[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)]\}$$

$$\geq max\{min\{f_c(y_1), f_c(y_2)\}, min\{g_c(y_1), g_c(y_2)\}\}$$

$$= min\{max\{f_c(y_1), g_c(y_1)\}, max\{f_c(y_2), g_c(y_2)\}\}$$

$= min\{f_c \cup g_c(y_1), f_c \cup g_c(y_2)\}$

$= min \{ h_c (y_1), h_c (y_2)\}$

And

$$h_c[(x_1 - d_1y_1)\alpha(x_3 - d_3y_3)\beta(x_2 - d_2y_2)]$$
$$= min\{f_c[(x_1 - d_1y_1)\alpha(x_3 - d_3y_3)\beta(x_2 - d_2y_2)], g_c[(x_1 - d_1y_1)\alpha(x_3 - d_3y_3)\beta(x_2 - d_2y_2)]\}$$

$\geq min \{f_c(y_3), g_c(y_3)\}$

$= f_c \cap g_c (y_3)$

$= h_c(y_3)$

Let $x_1, x_2, y_1, y_2, d_1, d_2 \in M$ and $(x_1 - d_1y_1) \leq (x_2 - d_2y_2)$. Then

$$f_c (y_1) \geq f_c(y_2), g_c(y_1) \geq g_c(y_2)$$

$\Rightarrow max\{f_c(y_1), g_c(y_1)\} \geq max\{f_c(y_2), g_c(y_2)\}$

$\Rightarrow f_c \cup g_c(y_1) \geq f_c \cup g_c(y_2)$

$$\Rightarrow h_c(y_1) \geq h_c(y_2)$$

Hence h_c is a H- fuzzy soft interior Euclidean ideal over M. Therefore $(f, A) \cup (g, B)$ is a H-fuzzy soft interior Euclidean ideal over M.

Theorem 3.4
Let (f, A) and (g, B) be two H- fuzzy soft interior Euclidean ideals over ordered Γ – semiring M. Then $(f, A) \wedge (g, B)$ is a H- fuzzy soft interior Euclidean ideal over M.

Proof
By definition, $(f, A) \wedge (g, B) = (h, C)$ where $C = A \times B$

Let $c = (a, b) \in C = A \times B$ and $x_1, x_2, x_3, y_1, y_2, y_3, d_1, d_2, d_3 \in M, \alpha, \beta \in \Gamma$

$$h_c[(x_1 - d_1y_1) - (x_2 - d_2y_2)] = min\{f_a[(x_1 - d_1y_1) - (x_2 - d_2y_2)], g_b[(x_1 - d_1y_1) - (x_2 - d_2y_2)]\}$$
$$\geq min\{min\{ f_a(y_1), f_a(y_2)\}, min\{g_b(y_1), sg_b(y_2)\}\}$$
$$= min\{min\{ f_a(y_1), g_b(y_1)\}, min\{f_a(y_2), g_b(y_2)\}\}$$

$= min \{f_a \wedge g_b(y_1), f_a \wedge g_b (y_2)\}$

$= min \{ h_c (y_1), h_c (y_2)\}$

And

$$h_c[(x_1 - d_1y_1)\alpha(x_3 - d_3y_3)\beta(x_2 - d_2y_2)]$$
$$= min\{f_a[(x_1 - d_1y_1)\alpha(x_3 - d_3y_3)\beta(x_2 - d_2y_2)], g_b[(x_1 - d_1y_1)\alpha(x_3 - d_3y_3)\beta(x_2 - d_2y_2)]\}$$

$\geq min \{f_a(x_3 - d_3y_3), g_b(x_3 - d_3y_3)\}$

$= min \{f_a(y_3), g_b(y_3)\}$

$= f_a \wedge g_b (y_3)$

$= h_c(y_3)$

Let $x_1, x_2, y_1, y_2, d_1, d_2 \in M$ and $(x_1 - d_1y_1) \leq (x_2 - d_2y_2)$. Then

$$f_a(y_1) \geq f_a(y_2), g_b(y_1) \geq g_b(y_2)$$

$\Rightarrow min\{f_a(y_1), g_b(y_1)\} \geq min\{f_a(y_2), g_b(y_2)\}$

$\Rightarrow f_a(y_1) \wedge g_b(y_1) \geq f_a(y_2) \wedge g_b(y_2)$

$$\Rightarrow h_c(y_1) \geq h_c(y_2)$$

Hence h_c is a H- fuzzy soft interior Euclidean ideal over M. Therefore $(h, A \times B)$ is a H- fuzzy soft interior Euclidean ideal over M.

Theorem 3.5

If $(f; A)$ is a H- fuzzy soft interior Euclidean ideal over an ordered Γ – semiring M and for each $a \in A$, $f_a{}^+(x_1 - d_1 y_1) = f_a(x_1 - d_1 y_1) + 1 - f_a(0)$ then (f^+, A) is a normal H- fuzzy soft interior Euclidean ideal over an ordered Γ – semiring M and (f, A) is a H- fuzzy soft interior Euclidean ideal of (f^+, A)

Proof

Let $x_1, x_2, x_3, y_1, y_2, y_3, d_1, d_2, d_3 \in M, \alpha, \beta \in \Gamma$

$$f_a{}^+[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)] = f_a[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)] + 1 - f_a(0)$$

$$\geq \{f_a(y_1), f_a(y_2)\} + 1 - f_a(0)$$

$$= min\{f_a(y_1) + 1 - f_a(0), f_a(y_2) + 1 - f_a(0)\}$$

$= min\{f_a{}^+(y_1), f_a{}^+(y_2)\}$

And

$f_a{}^+[(x_1 - d_1 y_1)\alpha(x_3 - d_3 y_3)\beta(x_2 - d_2 y_2)] = f_a[(x_1 - d_1 y_1)\alpha(x_2 - d_2 y_2)\beta(x_3 - d_3 y_3)] + 1 - f_a(0)$

$\geq min\{f_a(y_3)\} + 1 - f_a(0)$

$$= min\{f_a(y_3) + 1 - f_a(0)\}$$

$= min\{f_a{}^+(y_3)\}$

Let $x_1, x_2, y_1, y_2, d_1, d_2 \in M$ and $(x_1 - d_1 y_1) \leq (x_2 - d_2 y_2)$.Then

$$\Rightarrow f_a(y_1) \geq f_a(y_2)$$

$$\Rightarrow f_a(y_1) + 1 - f_a(0)\} \geq f_a(y_2) + 1 - f_a(0)\}$$

$$\Rightarrow f_a{}^+(y_1) \geq f_a{}^+(y_2)$$

Hence (f^+, A) is a normal H- fuzzy soft interior Euclidean ideal over an ordered Γ – semiring M and (f, A) is a H- fuzzy soft interior Euclidean ideal of (f^+, A)

Theorem 3.6

Let M be an ordered Γ – semiring. Then f is a H- fuzzy soft interior Euclidean ideal of M

if and only if $f_b{}^M$ the fuzzy soft multiplication of f is an H- fuzzy soft interior Euclidean ideal of an ordered Γ – semiring M

Proof

Suppose f is a hesitant fuzzy soft interior Euclidean ideal of an ordered Γ – semiring M.

$x_1, x_2, x_3, y_1, y_2, y_3, d_2, d_3 \in M, \alpha, \beta \in \Gamma$

$$f_b{}^M[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)] = bf[(x_1 - d_1 y_1) - (x_2 - d_2 y_2)]$$

$$\geq bmin\{f(y_1), f(y_2)\}$$

$= min\{bf(y_1), bf(y_2)\}$

$$= min(f_b{}^M(y_1), f_b{}^M(y_1))$$

$f_b{}^M[(x_1 - d_1 y_1)\alpha(x_3 - d_3 y_3)\beta(x_2 - d_2 y_2)] = b f[(x_1 - d_1 y_1)\alpha(x_3 - d_3 y_3)\beta(x_2 - d_2 y_2)]$

$\geq b min\{f(y_3)\}$

$$= min\{bf(y_3)$$

$= min\{f_b{}^M(y_3)\}$

If $(x_1 - d_1 y_1) \leq (x_2 - d_2 y_2)$ then $f(y_1) \geq f(y_2)$

and hence $bf(y_1) \geq bf(y_2)$.Therefore $f_b{}^M(y_1) \geq f_b{}^M(y_2)$.hence $f_b{}^M$ is a H-fuzzy soft interior Euclidean ideal of ordered Γ – semiring M .converse is obvious.

CONCLUSION

In this paper, we introduced the notion of fuzzy soft interior ideal over ordered Γ – semiring to a H- fuzzy soft interior Euclidean ideal .To prove some of their algebraical properties and relation between them.

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Statistics and Biometry

No complex statistical methods were necessary for this paper.

INFORMED CONSENT

Only If the Study is on Human Subjects

Written informed consent was not required for this study.

Only If the Study is on Animals

Approval from the institutional animal care committee was not required.

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VALIDATION OF NAÏVE BAYESIAN MODEL FOR PREDICTION OF DIABETES WITH FIELD DATA

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ABSTRACT
Diabetes is one of the most rapidly growing diseases, which has affected millions of people around the globe. Its diagnosis, prediction, proper cure, and management are crucial. Individuals with diabetes face a risk of developing some secondary health issues such as heart diseases and nerve damage. Thus, early detection and treatment of diabetes can prevent complications and assist in reducing the risk of severe health problems. Machine learning based models are being built for the prediction of diabetes in individuals. Though machine learning based forecasting techniques for data analysis of diabetes can help in the early detection and prediction of the disease, most of the models developed using machine learning algorithms use benchmark dataset for their evaluation. What is more needed is to evaluate the developed artificial intelligence-based models using real patient data collected from different hospitals. As collection of data from hospitals needs more formal procedures, more frequently the models remain open for validation.In this project, it is proposed to validate artificial intelligence-based models with data collected from individuals in nearby villages by using a Questionnaire. It is proposed to construct the model using benchmark dataset. In addition, it is proposed to validate the constructed model using real data using different evaluation measures.

Keywords: prediction of diabetes, validation of Naïve Bayesian, artificial intelligence based model for prediction of diabetes

1. INTRODUCTION
Diabetes mellitus is chronic, a ceaseless ailment where it caused because of the high sugar level in the circulatory system. It is caused because of the inappropriate working of the pancreatic beta cells. It has an impact on different parts of the body which incorporates pancreas glitch, risk of heart ailments, hypertension, kidney disappointments, pancreatic issues, nerve harm, foot issues, ketoacidosis, visual unsettling influences, and other eye issues, waterfalls and glaucoma and so on. Diabetes is one of the most rapidly growing diseases, which has affected millions of people around the globe. Its diagnosis, prediction, proper cure, and management are crucial. Individuals with diabetes face a risk of developing some secondary health issues such as heart diseases and nerve damage. Thus, early detection and treatment of diabetes can prevent complications and assist in reducing the risk of severe health problems. Many researchers in the bioinformatics field have attempted to address this disease and tried to create systems and tools that will help in diabetes prediction.

On one side, machine learning based forecasting techniques for data analysis of diabetes can help in the early detection and prediction of the disease. On the other side, most of the models developed using machine learning algorithms use benchmark dataset for their evaluation. What is more needed is to evaluate the developed artificial intelligence based models using real patient data collected from different hospitals. As collection of data from hospitals needs more formal procedures, more frequently the models remain open for validation.

In this research work, it is proposed to validate artificial intelligence-based models with data collected from individuals by surveying using a questionnaire. A machine learning based model will be constructed using classification algorithm with standard benchmark dataset which is publicly availableMore specifically, Naïve Bayesian model has been chosen for the present study. After construction of the model, it is validated using the data collected from individuals. Ultimately validated model for diabetes prediction will be setup

2. RELATED WORK
Significant amount of research works is being carried out in the area of prediction of diabetes using machine learning techniques [1-24]. There are some research works that have employed deep learning techniques for the prediction of diabetes [25-30]. Despite the existence of different machine learning models, there are other aspects such as validation of such models with actual data.

3. PROPOSED WORK

The primary aim of the research work is at first to construct an artificial intelligence based model for prediction of diabetes with benchmark dataset and afterwards to validate the model with actual data collected from individuals. The higher-level block diagram of the proposed project work is shown in Fig.1.

Naïve Bayes classifier algorithm has been chosen for prediction.Naïve Bayes algorithm is a supervised learning algorithm, which is based on Bayes theorem and used for solving classification problems.Naïve Bayes Classifier is one of the simple and most effective Classification algorithms which helps in building the fast machine learning models that can make quick predictions.It is a probabilistic classifier, which means it predicts on the basis of the probability of an object.Bayes' theorem is used to determine the probability of a hypothesis with prior knowledge. It depends on the conditional probability.
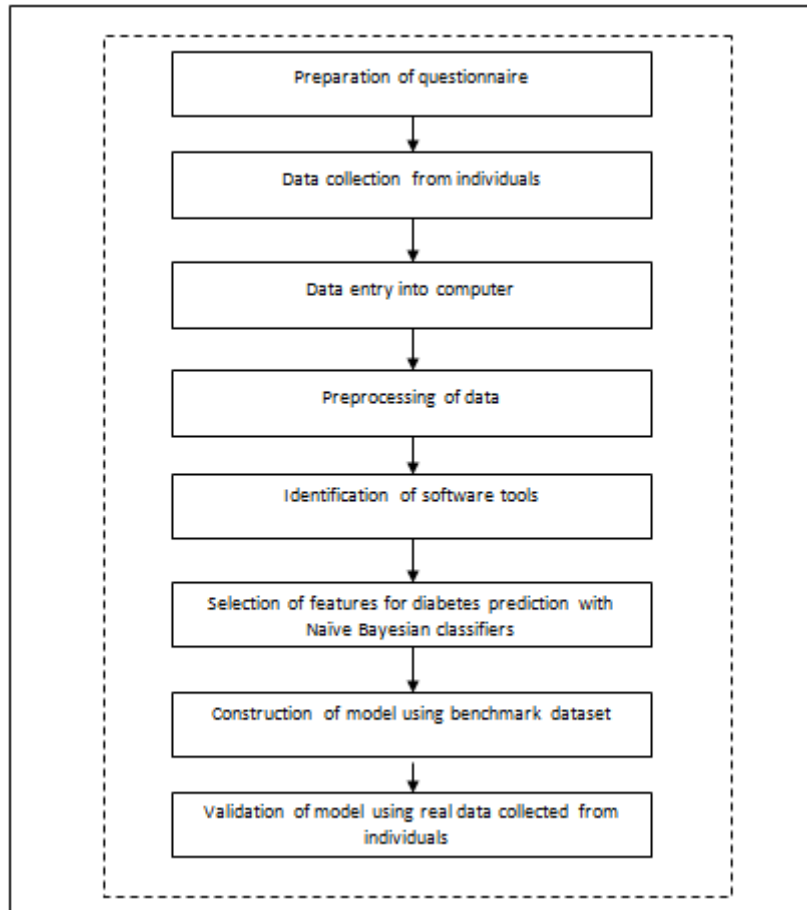
Fig.1: Block diagram of the proposed methodology

The formula for Bayes' theorem is given as:

$$P(A\,|\,B) = \frac{P(A\,|\,B)P(A)}{P(B)}$$

P(A|B) is Posterior probability: Probability of hypothesis A on the observed event B.

P(B|A) is Likelihood probability: Probability of the evidence given that the probability of a hypothesis is true.

P(A) is Prior Probability: Probability of hypothesis before observing the evidence.

P(B) is Marginal Probability: Probability of Evidence.

In the proposed research, consider the class variable as y which predicts whether an individual is having diabetes or not. Variable X represents the features

Let X is given as

$$X = (x_1, x_2, x_3, \ldots x_n)$$

Here, $x_1, x_2, x_3, ...x_n$ denote various features involved in the present study, which includes, glucose, blood pressure, Body Mass Index(BMI), age, skin thickness, diabetes pedigree function etc.

By substituting the X in the Bayes rule, the prediction of class variable can be arrived as

$$P(y \mid x_1, x_2, x_3, ...x_n) = \frac{P(x_1 \mid y)P(x_2 \mid y)...P(x_n \mid y)P(y)}{P(x_1)P(x_2)...P(x_n)}$$

For all entries in the dataset, the denominator does not change. Therefore, the denominator can be removed and proportionality can be injected.

$$P(y \mid x_1, x_2, x_3, ...x_n) \propto P(x_1 \mid y)P(x_2 \mid y)...P(x_n \mid y)P(y)$$

Using the above function, we can obtain the class, given the features. The posterior probability P(y|X) can be calculated by first, creating a frequency table for each attribute against the target. Then, the frequency tables are converted into likelihood tables. Finally, the Naïve Bayesian formula is used to calculate the posterior probability for each class. The class with the highest posterior probability is the outcome of the prediction.

3.1 Dataset Description
In this work, there are two datasets involved, (i) benchmark dataset and (ii) real data set.

Benchmark Dataset
(i) benchmark dataset, obtained from the National Institute of Diabetes and Digestive and Kidney Diseases (publicly available at: UCI ML Repository), the Pima Indian Diabetes (PID). This will be used for construction of model

This dataset is originally from the National Institute of Diabetes and Digestive and Kidney Diseases. The objective of the dataset is to diagnostically predict whether or not a patient has diabetes, based on certain diagnostic measurements included in the dataset. Several constraints were placed on the selection of these instances from a larger database. In particular, all patients here are females at least 21 years old of Pima Indian heritage. The datasets consist of several medical predictor variables and one target variable, Outcome. Predictor variables includes the number of pregnancies the patient has had, their BMI, insulin level, age, and so on.

The description of various columns is given as follows

- Pregnancies: Number of times pregnant
- Glucose: Plasma glucose concentration a 2 hours in an oral glucose tolerance test
- BloodPressure: Diastolic blood pressure (mm Hg)
- SkinThickness: Triceps skin fold thickness (mm)
- Insulin: 2-Hour serum insulin (mu U/ml)
- BMI: Body mass index (weight in kg/(height in m)^2)
- DiabetesPedigreeFunction: Diabetes pedigree function
- Age: Age (years)
- Outcome: Class variable (0 or 1)

Real Data Collected from Individuals
The real data collected from individuals are given below for reference.

S.NO	PREGENT	GLUCOSE LEVEL	BLOOD PRESSURE	SKIN THIKNE	INSULIN	BMI	DIABETES PEDIGREE FUL	AGE	DIABETES
1	2	93mg/dl	100/70mmHg	162cm/57kg	0	21.7	0.267	25	NO
2	4	214mg/dl	140/70mmHg	152cm/50kg	0	21.6	0.19	45	YES
3	1	82mg/dl	90/60mmHg	162cm/58kg	0	22.1	0.725	22	N0
4	5	136mg/dl	150/90mmHg	155cm/50kg	0	20.2	0.615	61	NO
5	1	160mg/dl	120/70mmHg	160cm/55kg	20UNITS	21.3	0.399	21	YES
6	3	125mg/dl	90/60mmHg	163cm/70kg	0	26.3	1.4	34	NO
7	4	188mg/dl	130/70mmHg	154cm/50kg	0	23.6	0.198	57	YES
8	2	65mg/dl	90/60mmHg	136cm/38kg	0	20.5	0.096	22	NO
9	3	188mg/dl	130/80mmHg	160cm/60kg	0	23.6	0.268	55	YES
10	4	62mg/dl	110/80mmHg	145cm/38kg	0	18.1	0.354	32	N0
11	3	140mg/dl	118/78mmHg	155cm/50kg	6UNITS	22.6	0.676	22	YES
12	7	188mg/dl	170/90mmHg	154cm/56kg	0	23.6	1.478 / HYPER TENSION	87	YES
13	0	97mg/dl	120/20mmHg	148cm/45kg	0	20.5	0.335	18	NO
14	3	220mg/dl	130/20mmHg	153cm/50kg	0	19.6	0.254 / HYPER TENSION	42	YES
15	4	96mg/dl	110/60mmHg	159cm/52kg	0	20.6	0.183	26	N0
16	7	200mg/dl	160/20mmHg	155cm/50kg	10UNTITS	20.8	0.551 / HYPER TENSION	54	YES
17	3	80mg/dl	90/60mmHg	143cm/46kg	0	22.5	0.587	23	NO
18	12	299mg/dl	140/80mmHg	160cm/58kg	0	22.6	1.441 / DIABETES MELLITUS	70	YES
19	2	90mg/dl	110/20mmHg	153cm/49kg	0	20.9	0.398	21	NO
20	5	400mg/dl	150/60mmHg	165cm/57kg	30UNITS	20.5	0.512	62	YES
21	3	71mg/dl	90/60mmHg	161cm/60kg	0	23.1	0.698	24	NO
22	8	240mg/dl	130/80mmHg	165cm/65kg	0	23.9	0.277 / HYPER TENSION/DIAE	70	YES
23	6	267mg/dl	120/80mmHg	154cm/56kg	0	23.6	0.487 / HYPER TENSION	50	YES
24	5	148mg/dl	128/88mmHg	160cm/58kg	0	20.4	0.42	36	NO
25	7	236mg/dl	140/90mmHg	160cm/60kg	0	23.4	0.487 / HYPER TENSION	50	YES
26	2	180mg/dl	120/80mmHg	160cm/60kg	0	20.5	0.271	25	YES
27	7	192mg/dl	130/80mmHg	151cm/51kg	15UNITS	22.6	0.232 / HYPER TENSION/DIAE	62	YES
28	5	219mg/dl	140/80mmHg	156cm/56kg	0	23	0.484 / HYPER TENSION/DIAE	60	YES
29	9	219mg/dl	140/80mmHg	150cm/48kg	0	21.3	0.398 / HYPER TENSION/DIAE	65	YES
30	6	233mg/dl	180/100mmHg	151cm/47kg	0	20.6	0.801 / HYPER TENSION	61	YES
31	4	151mg/dl	130/90mmHg	158cm/57kg	0	22.8	0.356 / HYPER TENSION	42	YES
32	11	244mg/dl	150/90mmHg	150cm/80kg	30UNITS	23.8	0.543	78	YES
33	7	167mg/dl	120/80mmHg	153cm/50kg	0	21.4	0.801	67	YES
34	0	244mg/dl	150/90mmHg	150cm/80kg	0	24.2	0.789 / HYPER TENSION / DIA	78	YES
35	0	167mg/dl	120/80mmHg	153cm/58kg	0		0.678 / DIABETES MULLITUS	67	YES
36	0	170mg/dl	130/20mmHg	150cm/48kg	0	27.8	0.580 / DIABETES MULLITUS	70	NO
37	0	_	130/80mmHg	156cm/58kg	0	23.8	0.634 / HYPER TENSION	47	YES
38	0	_	140/80mmHg	154cm/44kg	0	18.5	0.600 / HYPER TENSION	70	YES
39	0	_	150/80mmHg	152cm/54kg	0	23.3	0.767 / HYPER TENSION	62	YES
40	0	180mg/dl	120/80mmHg	156cm/58kg	0	23.8	0.587 / DIABETES MULLITUS	47	YES

The missing values are filled by average method. Data has been preprocessed for numeric data type. The data has been captured as Comma Separated Value(CSV) file. The CSV file has been converted in .ARFF file which is the input requirement for WEKA. The conversion has been done using the tool, available in the link, https://ikuz.eu/csv2arff/. The converted .arff file is given in Appendix-A for reference.

4. Experimentation

Two experiments have been conducted, one with benchmark dataset and the other with field data collected from individuals.In this experiment, the diabetes data consist of 768 records, which are collected from publicly available website is given as .arff file for selection of attributes.

4.1 Experiment -1

In this experiment, the diabetes data consist of 768 records, which are collected from publicly available website, is given as .arff file for prediction. With 10 fold cross validation, the performance obtained for benchmark dataset is given below for reference.

Correctly Classified Instances	586	76.3021 %
Incorrectly Classified Instances	182	23.6979 %
Kappa statistic	0.4664	
Mean absolute error	0.1894	
Root mean squared error	0.3403	
Relative absolute error	62.3949 %	
Root relative squared error	87.4346 %	

Total Number of Instances   768

=== Confusion Matrix ===

a   b   c   <-- classified as

0   0   0 | a = Outcome

0 422 78 | b = 0

0 104 164 | c = 1

4.2 Experiment-2
In this experiment, real data collected from individuals, which consists of 40 records is given as input. Results obtained for data collected from individuals is given along with ranking of attributes

Ranked attributes:
0.7213   2 attribute_1

0.6152   3 attribute_2

0.5817   8 attribute_7

0.5416   4 attribute_3

0.2749   1 attribute_0

0.2566   5 attribute_4

0.0961   6 attribute_5

0.0129   7 attribute_6

Correctly Classified Instances   36   90   %

Incorrectly Classified Instances   4   10   %

Kappa statistic   0.7721

Mean absolute error   0.0827

Root mean squared error   0.2535

Relative absolute error   27.036 %

Root relative squared error   65.7608 %

Total Number of Instances   40

=== Confusion Matrix ===

a b c   <-- classified as

0 0 0 | a = OUTCOME

0 11 2 | b = 0

0 2 25 | c = 1

The performance of the model has been determined using confusion matrix. Confusion matrix is represented using four measures, namely, True Positive (TP), False Positive (FP), False Negative (FN) and True Negative (TN) which are defined as follows.

- True Positive (TP) represents that the actual value as true and predicted value as true.

- False Positive (FP) denotes that the actual value as false and predicted value as true.

- False Negative (FN) represents that the actual value as true and predicted value as false.

- True Negative (TN) represents that the actual value as false and predicted value as false.

A sample confusion matrix looks like as given in Fig. 2

Fig. 2: Confusion matrix

Further, the mathematical formulae for different evaluation measures, namely, accuracy, precision, recall and F-score are given through the following equations

(i) Accuracy
Accuracy is calculated as the number of all correct predictions divided by the total number of the sample. Accuracy can be calculated with the following formula,

$$Accuracy = \frac{TP + TN}{TP + TN + FN + FP}$$

(ii) Precision
Precision is calculated as the number of correct positive predictions divided by the total number of positive predictions. The formula for calculating prediction is given below:

$$Precision = \frac{TP}{TP + FP}$$

(iii) Recall
Recall is calculated as the number of correct positive predictions divided by the total number of positives. Recall can be calculated as,

$$Recall = \frac{TP}{TP + FN}$$

(iv) F – score
F – score is a harmonic mean which helps to measure recall and precision at the same time. It can be calculated as,

$$F\text{-}score = 2 \times \frac{Recall \times Precision}{Recall + Precision}$$

4.3 RESULTS
From experiment 1, the accuracy of the Bayesian classification with benchmark dataset has been found as 76.3%. From experiment 2, the accuracy of the same classifier with real dataset has been found as 90%. The values of accuracy, precision, recall and F-measure obtained for benchmark dataset and real dataset are given Table 1

Table 1 Performance of the classifier

	Accuracy	Precision	Recall	F-Score
Benchmark dataset	76.3%	75.9%	76.3%	76%
Real dataset	90%	90%	90%	90%

5. CONCLUSION
In this project work, prediction of diabetes in individuals using machine learning algorithm has been taken up. Special emphasis has been given for data collection and applying the algorithm to real data. This has been done with an intension of validating the constructed model with real data. From experimentation, it is found that the

Naïve Bayes algorithm gives an accuracy of 90% for a dataset consisting of 40 records. Though the results are encouraging, the algorithm needs to employed for huge datasets and model needs to be generalized.

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APPENDIX - A

@RELATION diabetes2

@ATTRIBUTE attribute_0 REAL

@ATTRIBUTE attribute_1 REAL

@ATTRIBUTE attribute_2 REAL

@ATTRIBUTE attribute_3 REAL

@ATTRIBUTE attribute_4 REAL

@ATTRIBUTE attribute_5 REAL

@ATTRIBUTE attribute_6 REAL

@ATTRIBUTE attribute_7 REAL

@ATTRIBUTE attribute_8 {OUTCOME,0,1}

@DATA

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1,82,90,20.45,0,22.1,0.725,22,0

5,136,150,25.01,0,20.2,0.615,61,0

1,160,120,21.09,20,21.3,0.399,21,1

3,125,90,23.07,0,26.3,1.467,34,0

4,188,130,26.56,0,23.6,0.198,57,1

2,65,90,19.06,0,20.5,0.096,22,0

3,188,130,24.56,0,23.6,0.268,55,1

4,62,110,21.23,0,18.1,0.354,32,0

3,140,118,19.43,6,22.6,0.676,22,1

7,188,170,25.78,0,23.6,1.478,87,1

1,97,120,16.65,0,20.5,0.335,18,0

3,220,130,22.07,0,19.6,0.254,42,1

4,150,110,21.5,0,20.6,0.183,26,0

7,200,160,23.76,10,20.8,0.551,54,1

3,80,90,19.4,0,22.5,0.587,23,0

12,299,140,27.32,0,22.6,1.441,70,1

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3,71,90,21.04,0,23.1,0.698,24,0

8,240,130,26.4,0,23.9,0.277,70,1

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5,148,128,20.08,0,20.4,0.942,36,0

7,236,140,24.65,0,23.4,0.487,50,1

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7,192,130,24.56,15,22.6,0.232,62,1

5,219,140,23.21,0,23,0.484,60,1

9,219,140,26.21,0,21.3,0.398,65,1

6,233,180,25.45,0,20.6,0.801,61,1

4,151,130,24.09,0,22.8,0.356,42,1

11,244,150,26.05,30,23.8,0.543,78,1

7,167,120,25.55,0,21.4,0.801,67,1

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0,190,180,27.07,0,23.3,0.858,62,1

0,180,120,26.45,0,23.8,0.659,47,1

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ANTI COMPLEX FUZZY SOFT EUCLIDEAN RING

N. SARALA AND S. DHAYALNITHI

ABSTRACT

In this paper, we introduced the concept of anti complex fuzzy soft Euclidean ring .Then we investigated some of their characteristics of anti complex fuzzy soft Euclidean ring. The relationship between anti complex fuzzy soft Euclidean ring and complex fuzzy soft ring is also investigated

In section 2, preliminary definitions and results are given. In section 3, a definition of anti complex fuzzy soft Euclidean Ring and theorems

Keywords: Complex fuzzy soft ring, homogeneous complex fuzzy soft set, anti complex fuzzy soft Euclidean ring.

1. INTRODUCTION
The fuzzy sets was introduced by Zadeh[16].Rosenfeld introduced fuzzy groups[14].Molodtsov introduced soft set theory first result[9].Aktas ,cagman introduced soft sets and soft groups[5].Maji et.al. introduced fuzzy soft sets[7].Abdullkadir aygunoglu ,Halis aygun introduced Introduction to fuzzy soft groups [1].Motzkin introduced the Euclidean algorithm[10].Nagata introduced on Euclidean algorithm and some remarks on Euclidean Ring[11,12].Agargun ,Ersoy introduced about Euclidean Rings [2].Agargun and Fletcher introduced on Euclidean rings [3].Alsarahead and Ahmad introduced complex fuzzy sub ring [6].Varol et.al. Introduced on fuzzy soft rings[15]. Ramot et.al introduced complex fuzzy sets[13].

2. PRELIMINARIES

Definition 2.1
A complex fuzzy set ,defined on a universe of discourse U, is characterised by a membership function $\mu_A(x)$ that assigns any element $x \in U$,a complex valued grade of membership in A .By definition ,the values $\mu_A(x)$ may receive all lie within the unit circle in the complex plane ,and are thus of the form $r_A(x)e^{i\omega_A(x)}$,where $i = \sqrt{-1}$, $r_A(x)$ and $\omega_A(x)$ are both real valued ,and $r_A(x) \in [0,1]$, $\omega_A(x) \in [0,2\pi]$.The complex fuzzy set may be represented as the set of ordered pairs

$$A = \{(x, \mu_A(x)): x \in U \}$$

Definition 2.2
Let $A = \left\{(x, \mu_A(x): \mu_A(x) = r_A(x)e^{i\omega_A(x)}, x \in U \right\}$ and $B = \left\{(x, \mu_A(x): \mu_A(x) = r_A(x)e^{i\omega_A(x)}, x \in U \right\}$

Be two complex fuzzy sets of the same universe U. Then

$$\mu_{A\cap B}(x) = r_{A\cap B}(x)e^{i\omega_{A\cap B}(x)} = \min\{r_A(x), r_B(x)\}e^{imin\{\omega_A(x),\omega_B(x)\}} \qquad A_\pi$$

Definition 2.3
Let R be a ring and $A = \{(x, \mu_A(x)): x \in U \}$ be a fuzzy set. Then A is said to be a fuzzy subring if the following hold

(i) $\mu_A(x + y) \geq \min\{\mu_A(x), \mu_A(y) \}$ for all $x, y \in R$

(ii) $\mu_A(xy) \geq \min\{\mu_A(x), \mu_A(y) \}$ for all $x, y \in R$

Definition 2.4
Let $A = \{(x, \mu_A(x)): x \in U \}$ be a fuzzy set .Then the set $A_\pi = \left\{\left(x, \gamma_{A_\pi}(x)\right): \gamma_{A_\pi}(x) = 2\pi\mu_A(x), x \in U\right\}$ is said to be a π – fuzzy set.

Definition 2.5
Let R be ring and A_π be a π – fuzzy set. Then A_π is said to be a π – fuzzy subring if the hold

(i) $\gamma_{A_\pi}(x + y) \geq \min\{\gamma_{A_\pi}(x), \gamma_{A_\pi}(y) \}$ for all $x, y \in R$

(ii) $\gamma_{A_\pi}(xy) \geq \min\{\gamma_{A_\pi}(x), \gamma_{A_\pi}(y) \}$ for all $x, y \in R$

Definition 2.6
A π – fuzzy set. A_π is a π – fuzzy subring if and only if A is a fuzzy subring

Definition 2.7
Let U be the initial universe and E be the set of parameters. let S^U denote the set of all complex fuzzy sets of U, $A \subset E$ and $f: A \mapsto S^U$. A pair (f, A) is said to be a complex fuzzy soft set over U.

Let U be a universe set and (f, A) be a complex fuzzy soft set over U. Then (f, A) yields two fuzzy soft sets over U as follows

(i) The fuzzy soft set $(\overline{f}, A)$,where $\overline{f}: A \mapsto S^{-U}$ and S^{-U} is the set of all fuzzy sets of the for $\{(x, r_{f(a)}(x): x \in U, a \in A\}$ such that $\mu_{f(a)}(x) = r_{f(a)}(x)e^{i\omega_{f(a)}(x)}$ is the membership function of the complex fuzzy set $f(a)$

(ii) The π – fuzzy soft set $(\underline{f}, A)$,where $\underline{f}: A \mapsto \underline{S}^U$ and $\underline{S}^U$ is the set of all π – fuzzy sets of the form $\{(x, \omega_{f(a)}(x): x \in U, a \in A\}$ such that $\mu_{f(a)}(x) = r_{f(a)}(x)e^{i\omega_{f(a)}(x)}$ is the membership function of the complex fuzzy set $f(a)$

(iii) Definition 2.8
A fuzzy soft set $(\overline{f}, A)$ is said to be a fuzzy soft ring if and only if $\overline{f}(a)$ is a fuzzy soft subring for all $a \in A$

Definition 2.9
A π – fuzzy soft set $(\underline{f}, A)$ is said to be a π – fuzzy soft ring if and only if $\underline{f}(a)$ is a π – fuzzy soft subring for all $a \in A$

Definition 2.10
The intersection of two complex fuzzy soft sets (f, A) and (g, B) over U,denoted by $(f, A) \cap (g, B)$,is the complex fuzzy soft set (h, C),where $C = A \cap B$ and $h(c) = f(c) \cap g(c)$ for all $c \in C$

Definition 2.11
The union of two complex fuzzy soft sets (f, A) and (g, B) over U,denoted by $(f, A) \cup (g, B)$,is the complex fuzzy soft set (h, C),where $C = A \cup B$ and for all $c \in C$

$$h(c) = \begin{cases} f(c) & c \in A - B \\ g(c) & c \in B - A \\ f(c) \cup g(c) & c \in A \cap B \end{cases}$$

Definition 2.12
let $A = \{(x, \mu_A(x)): x \in U\}$ and $B = \{(x, \mu_B(x)): x \in U\}$ be two complex fuzzy subsets of U ,with membership functions $\mu_A(x) = r_A(x)e^{i\omega_A(x)}$ and $\mu_B(x) = r_B(x)e^{i\omega_B(x)}$,respectively .Then

(i) A complex fuzzy subsets A is said to be a homogeneous complex fuzzy set if for all $x, y \in U$

(ii) $r_A(x) \le r_A(y)$ if and only if $\omega_A(x) \le \omega_A(y)$

(iii) A complex fuzzy subsets A is said to be a homogeneous with B ,if for all $x, y \in U$

$r_A(x) \le r_B(y)$ if and only if $\omega_A(x) \le \omega_B(y)$

Definition 2.13
Let R be ring and $A = \{(x, \mu_A(x)): x \in R\}$ be homogeneous complex fuzzy soft set with membership function $\mu_A(x) = r_A(x)e^{i\omega_A(x)}$. Then A is complex fuzzy soft subring of R if and only if

(i) The fuzzy set $\bar{A} = \{(x, r_A(x)): x \in R, r_A(x) \in [0,1]\}$ is a fuzzy subring

(ii) The π – fuzzy set $\underline{A} = \{(x, \omega_A(x)): x \in R, \omega_A(x) \in [0, 2\pi]\}$ is a π – fuzzy subring

Definition 2.14
Let (f, A) be a complex fuzzy soft set over a universe U.Then for all $\alpha \epsilon [0,1]$ and $\beta \epsilon [0, 2\pi]$, the set $(f, A)_{(\alpha, \beta)} = \{(f, A)_{(\alpha, \beta)}: a \in A\}$ is called an (α, β)–level soft set of complex fuzzy soft set where (f, A), $(f, A)_{(\alpha, \beta)} = \{x \in U: r_{f(a)} \ge \alpha,$

$\omega_{f(a)}(x)\}$ is an $(\alpha, \beta) -$ level set of complex fuzzy set $f(a)$ .Here for each $\alpha \epsilon$ [0,1] and$\beta \epsilon [0,2\pi]$, $(f, A)_{(\alpha,\beta)}$is a soft set in the classical case.

3. Anti Complex Fuzzy Soft Euclidean Ring

Definition 3.1

Let $(\tilde{f}, A)$ and $(\tilde{g}, B)$ be two complex fuzzy soft sets over a universe set U.Then

(i) A complex fuzzy soft set $(\tilde{f}, A)$ is said to be a homogeneous fuzzy soft set if and only if $\tilde{f}(a)$ is a homogeneous complex fuzzy set for all $a \in A$

(ii) A complex fuzzy soft set $(\tilde{f}, A)$ is said to be a completely homogeneous complex fuzzy soft set if and only if$\tilde{f}(a)$ is a homogeneous with $\tilde{f}(b)$ for all $a, b \in A$

(iii) A complex fuzzy soft set $\tilde{f}(a)$ be a homogeneous with $\tilde{g}(b)$ if and only if is a homogeneous with for all $a \in A \cap B$

Definition 3.2

Let R be a ring and $(\tilde{f}, A)$be a homogeneous complex fuzzy soft set over R .Then$(\tilde{f}, A)$ is said to be a anti complex fuzzy soft Euclidean ring shortly (CHFSER) over R if and only if the following hold

(i) $\mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq max\{\mu_{\tilde{f}(a)}(y_1), \mu_{\tilde{f}(a)}(y_2)\}$

(ii)$\mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big) \leq max\{\mu_{\tilde{f}(a)}(y_1), \mu_{\tilde{f}(a)}(y_2)\}$ for all $a \in A, x_1, x_2, y_1, y_2, d_1, d_2 \in R$.

Theorem 3.3

Let R be a ring and $(\tilde{f}, A)$ be a homogeneous complex fuzzy soft set over R .Then $(\tilde{f}, A)$ is a anti complex fuzzy soft Euclidean ring of R if and only if

(i) The fuzzy soft set $(\overline{\tilde{f}}, A)$ is a fuzzy soft Euclidean ring

(ii)The $\pi -$ fuzzy soft set $(\underline{\tilde{f}}, A)$ is a $\pi -$ fuzzy soft Euclidean ring

Proof

Let $(\tilde{f}, A)$ be a and $x, y \in G$ .then for all $a \in A$ we have

$$r_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big)e^{i\omega_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big)} = \mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big)$$

$$\leq max\{\mu_{f(a)}(y_1), \mu_{f(a)}(y_2)\}$$

$$= max\{r_{\tilde{f}(a)}(y_1)e^{i\omega_{\tilde{f}(a)}(y_1)}, r_{\tilde{f}(a)}(y_2)e^{i\omega_{\tilde{f}(a)}(y_2)}\}$$

$$= max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}e^{imin\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}}$$

since $(\tilde{f}, A)$ is homogeneous

So $r_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}$ and

$\omega_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq max\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}$

on the other hand

$$r_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big)e^{i\omega_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big)} = \mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big)$$

$$\leq max\{\mu_{f(a)}(y_1), \mu_{f(a)}(y_2)\}$$

$$= max\{r_{\tilde{f}(a)}(y_1)e^{i\omega_{\tilde{f}(a)}(y_1)}, r_{\tilde{f}(a)}(y_2)e^{i\omega_{\tilde{f}(a)}(y_2)}\}$$

$$= max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}e^{imin\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}}$$

since $(\tilde{f}, A)$ is homogeneous

Which implies

$r_{\tilde{f}(a)}((x_1 - d_1y_1)(x_2 - d_2y_2)) \leq \max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}$ and

$\omega_{\tilde{f}(a)}((x_1 - d_1y_1)(x_2 - d_2y_2)) \leq \max\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}$

So $(\overline{\tilde{f}}, A)$ is a fuzzy soft Euclidean ring and $(\underline{\tilde{f}}, A)$ is a π –fuzzy soft Euclidean ring

Conversely, let $(\overline{\tilde{f}}, A)$ be a fuzzy soft Euclidean ring and $(\underline{\tilde{f}}, A)$ is a π –fuzzy soft Euclidean ring, then for all $a \in A$ we have

$r_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2)) \leq \max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}$

$\omega_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2)) \leq \max\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}$

$r_{\tilde{f}(a)}((x_1 - d_1y_1)(x_2 - d_2y_2)) \leq \max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}$

$\omega_{\tilde{f}(a)}((x_1 - d_1y_1)(x_2 - d_2y_2)) \leq \max\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}$

Now

$\mu_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2)) = r_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2))e^{i\omega_{\tilde{f}(a)}((x_1-d_1y_1)+(x_2-d_2y_2))}$

$\leq \max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}e^{imin\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}}$

$\leq \max\{r_{\tilde{f}(a)}(y_1)e^{i\omega_{\tilde{D}(a)}(y_1)}, \quad r_{\tilde{f}(a)}(y_2)e^{i\omega_{\tilde{f}(a)}(y_2)}\}$

$\leq \max\{\mu_{f(a)}(y_1), \mu_{f(a)}(y_2)\}$

On the other hand,

$\mu_{\tilde{f}(a)}((x_1 - d_1y_1)(x_2 - d_2y_2)) = r_{\tilde{f}(a)}((x_1 - d_1y_1)(x_2 - d_2y_2))e^{i\omega_{\tilde{f}(a)}((x_1-d_1y_1)(x_2-d_2y_2))}$

$\leq \max\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}e^{imin\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}}$

$\leq \max\{r_{\tilde{f}(a)}(y_1)e^{i\omega_{\tilde{f}(a)}(y_1)}, \quad r_{\tilde{f}(a)}(y_2)e^{i\omega_{\tilde{f}(a)}(y_2)}\}$

$\leq \max\{\mu_{f(a)}(y_1), \mu_{f(a)}(y_2)\}$

So $\tilde{f}(a)$ is a anti complext fuzzy soft Euclidean subring thus $(\tilde{f}, A)$ is a anti complex fuzzy soft Euclidean ring

Theorem 3.4
Let $\{(\tilde{f}_i, A_i); i \in I\}$ be a collection of anti complex fuzzy soft Euclidean ring over a ring R such that $(\tilde{f}_i, A_j)$ is homogeneous with $(\tilde{f}_k, A_k)$ for all $j, k \in I$.Then $\cup_{i \in I}(\tilde{f}_i, A_i)$ is a anti complex fuzzy soft Euclidean ring

Proof
Let $\cup_{i \in I}(\tilde{f}_i, A_i) = (\tilde{h}, C)$ where $C = \cup_{i \in I} A_i$

Then we have $\tilde{f}_i(c)$ is a anti complex fuzzy soft Euclidean subring for all $i \in I$ and $c \in C$ so $r_{\tilde{f}_i(c)}(x_1 - d_1y_1)$ is a normal complex fuzzy soft subgroup and $\omega_{\tilde{f}_i(c)}(x_1 - d_1y_1)$ is a π- fuzzy soft Euclidean subring .Now, for all $x_1, x_2, y_1, y_2, d_1, d_2 \in R$ we have

$\mu_{\tilde{h}(c)}((x_1 - d_1y_1) + (x_2 - d_2y_2)) = \mu_{\cup_{i \in I}\tilde{f}_i(c)}((x_1 - d_1y_1) + (x_2 - d_2y_2))$

$= r_{\cup_{i \in I}\tilde{f}_i(c)}((x_1 - d_1y_1) + (x_2 - d_2y_2))e^{i\omega_{\cup_{i \in I}\tilde{f}_i(c)}((x_1-d_1y_1)+(x_2-d_2y_2))}$

$= \max_{i \in I}\{r_{\tilde{f}_i(c)}((x_1 - d_1y_1) + (x_2 - d_2y_2))\}e^{imax_{i \in I}\{\omega_{\tilde{f}_i(c)}((x_1-d_1y_1)+(x_2-d_2y_2))\}}$

$\leq \max_{i \in I}\{max\{r_{\tilde{f}_i(c)}(y_1), r_{\tilde{f}_i(c)}(y_2)\}e^{imax_{i \in I}\{max\{\omega_{\tilde{f}_i(c)}(y_1), \omega_{\tilde{f}_i(c)}(y_2)\}\}}\}$

$$= \text{Max}\left\{\max_{i\in I}\{r_{\tilde{f}_i(c)}(y_1)\}, \min_{i\in I}\{r_{\tilde{f}_i(c)}(y_2)\}\right\} e^{imax\left\{\max_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_1),\}, \max_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_2)\}\right\}}$$

$$= \text{Max}\left\{\max_{i\in I}\{r_{\tilde{f}_i(c)}(y_1)\}e^{imax_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_1)\}}, \max_{i\in I}\{r_{\tilde{f}_i(c)}(y_2)\}e^{imax_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_2)\}}\right\}$$

(Since, $(\tilde{f}_j, A_j)$ is homogeneous $(\tilde{f}_k, A_k)$ with for $j, k \in I$)

$$= \text{Max}\{\mu_{\cap_{i\in I}\tilde{f}_i(c)}(y_1), \mu_{\cap_{i\in I}\tilde{f}_i(c)}(y_2)\}$$

$$= \text{Max}\{\mu_{\widetilde{h}(c)}(y_1), \mu_{\widetilde{h}(c)}(y_2)\}$$

On the other hand

$$\mu_{\widetilde{h}(c)}((x_1 - d_1y_1)(x_2 - d_2y_2)) = \mu_{\cup_{i\in I}\tilde{f}_i(c)}((x_1 - d_1y_1)(x_2 - d_2y_2))$$

$$= r_{\cup_{i\in I}\tilde{f}_i(c)}((x_1 - d_1y_1)(x_2 - d_2y_2))e^{i\omega_{\cup_{i\in I}\tilde{f}_i(c)}((x_1-d_1y_1)(x_2-d_2y_2))}$$

$$= \max_{i\in I}\{r_{\tilde{f}_i(c)}((x_1 - d_1y_1)(x_2 - d_2y_2))\}e^{imax_{i\in I}\{\omega_{\tilde{f}_i(c)}((x_1-d_1y_1)(x_2-d_2y_2))\}}$$

$$\geq \max_{i\in I}\left\{max\{r_{\tilde{f}_i(c)}(y_1), r_{\tilde{f}_i(c)}(y_2)\}e^{imax_{i\in I}\left\{max\{\omega_{\tilde{f}_i(c)}(y_1), \omega_{\tilde{f}_i(c)}(y_2)\}\right\}}\right\}$$

$$= \text{Max}\left\{\max_{i\in I}\{r_{\tilde{f}_i(c)}(y_1)\}, \max_{i\in I}\{r_{\tilde{f}_i(c)}(y_2)\}\right\} e^{imax\left\{\max_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_1),\}, \max_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_2)\}\right\}}$$

$$= \text{Max}\left\{\max_{i\in I}\{r_{\tilde{f}_i(c)}(y_1)\}e^{imax_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_1)\}}, \max_{i\in I}\{r_{\tilde{f}_i(c)}(y_2)\}e^{imax_{i\in I}\{\omega_{\tilde{f}_i(c)}(y_2)\}}\right\}s$$

(Since, $(\tilde{f}_j, A_j)$ is homogeneous $(\tilde{f}_k, A_k)$ with for $, k \in I$)

$$= \text{Max}\{\mu_{\cup_{i\in I}\tilde{f}_i(c)}(y_1), \mu_{\cup_{i\in I}\tilde{f}_i(c)}(y_2)\}$$

$$= \text{Max}\{\mu_{\widetilde{h}(c)}(y_1), \mu_{\widetilde{h}(c)}(y_2)\}$$

Theorem 3.5

Let $(\tilde{f}, A)$ be a complex fuzzy soft over a Euclidean ring R.Then $(\tilde{f}, A)$ is a anti complex fuzzy soft Euclidean ring over a ring R if and only if for all $a \in A$ and for arbitrary $\alpha \epsilon$ [0,1] and $\beta\epsilon[0,2\pi]$,and $a \in A$ with $\tilde{f}(a)_{(\alpha,\beta)} \neq \emptyset$ the $(\alpha, \beta) -$ level soft set $\tilde{f}(a)_{(\alpha,\beta)}$ is a soft Euclidean ring over R in classical case

Proof

Let $(\tilde{f}, A)$ be a anti complex fuzzy soft Euclidean ring over a R.Then for all $a \in A$, $\tilde{f}(a)$ is a anti complex fuzzy Euclidean subring R . For arbitrary $\alpha\epsilon$ [0,1] and $\beta\epsilon[0,2\pi]$,and $a \in A$ with $\tilde{f}(a)_{(\alpha,\beta)} \neq \emptyset$,let $(x_1 - d_1y_1), (x_2 - d_2y_2) \in \tilde{f}(a)_{(\alpha,\beta)}$

Then we have $r_{f(a)}((x_1 - d_1y_1)) \leq \alpha$ and $\omega_{f(a)}((x_1 - d_1y_1)) \leq \beta$ also $r_{f(a)}((x_2 - d_2y_2)) \leq \alpha$ and $\omega_{f(a)}((x_2 - d_2y_2)) \leq \beta$.Now

$$r_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2))e^{i\omega_{\tilde{f}(a)}((x_1-d_1y_1)+(x_2-d_2y_2))} = \mu_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2))$$

$$\leq \text{Max}\{\mu_{f(a)}(y_1), \mu_{f(a)}(y_2)\}$$

$$= \text{Max}\{r_{\tilde{f}(a)}(y_1)e^{i\omega_{\tilde{f}(a)}(y_1)}, r_{\tilde{f}(a)}(y_2)e^{i\omega_{\tilde{f}(a)}(y_2)}\}$$

$$= \text{Max}\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\}e^{imin\{\omega_{\tilde{f}(a)}(y_1),\omega_{\tilde{f}(a)}(y_2)\}}$$

This implies

$$r_{\tilde{f}(a)}((x_1 - d_1y_1) + (x_2 - d_2y_2)) \leq \max\{r_{\tilde{f}(a)}(x_1 - d_1y_1), r_{\tilde{f}(a)}(x_2 - d_2y_2)\}$$

$$\geq \text{Max}\{\alpha, \alpha\}$$

$$= \alpha$$

$$\omega_{f(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq \max\big\{\omega_{f(a)}(x_1 - d_1 y_1), \omega_{f(a)}(x_2 - d_2 y_2)\big\}$$

$$\leq \text{Max } \{\beta, \beta\}$$

$$= \beta$$

$$r_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big)e^{i\omega_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big)} = \mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big)$$

$$\leq \max\big\{\mu_{\tilde{f}(a)}(y_1), \mu_{\tilde{f}(a)}(y_2)\big\}$$

$$= \text{Max}\big\{r_{\tilde{f}(a)}(y_1)e^{i\omega_{\tilde{f}(a)}(y_1)}, r_{\tilde{f}(a)}(y_2)e^{i\omega_{\tilde{f}(a)}(y_2)}\big\}$$

$$= \text{Max }\big\{r_{\tilde{f}(a)}(y_1), r_{\tilde{f}(a)}(y_2)\big\}e^{i\min\{\omega_{\tilde{f}(a)}(y_1), \omega_{\tilde{f}(a)}(y_2)\}}$$

This implies

$$r_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big) \leq \max\big\{r_{\tilde{f}(a)}(x_1 - d_1 y_1), r_{\tilde{f}(a)}(x_2 - d_2 y_2)\big\}$$

$$\leq \text{Max } \{\alpha, \alpha\}$$

$$= \alpha$$

$$\omega_{f(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big) \leq \max\big\{\omega_{f(a)}(x_1 - d_1 y_1), \omega_{f(a)}(x_2 - d_2 y_2)\big\}$$

$$\leq \max\{\beta, \beta\}$$

$$= \beta$$

So $(x_1 - d_1 y_1), (x_2 - d_2 y_2) \in \tilde{f}(a)_{(\alpha,\beta)}$. There $\tilde{f}(a)_{(\alpha,\beta)}$ is a Euclidean subring of R ,thus $\big(\tilde{f}, A\big)_{(\alpha,\beta)}$ is a soft Euclidean ring over R.

Conversely,

For all $a \in A$ and for arbitrary $\alpha \epsilon$ [0,1] and $\beta \epsilon [0,2\pi]$ let $\big(\tilde{f}, A\big)_{(\alpha,\beta)}$ be a soft Euclidean ring over R .let $(x_1 - d_1 y_1), (x_2 - d_2 y_2) \in R$, assume $r_{\tilde{f}(a)}(x_1 - d_1 y_1) = \tau, r_{\tilde{f}(a)}(x_2 - d_2 y_2) = \rho, \omega_{f(a)}(x_1 - d_1 y_1) = \eta$

$\omega_{f(a)}(x_1 - d_1 y_1) = \sigma$.suppose $\alpha = \max\{\tau, \rho\}$ and $\beta = \max\{\eta, \sigma\}$,this implies $(x_1 - d_1 y_1), (x_2 - d_2 y_2) \in \tilde{f}(a)_{(\alpha,\beta)}$ .By hypothesis $\tilde{f}(a)_{(\alpha,\beta)}$ is a Euclidean subring of R,so $(x_1 - d_1 y_1) + (x_2 - d_2 y_2) \in \tilde{f}(a)_{(\alpha,\beta)}$ and $(x_1 - d_1 y_1)(x_2 - d_2 y_2) \in \tilde{f}(a)_{(\alpha,\beta)}$.

Thus

$$r_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq \alpha$$

$$= \max\{\tau, \rho\}$$

$$= \max\{r_{\tilde{f}(a)}(x_1 - d_1 y_1), r_{\tilde{f}(a)}(x_2 - d_2 y_2)\}$$

$$\omega_{f(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq \beta$$

$$= \max\{\eta, \sigma\}$$

$$= \max\{\omega_{f(a)}(x_1 - d_1 y_1), \omega_{f(a)}(x_2 - d_2 y_2)\}$$

Therefore,

$$\mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq \max\{\mu_{\tilde{f}(a)}(x_1 - d_1 y_1), \mu_{\tilde{f}(a)}((x_2 - d_2 y_2)\}$$

Also , $r_{\tilde{f}(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq \alpha$

$$= \max\{\tau, \rho\}$$

$$= \max\{r_{\tilde{f}(a)}(x_1 - d_1 y_1), r_{\tilde{f}(a)}(x_2 - d_2 y_2)\}$$

And

$$\omega_{f(a)}\big((x_1 - d_1 y_1) + (x_2 - d_2 y_2)\big) \leq \beta$$

$$= \max\{\eta, \sigma\}$$

$$= \max\{\omega_{f(a)}(x_1 - d_1 y_1), \omega_{f(a)}(x_2 - d_2 y_2)\},$$

Therefore

$$\mu_{\tilde{f}(a)}\big((x_1 - d_1 y_1)(x_2 - d_2 y_2)\big) \leq \max\{\mu_{\tilde{f}(a)}(x_1 - d_1 y_1), \mu_{\tilde{f}(a)}((x_2 - d_2 y_2)\}$$

So $(\tilde{f}, A)$ is a anti complex fuzzy soft Euclidean ring over a ring R.

CONCLUSION

In this paper, we introduced the notion of anti complex fuzzy soft Euclidean ring.To extended to the properties of different notion of anti complex fuzzy soft Euclidean ring.

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DIFFERENT ENERGY HARVESTING, ENERGY SAVING TECHNIQUES TO IMPROVE BATTERY ENERGY OF WIRELESS SENSOR NETWORKS-A REVIEW

Y. P. MAKIMAA, SUDARMANI R AND VANITHAMANI R

ABSTRACT

Nowadays, many practical and real time applications are using sensors and Wireless Sensor Networks (WSNs) due to its characteristics such as scalability and small in size. Enormous number of sensor nodes is associated with Wireless Sensor Networks with limited sensing, computing, and communication capabilities. All of the units in the sensor nodes, on the other hand, are powered by the primary batteries that come with it. The energy associated with the batteries are finite and also must be replaced when they run out, which raises the expense of maintenance. Furthermore, because a battery's State of Charge (SoC) is difficult to determine, hence for a crucial applications preventive replacement is necessary before the actual drain out. In some other applications, battery replacement can be prohibitively expensive or even impossible.To overcome these problemsand to increase the efficiency of the battery in terms of power density a suitable material is needed. This article presents different materials for battery and different energy harvesting and battery energy saving techniques to overcome the said problems.

Index Terms: Wireless Sensor Networks, Battery materials, Energy harvesting, Energy saving, Water level variations.

1. INTRODUCTION

Environmental disasters are largely unpredictable and occur in a relatively short amount of time. As a result, technology must be created to record appropriate signals with the lowest possible observing disruption. In regions where cabling is not possible, a WSN is one of the latest technologies that can instantly respond to rapid alterations in data and communicate sensed data to a data analysis centre [1]. Despite the availability of satellite image systems that allow for rainfall forecasts, real-time monitoring and alerting systems are required to continuously monitor flow, precipitation level, and water level, make necessary judgments, and send an urgent alert to avert flooding [2].In addition, water level monitoring of rivers, bays, and the sea is an essential concern in the face of rapidly changing environmental circumstances, and many scholars have recently been drawn to this field of study.

The improvements in wireless technologies and communication protocols, environmental monitoring systems based on low-cost, low-power, and multi-functional sensors that can normally communicate within predetermined distance constraints have been developed [2]. The standard method for data collecting and monitoring relies on a large number of sensors aggregated in a single station that is powered from the outside.This system must be submerged in water and continue to record data for a specified period of time, which could be longer [1]. Energy is a scarce resource in sensor nodes due to limited battery availability and the necessity for frequent battery swaps and recharging. The four methods of media access control commonly employed in sensor networks are (a) time uncertainty, (b) asynchronous method: prolonged preamble, (c) asynchronous approach: wake-up frames, and (d) synchronous approach [35]. WSNs have been used for a variety of purposes in the past, ranging from small-scale healthcare surveillance to large-scale environmental monitoring [26].In order to power the sensor nodes, batteries are used. These batteries must be replaced or recharged often, which is expensive. To ensure uninterrupted work, it is necessary to plan battery replacement beforehand in accordance with battery depletion [37]. In mobile applications, lithium-ion batteries are subjected to continuous cycling and usually operate under constant voltage conditions. All users can experience the strong heating of batteries; it is detrimental because high temperatures result in the degradation of the electrolyte [41]. Also, the capacity of a battery and maximum energy delivered by of a battery is depending on the type of active material and the amount of it. Also, energy output of the battery is depending on the weight or size of it [46].

Different types of materials used for batteries and available are,

❖ Zinc-Carbon Batteries

❖ Magnesium and Aluminum

Batteries
❖ Alkaline-Manganese Dioxide

Batteries

❖ Mercuric Oxide Batteries

❖ Silver Oxide Batteries

❖ Zinc/Air Batteries

❖ Lithium Batteries

❖ Solid/Electrolyte Batteries

❖ Nickel-Cadminumetc [45].

The station is repaired at the end of the specified time for data transfer, dispensation evaluation, and to undertake a predefined set of actions.In this paper, a survey on different battery materials to intensify the battery lifetime, different energy harvesting and saving techniques are discussed for improved life of sensor nodes in WSN. The following section deals with literature review, and followed with different issues related with energy harvesting, comparison of different routing protocols for energy saving, different power management techniques to estimate battery life and concluded with conclusion.

2. RELATED WORK

Many researchers have discussed and carried out research about energy saving, optimization and efficient energy harvesting techniques for battery energy of nodes present in WSN.Mohammad HosseinAnisi et al (2017) [1], explained about different energy efficient routing technique, where the reduction in the energy consumption-based routing schemes also discussed. Authors also presented, a comparative study of various energy harvesting mechanisms and routing protocols based on battery power for energy saving. To save energy different techniques were adopted in WSN, which includes routing, clustering etc. M. Pramanick et al (2014) [2] have discussed different routing and load balanced clustering scheme for energy saving of nodes present in the WSN. The simulation results of different techniques were compared and analyzed.Sudarmani. R, K.R. Shankar Kumar (2012) [3], proposed clustering technique with energy efficiency for heterogeneous sensor networks and also sink is in mobile nature. By adopting this technique sensor nodes energy consumptionget reduced for clustering with mobile sink compared with stationary sink.

Rohner C et al (2013) [4], evaluated the energy efficiency of three battery models for WSN. The parameter taken for analysis was capacity effect with a rate of change and power recovery which indicates the battery discharge behaviors. The conclusion was the load's peak current play a vital role in saving energy compared to its timing. Agnelo Silva et al (2012) [5], authors suggested a novel combined three power management techniques for increasing energy solutions of battery energy of WSN. The work had been implemented in outdoors with high temperatures in underground by placing beneath the ground and alsoplaced in the structures such as buildings, bridges, and roads. The battery lifetime of communication devices got extended by the allocation of the developed techniques. Chulsung Park et al (2005) [6], have developed analysis of the battery performance characteristics to improve the operating life of battery powered systems through the battery discharge in WSNs. The impact of environmental parameters in sensor networks and how these parameters interact with electrochemistry of battery parameters such as efficiency, capacityrecovery rate and effects due to temperature.

O Mokrenko et al (2015) [7], proposed a power management strategy and estimation of the battery energy. Amount of energy that has been received from the battery represents the battery capacity where the State of-Charge (SoC) is used by the battery manufacturers to specify the battery performance. The authors have carried out the minimization of a cost function by Constrained Optimal Control problem, which was based on the predicted system evolution, under a set of constraints. Felicia Engmann et al (2018) [8], the authors gave an insight into different energy management schemes and harvesting schemes. These different techniques were designed for the efficient utilization of battery energy in a network and in some occasions for the efficient use of harvested energy also. Energy harvesting had been obtained from external sources such as wind, vibrations, solar, acoustic, and thermal etc. The harvested energy could be electrical in nature and that could be used in wireless sensing nodes/devices. The harvested energy solved the black hole problem. But the harvested energy would not always be available; this is a main drawback in this system. Hence, storing of the harvested energy is an essential one for later use. The authors suggested that the storage devices used in the system were either batteries (rechargeable and nonchargeable) or supercapacitors.

Communication-based power management is a battery-driven system-level power management methodology in which the system level communication architecture regulates the execution of various system components with

the goal of increasing battery efficiency and thus battery life, as proposed by KanishkaLahiri et al. (2002) [9]. In order to respond to the present discharge battery characteristics, this method may postpone the execution of certain system components if they are active.To increase the battery life of sensor nodes many routing protocols had been developed, also different energy harvesting techniques developed, which are used to supply the energy directly to nodes or it could be used to store for further use. Stefano Basagni et al [10], gave an insight in to different energy harvesting and storage techniques. Secondary rechargeable batteries and supercapacitors are the two most prevalent energy storage options (also known as ultracapacitors). Supercapacitors are comparable to ordinary capacitors, except they have a much higher capacitance in a much smaller package.

Estimating battery lifetime in WSN is essential one to improve the lifetime of sensor nodes. LeonardoM.Rodrigues et al (2017) [11], have proposed estimating of battery operating behavior using software-based solutions. The authors have implemented by using the two steps such as, (i) evaluation of the computational cost of performing sophisticated algorithms in microcontrollers with limited processing power, and (ii) deployment of analytical battery models in WSN nodes.In this study, authors used MICA 2 based experimental test-bed with commercial lithium-coin batteries. Also, many different techniques for battery discharge analysis are carried out, in which its performance measures on actual batteries, an accurately calibrated version of the low-level battery had been carried out using simulator Dualfoil, and battery emulation. Increasing battery lifetime is an important one in the real time application scenario of WSN. This can be increased by increasing cell capacity, reducing voltage losses and by decreasing self- discharge characteristics (Thomas Dittrich et al[12]).
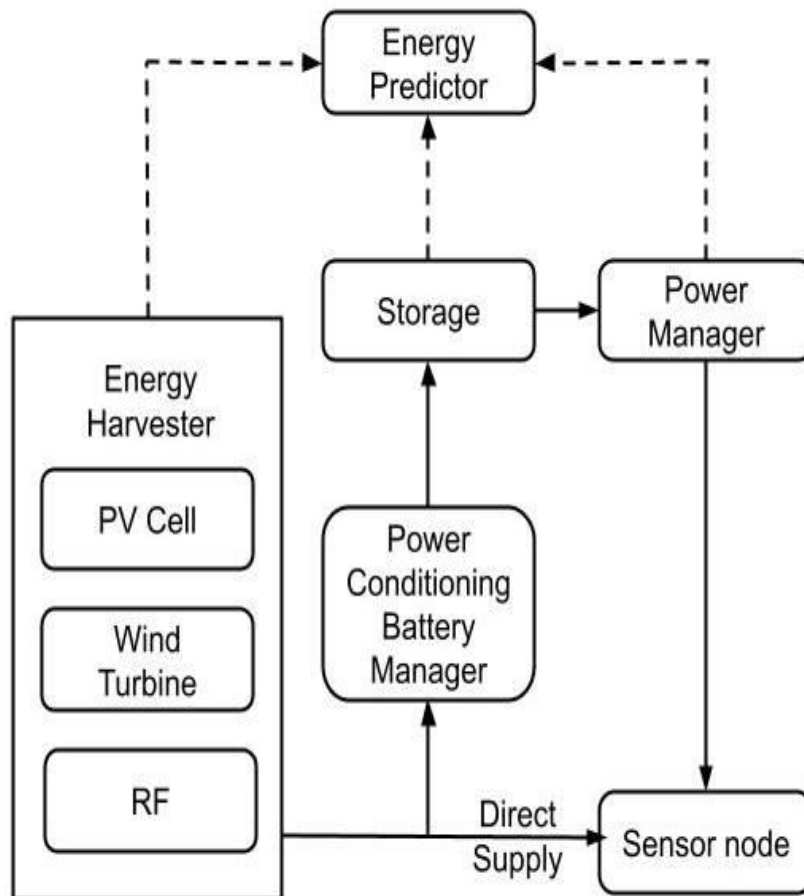
Figure 1: Architecture of WSN with energy harvesting capabilities

Agnelo Silva et al (2012) [13], placement of nodesin the unattended environment would lead to exhaust the battery storage of nodes. Hence extension of lifetime of battery is a necessary one through power management strategies. Furthermore, buried nodes in wireless underground sensor networks [1], as well as nodes located inside building walls [2, in highways, or in the internal structures of a bridge, cannot generally employ rechargeable batteries.Power gating technique is applied to save energy. A feasible power gating technique was developed by using proper designed software module. Hence rechargeable batteries are essential. Also, the authors implemented and validated the power matching technique for low current profile.

Maria Teresa Penella et al (2009) [14], authors implemented energy harvesting source such as solar cells for powering of sensor nodes. By using this harvesting source, the lifetime of nodes gets increased. Along with the efficient use of primary batteries would increase the lifetime. The secondary batteries were utilized to store the harvested energy. Chris Knight et al (2008) [15], a detailed survey had presented by the authors about energy storage and energy harvesting. Among the energy storage devices discussed are batteries, capacitors, fuel cells, heat engines, and betavoltaic systems. Energy harvesting includephotovoltaics, temperature gradients, fluid movement, pressure changes, and vibration harvesting.An emphasis was placed on the state of the art in energy storage as well as energy harvesting for sensor nodes. Batteries, capacitors, fuel cells, heat engines, and betavoltaics are among the energy storage technologies addressed. Photovoltaics, temperature gradients, fluid movement, pressure fluctuations, and vibrations were all discussed in relation to energy harvesting [16].Rosdiazli Ibrahim et al (2016) [17], energy harvesting from solar cell was developed by these authors for the industrial WSN applications. This energy harvesting mechanism was developed using photovoltaic (PV) cell array. Also, it was tested experimentally. The solar energy could be converted into electrical energy with maximum output voltage of 21 V using this PV.

Junaid Ahmed Khan   et al (2014) [18], authors surveyed a different energy harvesting schemes for the maximization of sensor nodes lifetime. All the nodes present are battery operated nodes. Finding alternate source is an important for the continuous work flow. Different energy harvesting schemes are discussed as alternate to the primary source. Authors concluded that parallel combination of recent energy providing schemes with traditional approaches would help to design energy efficient schemes in WSN. Felix Mazunga et al (2021) [28], authors proposed a dynamic power management technique to harvest the energy effectively. The article discusses recent developments in ultra-low power approaches. Also resented are the possible power management mechanisms in WSNs. The proposed ultra-low power strategies are analyzed, as well as their strengths and weaknesses. In addition, he discussed open research questions and prospective research initiatives. In a variety of applications, including as disaster prevention and chemical process control, changing or recharging node batteries is complex and expensive.As a result, there is a growing need to find alternative energy-efficient methods to power nodes and reduce network energy usage. Energy-aware strategies are required to ensure the network's long-term viability and performance while lowering costs and reducing energy usage.Overhearing, retransmission of data, idle listening, etc. will consume more energy.

Qian Zhao et al. (2013) proposed a new energy efficient system to reduce the power consumption in WSN, threshold controlled hierarchical routing was employed to reduce the communication distance in WSN. The proposed system was achieved a better result, the life of WSN was extended 6 times longer that compared to the direct data transmission. The simulation of the system was done for 50 nodes, and 100 nodes. When the sensor nodes have more than one child node, the frequency of data transmission was more, obviously resulting in the "tiredness" of the parenting node. In the proposed architecture, the tired nodes send the data, without receiving them, thereby consuming power. The positions of the nodes were calculated by determining the path loss using the principle of Received Signal Strength Indicator (RSSI). The considerations taken were: The sensor nodes were accommodated in the circumference of the base station. A model was proposed to give all the senor nodes a global knowledge [48].

O. N. Samijayani et al, (2017), experimented solar cell energy for WSN applications. The output solar cell voltage was 2V – 6V. The value was suitable for WSN devices, and XBee series. The performance of the cell was determined on the intensity of solar energy, the output power range of the solar cell was 220 mV-750 mV. Smaller solar panel was not efficient enough to supply energy to WSN. Hence, a larger solar panel of dimension 180x81x1.55 mm was used to supply the energy required for WSN. The efficiency of the solar panel was 76.59%, and 56.22% during morning and afternoon respectively. In the later version of XBee, the solar panel was sufficient to supply energy only in idle and in operating mode [19].

The energy consumption of the entire sensor network was determined based on the network protocols. S. Chanagala and Z. J. Khan, (2017), mentioned the applications of WSN in various fields such as agriculture, defense, wild life monitoring, monitoring of pollution levels, and vehicular traffic etc [20].
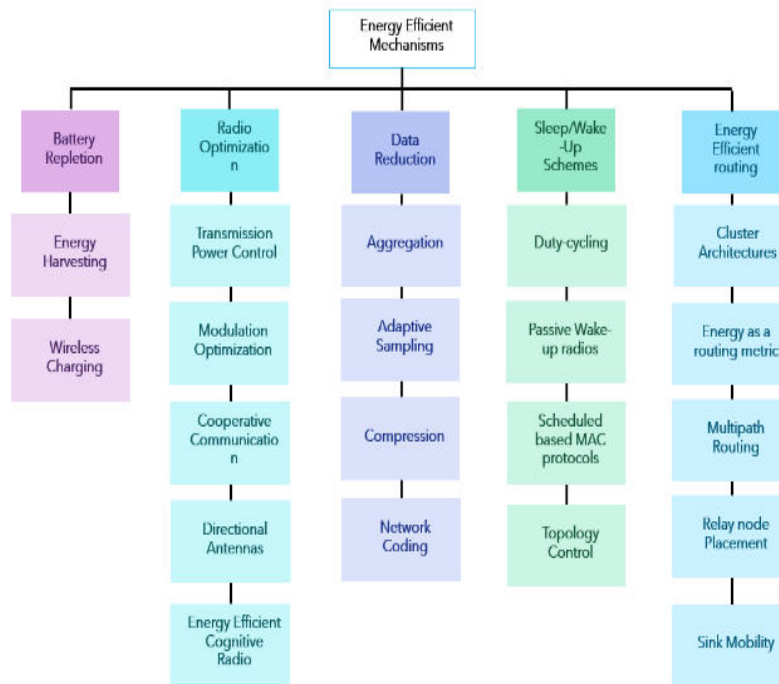
Figure 2: Various Energy Efficient Mechanisms

Transmission power control is one way to reduce energy consumption by adjusting transmission powers based on channel conditions. Utilizing environmental energy sources as a way of providing additional power for nodes is another technique. This research created a solar and electromagnetic energy harvesting model, as well as a Mixed Integer Programming (MIP) technique to reduce energy dissipation by sensor nodes. The influence of a hybrid energy harvesting model and transmission power regulation on node energy savings was studied using a model based on the MIP framework [21].The energy efficient mechanisms are applications dependent. In case of radio optimisation, the directional antennas, and transmission power control affects the coverage by adjusting the communication range and direction. The quality of the signal was affected due to the impact of cognitive radio and cooperative communication module by smart channel selection and collaborative re-transmission.The impacted requirements includes coverage, and robustness. The cluster networks in the energy efficient routing maintained a hierarchy in the network leading to the improvement in the scalabilty of the network [22]. Alternative routing paths were provided in case of node failures, leading to the increase in the robustness in multi routing paths. The network coverage and the node connectivity was controlled by relay node placement technique. The scalability of the network was improved by connecting the sparse networks through sink mobility technique.

Data reduction approaches were useful for improving the latency by:

- Reducing the number of packets sent, and

- Decreasing the waiting time.

- The traffic load was decreased as these techniques exhibited good scalability properties.

In sleep/wake schemes, the adaption in the duty-cyclcing schemes were useful to improve the context-awareness. A god delay was achieved under high traffic by using TDMA based MAC protocols [23]. Fig.3 shows the taxonomy of WSN applications.

Solar cells were repurposed as antennas to save space. To improve the amount of RF energy gathered, a multiport antenna was used. When the incident RF input power density is varied from 13.30 to 52.96 mW/m 2, the solar cell can produce 1.68 mW of power, while the antenna can create an extra 4.8 percent to 45.8% of power when the incident RF input power density is varied from 13.30 to 52.96 mW/m 2. The transparent antenna is said to have a 72.4 percent efficiency, which is one of the best figures ever recorded. Furthermore, at RF input power of 10 dBm, the rectifiers achieve 53.2 percent conversion efficiency. The suggested RF-solar energy harvester, based on these findings, can boost harvesting and provide energy diversity [24]. A threshold-optimal policy was proposed to maximize the energy utility using a Markov-Decision model in the infinite horizon. As a result of using distributed techniques, redundant nodes in the network will conserve energy, and they will be dynamically activated based on feedback. Indriya and FlockLab testbeds were used to implement

ReNEW. There were 20 source nodes in the network out of a total of 30 source nodes. With a harvesting energy of 50 J/s for 100B packets every 30s, ReNEW collected data on a more frequent basis than LWB, with 2.5 times higher packet reception and a 25% higher residual energy savings [25].

Healthcare
Vital signs monitoring, Remote Healthcare surveillance

Agriculture and Nature
Precision agriculture, cattle monitoring, Environment monitoring

Transportation Systems
Traffic control, Safety systems.

Industry
SCADA systems, Smart Grids

Public safety and Military Systems
Active Intervention
Passive Supervision
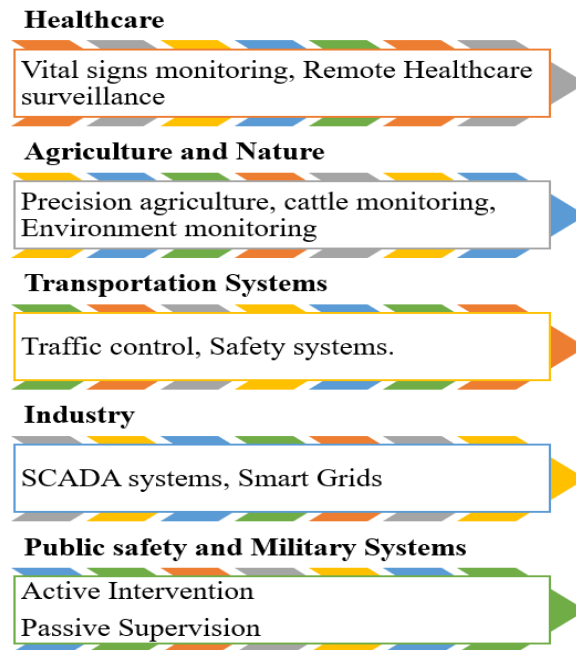
Figure 3: WSN Taxonomy

Because of their large range of real-time applications, Wireless Sensor Networks are a popular choice. The energy consumption of a wireless sensor network is one of the main issues in a typical deployment of a large number of wireless sensor nodes [27]. By using an energy neutral minimum cost path between a source and a sink node, the path energy can be optimised. A polynomial-time approach has been presented to discover the best path from a single source to a sink. In order to approach the maximum flow potential, a Ford-Fulkerson method was utilised to examine the network capacity. The algorithm was validated using path capacity, energy ratio, least energy of nodes, and path cost. In the work, energy-neutral nodes, energy-neutral paths and energy-neutral minimum cost paths were defined. Two different approximation algorithm were proposed to achieve a maximum communication in a single-source single-sink network. The proposed algorithm has showed better results compared to the existing methods [28].

Thomas Menzel and Adam Wolisz (2013), proposed a novel technique to indicate the end-of-life in duty-free WSN. It was measured by calculating the difference in the voltage under loaded and unloaded battery conditions. The over potential in common batteries were prone to less variations, due to the operational parameters, and construction. This approach enabled precise identification of imminent battery depletion. The battery discharge values were collected from 82 experiments, each of them running for 3 to 14 days. Experienced holes in the individual voltage traces due to various reasons, power cuts, human failure, and lower measurement reference values. The important aspect of the evaluation was the Confidence Intervals (CI) [47]. WSNs consisted of a target, sensor node, sensor field, switch, ethernet and end-user.Energy-efficient techniques were identified for minimizing the energy consumption of WSNs.The energy harvesting WSNs were developed to solve this problem.

3. **ISSUES FACED**
- In most of the applications developed, the source node is kept static, however, in case of WSN used in real-time applications like animal tracking and intelligent transportation systems mobility is needed. More techniques need to be analyzed for the support of mobility in WSNs.

- Considering various energy sources like solar, which will be available based on the climate, location and the season of the environment. The RF energy though it is predominantly found everywhere, the major challenge faced is the fluctuations and the low power density. Hence a single energy source is not efficient when connected to the energy conservation system. A hybrid energy source must be developed, efficient for the energy conservation in WSN.

- Different power management strategies can help in the conservation of energy and the network can be put to sleep if it's not in use. Dynamic Power Management (DPM) systems has many sub systems which enables the most economical power nodes for the working of the WSN. The power consumption can be minimized by disabling the idle nodes of the network or the communication sub system. Several predictive models for the energy conservation are developed. As a result, erratic sleep and waking cycles are introduced since it is not possible to know, in advance, how much energy is left in each node.

- A few proposed models did not have a significant impact on battery life because they were theoretical types or high-level implementation protocols. In addition, most of the models used a battery powered design that resulted in an overestimated lifetime because of the constant voltage. Modeling batteries was also problematic due to their non-linear behavior [40].

Few recent routing protocols are discussed in table 1.

Table 1: Recent Routing Protocols

Routing Protocols	Advantages	Disadvantages	Inference/Solutions
NEEC algorithm [29]	• The selection of the channel is guided by the present remaining energy of the node and the rate of energy harvesting. • The energy is balanced among all the nodes and the lowest energy node is rejected. • It avoids long distance transmissions instead multi-hop transmissions system is adopted for long distance.	• Mobile nodes are not considered over here. • Additional overhead by requiring all nodes to calculate the distance from the sink based on the received signal. • The performance of the network is degraded during cloudy weather and at night. They possess no mobility support system.	• Clustering approach is proposed for large scale network. • The algorithms can be developed considering the stochastic nature of the surroundings.
EAMP [28]	• Residual energy of the all the nodes present in the network is maximized and the Electricity System Operator (ESO) is minimized. • The data is delivered at a faster rate compared to conventional methods, and the network lifetime is increased due to multiple routing.	• Due to the presence of several source nodes, the performance is degraded. • The delivery of data during the night is delayed because of solar energy source.	• Hybrid Energy systems can be used.
SEH-WSN [30]	• The network throughput is increased by 31.42 times. • Increased network lifetime of 115.75 days.	• The total energy consumption of the network is increased tremendously.	• The energy consumption at the sensor nodes is reduced. • Integrated power management system is used along with renewable energy-based system.
E^2–MACH [31]	• Residual energy got increased, packet loss got reduced, and enhancement in stability of WSN.	• Overhead of message broadcasting, • No mobility support. • More energy consumption in the CH section.	• Requires more accurate solar energy techniques, energy harvesting systems with multi source can be built. • Mobility support needs modification.

Energy aware distributed clustered routing protocol mechanism based on neural network-solar energy prediction model [32]	• Energy consumption across all the nodesare in balanced condition. • Increase in network throughput.	• Not efficient during the night.	• Hybrid energy systems can be utilized to obtain a better predictive model. • The seasonal change must be considered.
Optimal routing for time-driven EH-WSN under regular energy sources [33]	• The average traffic load is reduced by the minimum hop count. • Increase in node average duty cycle. The traffic load is equally distributed among the whole WSN.	• No power control for transmitter nodes. • The transmission impairments and poor energy situations are not catered.	• Dynamic duty cycling mechanisms. • Adjusting the routing topology. • Energy harvesting predictive algorithms can be used for the estimation of the future energy intake of the network.
FFC [34]	• Lifetime is increased by energy sharing • High packet delivery	• Increase in mobility decreases the performance of the protocol. • Not suitable for small packet sizes.	• Mobility support systems can be utilized.

Battery-operated sensor nodes were limited in their energy storage capacity due to their small size. Wireless sensor networks connected traditional computer networks to the physical world. An energy-efficient sensor node model was presented. It was found that higher layer optimization of the sensors yielded better results, with the sensors consuming most of the energy. This network was shown as having both low and high workloads. First-phase systems, which represent the network when there are no intruders, have been referred to as low workload systems. When no intruders are detected, the nodes wake up, then fall back to sleep when no intruders are detected. Consequently, this model is highly energy efficient and provides power management. The second stage is an indication of the activity of intruders. The location of the intruder was determined at this stage through communication and computation. A metric involving the energy pent for each unit of work done was calculated in this stage, and the corrective measures were applied to reduce consumption of energy [35].

An experiment showed that the performance of the cell under concentrated sunlight was 40.8% higher because the cells were monolithic Gallium Indium Phosphate/Gallium Arsenic/Gallium Indium Arsenic. National Renewable Energy Laboratory (NREL) tested the developed model in a low Aerosol Optical Depth (low-AOD) spectrum [36]. The sensor nodes in sensor networks must increase their energy efficiency in order to meet the increased demand. A discussion of relative works for which solar cells are the primary power source. The design parameters of nodes, optical energy, energy storage, and the efficiency of solar cells compared to conventional batteries. During darkness, solar cells can store energy for five days. Comparatively, the battery strength was two orders of magnitude greater than supercapacitors. Solar energy batteries performed well both outdoors and indoors, according to the study. Outdoor solar power was deemed to be the most efficient method of powering continuous nodes. A total of three types of nodes were implemented, two outdoor and one indoor [37]. A study was conducted on the routing and initial energy allocation of sensor networks to maximize their lifetimes. An optimal model consisting of time-invariant routing in a fixed topology network has been used as a solution to a set of nonlinear programming problems. The purpose of the optimization was to consider an initial energy allocation and joint routing over the nodes, while retaining a constant lifetime. Several factors were considered when analyzing the network's performance, including threats to security, the network's lifetime, and normalized throughput [38].

A microcontroller-controlled energy harvesting and storage system using two capacitors, four DC/DC converters, and four DC batteries is the most efficient way to keep the WSN running. A supercapacitor acted as an energy buffer, supplying energy to other components in the system. A specific voltage level in the superconductors was controlled to minimize the WSN's energy consumption. When supercapacitors were compared with capacitors, their energy density, capacity, and price were compared. The supercapacitors were

found to have a hundred times greater energy capacity than capacitors, but they were more expensive. As a result of the proposed system, they were found to be more environmentally friendly, capable of operating in a wider temperature range, and have more than 5,00,000 recharging cycles. Step-up and step-down converters were used to control the amount of energy and to utilize the energy stored in supercapacitors [39].

To run the application cycle-accurately, and log the states of all component components, MSPSim/Cooja's node emulator and network simulator was used. In the lifetime estimation framework, the logs were fed. On the basis of the radio duty cycle, the proposed battery model was compared to the ideal battery model. Several limitations of the model were noted, such as the lack of ground truth, nodes experiencing losses when deployed, re-transmission reactions, and a lack of routing topology adaptation. Using the duty cycle when estimating the battery's life is one of the limitations of the ideal battery model. There is a vast difference between the two methods, ranging from 36 to 76%[40].The study compares temperature variations in three different locations of a lithium battery between thermocouples and fiber sensors. The battery was subjected to constant current charge at different voltage rates. The result inferred that Fiber Bragg Grating (FBG) sensor had better resolution and lower rise time up to 28.2% compared with K-type Thermocouples (TC). The comparative model showed that they were suitable for real-time monitoring and were used for failure detection and optimization. FBG and TC sensors were used in Lithium-ion Batteries (LiB)[41] to monitor temperature variations at varying discharge rates. The issue of charging the batteries was taken into account. Node's energy capacity was calculated considering the charging device availability. An algorithm for creating exact columns that integrates a genetic algorithm was proposed. Lifetime improvements was achieved by choosing the charge levels, when there was energy scarce [42].

The temperature and expansion sensor were used for testing to improve the state of charge and state of health estimation. The sensors were built on polyimide substrate, enabling direct integration between the cells. Inductive coil eddy current was created to identify cracks in sensor fabrication. The thickness of the developed sensor was 100 μm. The performance of the pack-life environment was tested using three-cell fixture. The system showed advantages including the decrease in the system cost, improved battery utilization, and physics-based battery control [43].

Sensor nodes and wireless sensor networks are determined by their battery condition. In this study, an optimal approach was presented for extending the lifetime of lithium batteries by examining the discharge characteristics, and the power dissipation of the sensor nodes. At lower temperature conditions, the sensor nodes dissipate less power, increasing the lifetime of the WSN. By compressing data, the battery performance was increased by 12-18%, and the battery life by 9%. In order to minimize the rate capacity of the battery, a data compression strategy was adopted. The sensor nodal distance was decreased to achieve higher levels of lifetime improvements. Additionally, the reduction in transmission power led to an increase in the lifetime of WSN [44].

4. FACTORS AFFECTING BATTERY PERFORMANCE

The performance difference in the battery discharge, capacity, recharging ability, storage depends based on the manufacturing industries, the load, temperature variations, operating conditions, applications used etc., The battery discharge capabilities depend on the voltage profiles. With greater value of voltage, the discharge value is also greater. The precise design of the multicell battery, as well as the hardware employed, will have an impact on its performance (such as packaging techniques, spacing between cells, container material, insulation, potting compound, fuses and other electronic controls, etc.)because those elements affect the battery's environment and temperature.To avoid hot spots in batteries, they should be designed thermally so that their internal temperature is uniform [45].

5. CONCLUSION

During the previous decade, our world has seen a boom of technologies. Energy Harvesting Wireless Sensor Networks (EHWSNs) are becoming increasingly popular in a variety of applications. The amount of energy required for continuous network operation remains a challenge, despite recent developments in energy management and harvesting techniques for EHWSNs. To maximise EHWSN lifetime in real-life conditions, ultra-low power and ultra-longevity solutions for EHWSNs should be further developed. A brief overview of current advances in energy-saving strategies for extending the battery life of WSNs. As all the protocols used are focused on the small-scale sector, hence a large-scale evaluation of the protocols remains an open area of research. The study highlights the challenges and the strengths of different network protocols.

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DETECTION OF MULTIPLE ACCESS MU-LS MIMO OFDM SYSTEMS BY MLPNN

SHEFIN SHOUKATH AND P. A. HARIS

ABSTRACT

Large Scale MIMO OFDM gains the transmission throughput and spectral efficiency requirements of wireless channel. LS MIMO system helps to improve the dispersive nature of the fading channels by incorporating multiple antennas at the receiver. Multiuser detectors at the base station suitably elevates the reduction of multiuser interference occurring within the users. The performance of the MUD in a LS MIMO environment is classified by suitable nonlinear algorithms.The detection is evaluated using cumulative distribution function corresponding to the variation of the receiver terminals. The detector performance is also measured by the outage probability of the receiver. The system also outperforms in its behaviour with a low symbol error rate at high SNR values. The multiuser signal detection is done initially with a linear detector and is further improved by suitable nonlinear MLP classifier. Bit error rate (BER) of MLPNN MUDs has 23dB gains over MMSE detectors specifically at $10^{(-5)}$ bit error rate. Thus MLP multiuser detector is proposed for improving the performance of the MU detectors in an LS MIMO OFDM scenario.

Keywords: LS MIMO, OFDM, Multiuser detection, MMSE MUD, MLP, BER, Spectral efficiency.

1. INTRODUCTION

Wireless networks has growing exponentially as the demand for data transmission in machine to machine communication and live video streaming must be supported. The main problems faced are transferring of information demanding a frequency channel and energy which are very scarce resources, traffic management and latency are the problems faced in this field. In wireless networks, the most profound requisite is data throughput (bits/s), hence terminologies which sufficiently use the channel allocation must put forward. The consumption of energy by the user terminals and base transceiver station has to be addressed in this scenario. Multiple access spatial LS MIMO uses aerials in the reception station ensuring high information throughput in minimum inter user interference. By utilizing the increased degrees of freedom, MU- Uplink LS MIMO users are aided with antenna terminals in radiating signals the base station (BS).The propagation limitations and the energy consumption is drastically reduced with multiple antennas in MU- MIMO. The multiuser interference among the users degrades the performance of users in an uplink MU- LS MIMO. The degradations occurring in the LS MIMO link can be overcomed by adopting suitable interference reduction or cancellation techniques [1].

Degradations in multiple access path due to intersymbol interference is brought down by multicarrier waveforms, Orthogonal Frequency Division Multiplexing. These multiple carriers has the potential in overcoming the grave conditions arising in the channel. OFDM by transmitting the streams of information in parallel diverse paths achieves the high throughput [2]. The integration of techniques, MU LS MIMO to OFDM can thus meet the growing applications requiring elevated data rates. The tradeoff between complexity and performance is balanced by the MIMO OFDM technique. MIMO OFDM realize a remarkable spectral efficiency rate (SE) and data throughput in a multipath channel bandwidth in wireless communication. Thus the OFDM multicarrier modulation technique with LS MIMO is suggested since a considerable improvement achieved in spectral efficiency and BER improvement [3].

Multiuser LS MIMO provides the information bits into diverse channels between the multiuser and the base station, thereby solving wireless communication capacity issues. The channel impulse response of each specific user makes it possible to identify the user at the destination. The reduction of inter symbol interference by OFDM technique and the capability to gain excessive capacity, turns this into a favourable technique in future wireless field of communication [4-8].

The multiuser detection (MUD) is conducted at the receiver aerials by knowing features of the channel. Linear combiners, Minimum mean square error (MMSE) and Zero forcing (ZF) MUDs detects the signals at the base station. The channel coefficients in linear detectors are non-separable, hence nonlinear degradation due to the inter symbol interference cannot be diminuated in the multipath transmission. At the same instance the maximum likelihood (ML) MUDs attains the best performance due to the subsequent exhaustive search performed at the receiver which in turn leads to the receiver complexity. Nonlinear MUDs are employed in detecting the multiuser signals under the overloaded condition [9-11]. This problem can be resolved by

nonlinear classifiers like deep learning models. Among the nonlinear classifiers, the Multilayer perceptron (MLP) algorithm is chosen for data detection of multiusers in the base station [12-13].

The paper is structured as: the review of the works related to LS MIMO OFDM technology and neural networks discussed in Section 2. Section 3, elaborated the principles behind multiuser detection. The concepts of multiuser detection principles are detailed in Section 4. Section 5 discussed the analysis and simulation results. Finally, in section 6 the inferences of the study is concluded.

2. RELATED WORKS

Wireless channel are frequency selective channels because of the multipath nature of the environment. This characteristics of the multipath channel makes to be dominant of inter symbol interference. This feature can be resolved by streaming the transmission bits in parallel paths each of narrow bandwidth. R.W.Chang put forwarded the idea of multicarrier modulation waveform, orthogonal frequency division multiplexing [14]. This transmission scheme faced many difficulties in its implementation due complex modulator and demodulator structures. These difficulties were later overcome by an alternative solution suggested by Weinstein and Ebert [15] by implementing the modulator and demodulators by Discrete Fourier Transform (DFT), which possibly elevate the complexity.

The multiuser detection of the signals transmitted by the multiusers are detected by the MUDs if it is sensible to features of the channel. By undergoing significant researches in the field of multiuser detectors paved the way to its development. The minimum MSE detector and zero forcing receivers detects multiuser signals with combiners [16-17]. These linear detectors cannot eliminate the multipath fading effects as these signals are inseparable and hence causes residual errors. The nonlinear detectors and the computationally complex maximum likelihood (ML) detectors gains much better performance compared to these linear detectors by undergoing exhaustive search [16].

Nonlinear MUDs, successive interference (SIC) and parallel interference cancellation (PIC) [18, 19,20], sphere decoders (SD) [21–22] , QR decomposing (QRD) [21–25] and its modified techniques [25-31] are also introduced in these research works which compromises between the complexity and performance. But these MUDs cannot detect the multiuser signals in overloaded and rank deficient scenario.

The neural networks (ANNs), the nonlinear classifiers can handle the circumstances which are not resolved in practical situations with the supposition of knowing the channel features [32-33]. ANN based MUDs were employed as detectors in CDMA technique in the earlier techniques [34-38]. This technique was even used in SDMA OFDM models for signal detection of multiusers [39]. The neural network structures namely, multi-layered perceptron (MLP) MUD and radial basis function (RBF) MUD is powerful tools in detecting the multiuser signals with less complexity.

Supervised classifiers outputs a decision based on the discrete unknown inputs. In the field of MIMO detection, the learning so as to choose the best decoder from the set of classes of algorithms. The best design to be applied is chosen by Machine learning. The unknown symbols are the hypotheses in detection and detection rules in learning [40]. The implementation depends upon the selection of a suitable algorithm. The classes of algorithms known as architectures are included in learning. Many nonlinear operations and layers forms the deep learning structures and one among them is by iterative algorithms [41-42]. In this model each layer is designated by the iterations and a network by its algorithm [43].

3. UPLINK MU- LS MIMO OFDM

Uplink Multiuser-Large Scale MIMO OFDM is a real-time wireless broadband service without utilizing additional spectrum. It is a promising technique, meeting the higher data throughput requirements and enhanced service quality for the next generation multiuser wireless systems. A reliable connection of high speed is attained by the channel diversity of MIMO systems. This technology satisfies data transmission requirements of wireless channels while also improving transmission performance through improved spectral and energy efficiencies [44-46].

The information bits of multiple users is communicated through the uplink channel to the base station (BS) with many antennas in Multi-user Large Scale MIMO OFDM prototype. The users at receiver ends detect the signals transmitted from multiple users by the channel's impulse response. This technique is extensively acceptable now days in wireless cellular systems by sharing the time and frequency domains of the spectrum.
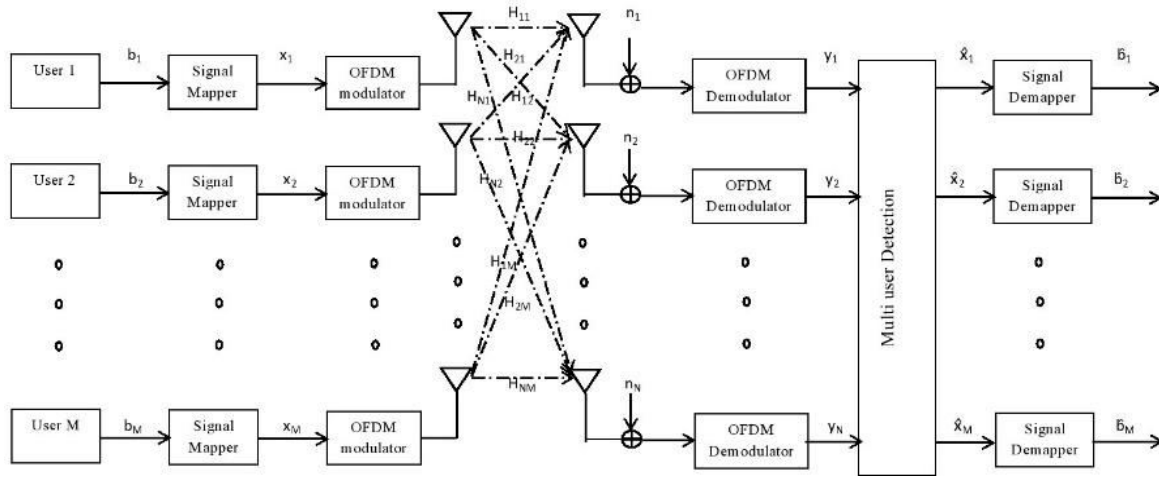
Fig. 1: Large Scale MIMO OFDM

The uplink Multi-user LS MIMO OFDM model having a considerable antenna terminals at the base receiver station is operating in Time division duplexing (TDD).

The configuration of uplink Multi-user LS MIMO OFDM prototype is demonstrated in the Figure.1. The model incorporate a base station of *N* aerial terminals and *K* multiusers with *M* antenna terminals. The uplink channels connecting the user and base station is accessed by *K* users. This diverse channel increases the spatial degrees of freedom and leads to acquire a significant data rate by the improved throughput and spectral efficiencies.

Multiple *M* users transmit the data bits b_m and which is then encoded by the independent *M* coders while transmitting to the receiver. The b^c_m the coded bits are then modulated to x_m high value modulation symbols. These x_m symbols are then OFDM modulated by IFFT algorithm, as it combats the dispersion occurring in signal. The data bits are thus transmitted through parallel low data rate sub channels. The OFDM symbols thus transmitted by each subcarriers are unaffected by multi path fading. The received symbol $y[s,k]$s,k]dimension $(Nx1)$ is detected by multiuser detector. The emitted signal x is of vector dimension $(Mx1)$x1)d noise n of vector dimension $(Nx1)$ with zero mean and variance σ^2_n. The symbol $y[s,k]$s,k]demonstrated as:

$$y[s,k] = H[s,k]x[s,k] + n[s,k] \qquad \text{y[s,k]= Hs,kx[s,k]+ n[s,k]} \qquad (1)$$

Impulse channel matrix H in frequency domain with a dimension of (NxM) is:

$$H = \begin{bmatrix} h_{11} & h_{12} & \cdots & h_{1M} \\ h_{21} & h_{22} & \cdots & h_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ h_{N1} & h_{N2} & \cdots & h_{NM} \end{bmatrix} \qquad [2]$$

The channel gain between the M_{th} multiusers and the N_{th} reception antenna of the uplink multi-user Large Scale MIMO OFDM is given by h_{NM}. The multiusers at the MUD is specified by its spatial signature in each column of the impulse response matrix H. The impulse response matrix for the uplink propagating path connecting m_{th} user and n_{th} detector antenna, for each subcarrier, is denoted as

$$H_{n,m} = \sum_{l=1}^{M} h_{n,m}(m) exp\left(\frac{-i2\pi kl}{N_c}\right) \qquad [3]$$

where l is the subcarrier path and N_c representing the IFFT length. The bits are detected by the multiuser detector and decoded by FEC decoders to recover the uplink transmitted information bits by each multiuser.

4. MULTIUSER DETECTION

The mutually interfered signals transmitted through the uplink path is to be demodulated drew on the vector received. Interference among the signals is unavoidable even by using the multicarrier waveform, OFDM. The signals communicated from the multiple aerials interferes at the base transreceiver station other than the severe distortions in the channel. The bit error rate, spectral efficiency, reduction in inter cell interference and the saturated users the system can incorporate is gained due to the multiuser detection. The uplink channel capacity rises linearly to the minimum number of aerials in the transmitter and receiver. The spatial multiplexing improves the transmission rate without the consumption of larger resources and transmitting power. The estimated signal ta the multiuser end is denoted as:

$\hat{x} = W^H y$ (4)

4.1 MMSE Detector

The signals are detected in a Minimum mean square error (MMSE) detector by detecting only those signals of the transmitter intended and others as interference, being a linear signal detector. During the detection of the pertinent user signal, signals of undesired terminals are eliminated. Thus the signal of the respective antenna is estimated by inverting the channel by weight matrix.

A linear MMSE detector has low complexity with an undesired performance. This detector also provides the highest SINR among the all other linear detectors, as noise and interference has a comparable level. Its performance considered not as an appreciable factor in rank deficient and overloaded scenarios. The weight vector of the pertinent user signal at the detector is :

$Zmmse = (HH^H + 2\sigma^2 I_n)^{-1} H_m$ [5]

σ is the noise variance. and Hermitian matrix (.),identity matrix denoting by I_n and conjugate of the transfer function by H*.

The residual interference components due to multiuser interference is contained in the detected signal of the MMSE MUD. The nonlinear detectors effectively eliminates multiuser interference components than linear detectors.
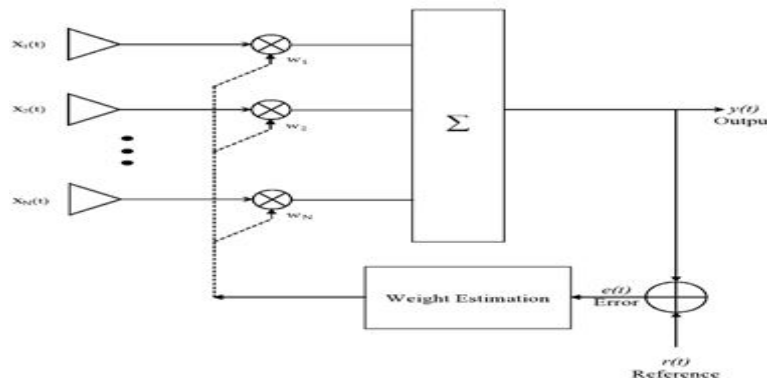
Fig. 2: MMSE DETECTOR
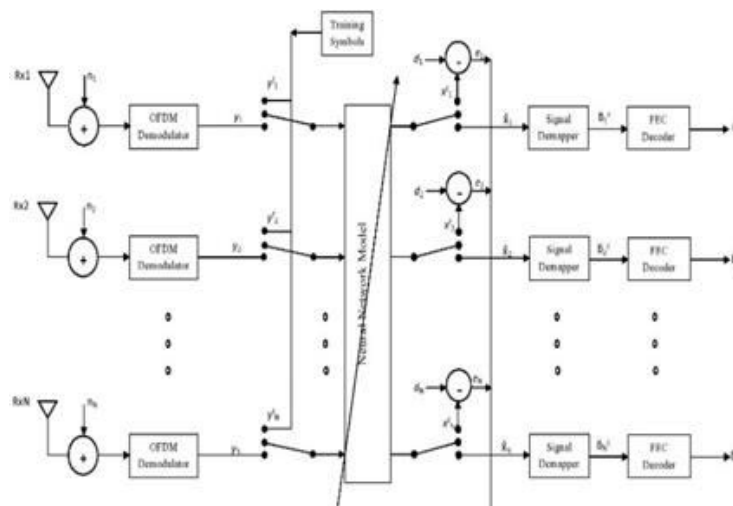
Fig. 3: Multiuser Detection using ANN model

4.2 Nonlinear Multiuser Detector

The signal detected by the MUDs upon the principle of linear classifier constitute a poor performance since the signals gets distorted because of interferences and noises in multipath scenario. Hence multiuser detector performing nonlinear modelling need to be incorporated at the receiver to mitigate this interference during the signal detection. Nonlinear neural network models detect the multiuser symbols with minimum interference, so an improved feature can be attained by quality of service and efficiency. Nonlinear models appropriately mend the synaptic weights and biases by training algorithms [9,10]. The architecture for nonlinear detector for MU-LS MIMO OFDM is illustrated in Figure 3.
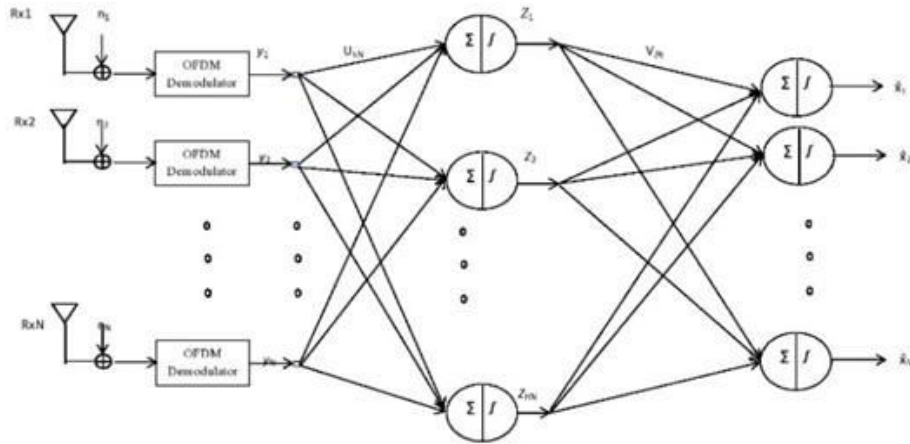
Fig 4: Multiuser Detection using MLP
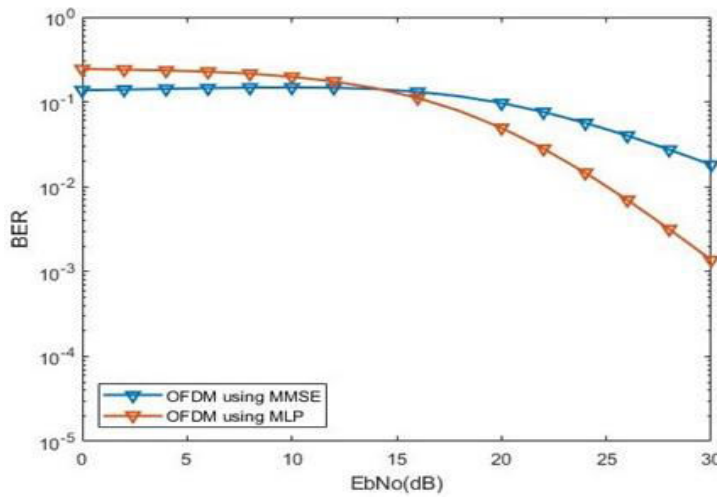
Fig 5: Bit Error Rate Analysis

4.2.1 **Multilayer Perceptron MU Detector**

Multilayer Perceptron (MLP) MUDs transforms the input vector to output vector within which suitable regression analysis are applied. The input feed data are projected as linearly separable by nonlinear transformation function in the forward direction. The layers namely, input, output and hidden are included by MLP model. The computations are mainly done by the incorporated arbitrary layers of hidden nodes. The supervised learning trains the multiple layers in MLP MUD using back propagation algorithm.

The gradient-descent optimization algorithm is employed as back propagation algorithms to minimize errors by adjusting the parameters. The function of the MLP MUD is:

$$y = \varphi\left(\sum_{i=1}^{n} w_i x_i + b_i\right) = \varphi(w^T + b) \qquad \text{(7)}$$

In the above expression, the activation function is denoted by φ, the weights are denoted by w, and the input denoted by x.

Figure 4 shows the MLP multi-user detector for uplink multi-user Large Scale MIMO OFDM. The MLP multiuser detector has N input nodes that correspond to the receiver terminals and M output nodes that detect the estimated input. The forward path is completely connected to each layers in the network. Within the forward path, the network is connecting from one layer of hidden node point to the successive. The hidden layer includes summer circuit and nonlinear activation feature [47].

5. **SIMULATION RESULTS**

The performance characteristics of an uplink multi-user Large Scale MIMO OFDM model is analysed as simulating its architecture. The architecture is analysed with multiusers of around ten users transmitting the OFDM modulated symbols to the base station incorporated with multiple number of antennas. The multiuser signal detection in multi-user LS MIMO OFDM scenario is performed satisfying the condition that statistics of

the channel is known to the detector. Rayleigh Winner-II channel model is chosen as it is appropriate for both short distance and broad area communications.

The Winner-II Rayleigh channel model finds application in both indoor and outdoor, outdoor to indoor and elevation in indoor scenario etc. This model also suitable for SISO, MIMO link and even for a multilink MIMO domain. The channel model can also operate for a wide range of frequencies from 2 to 6 GHz, of about 100 MHz. The characteristics of this channel is listed in the given table.
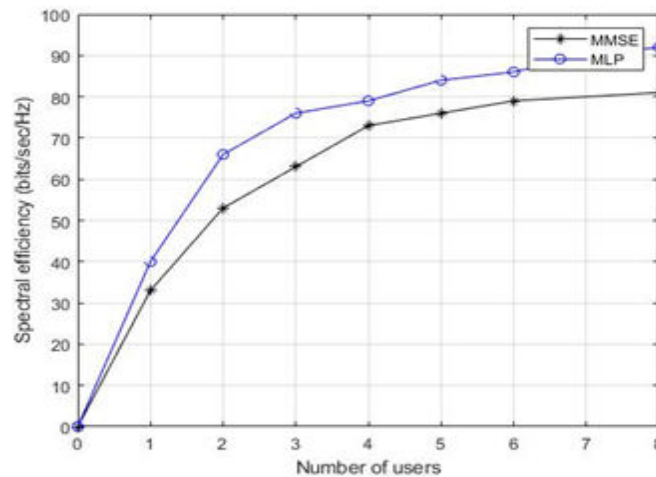
Fig 6: Spectral Efficiency Analysis

5.1 Bit Error Rate

The output estimate of the MUD for LS MIMO OFDM analysed by its bit error rate for the MUDs, respectively the linear MMSE and nonlinear MLP detector. Figure 5 sketches the BER response corresponding to the SNR variation. Interference of the multiuser components during its propagation to the base station is mitigated at the maximum extent by the MLP classifier. So these detectors has a low error rate with respect to the MMSE detector. The SNR value (Eb/No) for MLP detector, and that for MMSE MUD is 36dB and 54dB respectively at a BER of 10^{-4}

5.2 Spectral Efficiency

As spectral efficiency is enhanced by installing antenna arrays at the receiver location of LS MIMO OFDM, it becomes the promising strategy compared with 4G and LTE networks. The output data bits of the MUD of LS
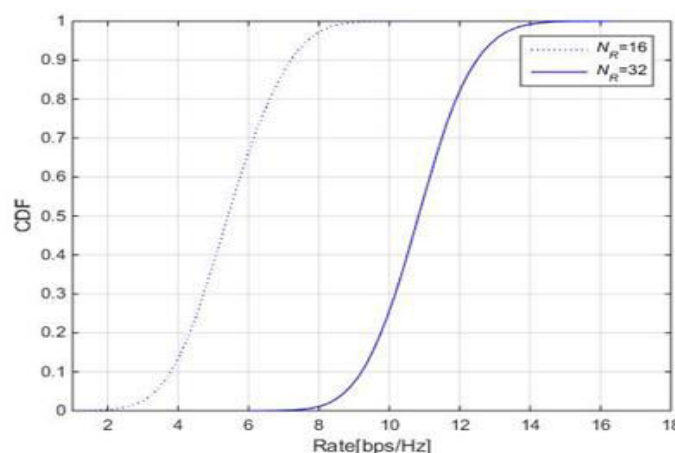
Fig 7: Cumulative Distribution Function (Spectral Efficiency)

MIMO OFDM is analysed in terms of spectral efficiency for both MUDs: MMSE and MLP. The spectral efficiency of MUDs portrayed in Figure 6 depicts spectral efficiency of MLP detection is enhanced than that of MMSE detection. The plot shows, the linear variation in spectral efficiency following a saturation with the increase of SNR. Neural network MUDs possess a comparatively higher values than that of MMSE detector. 80bps/hz, of spectral efficiency with MMSE and of 85bps/hz for the same SNDR(80dB) in MLP MUDs, which can considered as appreciable.

5.3 Cumulative distribution function of Spectral Efficiency
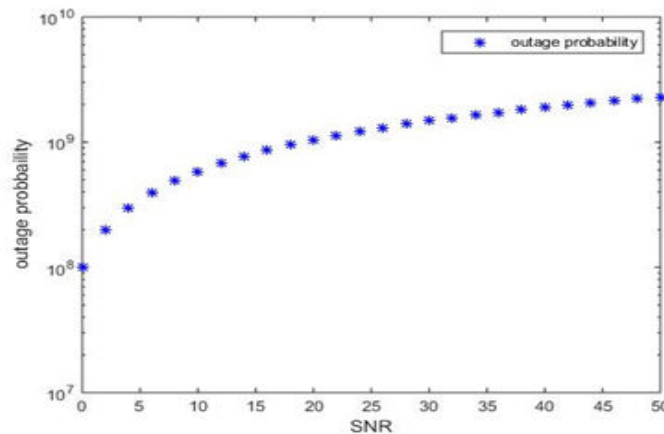
Fig 8: Outage Probability

Cumulative distribution function or CDF plot the spectral efficiency per user with base station of around 16 or 32 antennas. The integral of the function to a defined value of spectral efficiency from zero is termed to be Cumulative distribution. The spectral efficiency for the terminals in the base trans receiver illustrates better with receiver antenna of 32 than for 16 in 32 in Figure.7.

5.4 Outage Probability
The outage probability of the detected bits is plotted corresponding to the SNR variation of the signal received. The graph plotted in Figure.8 indicates the level beyond which the receiver power falls below the threshold and which is leading to failure in detecting the received signal at the detector.

5.5 Symbol Error Rate
Figure.9, plot indicates the Symbol error variation of the received multiuser signals corresponding to the signal to noise ratio. The symbol error provides indication of symbols decoded incorrectly, and those symbol falling into the adjacent symbol bin and causing error. Plot shows, rate of symbol error of the multiuser signal detected by the receiver can be varied with the improvements in SNR.

6. CONCLUSION
The detection at the base station over Winner-II Rayleigh channel is evaluated by the characteristics of the MMSE MUD and nonlinear detector performance based on outage probability, erroneous rate of symbols (SER) and bits (BER). The deployment of large number of antenna terminals at the transciever station enhanced the Large Scale MIMO OFDM with increased SNR. Directivity in wireless environment as desired, is attained by elevating diversity as providing more degrees of freedom with the result of overloaded scenario in terms of antenna terminals. A way for multiuser interference cancellation as aimed is resulted with the multiuser detectors in LS MIMO OFDM model. The spectral emissions and BER will further enhanced either by Turbo or LDPC coding of LS MIMO OFDM model.
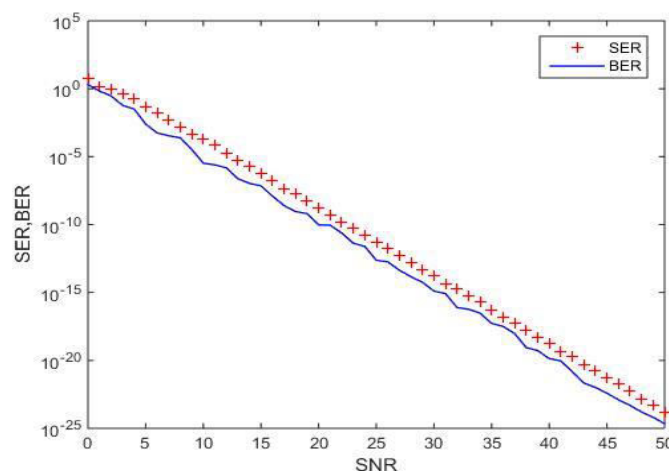
Fig 9: Error Rate Analysis

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DEEP LEARNING TECHNIQUES TO DETECT ARTEFACTS IN ENDOSCOPIC IMAGES: A RETROSPECTIVE REVIEW

N. KIRTHIKA AND B. SARGUNAM

ABSTRACT

Endoscopy is a popular technique for diagnosing and treating diseases in hollow organs like the gastrointestinal tract. In the present decade, computer-assisted tools are preferred to detect and diagnose clinical abnormalities in endoscopic images, which rely on deep learning algorithms for predictions. Endoscopic images recorded during the procedure is said to be affected by imaging artefacts. These artefacts challenge the robustness of computer-assisted tools in detecting and delineating the boundaries of abnormalities. Thus, an efficient algorithm is essential to resolve this challenge in detecting artefacts present in endoscopic images. The focus of this survey is to (1) Discuss various branches of deep learning-based object detectors (2) Comprehensively bring together diverse results of researchers who used the state-of-the-art deep learning-based object detection algorithm to detect the multi-class artefacts present in endoscopic images (3) Discuss on various public datasets available for multi-class artefact detection and common performance metrics used by authors to assess the network performance (4) Discuss on the future of artefact detection in CAD/CADx systems for real-time clinical practice. In the context of drawing an inference to this survey, this paper concludes by stating that there is high scope for multi-class artefact detection to play a pivotal role in the endoscopic imaging pipeline where the research could be deployed as a part of the future surgical robots.

Keywords: Deep learning, Object detection, Endoscopy, Artefacts, CAD tools.

1. INTRODUCTION

Endoscopy, a Greek term that means "look inside". An endoscope is a thin and long, flexible/rigid tube inserted into the body of human beings through mouth/anus/small incisions etc. It is helpful to observe, image and perform minor surgery in the internal organs. The first endoscope was designed in 1806. It is preferably used to investigate organs like the gastrointestinal (GI) tract, ear, respiratory tract, female reproductive tract, urinary tract and more. A modified endoscope called a laparoscope is used to perform keyhole/buttonhole surgery to make the process less invasive. It can be performed in the abdominal/ pelvic cavity, joints etc.

Advancement in the area includes Wireless Capsule Endoscopy (WCE), where humans will swallow a pill-sized camera. It takes pictures that will be recorded in a device attached to the human body. It is specially designed for examining the small intestine due to its complex structure. During endoscopic procedure, a video or an image is produced by the camera attached to the scope. The surgical team visualize the organs using an endoscopic imaging system connected externally. The imaging system helps the team to guide throughout the organ for further actions. These intrinsically produced video signal/images are intended for pre/post-processing and storage where the growing trend has led to many possibilities like (1) reexamine the videos/images as and when necessary, (2) to act as a good source of data for scientist and researchers from industry and academia, (3) assist report preparation for patients, (4) to discuss with fellow clinicians for suggestions and further operations, (5) for the fresh endoscopist to review the videos for knowledge enhancement and many more. In every instance, the content in the image/video plays a more significant role. Imaging artefacts haul back from attaining the benefits of the possibilities mentioned above.

Imaging artefact is a new feature (error) that appears in the resultant image but not in the original imaged object. It occurs due to mishandling of the imager or due to the natural properties of the human body. It is common in every field of medical imaging like ultrasound [1], X-ray [2], Computerized Tomography (CT) scan [3], Magnetic Resonance Imaging (MRI) [4],[5] etc. The reason for the occurrence of artefact varies based on imaging technique. This review primarily focuses on articles related to detecting the imaging artefacts present in endoscopic images. Some of the imaging artefacts, along with the reason for the occurrence, is brief in Table 1.

Table.1: Common Imaging Artefacts Occurring in Endoscopic Images

Artefacts	Reasons
Specularity	Reflection of light by smooth/watery surface
Saturation	Overexposure of light
Contrast	Underexposure of light
Motion Blur	Motion of imager

Bubbles	Presence of Saliva
Instruments	Instruments falling within the scope of the imaging area
Surgical Smoke	Dissecting/Cauterizing using heat-generating instruments
Bleeding	Tears in the lining, ulcers etc.,

Numerous articles published in the past propose various methods to detect, segment and restore the artefacts [6]. Many recent technologies like machine learning, deep learning and computer vision are deployed to aid clinicians in diagnostic and therapeutic procedures. Such systems are categorized as Computer-Aided Detection (CAD) or Computer-Aided Diagnostic (CADx) system. These systems are employed in real-time for immediate feedback. In the endoscopic imaging pipeline, this system uses a trained network that has prior knowledge on detecting all common imaging artefacts, which must be later restored using another algorithm, thus aiding the clinicians by giving a better view of internal organs. The system must have exceptional computation power to do the process in real-time. The challenges and need for the detection of artefacts are discussed in the following sections.

1.1 CHALLENGES
The major challenges identified in the field of endoscopic artefact detection are as follows. The tissue appears different when different imaging modalities are used, such as Narrow Band Imaging (NBI), white light and fluorescent light. Artefacts vary in size and often overlap. It lacks prominent geometrical structures and location. More than one artefact occurs in every frame and some as clusters. Amidst every challenge mentioned above, the detector is expected to perform well, overcoming every challenge.

1.2 NEED FOR ARTEFACT DETECTION
The need for a robust artefact detector is that the artefact may cover the clinical abnormalities in the underlying tissue during the procedure. For report preparation, meaningful frames must be retrieved from the recorded video, which becomes tedious due to the presence of multiple artefacts in a single frame. On the other hand, if frames with artefacts are discarded, it reduces the video information content and thus affects video mosaicking quality. The detection process is more helpful when an artefact restoration procedure is carried out.

To localize artefacts in the endoscopic image, most of the researchers used an object detection algorithm. Object detection can be classified under visual recognition problems in computer vision. In the past decades, many researchers proposed novel techniques to precisely locate an object of targeted classes (ground truth) on the image and map each of the detected objects to one of the classes specified. With the meteoric development of deep neural networks for object detection, the performance of the object detectors also greatly improved. Enablers of deep neural network performance include sophisticated algorithms, data availability, more computation power offered by Graphical Processing Units (GPUs), data augmentation techniques etc. In recent years Generative Adversarial Networks (GANs) have created synthetic images which are very similar to original datasets images, which aids dataset expansion. It also boosts the algorithm performance as the deep learning algorithms greatly rely upon input data.

2. METHODOLOGY OF REVIEW
The review process started with searching algorithms in the field of object detection, especially for health care applications. After reviewing articles from various fields of health care, the search narrowed down to endoscopy. Numerous Artificial Intelligence (AI) based applications in the field of endoscopy like polyp detection, cancer identification, polyp characterization, polyp classification, single and multi-class artefact detection, restoration of artefacts, diagnosis of helicobacter pylori, depth assessment of gastric cancer was studied. Multi-class artefact detection was found interesting due to limited researches and exciting challenges. At this stage, the search was restricted to deeply dive into the area of multi-class artefact detection and moved on for an extensive survey and preparation of this review article.

3. OBJECT DETECTION

3.1 History of Object Detectors
Every digital image and video contain an instance of semantic objects that belong to a specific class, such as a bag, car, laptop, mug etc. Object detection refers to a computer vision task for identifying, localizing, drawing a bounding box and classifying the objects present in the bounding box. Object detection forms a base for several other computer vision tasks like object tracking, image captioning etc. Object detection algorithms can be classified into non-neural network approach and neural network approach. The non-neural network approach includes Voila-Jones [7], Histogram of Oriented Gradients (HOG) [8], Deformable Part Models (DPM) [9], Scale-Invariant Feature Transform (SIFT) [10]. On the other hand, the neural network approach includes You

Only Look Once (YOLO) [11], Single Shot Detector (SSD) [12], Region-based Convolutional Neural Network (R-CNN) [13], Fast R-CNN [14], Faster R-CNN [15] etc. In the present decade, deep learning-based neural network algorithms are classified into single-stage, two-stage, multi-stage and anchor free object detectors. This section presents a review of the state-of-the-art object detectors used in the field of endoscopic artefact detection.

3.2 Single-Stage Object Detectors in Endoscopic Artefact Detection

3.2.1 You Only Look Once (YOLO)
YOLO was first proposed by R. Joseph et al. [11]. It divides images into regions and predicts bounding boxes, and simultaneously it predicts probabilities hence the name single stage detector. YOLO achieved attention as it achieved high accuracy while it could work in real-time. The network uses only one forward pass through the network to make necessary predictions. The network proposes multiple bounding boxes, and for each box, class probabilities will be predicted. Non-Max Suppression (NMS) suppresses unnecessary bounding boxes and makes sure the algorithm detects each object once. Finally, the network output will be a bounding box over a semantic object to be recognized. YOLO successors include YOLO9000 [16], YOLOv3 [17], YOLOv4[18] and YOLOv5[19].

In the field of endoscopic artefact detection lot of researches were proposed especially using YOLOv3. Sharib Ali et al. [6] trained variants of YOLOv3 and proposed YOLOv3-Spatial Pyramid Pooling (SPP). The trained network outperformed with best results in terms of mean Average Precision(mAP) and detection time. The network produced good Average Precision (AP) scores on detecting miscellaneous artefacts and bubbles and reached a reasonable computational time of 88ms. Zhang and Die Xie [20] used YOLOv3 network results as a baseline for their research. Seiryo Wantanabe et al. [21] proposed a network combining YOLOv3 and Mask R-CNN where YOLOv3 was used to detect specific artefacts like blur and contrast as the network can maintain spatial relationships between objects and background. Xiaohong W Gao and Yu Qian [22] and Le Duy Huynh and Nicholas Bounty [23] trained YOLOv3 for their research. The results presented by authors based on the parameters like mAP, Intersection over Union (IoU) and $Score_d$ are tabulated in Table 2.

Table.2: Performance of YOLO Variants in Endoscopic Artefact Detection

S.No.	Reference	Neural Network Architecture	Backbone	Performance Score
1.	Sharib Ali et al. [6]	YOLOv3	Darknet53	mAP= 0.351 IoU=0.242
		YOLOv3-SPP	Darknet53	mAP = 0.347 IoU=0.244
2.	Xiaohong W Gao and Yu Qian [22]	YOLOv3 (threshold=0.1)	Darknet53	mAP=0.1750 IoU=0.2273
		YOLOv3 (threshold=0.25)	Darknet53	mAP=0.1668 IoU=0.2687
3.	Le Duy Huynh and Nicholas Bounty [23]	YOLOv3	Darknet53	$score_d$=0.1702

3.2.2 RetinaNet
The RetinaNet architecture achieved state-of-the-art performance in 2017 international conference on computer vision [24]. The architecture incorporates focal loss to tackle the class imbalance problem. It contributes more to complex negative examples than easy examples, thus helping to improve the prediction accuracy. RetinaNet uses ResNet and Feature Pyramid Network (FPN) as the backbone. It also combines two task-specific networks for classification and bounding box regression.

RetinaNet with ResNet50 and FPN as backbone was adopted by Suyog Jadhav et al. [25] as one of the models for ensembled architecture. Xiaohong Gao and Barbara Braden [26] built an architecture based on RetinaNet for detection and instance segmentation. Sharib Ali et al. [6] trained RetinaNet with Resnet50 backbone. Anand Subramanian and Koushik Srivatsan [27] trained two RetinaNet networks with ResNet50 and ResNet101 feature extractors. Both the models were used to predict outputs for the original and augmented image. The results were ensembled for the final predictions. The authors proved that RetinaNet with ResNet101 backbone has a higher mAP score. Vishnusai Y. et al. [28] trained RetinaNet architecture to extract baseline results. Mohammad Azam Khan and Jaegul Choo [29] optimized the RetinaNet network with weights pre-trained on the ImageNet dataset, applied various data augmentation techniques, employed hyperparameter tuning strategies to obtain the best detection score. Maxime Kayser et al. [30] proposed an ensemble method combining seven

different RetinaNet architectures where every network varies in the backbone, hyperparameters, transfer learning strategies, training subsets and data augmentation technique used. It was concluded that ensembled architecture along with incorporating other optimization techniques yielded the best scores. Ilkay Oksuz et al. [31] built FPN on top of ResNet-152 as the backbone for RetinaNet. The authors modified variable parameters of focal loss and used them across all 100k anchors in each of the sampled images. The author generated a massive dataset employing several data augmentation techniques. five-fold cross-validation was used to optimize the network parameters. Gorkem Polat et al. [32] used the RetinaNet architecture as one of the models during the design of an ensembled architecture. Table 3 presents the performance scores obtained by various RetinaNet based object detection networks.

Table. 3: Performance of RetinaNet Variants in Endoscopic Artefact Detection

S.No.	Reference	Neural Network Architecture	Backbone	Performance Score
1.	Suyog Jadhav et al. [25]	RetinaNet	ResNet50+FPN	mAP= 0.2607
2.	Xiaohong Gao and Barbara Braden [26]	RetinaNet	ResNet101	$score_d$=0.2205
3.	Sharib Ali et al. [6]	RetinaNet	ResNet 50	mAP=0.347
4.	Anand Subramanian and Koushik Srivatsan [27]	RetinaNet	ResNet101 without TTA[*]	mAP=0.2151
			ResNet 50+ResNet101 with TTA	mAP=0.1537
5.	Mohammad Azam Khan and Jaegul Choo [29]	RetinaNet	ResNet 101	mAP=0.2581 IoU=0.333 $score_d$=0.288
6.	Maxime Kayser et al. [30]	RetinaNet	ResNet50, ResNet101, ResNet152	mAP=0.3087 IoU=0.3997 $score_d$=0.3451
7.	Ilkay Oksuz et al. [31]	RetinaNet	ResNet152	mAP=0.2719 IoU=0.3456

[*] - Test Time Augmentation

3.3 Two-Stage Object Detectors in Endoscopic Artefact Detection

3.3.1 R-CNN

Girshick et al. [13] proposed an R-CNN network for object detection, which was the first of its kind to use a CNN into an object detection network for higher performance. A basic R-CNN consists of four stages as follows. The first stage generates region proposals, the second stage extracts feature vectors of fixed length for each region proposed by stage 1, the third stage classifies the object using a Support Vector Machine (SVM) classifier, and the fourth stage is a bounding box regressor for drawing a precise bounding box. A fast version of R-CNN called Fast R-CNN was proposed by Ross Girshick et al. [14] in the year 2015. Fast R-CNN extracts features for the entire image first and then sends them to the Region of Interest (RoI) pooling layer to extract the fixed size features, which are then sent to the classification layer and bounding box regressor. After few months, an updated version called Faster R-CNN[15] came up with an efficient Region Proposal Network (RPN), which predicts region proposals with a vast range of scales and aspect ratio. Mask R-CNN [33] proposed by He et al. is an extension of Faster R-CNN with a parallel branch, for instance segmentation. The author used Faster R-CNN with ResNet and FPN as the backbone for extracting features and replaced RoI pooling with RoI align to improve accuracy. Many researchers used networks belonging to the R-CNN family for endoscopic artefact detection.

Xiaokang Wang and Chunqing Wang [34] took a Faster R-CNN model and applied the right training strategy to improve the network performance. Randomly initialized weights were used for classification and regression head, whereas for others, weights trained on Microsoft Common Object in Context (MSCOCO)[35] dataset was preferred. To counterbalance the class imbalance problem, patches were cut from images at the right scale and scaled up or down depending upon the object's size that was cut as a patch from the original image, which serves as a data augmentation technique. Detector performance was further boosted by replacing deformable convolution operation instead of regular convolution layers in FPN. Seiryo Watanabe et al. [21] proposed a new scheme combining Mask R-CNN and YOLOv3 for detecting endoscopic artefacts. The author reported that the Mask R-CNN network loses spatial relation between object and non-object regions. Thus, Mask R-CNN was preferred for artefacts with only clear and defined boundaries like specularity, saturation, bubbles, instruments, and miscellaneous artefacts.

XPengyi Zhang et al. [36] proposed a Mask aided R-CNN. The author initially trained existing Mask R-CNN with images from the training set of segmentation task, where the instance masks were bounded by bounding box from the training set of detection task. The trained model will now be used to predict masks for images from the training set of detection task, which will be called as soft-pixel level labels. The augmented dataset now comprises images from the original segmentation set with binary mask and training images from the detection task with soft pixel-level labels. The Mask R-CNN was retrained with an augmented dataset and is now called a Mask aided R-CNN. Later Mask aided R-CNN with various backbone architectures like ResNet50, ResNet50+FPN and ResNet101+FPN were trained with the augmented dataset for building an ensembled architecture. The author reported that improving the performance of the network with soft pixel-level labels is not much explored. Xiaohong W. Gao and Yu Qian [22] trained the existing Fast R-CNN network with ResNet101 as the backbone for the detection task. Gorkem Polat et al. [32] utilized Faster R-CNN as one of his models during his ensembled architecture design. Vishnusai et al.[28] proposed Faster R-CNN based on ResNet and ResNeXt modules. The author tuned various hyperparameters to produce a state of the art results. Table 4 details the results of various two stage object detection networks

Table.4: Performance of R-CNN Variants in Endoscopic Artefact Detection

S.No.	Reference	Neural Network Architecture	Backbone	Performance measured
1.	Xiaokang Wang and Chunqing Wang [34]	Faster R-CNN	ResNet50+ FPN	mAP= 0.2621 IoU=0.3205 $Score_d$=0.2855
2.	Seiryo Watanabe et al. [21]	Mask R-CNN+ YOLOv3	ResNet101 + FPN	mAP= 0.2901 IoU=0.318 $Score_d$=0.3013
3.	Pengyi Zhang et al. [36]	Ensembled Mask Aided R-CNN	ResNet50, ResNet101 + FPN	mAP= 0.3117 IoU=0.4051 $Score_d$=0.361
4.	Xiaohong W. Gao and Yu Qian [22]	Fast R-CNN	ResNet 101	mAP=0.2416 IoU=0.3482 $score_d$= 0.2842
5.	Vishnusai et al.[28]	Faster R-CNN	ResNeXt 101+FPN	$Score_d$=0.2319

3.4 Multi-Stage Object Detector for Endoscopic Artefact Detection

Multi-stage detectors aim at achieving better accuracy than one-stage and two-stage detectors. Cascaded R-CNN [37], an extended version of Faster R-CNN, is said to overcome the problem of overfitting during training and inference time mismatch between the Intersection over Union (IoU). IoU threshold is said to have a greater impact to classify positive and negative samples. The idea behind the design is that various IoUs are set to train the model. Basic R-CNN based models are cascaded where the output of the previous detection model is set as input to the later detection model. The IoU is said to keep increasing as the stage progress.

Qingtian Ning et al. [38] used basic cascaded R-CNN with L1 loss function for the purpose of artefact detection. Yan-Yi Zhang and Di Xie [20] proposed a multi-stage cascaded R-CNN combined with FPN. The author used a phased approach to increase the IoU threshold during training gradually. Initially, the model was pretrained with images from the MSCOCO dataset and later trained using images from Endoscopic Artefact Detection (EAD2019) dataset. Various data augmentation techniques were involved. To improve the performance chain method was incorporated where binary classifiers use predictions of all previous stages to produce the result of the current stage.

Suhui Yang and Guanju Cheng [39] efficiently improved the cascaded R-CNN structure by adding ResNet101 as the backbone along with the FPN module. The model has two main sub-modules, namely multi-scale feature extractor and multi-stage object detector. The former module extracts the best features to improve the detection rate. The author used t-SNE [40] to visualize the data distribution of the dataset. Outliers were removed based on the observations, data augmentation techniques for few samples concentrating on a few artefacts, namely saturation and blur, were employed. This proposed model has reported a good balance in performance between mAP and IoU.

Gorkem Polat et al. [32] proposed an ensemble model in which cascaded R-CNN was one among the three models used. The prediction of all three models, namely Faster R-CNN, Cascaded R-CNN and RetinaNet, were

fed into class agnostic NMS to remove redundant bounding boxes. It was followed by an ensemble, after which false-positive elimination was done to improve the performance. Hoang Manh Hung et al. [41] used cascaded R-CNN with FPN and ResNeXt101 networks to extract features, including Deformable Convolutions (DCN). A resampling mechanism was used to reduce overfitting. DCN is added to the backbone at stage 3 to stage 5 to differentiate background from desired objects. This helps to improve the performance. Hongyu Hu and Yuanfan Guo [42] used a cascaded R-CNN network with ResNeXt and FPN network from MM Detection Toolbox. Soft-NMS was used to avoid the over detection of objects in the image. Images were resized to 1024 x 1024 for effectively detecting small objects. Zhimiao Yu and Yuanfan Guo [43] took cascaded R-CNN as a base model with ResNet101 backbone network trained on ImageNet dataset along with FPN. Various training strategies like data augmentation, modified loss function, cosine decay learning rate schedule, and box ensemble techniques were used. Soft-NMS was replaced instead of regular NMS operation. The author quoted that the box ensemble does not perform well as it causes lower mAP. Table 5 briefs the results obtained by authors based on the Cascaded R-CNN network.

Table.5: Performance of Cascaded R-CNN Variants in Endoscopic Artefact Detection

S. No.	Reference	Neural Network Architecture	Backbone	Performance measured
1.	Qingtian Ning et al. [38]	Cascaded R-CNN	ResNet101	$IoU=0.1222$ $mAP=0.3068$ $Score_d=0.2330$
2.	Yan-Yi Zhang and Di Xie [20]	Cascaded R-CNN	FPN	$Score_d=0.3429$
3.	Suhui Yang and Guanju Cheng [39]	Cascaded R-CNN	ResNet+ FPN	$IoU=0.3221$ $mAP=0.2996$ $score_d=0.3086$
4.	Gorkem Polat et al. [32]	Ensemble of Faster R-CNN, Cascaded R-CNN and RetinaNet	ResNet50+FPN	$IoU=0.4591$ $mAP=0.4571$
5.	Hoang Manh Hung et al. [41]	Cascaded R-CNN	ResNeXt101+ FPN	$Score_d=0.2366$
6.	Hongyu Hu and Yuanfan Guo [42]	Cascaded R-CNN	ResNeXt+FPN	$Score_d=0.2202$
7.	Zhimiao Yu and Yuanfan Guo [43]	Cascaded R-CNN	ResNet101+FPN	$Score_d=0.2036$

3.5 Anchor Free Detectors

Traditional deep learning-based architectures heavily rely upon anchors for predicting semantic objects in an image. These anchors have various scales and aspect ratios based on the object to be detected in an image. It is said that the speed and accuracy of the detector are based on the anchors, where fewer the anchors faster the detectors, but it may reduce accuracy. At the same time, it involves a lot of hyper-parameters which directly affects the IoU score. Thus, anchor free detectors took advantage over existing object detection algorithms.

Anchor free object detectors work on the principle of key-point detection. It generates a heatmap using CNN and relies on NMS to suppress unnecessary bounding boxes. It is said that anchor free object detectors find it difficult to detect a dense and overlapping object. Present-day anchor free object detectors include CornerNet [44], CenterNet [45], FCOS [46], Mask Attention anchor free detection [47], PAFNet [48] and so on. Detection of endoscopic artefacts using anchor free object detectors is at its budding stage, and there is a large scope for researchers to explore.

4. DATASET AND PERFORMANCE METRICS

4.1 Dataset

Single artefact detection and restoration have been in practice for a decade. Datasets like CVC-ColonDB [49], CVC-ClinicDB [50], Kvasir-instrument [51] and Kvasir dataset [52] were used by researchers in the past for it. Research in the area of multi-class artefact detection has just emerged after the release of the EAD dataset in the year 2019. A brief description of the dataset is given in the following section.

4.1.1 EAD 2019 Dataset

It aims to establish a complete dataset for multi-class artefact detection, segmentation and generalization. It is the first-ever freely available dataset. The dataset embraces images of patients from different countries, namely France, Italy, the United Kingdom, Russia and Switzerland. It is a multi-organ (oesophagus, stomach, liver, bladder and colon) and multi-modality (white light, narrowband and fluorescence light) dataset covering imaging artefacts listed by expert clinicians like specularity, saturation, blur, contrast, instrument, bubbles and general artefacts. The images were taken using standard endoscopes built by Olympus, Biospec and Karl Storz following standard imaging protocols. Expert post-doctoral fellows did annotations with the help of clinicians using python and open-cv based annotation tools, and for segmentation VGG Image Annotator (VIA), an open-source annotation tool was used. The dataset was also validated with the help of a clinical endoscopist. The training set contains 2147 images annotated, and the test set includes 195 images for detection purpose. For segmentation, the dataset contains 475 annotated images covering five different artefacts, namely saturation, specularity, bubbles, artefacts and instrument. It also holds a set of images for the generalization task. Sample images from the dataset are shown in Fig.1.The training dataset is available to the public and not the test set. The dataset can be accessed through the link given in [53].
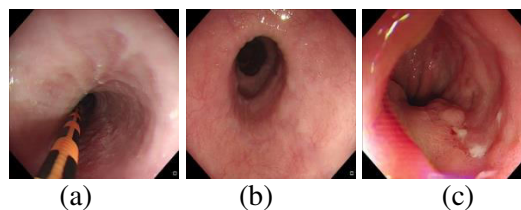
(a)   (b)   (c)
Fig. 1: Sample Images from EAD2019 Dataset [53]

4.1.2 EAD2020 Dataset

The dataset is comprised of images from patients across seven different centers worldwide taken in 3 diverse modalities comprising five different organs focusing on imaging artefacts like bubbles, blur, specularity, saturation, contrast, blood, instrument and general imaging artefacts. It contains 2531 annotated images for detection. The dataset covers only five classes for segmentation with 643 frames. Sample images from the EAD2020 dataset are shown in Fig. 2. The dataset can be downloaded through the link given in [54].
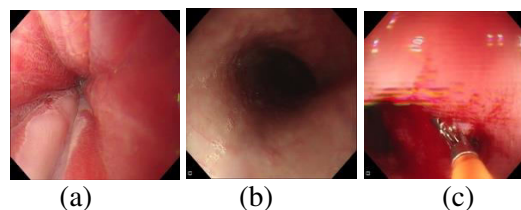
(a)   (b)   (c)
Fig. 2: Sample Images from EAD2020 Dataset [54]

4.2 PERFORMANCE METRICS

To measure the efficiency of the object detection algorithms, some metrics are being used in common by all the researchers, which include Intersection over Union, Precision, Recall, mean Average Precision and score$_d$. The formula for every metric is discussed in this section. Some of these metrics are found to be used in challenges like MSCOCO [35] and PASCAL Visual Object Classes (VOC) [55].

4.2.1 Intersection over Union (IOU)/ Jaccard Index

It is a common metric to evaluate object detection algorithms. IoU is calculated by using the area of intersection of ground truth (gt) and the prediction(pd) bounding box divided by the area of union between the ground truth and prediction bounding box. The formula for IoU is given by Eq. (1)

$$IoU = \frac{Intersection\ area\ between\ gt\ and\ pd}{Union\ area\ between\ gt\ and\ pd} \qquad (1)$$

Value of IOU ranges between 0 and 1, where 0 signifies no overlap and 1 signifies the complete overlap.

4.2.2 Precision

It measures the ability of the algorithm in identifying relevant classes, i.e. true positives among all detections. The formula for precision is given in Eq.(2), where TP and FP stand for True Positives and False Positives.

$$Precision = \frac{TP}{(TP+FP)} \qquad (2)$$

4.2.3 Recall

It measures the performance of the object detection model in detecting TP among all ground truths. The formula is given in Eq. (3). In the formula, False Negative is being represented using FN.

$$Recall = \frac{TP}{(TP+FN)} \qquad (3)$$

4.2.4 Mean Average Precision (mAP)

A high mAP score gives a better-trained model. Average precision (AP) must be calculated for every class. The AP values will then be averaged over all classes to obtain mAP. The formula to calculate mAP is given by Eq. (4) & Eq. (5).

$$mAP = \frac{1}{n}\sum_{k=1}^{n} AP_k \qquad (4)$$

Where $AP_k = \frac{1}{11}\sum r = (0,0.1,..1)pinterp(r')$ (5)

$pinterp(r') = max(p(r'))$, Where p(r') is the interpolated precision at recall value r'.

4.2.5 Score$_d$

It is a weighted score of two commonly used metrics, mAP and IoU. The formula for calculating score$_d$ is given in Eq. (6).

$$Score_d = 0.6 * mAP + 0.4 * IoU \qquad (6)$$

5. ARTEFACT DETECTION IN REAL-TIME CLINICAL PRACTICE

Technology development in the health care industry has led to complex and abundant medical data. In almost all cases, the unmitigated volume of medical data caters it unrealizable for traditional manual analysis and processing, where during the manual process, clinical abnormalities may evade the human eye. Focusing the vision towards endoscopic artefact detection, present decade high-performance computing facilities, a tremendous volume of data, powerful Machine Learning (ML), and Deep Learning (DL) algorithms has fueled the rise of CAD/CADx systems. In both CAD and CADx systems, it is essential to detect and remove artefacts in the initial stages of the imaging pipeline since it impedes abnormalities.

Many research pieces presented here show up promising results, but none of the algorithms has been seen penetrating into real-time clinical practice. Numerous challenges are to be overcome, including the limited availability of well-annotated datasets and the lack of direct contact between researchers in academia and industry. A collaborative approach may put the technology into a real-time endoscopic imaging pipeline, which may be foreseen in surgical bots in the future.

6. CONCLUDING REMARKS

The literature articles recited in this paper stick to applying a subset of AI called deep learning in the field of endoscopy. The need for high-performance artefact detection systems in the endoscopic imaging pipeline is becoming essential day by day. Achieving very high accuracy and reducing the inference time has become the ultimate goal for almost all researchers. Various strategies followed by researchers in the field include training from scratch, transfer learning, extracting features rich in spatial information, modifying existing architecture, proposing a new architecture, varying backbones, proposing ensemble method, incorporating pre-and post-processing techniques, train and test time augmentation etc. The profound potential of such AI-assisted technologies in the field of endoscopic imaging can transform the clinical practice efficiency and accuracy to uncover relevant information from data to help the endoscopist for better clinical decision making in the future. Throughout the conduct of this literature study, it was observed that there are just a couple of researchers working towards endoscopic artefact detection, and a lot of arenas are still seen to be unexplored in deploying autonomous surgical bots for minimally invasive surgery, which allows researchers to dive deeper into the areas and propose better results.

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OPTIMIZING CONNECTIVITY LIFETIME'S WORTH TO POWER GENERATION LOOK - AHEAD SMART COMPONENT RELAYING FRAMEWORK ON REPEATED GAME TRANSCEIVER SENSORS

V. VINOBA, LOKA PAVANI AND V. VIMALA

ABSTRACT
*The goal of the repeated game tournament theorist power management body of norms is to maximize the utility through an optimum security control strategy, thus also working to improve overall network fuel efficiency. Moreover, the **Naive Bayes Exact** solution in mathematics is tried to introduce to research the presence and distinctiveness evidence of the evolutionarily stable system of regulations, simulation results demonstrate that somehow there exist points for each of the function optimization regarded that give the total possible utility if all the other nodes take these same techniques as fixed. And the suggested system of regulations is more effective and accomplishes good outcomes.*

1. INTRODUCTION
In an attempt to face the restricted power physical features of sensor networks, we use repeated game mechanics to fix the control system dilemma in sensor nodes. In this article, a dispersed repeated game tournament hypothesis voltage regulation set of guidelines collaborative management and non-collaborative behavioural economics under incomplete data is suggested, with the functional form becoming the transmission noise proportion (Site is accessible).

2. POWER GENERATION RELAYING USING REPEATED GAME BEHAVIORAL ECONOMICS
The electricity routing algorithm, a default position originally came reactive procedure, is to increase substantially the internet backbone days. Even though this code of conduct is similar to the guided vascular system, it differentiates in the central nervous system in that it continues to hold onto a collection of paths as a perpetual way of keeping up or implementing one optimal route at fundamental rates. These pathways are trying to keep up and being selected by the income of highly variable odds. The valuation of this likelihood of occurrence is ascertained by how repetitively reduced the security usage of the collection of each path can be talented. A set of any on one's own path would not be used up pretty quickly by anyways handpicked at not the performance comparable evil eye. These can consequence in an extended network entire life because electricity is distributed more evenly among all nodes. The centre metric of the procedure is wsns damage reduction. The methodology is responsible for making sure that each data typeset is directly accessible over again and completed with class-based attempting to address, which also contains the nodes' physical location and types.

The methodology creates a relationship by using flash flooding to explore all pathways among both reference pairs and their costs, thus further inundating the forwarding table. The high-cost mechanisms are completely eradicated, and a squeeze back table is generated by choosing a particular near the area nodes in an expense sort of way. After which, hold-back tables are trawled to perform data to the initial juncture with a possibility that is inverse proportion to the endpoint cost. To preserve the pathways alive, the last station node performs flash floods in a small region. When taken in conjunction with absorption, this methodology provides an overall advancement of 25%, saving security, as well as a 50%, keep increasing in cluster formation. However, the scientific method necessarily requires accumulating the destination figures and trying to establish the meant to address machines and tools for the base stations that either complicate route configuration direction perpendicular to the dispersion development to nut.

3. MATHEMATICAL MODEL
The play-offs formula must always be ended up *finding* in the distributed control computer system using repeated game strategic plan. It is supposed that all endpoints in the network system are *identical; therefore* all nodes are well within the transmission range. The activity of all nodes is the same, so it tends to increase as the repeated game power densities communicate the message. Because the conditions of extreme, it is presumed in repeated game Behavioral Economics that nodes are transferring a lot of power. As a direct consequence, the steady-state game plan was used to limit repeated game behavior. Gameplay can be collaborative or non-collaborative. The power requirements of the nodes are indeed the upper and lower limit transceiver strength.

4. GAME OF REPEATED GAME VOLTAGE REGULATION

Let G = [N, ($\mathcal{R}_i$), {(u_i)(.)}] indicate the repeated game voltage regulation player where N={1,2,…N} is indeed the measure set for daily accounts nowadays in power management networks, $\mathcal{R}_i$ is the strategic approach set, and {(u_i)(.)} is the convenience factor of consumer i. So every user chooses a voltage level $\mathcal{R}_i \varepsilon \mathcal{R}_i$. Let $\mathcal{R} = \mathcal{R}_1, \mathcal{R}_2, \ldots \ldots \mathcal{R}_N \varepsilon \mathcal{R}$ signify the consequence of the Repeated Game Power Management Game regardless of randomly chosen rated power of all users, where $\mathcal{R}$ is the sequence of all electricity feature vectors. The functional form embodies user business strategy interconnectedness. The threshold of utility did receive by each user is ascertained by its own level of power and also the knowledge leading by other gamers, as assessed by the SNR values of that consumer. We make the assumption that each user's technique is reasonable, in the sense that each user provides the maximum of its own functionality in a distributed way. The GRGVR player G is authored in literal terms as

$\max_{\mathcal{R}_i \varepsilon \mathcal{R}_i} u_i(\mathcal{R}_i, \mathcal{R}_{-i})$ for all iεN, ----------------------- (1)

In which u_i is chosen to give in (1) and $\mathcal{R}_i = \{\mathcal{R}_i^{min} \mathcal{R}_i^{max}\}$ is user i's approach space. In this tournament, p seems to be the strategic planning profile, and indeed the strategic planning characteristics of i's adversaries are characterized as ($\mathcal{R}_{-i} = \mathcal{R}_1, \mathcal{R}_{i-1}, \mathcal{R}_{i+1}, \ldots \ldots \ldots \mathcal{R}_N$), so that $\mathcal{R} = (\mathcal{R}_i, \mathcal{R}_{-i})$. Other amounts will be subordinate to a comparable confirmation.

The best reply for consumers i's $R_i(\mathcal{R}_{-i}) = \arg \max_{p_i \varepsilon P_i} u_i(\mathcal{R}_i, \mathcal{R}_{-i})$,i.e., the $\mathcal{R}_i$ something which max $u_i(\mathcal{R}_i, \mathcal{R}_{-i})$ given a fixed $\mathcal{R}_{-i}$. With both the best reaction construct, we can introduce the Balance Point (NE) of GRGVR player G continues to follow.

Definition. 1: Nash Equilibrium (NE) of GRGVR game G
A strategic planning profile $\mathcal{R}^*$ is Nash Equation (NE) of GRGVR player G if it is a convergence point way of responding, $u_i(\mathcal{R}_i^*, \mathcal{R}_{-i}^*) \geq u_i(\mathcal{R}_i', \mathcal{R}_{-i}^*)$ for just about every $\mathcal{R}_i' \varepsilon \mathcal{R}_i$ as well as any consumer i.

The NE framework provided a dependable, stable outcome of the game in which agents with conflicting interests accomplish identity and reach the point from which no playmaker desires to stray away. Even so, such a tip often does not arise.

Definition. 2 Fuel Efficiency in Repeated Game Behavioral Economics
Sensor networks have local non-battery cells (usually less than 0.5 and 1.2 V). As a direct consequence, increased battery usage of a sensor network is critical to supporting the coordination mechanism lifetime of different nodes and the core system.

A WSN routing protocol is anticipated to (i) reduce the quantity of components that contribute to routing protocol and data transmission; and (ii) disseminate packet data propagation across branching routes, enabling all nodes to decimate one's battery packs at a rate similar. As a consequence, the lifetime of the network will be enlarged all in all.

Theorem.1
Nash Equilibrium is established and is distinguishable in repeated game power management games with imperfect maximum transmission control messages.

Proof
Let $N_{s_i}(x)$ be the probability distribution of s_i, presuming that node could indeed undertake data transmission under any charge of the group and non-collaborative control of the processes, that is, once s_i, node transmitting possibility is 1.

So $\int_0^\infty N_{s_i}(x)\, dx = 1$. …………… (1)

Nevertheless, in the actual world, repeated game power management, behavioral economics does not enable the base station forward at any charge of the group as well as non-collaborative power level in order to minimize payouts as well as repeated game power bills. So, if we allow repeated game transmit power over a certain spectrum, we can presume that when repeated game transmitting strength as $s_i \in [0, p_i]$, the n_i will have the largest repeated game connection utility. This same max current available when a node emits could be given by p_t is.

$\mathcal{R}(\mathcal{R}_t) = \int_0^{\mathcal{R}_t} f_{s_i}(x)\, dx$ ------------------------------------- (2)

1- $\mathcal{R}$ $(\mathcal{R}_t)$. is the likelihood of no transmitting. As a result, the statistical likelihood that every k of the number of nodes is active is provided by

$$\mathcal{R}_n = \sum_k \binom{n}{k} (\mathcal{R}(\mathcal{R}_t)^k) (1\text{-} \mathcal{R}(\mathcal{R}_t)^{N-k}) \text{ --------------------------------- (3)}$$

The anticipated repeated game internet backbone versatility of the ith transmitter's node than is provided by

$$E[U_i^{net}] = \sum_{k=o}^{N} (u_i(s_i, s_{-i}) - A(s_i)) \mathcal{R}_k \text{ ----------------------------(4)}$$

If indeed the node is broadcasting, the power companies of repeated game channels are calculated using (5). If the base station does not communicate, the expected benefits of repeated game connections are 0. Any network node predicted repeated game internet backbone utility is provided by

$$G_i(\mathcal{R}_t) = \int_{z_i}^{\mathcal{R}} [U_i(\mathcal{R}_t) - \acute{c}(x)] f_{s_i}(x) \, dx$$

$$= U_i(\mathcal{R}_t) \, \mathrm{R}(\mathcal{R}_t) - \int_{z_i}^{\mathcal{R}_t} c(x)] f_{s_i}(x) \, dx \text{----------------------- (5)}$$

Let B $(\mathcal{R}_t) = \int_{z_i}^{\mathcal{R}_t} c(x) f_{s_i}(x) dx$, then the equation (5) can be written as

$$G_i(\mathcal{R}_t) = U_i(\mathcal{R}_t) \, \mathcal{R}(\mathcal{R}_t) - \mathrm{B}(\mathcal{R}_t) \text{ ------------------------------------- (6)}$$

We could see from formula (6) that when the real transmit power exceeds the top restriction, we have the same utility function, i.e. $s_i = \mathcal{R}_i$. Thus $\mathcal{R}_i$ is the maximum voltage of nodes in order to transmit when the connectivity as a whole can reach optimal functionality. That is, p_t is the solution to the following expression.

$$U_i(\mathcal{R}_t) - c(\mathcal{R}_t) = 0 \text{ ---------------------------------- (7)}$$

5. SIMULATION AND PERFORMANCE ANALYSIS

Modeling has been used to verify and evaluate the different algorithms. The nodes are randomly dispersed in a (100, 100)-meter square, as well as the sink node is implemented at the juncture of (50, 50), with such a highest transmitting radial distance of 80 m for each base station; other simulated results are showcased in **Table.1.**

Parameters	Value
Vary of Transmitting	125 m
Region of the System	50× 50
Detectors being Used	50 – 100
Data packet price	5 pkt / sec
Wrapper Measurements	30 bytes
Broadcast Recurrence	35 kbps
Electricity Transferring	40 mW (270J)
Acquiring Jurisdiction	20 mW (129.6J)
Power Saving Power Usage	50 μ W (0.36J)
Slot machines for Source and Receiver	25 msec
The try typing of speck	Mica^2
Detector data type preliminary fuel	1KJ
Limit Power E^{thd}	0.001mJ
Table.1: Simulation Parameters	

In this segment, we initially consider the impact of utility and sales price variables on power transmission prior to actually assessing the no normative automated system and trying to compare it to other existing method

The Conclusion of the Proposed Scheme
We use modeling to examine the effect of routing in WSN**:**

❖ Stabilization timeframe: The time that it takes for a system to operate from start to finish, beginning with the first node as well as ending with the last base station.

❖ Internet backbone lifetime: This same duration of time from the beginning of the system until the very last node is awake.

❖ Unrest duration: The time that it takes is for the network to continue operating from the moment the very first node dies to the time the last base station ends up dead.

❖ Wrapper to BS: That's the rate during which data is properly produced to BS from CHs.

Table 2: Start comparing the LSRA to the proposed scheme to $E_0 = 0.12$J

Protocol	Stability	Network	Instability
LSRA	220	350	125
Proposed protocol	350	614.5	270

So when the transmitting rate is set with one pack per sec, we could see that the standard shipping postponement of Leeching and Leeching is less than that of the suggested Real exchange rate protocol and carefully consider. It's because Protocol is always looking for the highest path to hold back packets.
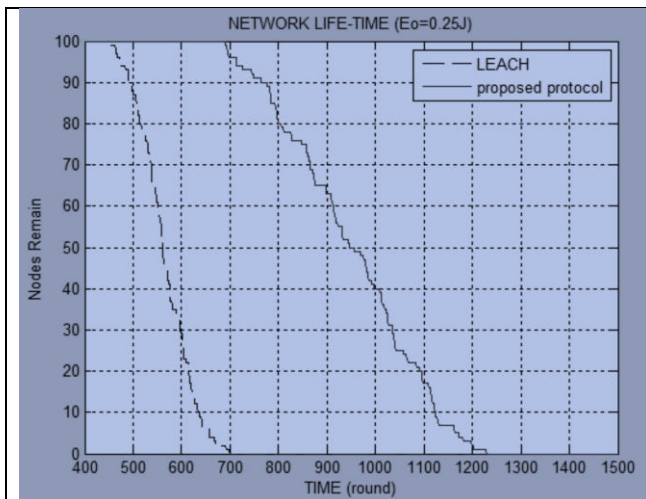
Figure. 1: Try comparing the network lifetimes of Leeching and the suggested procedure (E_0=0.12J
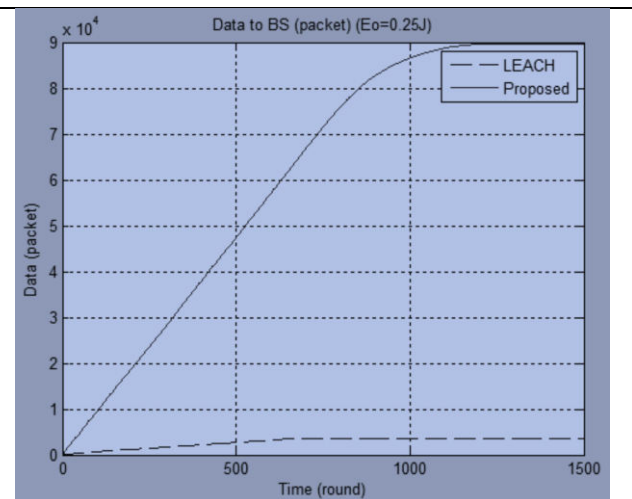
Figure. 2: Transfers data to BS among Leeching and the suggested procedure (E_0= 0.12J)
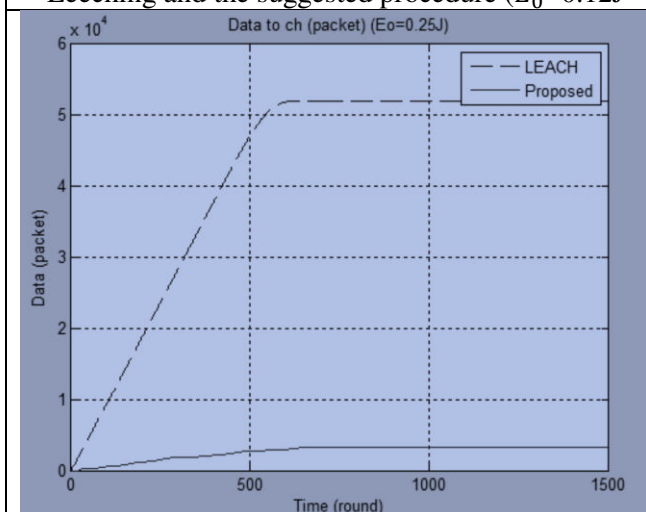
Figure. 3: Transfers data to CH among Leeching and the suggested procedure (E_0= 0.12J)
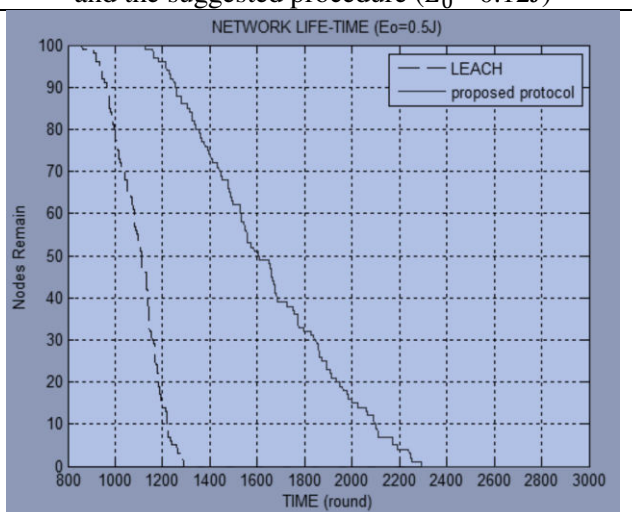
Figure. 4: Try comparing the internet backbone lifespans of Leeching and the suggested procedure (E_0= 0.25J)

The average service postpones of leeching greatly increases as that of the sensor base station transmitting rate rises. This is attributable to the fact that cramming happens in LSRA at endpoints. In the proposed scheme, when a data packet arrives, relay or even in nodes have a lesser lock back possibility than nodes. Nodes are due to the use of different tactics. In the transmitting node gathering repeated game, the probability of a large number of packets being stymied by a similar base station is significantly small. As a consequence, increasing the transmission speed has had no impact on the average late delivery of our procedure.

The security usage of the four procedures is visualized in Fig 3 in the Leeching, LSRA -M, as well as Listen and obeys protocols, the origin always can choose the node in the neighborhoods set that is nearest to the desired location. Nevertheless, in most instances, the nearest node is the outstanding local decision, not the global best decision. In our process, in the hold home sensor network collection match, if many nodes have a relatively small angle with the line intended by the origin as well as a place to start, it has a strong probability of being the

grip back node. As a consequence, the proposed Following sections detail the procedure conserved detector node security for data transfer between endpoints.

Fig.4 shows the proposed procedure's Delivery Service ratio to, in effect process. The figure showed that the recommended real effective exchange rate protocol outshines Wash away, LSRA -M, and carefully consider. As the transmitter's rate hikes, Scheme, Freeloading, and careful consideration should be given to always to forward packets all along relays as that of the outer boundaries strategic plan. This increases the chances of packets trying to cram all-around powerful communication nodes. Because the process of holding back node choice in the real effective exchange rate procedure is a game; the origin has a lower chance to make the same applicant gain too much advantage of the game process. That's why the delivery service ratio of our procedure does not drop dramatically as the transmitting rate rises.

The computation experiments demonstrated that the proposed protocol increased the life of the network time by 80 percentage points when tried to compare to the LSRA. To evaluate the efficacy of the suggested protocol, we use simulated results to quantify the following criteria. These really are 5% Base station Dead (BSD), Haft Endpoint Dead (HED), as well as Full Nucleus Dead (FND).

Table. 3: Try comparing the BSD, HED and FND of Leeching and the proposed procedure with E 0= 0.12J.

Parameter	5% Dead	25% Dead	50% Dead
LSRA	245	275	345
Proposed protocol	380	470	610

The simulation results demonstrate that the incoming signal is 0.12J. In contrast to the LSRA algorithm, the proposed scheme tends o increase BSD by 70%, HND by 75%, and FDN by 85%.

6. CONCLUSION

In this paragraph, we initiate Repeated Game Behavioral Economics for trying to extend the life span of sensing devices. This method will increase data packet rates of success while decreasing data packet delays. We complete the hold it back possibility and payoff feature for attendees in the hold-back. We hoped for a new routing algorithm to prolong the length of sensing devices. This procedure evolved from the LSRA by taking into consideration the electricity and length of endpoints in a WSN once choosing CHs. This procedure, even so, is only used in this same case of BS in the detection zone. In the future, we will start investigating the security transfer of nodes when the BS is situated far from the detection zone in order to enhance the service lifespan of the network eventually, the Nash Equilibrium is established whenever the upper and lower limits thresholds for channel quality and average power are presumed. The lifetime of the network is enlarged by using repeated game behavioral economics, such that even after 5x100 rounds, half of the nodes are awake, especially in comparison to 2%, 4%, and 8% of endpoints in existing routing protocol Leeching, LSRA -M, and Carefully consider, in both. As a result, the network lifetime is found to increase by 84 percentages when our prototype and method are used.

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TUNABLE OPTICAL BANDGAP OF CHROMIUM DOPED ND$_{0.5}$SR$_{0.5}$MNO$_3$ SYSTEM

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ABSTRACT

Chromium doped $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system were synthesized by sol-gel method. The X-ray diffraction patterns revealed the formation of single-phase orthorhombic structure (Pnma space group). The crystallite was observed to decrease from 41.68 nm to 30.87 nm with increase in Cr doping concentration. The dislocation density was observed to increase from 0.5755×10^{-3} to $1.0497 \times 10^{-3} nm^{-2}$ with increase in Cr doping concentration. The micro strain was observed to increase from 28.77×10^{-4} to 39.56×10^{-4} with increase in Cr doping concentration. There was no evidence of characteristic absorbance peaks for all the synthesized samples. The optical energy band gap was calculated using Kubelka–Munk equation based on Tauc's plot and observed in the range 0.22 eV to 0.47 eV.

Keywords: XRD, Optical energy bandgap, Refractive index, Absorption coefficient, Extinction coefficient, Real and imaginary parts of dielectric constant.

1. INTRODUCTION

Colossal magnetoresistance (CMR) is a property of some materials, generally manganese -based perovskite oxides, that empowers them to vividly change their electrical resistance in the presence of magnetic field. Thus, CMR materials fascinated research community due to their exciting and effective behaviour revealed by them in structural, electrical, transport, optical and magnetic properties and their potential applications [1-3]. The charge-ordered phase in half-doped manganites, with compounds, $RE_{0.5}A_{0.5}MnO_3$ (RE=La, Pr, Sm and Nd; A=Sr and Ca) shown a variation of phenomena such as charge, orbital, and spin ordering, with electric and magnetic field induced transitions [4,5]. Besides, the charge ordered (CO)/orbital ordered (OO) and antiferromagnetic insulating (AFMI) stages can be changed efficiently by adding impurities at Mn site. In detail, Mn site doping with Cr in manganites have attracted boundless consideration as Cr^{3+} ion is iso-electronic with Mn^{4+} ion. Magnetic impurities like Cr and Ru can make both metallicity and ferromagnetism in the insulating antiferromagnetic $Nd_{0.5}A_{0.5}MnO_3$ (A=Ca, Sr) [6,7].

2. EXPERIMENT

The samples of Polycrystalline $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) were prepared via the sol–gel method [8] by taking pure metal nitrates as the starting materials (99.9 % pure). Mixtures of $(NH_4)_2 CO_3$, $(CH_3COO)_2$ Mn $4H_2O$, Nd_2O_3, $SrCO_3$, $MnCO_3$, and CrN_3O_9 $9H_2O$ precursors in stoichiometric amounts were dissolved in distilled water and nitric acid to get a clear solution. Then citric acid was mixed with nitrates solution as the complexing agent (the molar ratio of cations/citric acid is 1:2). After that, a binding agent ethylene glycol was mixed with the chemical solution and heated under a constant stirring at 353 K for 10 minutes. After 6 h, the obtained gel was dried at 393 K for 24 h and ground the dried gel to a fine black powder. The resulting black powder was finally sintered at 1300 K for 10 h. Based on doping concentration $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system, the samples are designated as x = 0.0 - NSMCO-0, x = 0.1 - NSMCO-1, x = 0.2 - NSMCO-2, x = 0.3 - NSMCO-3 and x = 0.4 - NSMCO-4 respectively. The Raman spectroscopy measurements were performed using Raman spectrometer (Lab RAM Horiba France) with two grating, using 532nm Nd-YAG laser 100 mW. XPS measurements for NSMCO-4 at room temperature were undertaken by XPS spectrometer.

3. RESULT AND DISCUSSION

XRD patterns as shown in Fig.1 for all the $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples revealed the formation of single-phase structure without any impurities [9]. The Rietveld refinement technique [9, 10] confirmed the that all the synthesized samples belong to orthorhombic structure (Pnma space group). It was observed that there is no significant variation in lattice parameters with doping concentrations. This kind of behaviour in the lattice parameters may be attributed due to the fact that, there is little difference in the ionic radii between Cr^{3+} and Mn^{3+} ions [11]. The crystallite size was observed to decrease with increasing doping concentration. The micro strain value can be calculated from equation (1) [12].

$$\varepsilon = \frac{\beta}{4 \tan\theta} \qquad\qquad ---(1)$$

The micro strain value was observed to increase from 28.77×10^{-4} to 38.64×10^{-4} with the increase in the coping concentration. The dislocation density (δ_D) is inversely proportional to the square of crystallite size. The dislocation density increases with the defect occurrence due to several kinds of reason and is calculated using the following relation (2) [12]

$$\delta_D = \frac{1}{D^2} \qquad \text{---(2)}$$

The density of dislocation was increased from 0.5755×10^{-3} to 1.048×10^{-3} nm^{-2} with the increase in doping concentration. It is evident that there is a systematic effect of Chromium doping on the micro strain and dislocation density of the synthesized samples. The X-ray density for these samples is calculated from the following equation (3) [12, 13].

$$\rho_x = \frac{ZM}{NV} \qquad \text{---(3)}$$

The X-ray density was observed to decrease with increasing Cr doping. The X-ray density values decreased from 6478 to 6098 g/cm^3.

The UV-visible absorption spectra of all the samples were measured with a spectrophotometer (SYSTRONICS DOUBLE BEAM UV-Vis Spectrometer: 2202) at room temperature in the wave length range 200-800 nm, with a maximum step size of 0.2 nm. The absorbance can be obtained from the instrument and the transmittance can be calculated using the following relation (4).

$$T_s = 10^{-A} \times 100 \qquad \text{---(4)}$$

Where, T_s is known as transmittance and A is known as Absorbance. Hence, the absorption coefficient can be calculated using the following relation (5) [14].

$$\propto = \frac{2.303 \times A}{l} \qquad \text{---(5)}$$

Where, α is known as absorption coefficient, A is known as absorbance and l is known as thickness of the specimen. Fig. 2 shows the variation of absorbance and transmittance of all the $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples with wavelength in UV-visible range, 200 - 800 nm. In all the synthesized samples we did not observe ant characteristic absorbance peak in UV-visible range, probably it would be below 200 nm region. The refractive index for the samples can be measured with the help of following relation (6).

$$n = \frac{1}{T_s} + \sqrt{\frac{1}{T_s - 1}} \qquad \text{---(6)}$$

Where, n is refractive index and T_s is transmittance. Fig. 3 shows the variation of refractive index of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples with wavelength in UV-visible region, 200 - 800 nm. It is observed clearly that, the refractive index in all the samples increased slightly with the frequency without any characteristic absorbance peaks. Using the following relation (7), extinction coefficient can be calculated [15].

$$k = \frac{\propto \lambda}{4\pi} \qquad \text{---(7)}$$

Where, k is extinction coefficient, λ is wavelength and α is absorption coefficient. Fig. 4 shows the variation of extinction coefficient for $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples with wavelength in UV-visible region, 200-800 nm. In case of all the samples, the extinction coefficient was slightly increased with a linear curve.

The reflectance for all the $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples can be calculated with the help of refractive index, as follows (8) [16]:

$$R = \frac{(n-1)^2}{(n+1)^2} \qquad \text{---(8)}$$

Where, R is reflectance, and n is refractive index. Fig. 5 shows the variation of reflectance for $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples with wavelength in UV-visible region, 200-800 nm. All the samples showed a linear decrease in the extinction coefficient.

Using the refractive index and extinction coefficient, the real and imaginary parts of dielectric constant can be expressed with the following relations (9 and10) [17, 18].

$$\varepsilon_i = 2nk \qquad \text{---(9)}$$

$$\varepsilon_r = n^2 - k^2 \qquad \text{---(10)}$$

Fig. 6 shows the variation of real and imaginary parts of dielectric constant for $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples with wavelength in UV-Visible region, 200-800 nm. We did not observe any characteristic peak and probably the peak would be below 200 nm region.

Optical bandgaps for $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples were determined from UV-Vis absorption spectra and corresponding Tauc's plots are plotted as shown in Fig.7 for NSMCO-0, where hυ is incident light energy and absorption cofficient is denoted by α.

The optical bandgap plots for $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples is shown in Fig's 7 to 11. The absorption coefficient of the ferrite nanoparticles has been determined from the absorption data by using the fundamental relationships (11, 12 and13) [15, 16].

$$I = I_0 e^{\alpha t} \qquad \text{---(11)}$$

$$A = log \frac{I_0}{I} \qquad \text{---(12)}$$

$$\text{and } \alpha = \frac{2.303(A)}{t} \qquad \text{---(13)}$$

Where, α is absorption coefficient, A is the absorbance, and t is the thickness of the samples. To calculate the optical absorption for the present ferrite nanoparticles, the following Tauc's relation (14) [15, 16] is used

$$(\alpha h \nu)^{1/n} = A(h \nu - E_g) \qquad \text{---(14)}$$

Where, α is absorption coefficient, h is plank's constant, ν is frequency, A is absorbance and E_g is optical energy bandgap. $(\alpha h \nu)^{1/n}$ was plotted as a function of the photon energy (hν) for different n values (n=1/2, 3/2, 2, 3). These plots are known as Tauc plots and are presented in Fig's. 7 to 11. For direct allowed transition n=1/2, indirect allowed transition n=2, direct forbidden transition n=3/2 and forbidden indirect transition n=3. To determine the possible transitions, $(\alpha h \nu)^2$ vs hν is plotted and corresponding optical energy bandgap were obtained from extrapolating the straight portion of the graph on hν axis.

The calculated optical bandgaps were observed in the range 0.22–0.47eV, which are summaried in Table. 1. This optical bandgap range behaves similar to semiconductors (E_g is in the range 0.5–2.5eV). In these samples Mn cations exist a mixed valence of Mn^{3+} and Mn^{4+}, which are sorrounded by six O^{2-} anions, forming MnO_6 octahedral structure. The optical bandgaps can be attributed to the electronic transition from up-spin of Mn^{3+} ion and down-spin band of a adjacent Mn^{4+} ion, and the energy difference between two bands is Hund's coupling energy [17].

4. CONCLUSIONS

In this article we studied the different properties of sol-gel synthesized $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) samples and it's doping effect on the structural and optical properties as follows:

1. The crystallite size was decreased from 41.68 nm to 30.87 with the increase Cr doping concentration.

2. The dislocation density was observed to increase from 0.5755×10^{-3} to $1.048 \times 10^{-3} nm^{-2}$ with the increase Cr doping concentration.

3. The micro strain was observed to increase from 10×10^{-4} to 6.452×10^{-4} with the increase Cr doping concentration.

4. The characteristic absorbance peaks were not observed for any of the synthesized samples and probably it would be below 200 nm region.

5. The optical energy gap was calculated using Kubelka–Munk equation based on Tauc's plot and found in the range 0.22 eV to 0.47 eV, which could be attributed due to electronic transition from up-spin of Mn^{3+} ion and down-spin of an adjacent Mn^{4+} ions.

6. From our results it is evident that the band gaps can be tuned by varying Cr doping concentration.

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FIGURES
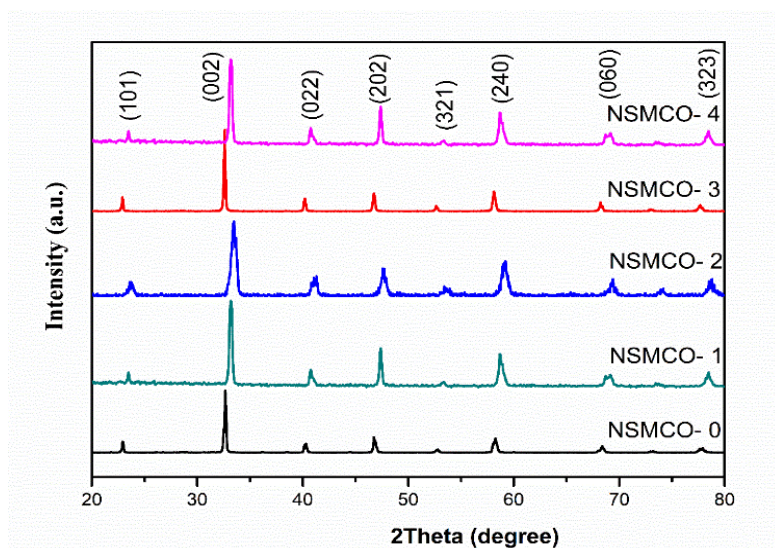
Figure 1: XRD pattern of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system.
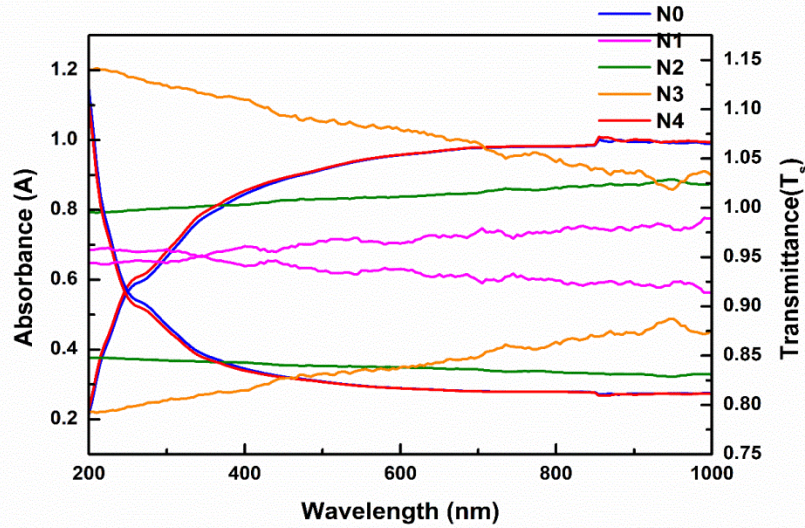
Figure 2: Variation of absorbance and transmittance of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system with wavelength in UV-Visible region.
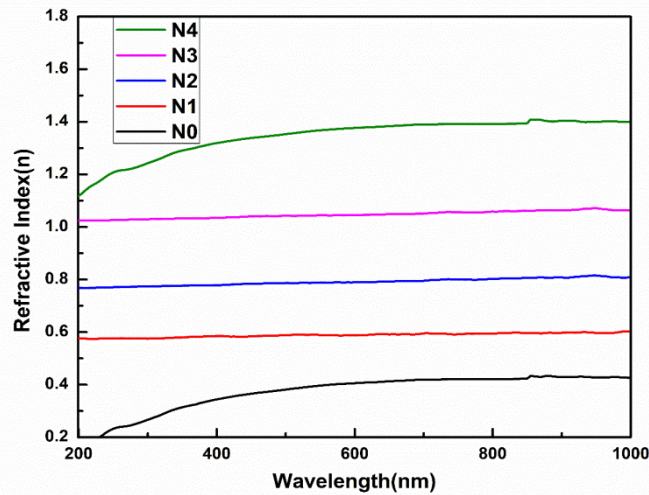
Figure 3: Variation of refractive index of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system with wavelength in UV-Visible region.
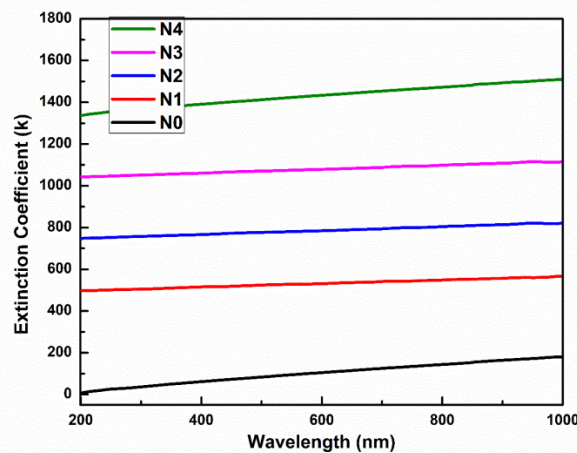
Figure 4: Variation of extinction coefficient of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system with wavelength in UV-Visible region.
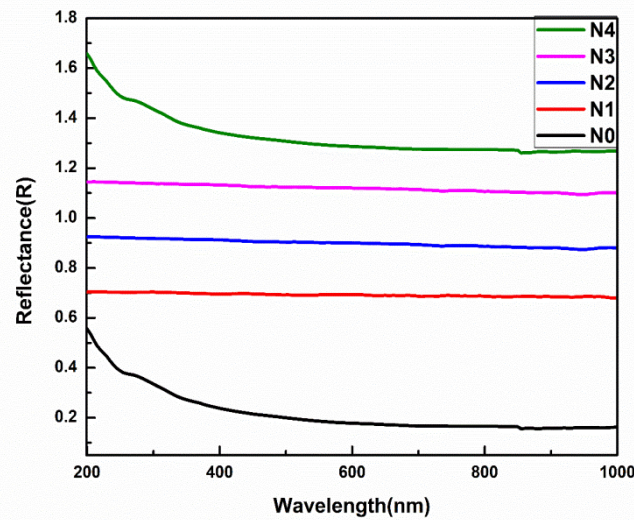
Figure 5: Variation of reflectance of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system with wavelength in UV-Visible region.
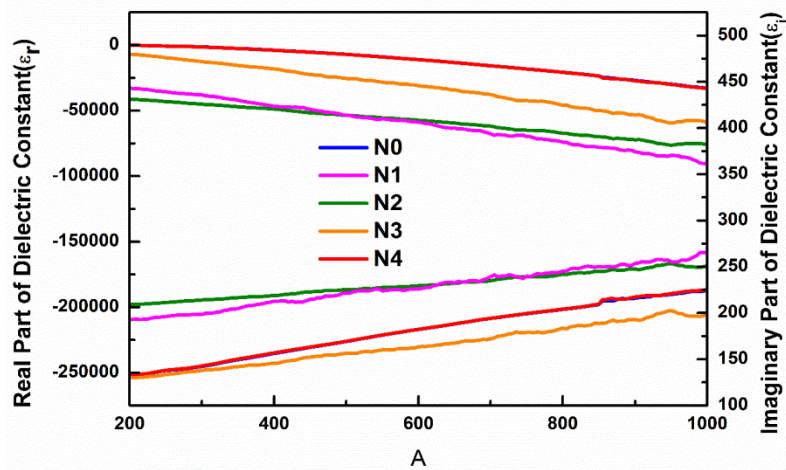
Figure 6: Variation of real and imaginary parts of dielectric constant of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system with wavelength in UV-Visible region.
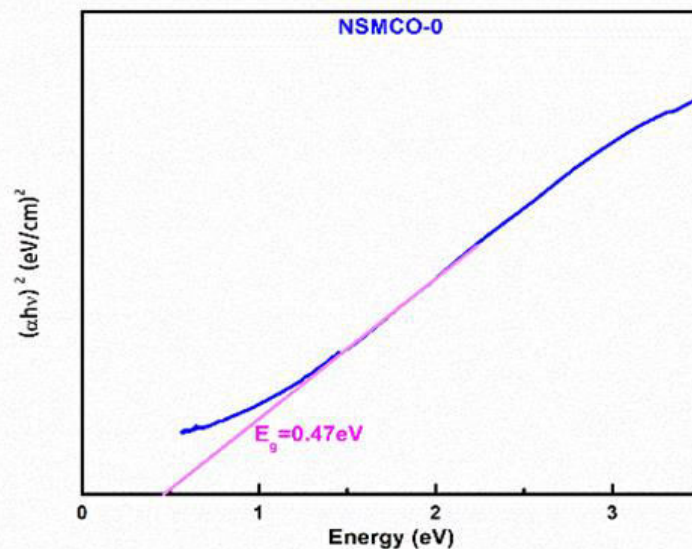
Figure 7: Tauc's plot for NSMCO-0 sample
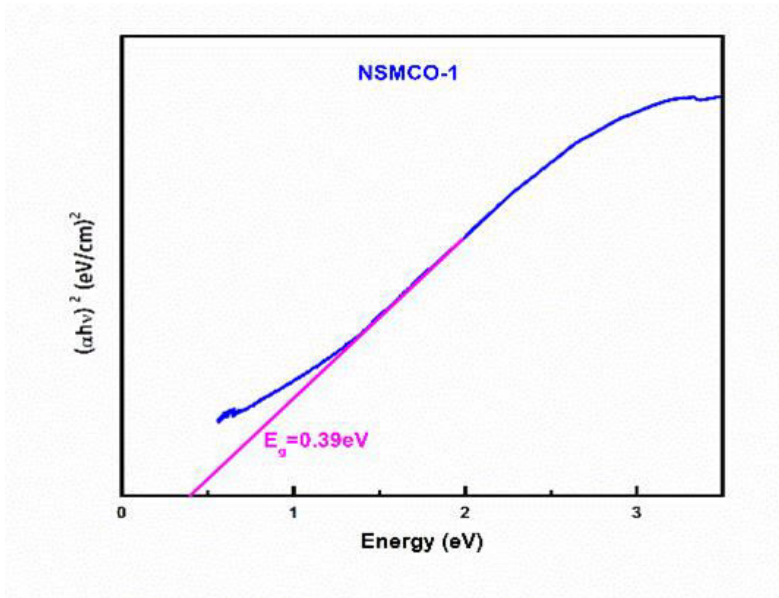
Figure 8: Tauc's plot for NSMCO-1 sample
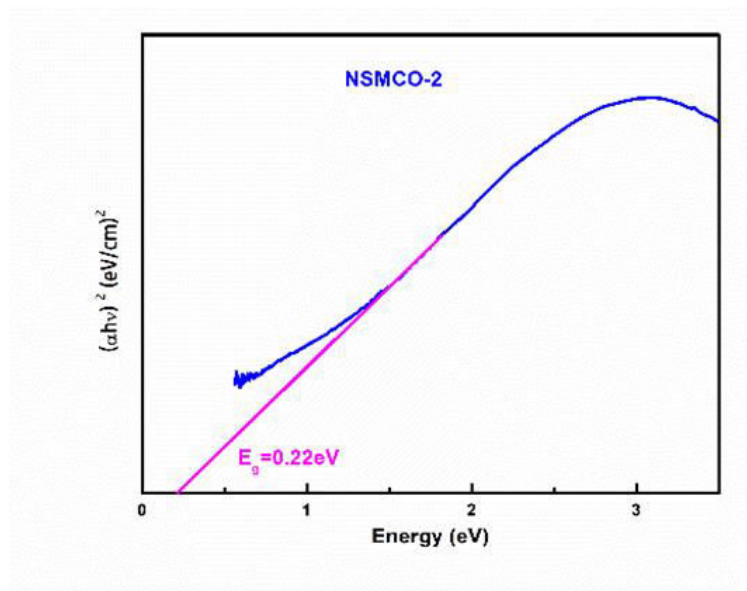
Figure 9: Tauc's plot for NSMCO-2 sample
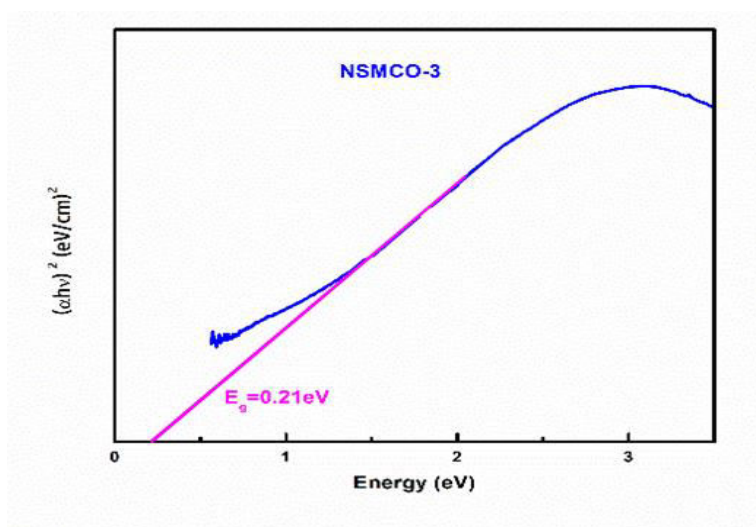
Figure 10: Tauc's plot for NSMCO-3 sample
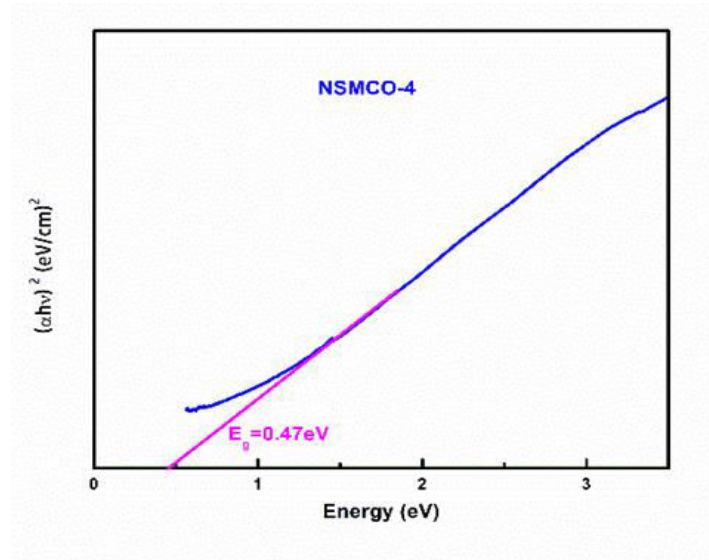
Figure 11: Tauc's plot for NSMCO-4 sample

Table-1: Lattice parameters, Bragg's angle, FWHM, crystallite size, density, microstrain and Energy gap of $Nd_{0.5}Sr_{0.5}Mn_{1-x}Cr_xO_3$ (x= 0.0, 0.1, 0.2, 0.3, 0.4) system.

Sample code	NSMCO-0	NSMCO-1	NSMCO-2	NSMCO-3	NSMCO-4
Lattice Parameter (a) (Å)	5.4301	5.4285	5.4292	5.4300	5.4296
Volume of Unit Cell ($Å^3$)	226.5512	226.6368	226.4342	226.7487	226.5724
Bragg's Angle (2θ) (°)	33.59798	33.03567	33.06761	32.97235	32.98448
FWHM (°)	0.19912	0.19906	0.2218	0.26835	0.26218
X-ray Density (ρ_x) (kg/m^3)	6478	6230	6183	6144	6098
Crystallite Size (D) (nm)	41.68262	41.63404	37.3686	30.87876	31.60643
Dislocation Density(δ_D) (nm^{-2}) x10^{-3}	0.5755	0.5769	0.7161	1.0487	1.0010
Microstrain (ϵ)x10^{-4}	28.779	28.289	32.601	39.564	38.639
Energy Gap (E) (eV)	0.47	0.39	0.22	0.21	0.47

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BI-DOMINATION IN SHADOW DISTANCE GRAPHS

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ABSTRACT

A D_{bi} is the dominating set of G and every $v \in D_{bi}$ dominates exactly two vertices in $V - D_{bi}$ such that $|N(v) \cap (V - D_{bi})| = 2$, is a bi-dominating set. The minimum cardinality of all bi-dominating set in G is the bi-domination number $\gamma_{bi}(G)$. We calculate bi-domination number $\gamma_{bi}(G)$ standard graphs and some shadow distance graphs in this paper.

Keywords: Dominating set, bi-domination number, minimal bi-dominating set.

AMS Subject Classification: 05C69.

1. INTRODUCTION

All graphs considered in this paper are simple connected graphs without loops and multiple edges. In graph theoretic literature, the concept of a dominating set[1,2,3] is well-known. In this paper we study the bi-domination number of a graph G and determine the bi- domination number of some standard graphs and shadow distance graphs.

Definition 1.1. A set D_{bi} of vertices in a graph G is a **bi- dominating set** [4,5] if every $v \in D_{bi}$ dominates exactly two vertices in $V - D_{bi}$ such that $|N(v) \cap (V - D_{bi})| = 2$. The **bi-domination number** $\gamma_{bi}(G)$ is the mininium size of a bi-dominating set. Throughout this paper we will denote **dominating set** by D **set.**

Let D be the set of all distances between distinct pairs of vertices in G and let D_s (called the distance set) $\subset D$ and is denoted by $D(G, D_s)$ [6] having the same vertex set as same in G and u and v are adjacent in $D(G, D_s)$ if $d(u, v) \in D_s$.

[7,8] The shadow distance graph of G, denoted by $D_{sd}(G, D_s)$ is establish from G with the following conditions:

i) consider two copies of G say G itself and G'

ii) if $k \in V(G)$ then the corresponding vertex is $k' \in V(G')$

iii) $V(D_{sd}(G, D_s)) = V(G) \cup V(G')$

iv) $E(D_{sd}(G, D_s)) = E(G) \cup E(G') \cup E_{ds}$ where $E_{ds} = \left\{ d(u, v) \in D_s, u \in V_{p_n} \text{ and } v' \in V_{p'_n} \right\}$

2. APPLICATIONS USING BI-DOMINATION

The mastery rule is tended to be a few of the issues that incorporate the prerequisite of bi-domination, by vertices of this organize, speaking to the key components (individuals, computers, stores, etc..) to rule the arrange with as few components as conceivable. In this area, test applications are presented by utilizing bi-domination in charts, as takes after: [1, 2] **Network-Attached Capacity (NAC):** The Organize Neighborhood could be a way to associate all the computers within the building to each other so that everybody can share substance and administrations among them, within the same neighborhood arrange to spare time it takes to exchange records. Particularly, the issue of the data capacity organizes is by introducing an arrange capacity gadget. In specific, in benefit organizations that bargain occasionally with information spare, the specialists prescribe that after you back up apformation through arrange capacity gadgets, we ought to depend on two stockpiles. In this way, information is put away on both stockpiles, in case of a mechanical disappointment on one of the two stockpiles, in this way avoiding misfortune of information. The bi-domination may be a way better procedure utilized for this depending on what the company possesses of capacity.

In this paper we determine the bi-domination number for some standard graphs and shadow distance graphs.

3. MAIN RESULTS

We begin this section with the following results which gives the condition for a minimal bi-dominating set.

Theorem 3.1. A Dset D_{bi} of G is a minimal bi-Dset, then the following conditions are satisfied

i) $\forall u, w \in V - D_{bi}$ such that u, w are adjacent to v

ii) for any vertices $u, w \in V - D_{bi}$, every $u - v$ path contain a vertex of D_{bi}

Proof. Let D_{bi} be the minimal bi-Dset, then every vertex $v \in D_{bi}$ of degree at least two and is adjacent to exactly two vertices of $V - D_{bi}$. Suppose some vertex $v \in D_{bi}$ of degree one and adjacent to one vertex of $V - D_{bi}$. Which contradicts a bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $|N(v) \cap (V - D_{bi})| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Theorem 3.2. If $G = (r, s)$, then $\gamma_{bi}(G) \leq \left\lceil \dfrac{r.\Delta(G)}{\Delta(G) + 1} \right\rceil$

The following upper bound is immediate

The following upper bound is a relationship between a bi-domination number and vertex covering number.

Theorem 3.3. If $G = (r, s)$, then $\gamma_{bi}(G) \leq \alpha_0(G)$

Proof. Let S be a maximum independent set of G. Then S has at least one end vertex of every edge and every $v \in S$ is adjacent to some vertex in V_S. It follows that V_S is a bi-Dset of G, Hence $\gamma_{bi}(G) \leq \alpha_0(G)$.

Theorem 3.4. If $G = (r, s)$, then $\gamma_{bi}(G) + \gamma(G) \leq r$

Proof. Since $\gamma(G) \leq \beta_0(G)$ and $\gamma_{bi}(G) \leq \alpha_0(G)$, $\gamma_{bi}(G) + \gamma(G) \leq \alpha_0(G) + \beta_0(G)$.

Hence $\gamma_{bi}(G) + \gamma(G) \leq r$

Theorem 3.5. If $r \geq 3$, then $\gamma_{bi}\left(D_2, \{P_r\}\right) = \begin{cases} 4, & r = 3, 4, 5 \\ r, & r \equiv 0, 2 \pmod 4 \\ r - 1, & r \equiv 1, 3 \pmod 4 \end{cases}$

Proof. Consider the two copies of P_r, one P_r itself and the other denoted by P_r'. Let $V_{P_r} = \{v_i\}$, $1 \leq i \leq r$ and $V_{P'} = \{v_j'\}$, $1 \leq j \leq r$. Let $E_{P_r} = \{e_i\}$, $1 \leq i \leq r - 1$ and $E_{P'} = \{e_j'\}$, $1 \leq j \leq r - 1$, where $e_i = (v_i, v_{i+1})$, $e_j' = (v_j', v_{j+1}')$ for $i, j = 1, 2, \ldots, r - 1$ and $E_{ds} = \left\{ d(u, v) \in D_s, u \in V_{P_r} \text{ and } v' \in V_{P_r'} \right\}$

Let $G = \left(D_2 \{P_r\}\right)$

If n = 3, 4, 5, the sets $D_{bi} = \{v_1, v_3, v_1', v_3'\}$, $D_{bi} = \{v_1, v_4, v_1', v_4'\}$, $D_{bi} = \{v_2, v_3, v_3', v_4'\}$ are the minimal bi-Dsets and hence $\gamma_{bi}(G) = 4$.

Let $r \geq 6$, then for

$Case(i)$: $r = 4a + 2$, $a = 1, 2, 3, 4 \ldots$ Consider the set

$D_{bi} = \left\{ \{v_{4j-2}\} \cup \{v_{4j'-1}\} \cup \{v_{4k-1}'\} \cup \{v_{4k'}'\} \cup \{v_r'\} \right\}$

Where $1 \leq j \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq j' \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq k \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k' \leq \left\lfloor \dfrac{r}{4} \right\rfloor$

Case(ii): $r = 4b + 3$, $b = 1, 2, 3, \ldots$ Consider the set

$$D_{bi} = \left\{ \left\{ v_{4j-2} \right\} \cup \left\{ v_{4j'-1} \right\} \cup \left\{ v_r \right\} \cup \left\{ v'_{4k-1} \right\} \cup \left\{ v'_{4k'} \right\} \right\}$$

Where $1 \leq j \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq j' \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq k' \leq \left\lfloor \dfrac{r}{4} \right\rfloor$

Case(iii): $r = 4c + 4$, $c = 1, 2, 3, \ldots$ Consider the set

$$D_{bi} = \left\{ \left\{ v_{4j-2} \right\} \cup \left\{ v_{4j'-1} \right\} \cup \left\{ v'_{4k-1} \right\} \cup \left\{ v'_{4k'} \right\} \cup \left\{ v'_{r-2} \right\} \right\}$$

Where $1 \leq j \leq \dfrac{r}{4}, 1 \leq j' \leq \dfrac{r}{4}, 1 \leq k \leq \dfrac{r}{4}, 1 \leq k' \leq \dfrac{r}{4} - 1$

Case(iv): $r = 4d + 5$, $d = 1, 2, 3, \ldots$ Consider the set

$$D_{bi} = \left\{ \left\{ v_{4j-2} \right\} \cup \left\{ v_{4j'-1} \right\} \cup \left\{ v'_{4k-1} \right\} \cup \left\{ v'_{4k'} \right\} \right\}$$

Where $1 \leq j \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq j' \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k' \leq \left\lfloor \dfrac{r}{4} \right\rfloor$

The above cases of D_{bi} are the minimal bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $|N(v) \cap (V - D_{bi})| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Therefore, D_{bi} is minimal bi-dominating set and Since $|D_{bi}| = \begin{cases} 4, & r = 3, 4, 5 \\ r, & r \equiv 0, 2 \pmod 4 \\ r - 1, & r \equiv 1, 3 \pmod 4 \end{cases}$

We immediately obtain $\gamma_{bi}\left(D_2, \{P_r\} \right) = \begin{cases} 4, & r = 3, 4, 5 \\ r, & r \equiv 0, 2 \pmod 4 \\ r - 1, & r \equiv 1, 3 \pmod 4 \end{cases}$

Hence the proof.

Theorem 3.6. *If* $r \geq 3$, *then* $\gamma_{bi}\left(D_2, \{C_r\} \right) = \begin{cases} 3, & r = 3 \\ 4, & r = 4, 5 \\ r, & r \equiv 0 \pmod 4 \\ r - 1, & r \equiv 1 \pmod 4 \\ r + 2, & r \equiv 2 \pmod 4 \\ r + 1, & r \equiv 3 \pmod 4 \end{cases}$

Proof. Consider the two copies of C_r, one C_r itself and the other denoted by C_r'. Let $V_{C_r} = \{v_i\}$, $1 \leq i \leq r$ and $V_{C_r'} = \{v'_j\}, 1 \leq j \leq r$. Let $E_{C_r} = \{e_i\}$, $1 \leq i \leq r$ and $E_{C_r'} = \{e'_j\}$, $1 \leq j \leq r$, where $e_i = (v_i, v_{i+1})$, $e'_j = (v'_j, v'_{j+1})$ for $i, j = 1, 2, \ldots r$ where the computation is under modulo n and $E_{ds} = \left\{ d(u, v) \in D_s, u \in V_{C_r} \text{ and } v' \in V_{C_r'} \right\}$

Let $G = \left(D_2 \{ C_r \} \right)$.

If $r = 3$ the set $D_{bi} = \{ v_1, v_3, v_2' \}$ is minimal so that $\gamma_{bi}(G) = 3$.

If $r = 4, 5$ the set $D_{bi} = \{ v_1, v_4, v_1', v_4' \}$ $D_{bi} = \{ v_2, v_3, v_2', v_3' \}$ are minimal so that $\gamma_{bi}(G) = 4$.

Let $r \geq 6$, then for

Case (i) : $r = 4a + 2$, $a = 1, 2, 3, 4.....$ Consider the set

$$D_{bi} = \left\{ \{ v_{4j-2} \} \cup \{ v_{4j'-1} \} \cup \{ v_{r-1} \} \cup \{ v'_{4k-2} \} \cup \{ v'_{4k'-1} \} \cup \{ v'_{r-1} \} \right\}$$

Where $1 \leq j \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq j' \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq k' \leq \left\lfloor \dfrac{r}{4} \right\rfloor$

Case (ii) : $r = 4b + 3$, $b = 1, 2, 3, 4.....$ Consider the set

$$D_{bi} = \left\{ \{ v_{4j-2} \} \cup \{ v_{4j'-1} \} \cup \{ v'_{4k-2} \} \cup \{ v'_{4k'-1} \} \right\}$$

Where $1 \leq j \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq j' \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq k \leq \left\lceil \dfrac{r}{4} \right\rceil, 1 \leq k' \leq \left\lceil \dfrac{r}{4} \right\rceil$

Case(iii) : $r = 4c + 4$, $c = 1, 2, 3, 4.....$ Consider the set

$$D_{bi} = \left\{ \{ v_{4j-2} \} \cup \{ v_{4j'-1} \} \cup \{ v'_{4k-2} \} \cup \{ v'_{4k'-1} \} \right\}$$

Where $1 \leq j \leq \dfrac{r}{4}, 1 \leq j' \leq \dfrac{r}{4}, 1 \leq k \leq \dfrac{r}{4}, 1 \leq k' \leq \dfrac{r}{4}$

Case (iv) : $r = 4d + 5$, $d = 1, 2, 3, 4.....$ Consider the set

$$D_{bi} = \left\{ \{ v_{4j-2} \} \cup \{ v_{4j'-1} \} \cup \{ v'_{4k-1} \} \cup \{ v'_{4k'} \} \right\}$$

Where $1 \leq j \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq j' \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k \leq \left\lfloor \dfrac{r}{4} \right\rfloor, 1 \leq k' \leq \left\lfloor \dfrac{r}{4} \right\rfloor$

The above cases of D_{bi} are the minimal bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $\left| N(v) \cap (V - D_{bi}) \right| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Therefore, D_{bi} is minimal bi-dominating set and Since $\left| D_{bi} \right| = \begin{cases} 3, & r = 3 \\ 4, & r = 4, 5 \\ r, & r \equiv 0 \pmod 4 \\ r - 1, & r \equiv 1 \pmod 4 \\ r + 2, & r \equiv 2 \pmod 4 \\ r + 1, & r \equiv 3 \pmod 4 \end{cases}$

we immediately obtain $\gamma_{bi} \left(D_2, \{ C_r \} \right) = \begin{cases} 3, & r = 3 \\ 4, & r = 4, 5 \\ r, & r \equiv 0 \pmod 4 \\ r - 1, & r \equiv 1 \pmod 4 \\ r + 2, & r \equiv 2 \pmod 4 \\ r + 1, & r \equiv 3 \pmod 4 \end{cases}$

Hence the proof.

Theorem 3.7. If $r \geq 3$, then $\gamma_{bi}\left(D_{sd}\left\{P_r,\{2\}\right\}\right) = \begin{cases} 2, & r = 3 \\ r, & r \equiv 0 \pmod 2 \\ r-1, & r \equiv 1 \pmod 2 \end{cases}$

Proof. Suppose that the vertex and edge sets are same in theorem 3.5

Let $G = \left(D_{sd}\left\{P_2,\{2\}\right\}\right)$

If $r = 3$ the set $D_{bi} = \{v_2, v_2'\}$ is the minimal so that $\gamma_{bi}(G) = 2$.

Let $r \geq 4$, then for

Case (i): $r = 2a + 2$, $a = 1, 2, 3, 4......$ Consider the set

$D_{bi} = \left\{\{v_{2j+1}\} \cup \{v_2\} \cup \{v_{2k+1}'\} \cup \{v_2'\}\right\}$

Where $1 \leq j \leq \dfrac{r}{2} - 1$, $1 \leq k \leq \dfrac{r}{2} - 1$

Case (ii): $r = 2b + 3$, $b = 1, 2, 3, 4.......$ Consider the set

$D_{bi} = \left\{\{v_{2j}\} \cup \{v_{2k}'\}\right\}$ where $1 \leq j \leq \left\lfloor \dfrac{r}{2} \right\rfloor$, $1 \leq k \leq \left\lfloor \dfrac{r}{2} \right\rfloor$

The above cases of D_{bi} are the minimal bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $\left|N(v) \cap (V - D_{bi})\right| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Therefore, D_{bi} is minimal bi-dominating set and Since $\left|D_{bi}\right| = \begin{cases} 2, & r = 3 \\ r, & r \equiv 0 \pmod 2 \\ r-1, & r \equiv 1 \pmod 2 \end{cases}$

we immediately obtain $\gamma_{bi}\left(D_{sd}\left\{P_r,\{2\}\right\}\right) = \begin{cases} 2, & r = 3 \\ r, & r \equiv 0 \pmod 2 \\ r-1, & r \equiv 1 \pmod 2 \end{cases}$

Hence the proof.

Theorem 3.8. Let $r \geq 4$, then $\gamma_{bi}\left(D_{sd}\left\{C_r,\{2\}\right\}\right) = \begin{cases} 4, & r = 4, 5 \\ \dfrac{2r}{3}, & r \equiv 0 \pmod 3 \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 \pmod 3 \\ \dfrac{2(r-2)}{3} + 2, & r \equiv 2 \pmod 3 \end{cases}$

Proof. Suppose that the vertex and edge sets are same in theorem 3.6

Let $G = \left(D_{sd}\left\{C_r,\{2\}\right\}\right)$

If $r = 4, 5$ the set $D_{bi} = \{v_2, v_3, v_2', v_3'\}$, $D_{bi} = \{v_2, v_4, v_1', v_4'\}$ are minimal.

so that $\gamma_{bi}(G) = 4$.

Let $r \geq 6$, then for

Case (i) : $r = 3a + 3$, $a = 1, 2, 3, 4, \ldots$ Consider the set

$$D_{bi} = \left\{ \{v_{3j-1}\} \cup \{v'_{3k-2}\} \right\} \text{ where } 1 \leq j \leq \frac{r}{3}, \ 1 \leq k \leq \frac{r}{3}$$

Case (ii) : $r = 3b + 4$, $b = 1, 2, 3, 4, \ldots$ Consider the set

$$D_{bi} = \left\{ \{v_{3j-1}\} \cup \{v_r\} \cup \{v'_2\} \cup \{v'_{3k+1}\} \right\} \text{ where } 1 \leq j \leq \left\lfloor \frac{r}{3} \right\rfloor, \ 1 \leq k \leq \left\lfloor \frac{r}{3} \right\rfloor$$

Case (iii) : $r = 3c + 5$, $c = 1, 2, 3, 4, \ldots$ Consider the set

$$D_{bi} = \left\{ \{v_{3j+1}\} \cup \{v_r\} \cup \{v'_2\} \cup \{v'_{3k}\} \right\} \text{ where } 1 \leq j \leq \left\lfloor \frac{r}{3} \right\rfloor, \ 1 \leq k \leq \left\lfloor \frac{r}{3} \right\rfloor$$

The above cases of D_{bi} are the minimal bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $|N(v) \cap (V - D_{bi})| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Therefore , D_{bi} is minimal bi-dominating set and

Since $|D_{bi}| = \begin{cases} 4, & r = 4, 5 \\ \dfrac{2r}{3}, & r \equiv 0 (\mathrm{mod}\, 3) \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 (\mathrm{mod}\, 3) \\ \dfrac{2(r-2)}{3} + 2, & r \equiv 2 (\mathrm{mod}\, 3) \end{cases}$

we immediately obtain $\gamma_{bi}\left(D_{sd}\{C_r, \{2\}\} \right) = \begin{cases} 4, & r = 4, 5 \\ \dfrac{2r}{3}, & r \equiv 0 (\mathrm{mod}\, 3) \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 (\mathrm{mod}\, 3) \\ \dfrac{2(r-2)}{3} + 2, & r \equiv 2 (\mathrm{mod}\, 3) \end{cases}$

Hence the proof.

Theorem 3.9. Let $r \geq 4$, then $\gamma_{bi}\left(D_{sd}\{P_r, \{3\}\} \right) = \begin{cases} 3, & r = 4 \\ \dfrac{2r}{3}, & r \equiv 0 (\mathrm{mod}\, 3) \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 (\mathrm{mod}\, 3) \\ \dfrac{2(r-2)}{3} + 4, & r \equiv 2 (\mathrm{mod}\, 3) \end{cases}$

Proof. Suppose that the vertex and edge sets are same in theorem 3.5

Let $G = \left(D_{sd}\{P_r, \{3\}\} \right)$

If $r = 4$ the set $D_{bi} = \{v_1, v_4, v_3'\}$ is minimal so that $\gamma_{bi}(G) = 3$.

Let $r \geq 5$, then for

Case (i) : $r = 3a + 2$, $a = 1, 2, 3, 4, \ldots\ldots$ Consider the set

$$D_{bi} = \left\{\{v_{3j}\} \cup \{v_1\} \cup \{v_r\} \cup \{v_1'\} \cup \{v_{3k}'\} \cup \{v_r'\}\right\} \text{ where } 1 \leq j \leq \left\lfloor \frac{r}{3} \right\rfloor, \ 1 \leq k \leq \left\lfloor \frac{r}{3} \right\rfloor$$

Case (ii) : $r = 3b + 3$, $b = 1, 2, 3, 4, \ldots\ldots$ Consider the set

$$D_{bi} = \left\{\{v_{3j-1}\} \cup \{v_{3k-1}'\}\right\} \text{ where } 1 \leq j \leq \frac{r}{3}, \ 1 \leq k \leq \frac{r}{3}$$

Case (iii) : $r = 3c + 4$, $c = 1, 2, 3, 4, \ldots\ldots$ Consider the set

$$D_{bi} = \left\{\{v_{3j-1}\} \cup \{v_r\} \cup \{v_{3k-1}'\} \cup \{v_r'\}\right\} \text{ where } 1 \leq j \leq \left\lfloor \frac{r}{3} \right\rfloor, \ 1 \leq k \leq \left\lfloor \frac{r}{3} \right\rfloor$$

The above cases of D_{bi} are the minimal bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $|N(v) \cap (V - D_{bi})| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Therefore, D_{bi} is minimal bi-dominating set and

Since $|D_{bi}| = \begin{cases} 3, & r = 4 \\ \dfrac{2r}{3}, & r \equiv 0 \pmod 3 \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 \pmod 3 \\ \dfrac{2(r-2)}{3} + 4, & r \equiv 2 \pmod 3 \end{cases}$

we immediately obtain $\gamma_{bi}\left(D_{sd}\{P_r, \{3\}\}\right) = \begin{cases} 3, & r = 4 \\ \dfrac{2r}{3}, & r \equiv 0 \pmod 3 \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 \pmod 3 \\ \dfrac{2(r-2)}{3} + 4, & r \equiv 2 \pmod 3 \end{cases}$

Hence the proof.

Theorem 3.10. If $r \geq 4$, then $\gamma_{bi}\left(D_{sd}\{C_r, \{3\}\}\right) = \begin{cases} 4, & r = 4 \\ \dfrac{2r}{3}, & r \equiv 0 \pmod 3 \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 \pmod 3 \\ \dfrac{2(r-2)}{3} + 2, & r \equiv 2 \pmod 3 \end{cases}$

Proof. Suppose that the vertex and edge sets are same in theorem 3.6

Let $G = \left(D_{sd}\{C_r, \{3\}\}\right)$

Let $r \geq 5$, then for

Case (i) : $r = 3a + 2$, $a = 1, 2, 3, 4, ...$ Consider the set

$$D_{bi} = \left\{ \{v_{3j-1}\} \cup \{v'_3\} \cup \{v'_{3k+2}\} \right\} \text{ where } 1 \leq j \leq \left\lceil \frac{r}{3} \right\rceil \, , \, 1 \leq k \leq \left\lfloor \frac{r}{3} \right\rfloor$$

Case (ii) : $r = 3b + 3$, $b = 1, 2, 3, 4, ...$ Consider the set

$$D_{bi} = \left\{ \{v_{3j-1}\} \cup \{v'_{3k-1}\} \right\} \text{ where } 1 \leq j \leq \frac{r}{3} \, , \, 1 \leq k \leq \frac{r}{3}$$

Case (iii) : $r = 3c + 4$, $c = 1, 2, 3, 4, ...$ Consider the set

$$D_{bi} = \left\{ \{v_{3j-1}\} \cup \{v_r\} \cup \{v'_1\} \cup \{v'_3\} \cup \{v'_{3k+2}\} \right\} \text{ where } 1 \leq j \leq \left\lfloor \frac{r}{3} \right\rfloor \, , \, 1 \leq k \leq \left\lfloor \frac{r}{3} \right\rfloor - 1$$

The above cases of D_{bi} are the minimal bi-Dset. Hence, for every $u, w \in V - D_{bi}$ is adjacent to $v \in D_{bi}$ such that $\left| N(v) \cap (V - D_{bi}) \right| = 2$ and every $u - v$ path contain a vertex of D_{bi}.

Therefore, D_{bi} is minimal bi-dominating set and

$$\text{Since } |D_{bi}| = \begin{cases} 4, & r = 4 \\ \dfrac{2r}{3}, & r \equiv 0 \pmod 3 \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 \pmod 3 \\ \dfrac{2(r-2)}{3} + 2, & r \equiv 2 \pmod 3 \end{cases}$$

$$\text{we immediately obtain } \gamma_{bi}\left(D_{sd}\left\{C_r, \{3\}\right\}\right) = \begin{cases} 4, & r = 4 \\ \dfrac{2r}{3}, & r \equiv 0 \pmod 3 \\ \dfrac{2(r-1)}{3} + 2, & r \equiv 1 \pmod 3 \\ \dfrac{2(r-2)}{3} + 2, & r \equiv 2 \pmod 3 \end{cases}$$

Hence the proof.

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MINIMIZE TOTAL COMPLETION TIME FOR HYPOTHETICAL CASES USING HEURISTIC APPROACH IN N<M, N>M AND N=M

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ABSTRACT

In an open shop scheduling environment, a given number of jobs must be handled for a certain period of time on each of a given set of machines in an arbitrary order. The goal of this research is to come up with a plan that greatly reduces on total completion time. Using a heuristic method, the current work focused on minimizing the overall completion time for hypothetical cases such as more jobs more machines, more jobs less machines, less jobs more machine, and less jobs less machine. This study analyses the completion time on various algorithms utilizing heuristics and solves the problem with several hypothetical cases using Longest Processing Time (LPT), Shortest Processing Time (SPT), and Random.

Keywords: Open shop scheduling problem, Hypothetical cases, Heuristics, Longest Processing Time (LPT), Shortest Processing Time (SPT), Random , Total Completion Time, N-number of jobs, M-number of machines.

1. INTRODUCTION

Flow shop scheduling problem (FSSP), Job shop scheduling problem (JSSP), and Open shop scheduling problem (OSSP) are the three types of scheduling problems. The flow shop scheduling difficulty occurs when jobs can be processed through sequencing. The job shop scheduling challenge occurs when jobs can be processed using sequencing and routing. Open shop scheduling is used when jobs can be completed in any way possible. The challenge of open shop scheduling is common in the real world, such as in the industries of vehicle maintenance and health care. This challenge usually involves a set of n>= 1 jobs and m >=2 machines. Each of these jobs has exactly m operations and must be run on many machines with no restrictions on the processing path. The goal is to find a schedule that optimizes a set of criteria. Because it can be handled in any order imaginable with the goal of reducing overall completion time for hypothetical cases. It is extremely interesting for allocating jobs in the Open shop scheduling problem since certain jobs do not require any machine for processing. In general, these types of problems are NP-Hard.

2. RELATED WORK

For the single machine case: the total completion time Open shop scheduling problem in any certain of jobs done by Ching-FangLiawchun-YuanChengMingchihChen (2002) with the problem is NP-hard in the strong sense even for the two machine case single machine scheduling problem with a learning effect with the goal of minimizing the total completion time by Chinyao Low and Wen-Yi Lin (2011) for the two machine case Gonzalez and Sahni. Jayakumar (2001) solved the problem in the general case by applying a heuristic approach to solve the general instances with the goal of minimizing the makespan. Jayakumar et al. (2019) solved the Open shop scheduling problem with the certain goal of minimizing total completion time, which is appropriate to both the production and manufacturing industries.

The algorithm developed by Jayakumar was also evaluated for the goal of minimizing total completion time for hypothetical cases (i.e. some jobs required n-1 operation instead of n operation), which we discussed in this paper. In the year 2019, we published the results of our inquiry into the open scheduling problem with the goal of reducing the total completion time. After that, we conducted research on OSSP with the goal of reducing overall completion time and resource idleness, and we released a paper in 2019.Panahi and Tavakkoli-Moghaddam (2011) presented a hybrid ant colony optimization to get near-optimal solutions to the open shop problem in order to minimize bi-objectives (i.e. makespan and total tardiness). For the open shop makespan problem, Ahmadizar and Farahani (2012) developed a hybrid genetic algorithm that uses a specific crossover operator to retain the relative order of jobs on machines and a method to avoid repeated search of solutions in the mutation operator.

No study has yet used the differential evolution (DE) algorithm (developed by Storn and Price 1997) to solve the open shop scheduling problem, to the best of the authors' knowledge. The DE algorithm is a group-evolution-based method for global optimization over continuous search spaces, in which mutation and crossover operators generate new candidate solutions. The DE algorithm is one of the most effective optimizers due to its many advantages, including its simple structure, ease of implementation, and speedy convergence.

3. OBJECTIVE STATEMENT

To solve the open shop scheduling problem for more than two jobs and two machines is NP-hard, a suitable solution, such as a heuristic approach must be needed. The tools for discovering a near-optimal solution include simulated annealing, Tabu Search, and a heuristic approach. Consider the three-job, three-machine situation of the huge automotive garage with specialist shops, where the tyre, sheet, and engine may be replaced in any order. The goal is to identify total completion time in order to decrease total completion time so that its performance can be easily measured.

4. HEURISTIC ALGORITHM

Heuristic algorithms are utilized to solve NP problems and provide rapid solutions, reducing the time complexity of the problem. A heuristic algorithm is one that sacrifices optimality, accuracy, precision, or completeness for speed in order to solve a problem faster and more efficiently than standard approaches. NP-complete problems, a type of decision problem, are frequently solved using heuristic algorithms.

4.1. Heuristic Algorithm Using LPT

Priority Rules

MWP (Maximum Work Pending): Choose the operation connected with the task that has the greatest work pending.

LPT (Longest Processing Time): Choose the procedure that takes the longest to complete.

RAN (Random): Choose the operation at random if there is a tie. At each level, the operation 'S_k' must be identified, as well as the times when the machines are available for processing. The work pending of the job linked with operation (i,j) is referred to as MWP_{ij}

Heuristic Schedule Generation

Step 1: Assume t=0 and P_k=(Empty), S_k = (All operation).

Step 2: In S_k, look at P*= min (P_{ij}), (i , j) and the related operation for which P* could be freed, as indicated. If 'P*' only appears for S_K operations. Then add that operation to 'P_k' and create the next partial schedule P_{k+1}, unless you want to proceed to step 3.

Step 3: Identify an operation in S_K for which 'P_{ij}' equals P* and add it to 'P_k' as soon as feasible, thereby producing just a partial schedule 'P_{k+1}' for the next step, according to the sequence of priorities as indicated in the earlier section.

Step 4: Update the data set as follows for each new partial schedule 'P_{k+1}' established in step 3: By eliminating operation (i , j) from S_K, we get 'S_{k+1}'. Increase the value of 't' by one.

Step 5: Repeat steps 2 to 4 for each P_{k+1} created in step 3, and keep going until all of the operations have been added to 'S_K'.

Step 6: Calculate the TCT by sum of processing time of all jobs and all the machines except sum machines doesn't required sum jobs for processing.

4.2. Heuristic Algorithm Using SPT

Priority Rules

MWP (Maximum Work Pending): choose operation related with the task that has the greatest work pending.

SPT (Shortest Processing Time): choose the procedure that takes the least amount of time to complete.

RAN (Random): If there is a tie, the operation will be chosen at random. At each level, the operation must be identified in 'S_K,' and the times when the machines are accessible for processing must be kept track of. MWP_{ij} is the work in progress of the operation (i, j).

Heuristic Schedule Generation

Step 1: Assume t=0 and P_k=(empty), S_k = "All operation."

Step 2: In S_K, find P*= min (P_{ij}),(i , j) and the associated operation for which P* could be freed, as indicated. If 'P*' only appears for S_K operations. Then add that operation to 'P_k' and create the next partial schedule P_{k+1}, unless you want to proceed to step 3.

Step 3: Identify an operation in S_K for which 'P_{ij}' equals P* and add it to 'P_k' as soon as feasible, thereby establishing just a partial schedule 'P_{k+1}' for the next stage, according to the sequence of priorities as specified in the previous.

Step 4: Update the data set as follows for each new partial schedule 'P_{k+1}' established in step 3: By eliminating operation (i , j) from S_K, we get 'S_{k+1}'. Increase the value of 't' by one.

Step 5: For each P_{k+1} formed in stage 3, $P_{ij}= 0$ from step 2 to step 4 and find in this manner until all operations are added to 'S_K'.

Step 6: Calculate the TCT by sum of processing time of all jobs and all the machines except sum machines doesn't required sum jobs for processing.

4.3. Heuristic Algorithm Using Random

Priority Rules
MWP (Maximum Work Pending): Choose the operation related with the task that has the greatest work pending.

RAN (Random): Choose a random procedure. At each level, the operation must be identified in 'S_K,' and the periods when the selections are available for processing must be kept track of. MWP_{ij} is the work in progress of the operation (i, j) jobs.

Heuristic Schedule Generation
Step 1: Assume t=0 and P_k=(empty), S_k = "All operation."

Step 2: In SK, find P* = min (P_{ij}), (i, j) and the appropriate operation for which P* could be freed, as indicated. If 'P*' only appears for S_K operations. Then add that operation to 'P_k' and create the next partial schedule P_{k+1}, unless you want to proceed to step 3.

Step 3: Identify an operation in S_K for which 'P_{ij}' equals P* and add it to 'P_k' as soon as feasible, thereby producing just a partial schedule 'P_{k+1}' for the next stage, according to the order of priorities as specified in the earlier.

Step 4: Update the data set as follows for each new partial schedule 'Pk+1' established in step 3: By eliminating operation (i , j) from SK, we get 'S_{k+1}'. Increase the value of 't' by one.

Step 5 : Repeat steps 2 to 4 for each P_{k+1} created in step 3, and keep going until all of the operations have been added to 'S_K'.

Step 6: Calculate the TCT by sum of processing time of all jobs and all the machines except sum machines doesn't required sum jobs for processing.

For various Hypothetical cases, three algorithms have been designed to fulfil the goal of minimizing total completion time.

5. Hypothetical Cases
A hypothetical is a made-up scenario in which the algorithm is tested. The hypothetical is created by the reasoner in order to draw out and test the outcomes. Decision-makers can use hypothetical cases to explore alternative possibilities for deciding a case. They highlight the sensitivity of a hypothetical case to seemingly minor factual discrepancies that may demand different outcomes because they cause opposing underlying principles to be applied or tradeoffs to be shifted. The decision-maker tries to develop as broad and robust a hypothetical case as feasible by anticipating future variants.

5.1. Case 1: Less Jobs and More Machines (N<M)
Let consider the below problem to solve when number of jobs less than the number of machines. Where N is number of jobs and M is number of Machines.

Table 1: 3 jobs, 4 machines Problem

	M1	M2	M3	M4
J1	6	9	12	7
J2	8	13	0	14
J3	11	4	16	8

According to the above given problem 3 jobs and 4 machines are there to solve Open shop scheduling problem to reduce the total completion time with various algorithms which is represented in the Gantt chart as given below

5.1.1. Gantt Chart for Longest Processing Time
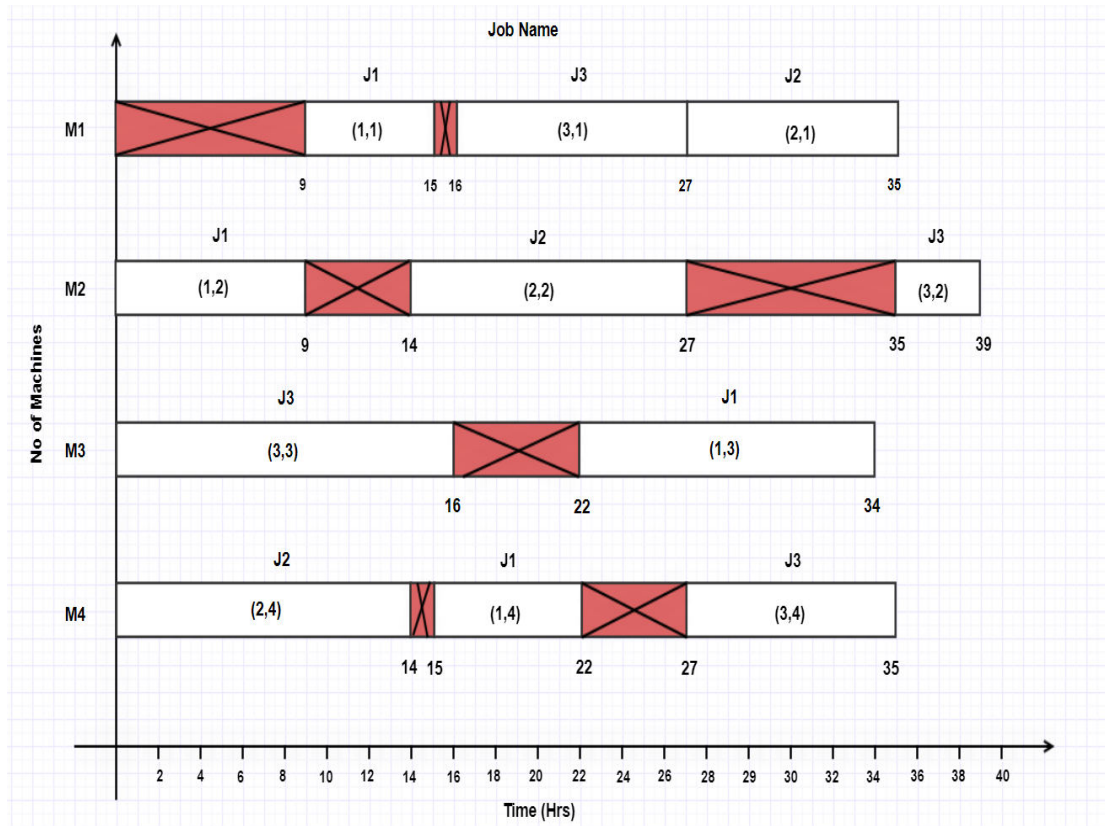
Figure 1: Case 1- Gantt chart for LPT

5.1.2. Gantt Chart for Shortest Processing Time
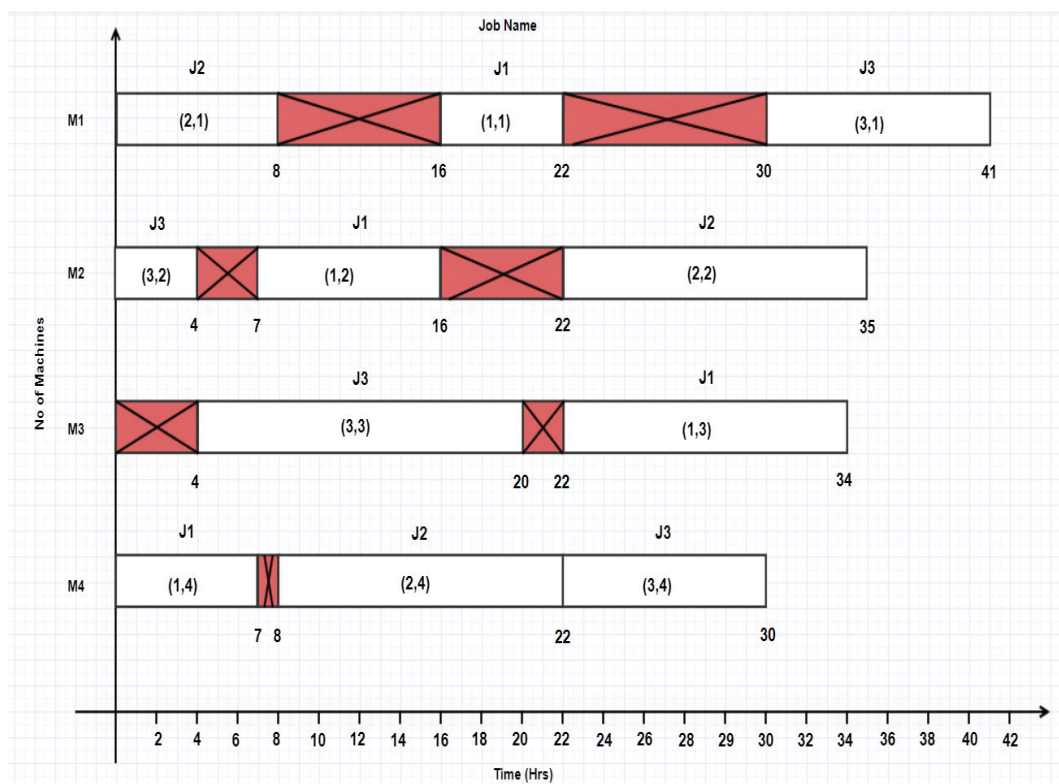
Figure 2: Case 1- Gantt chart for SPT

5.1.3. Gantt Chart for Random
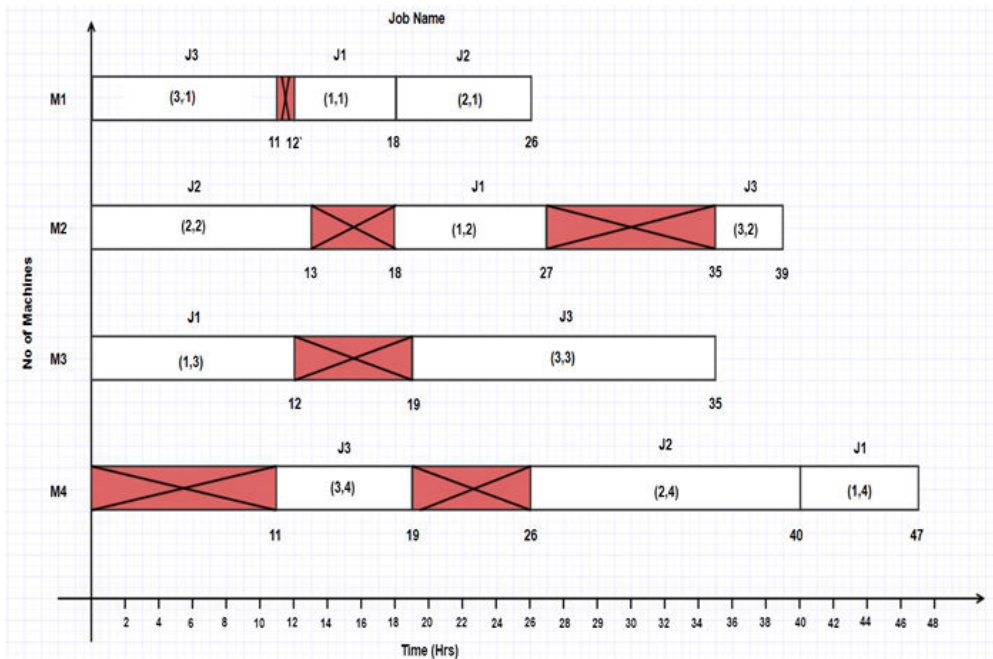
Figure 3: Case 1- Gantt chart for Random

5.2. Case 2: More Jobs and Less Machines (N>M)

Let consider the below problem to solve when number of jobs greater than the number of machines. Where N is number of jobs and M is number of Machines.

Table 2: 4 jobs, 3 machines Problem

	M1	M2	M3
J1	6	3	2
J2	4	5	7
J3	3	9	5
J4	0	2	6

According to the above given problem 4 jobs and 3 machines are there to solve Open shop scheduling problem to reduce the total completion time with various algorithms which is represented in the gantt chart as given below

5.2.1. Gantt Chart for Longest Processing Time
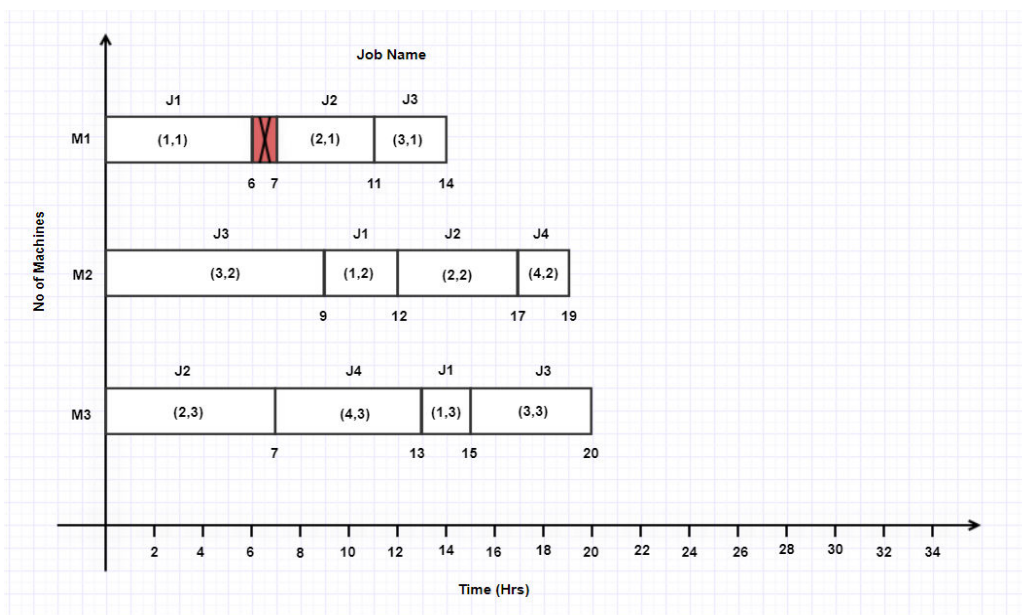
Figure 4: Case 2- Gantt chart for LPT

5.2.2. Gantt Chart for Shortest Processing Time
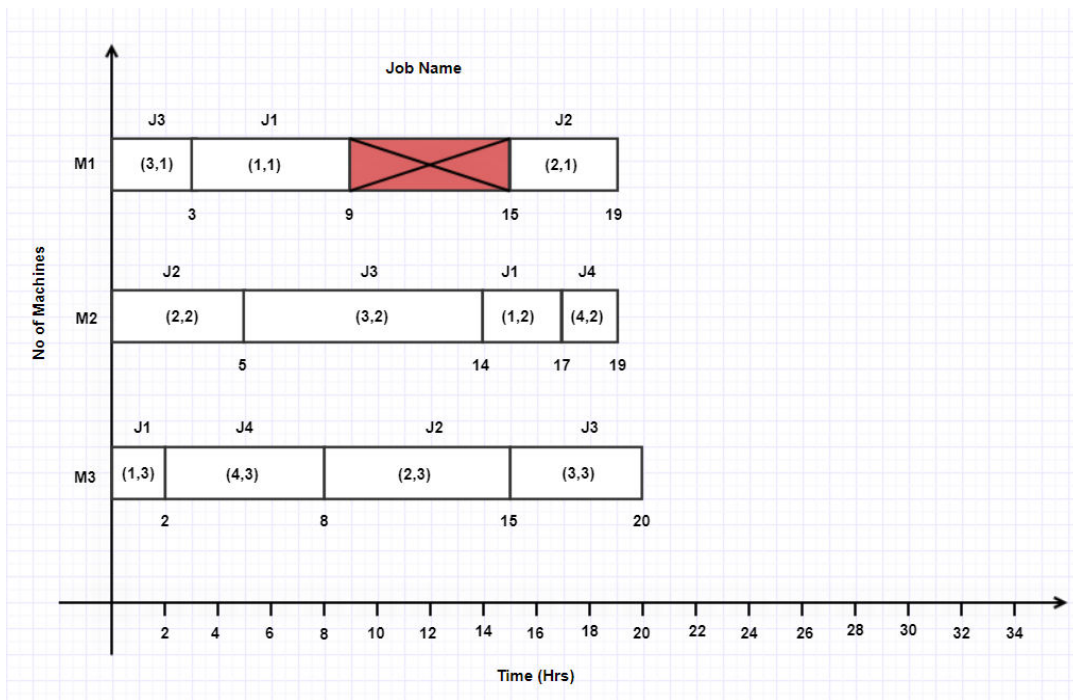
Figure 5: Case 2- Gantt chart for SPT

5.2.3. Gantt Chart for Random
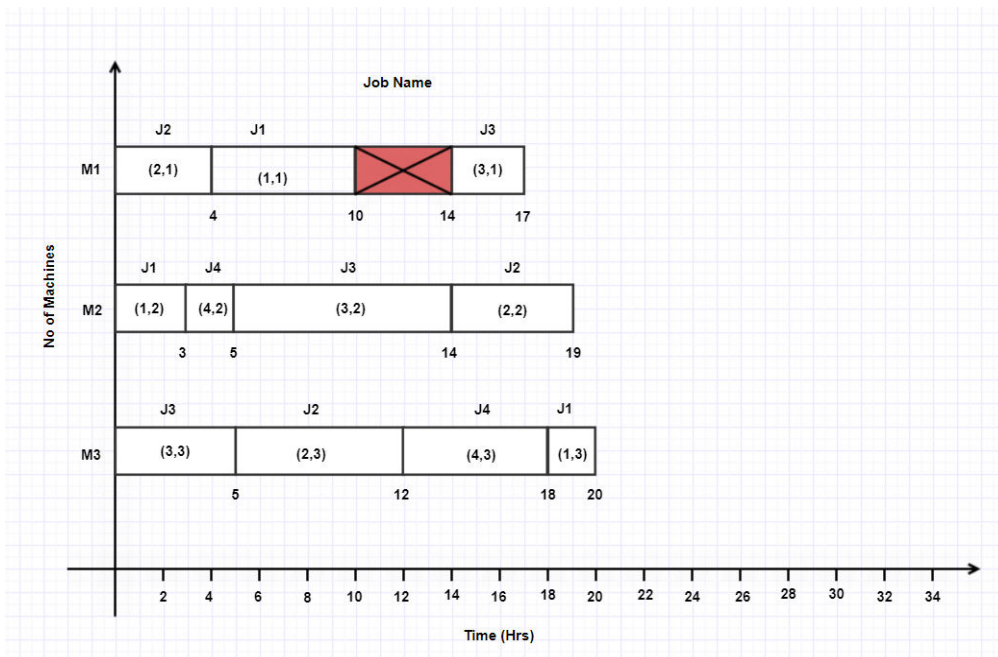
Figure 6: Case 2- Gantt chart for Random

5.3. Case 3: Number of Jobs Equal to Number of Machines (N=M)

Let consider the below problem to solve when number of jobs equal to number of machines. Where N is number of jobs and M is number of Machines.

Table 3: 4 jobs, 4 machines Problem

	M1	M2	M3	M4
J1	1	9	3	5
J2	7	2	6	4
J3	1	7	0	2
J4	8	6	3	4

According to the above given problem 4 jobs and 4 machines are there to solve Open shop scheduling problem to reduce the total completion time with various algorithms which is represented in the gantt chart as given below

5.3.1. Gantt Chart for Longest Processing Time
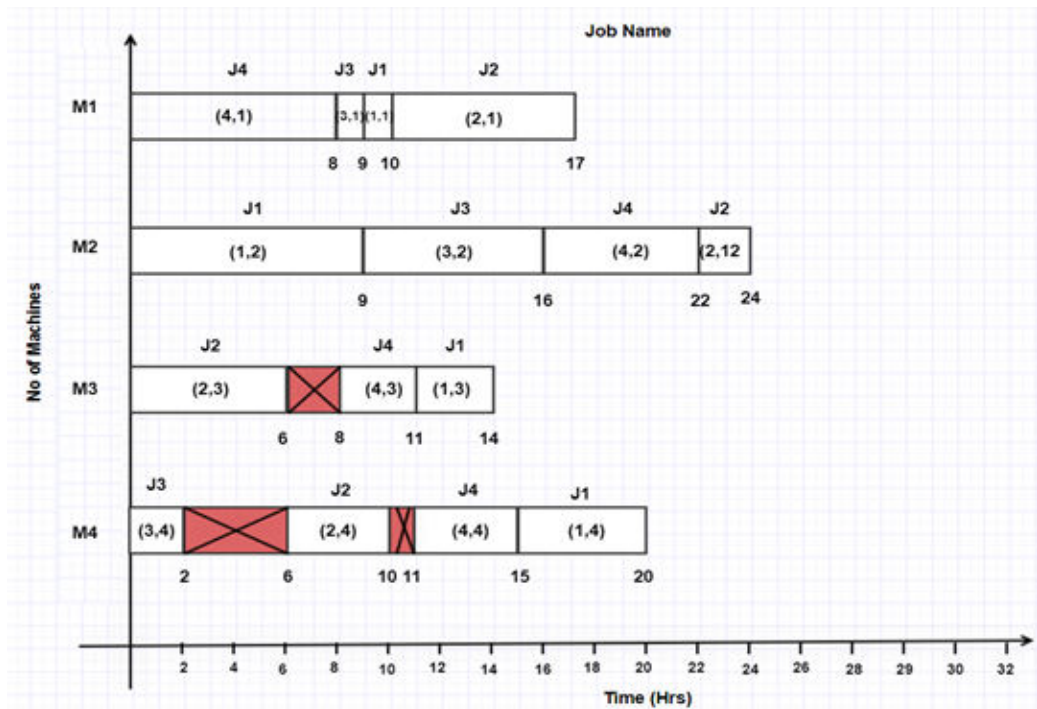
Figure 7: Case 3- Gantt chart for LPT

5.3.2. Gantt Chart for Shortest Processing Time
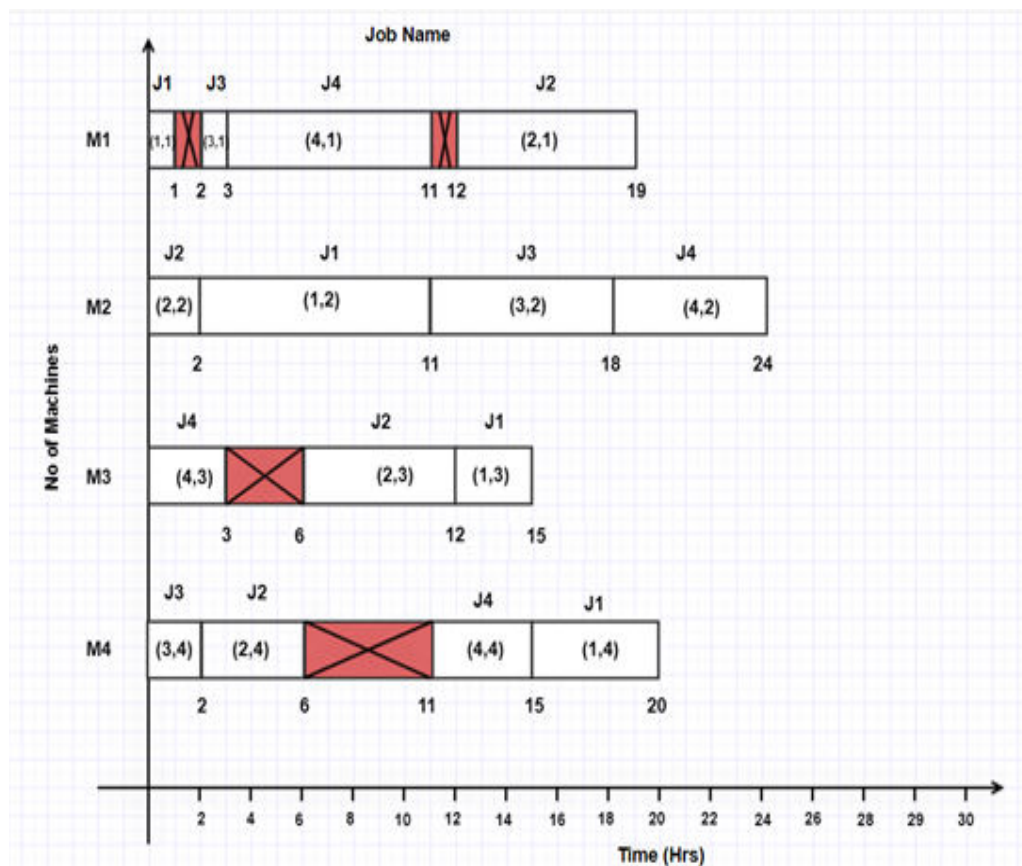
Figure 8: Case 3- Gantt chart for SPT

5.3.3. Gantt Chart for Random
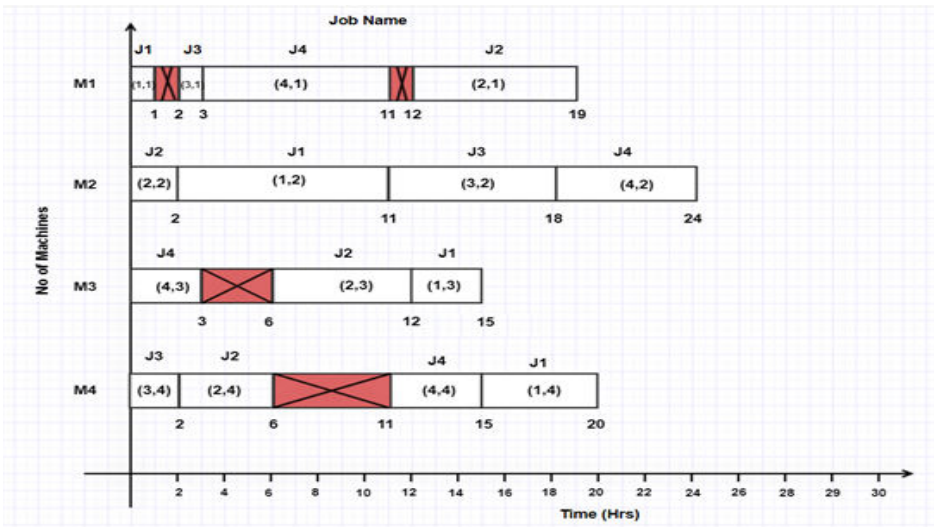
Figure 9: Case 3- Gantt chart for Random

6. RESULT AND DISCUSSION

The examination is done between the three algorithms described above for more than two machines with arbitrary processing time, and it has been determined that the LPT based approach performs better than the other two in discovering total completion time for the hypothetical cases. The computational result shows that the LPT-based approach performs better than the other two algorithms in case 2 and case 3. So performance of the LPT-based algorithm is superior to the other two algorithms for the open shop scheduling problem with the goal of minimising the total completion time for not only the 4 jobs 3 machines case but also for the 'n' jobs 'm' machine cases in general. As long as the processing time varies significantly, the performance varies as well. The figure 10, 11 and 12 shows the total completion time for various cases which clearly stated that LPT has less total completion time for both cases that N>M and N=M.
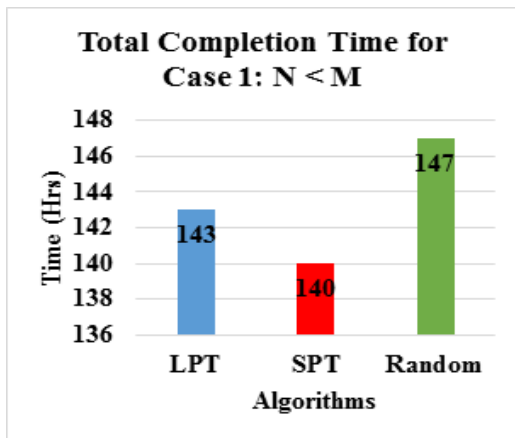
Figure 10: Total completion time for case 1
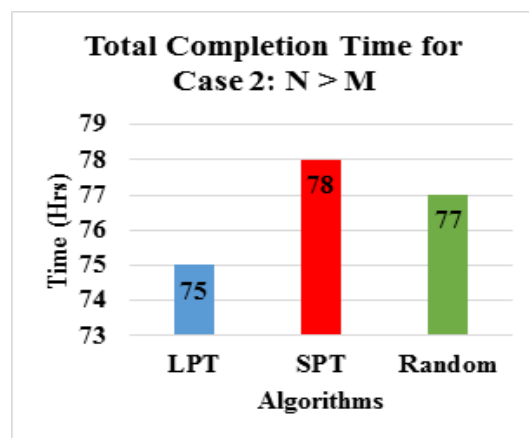
Figure 11: Total completion time for case 2
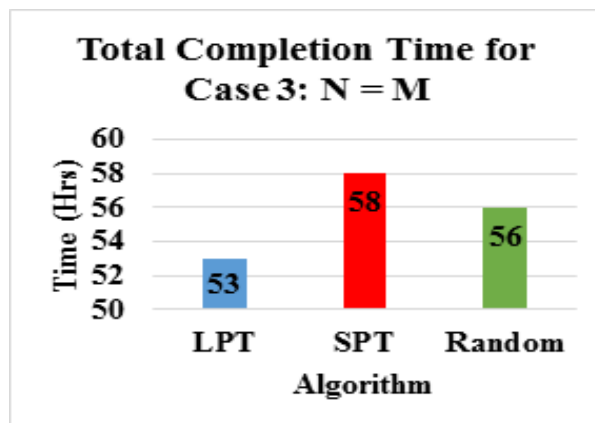
Figure 12: Total completion time for case 3

The table 4 shows the total completion time with various cases for LPT, SPT and Random. Here SPT has less totalcompletion time for Case 1 that is number of jobs lesser than number of machines. But in other two cases such as N>M and N=M , LPT based heuristic algorithm has less total completion time which increase the performance of the system.

Table 4: Total Completion time with various cases for LPT,SPT and Random algorithm

Total Completion Time			
Algorithm Name / Case	LPT	SPT	Random
Case 1: (N<M)	143	140	147
Case 2: (N>M)	75	78	77
Case 3: (N=M)	53	58	56

7. CONCLUSION

In an open shop scheduling environment, a given number of jobs must be handled for a certain period of time on each of a given set of machines in an arbitrary order. To meet the goal of minimizing the overall completion time for hypothetical cases, three algorithms have been developed. The examination is done between the three algorithms described above for more than two machines with arbitrary processing time, and it has been determined that the LPT based approach performs better than the other two in discovering total completion time for the hypothetical cases. The computational result shows that the LPT-based approach performs better than the other two. The performance of the LPT-based algorithm is superior to the other two algorithms for the open shop scheduling problem with the goal of minimizing the total completion time for not only the 4 jobs 3 machines case but also for the 'n' jobs 'm' machine cases in general. As long as the processing time varies significantly, the performance varies as well.

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CUSTOMER SATISFACTION WITH BANK SERVICES

ANAND BETHAPUDI AND MARAM VENKAT RAMANA REDDY

ABSTRACT
Customer satisfaction is the key to the service Business. The banking sector is the major contribution to the development of the human index. There are public sector, private sector, foreign banks, and cooperative banks are operating in India. There is a lot of competition among the banks to retain the customers. Hence, Banks are offering many value-added services to the customers to satisfy. The objective of the research paper is to study the public sector banks namely Indian Bank, Allahabad Bank, and SBI services that are satisfied by the customers or not, especially in Gold and Educational loans. The sample branches are selected from Hyderabadand a structured questionnaire is prepared for the collection of data and data is analyzed using SPSS. The paper concludes that the services offered by the select Public Sector Banks are varied and responses from the customers are moderately satisfied.

Keywords: Customer Satisfaction, Gold loans, Education Loans, Banks, Service quality.

CONCEPTUAL FRAME WORK OF CUSTOMER SATISFACTION
Satisfaction refers to the buyer's state of being adequately rewarded in a buying situation for the sacrifice he or she has made. Adequacy of satisfaction is a result of matching actual post-purchaseexperience and consumption experience with the expected reward from the brand in terms of its anticipated potential to satisfy the customer's motives. The concept of satisfaction is one about which there are presently few agreed-upon definitions or approaches to measurement. Hunt has summarized the concept in the following statement.

Satisfaction is a kind of stepping away from an experience and evaluating it. One could have a pleasurable experience that caused dissatisfaction because even though pleasurable, it was not as pleasurable as it was supposed or expected to be. So, satisfaction or/ dissatisfaction is not an emotion. It is the evaluation of acustomer'semotion. Satisfaction is a person's feelings of pleasure or disappointment that result from comparing a product's perceived performance (or outcome) to their expectations. If the service performance falls short of expectations, the customer is dissatisfied. If the service performance matches the customer'sexpectations, the customer is satisfied. If the service performance exceeds customer expectations, the customer is delighted. Customer satisfaction has been defined by researchers in a variety of ways. However, most of the definitions have favored the notion of consumer satisfaction as a response to an evaluation process. Specifically, there is an overriding theme of consumer satisfaction. For example, consumer satisfaction has been presented as an effective response (Halstead, Hartman and Schmidt 1994), overall evaluation (Formell, 1992); psychological state (Howard and Seth 1969), global evaluative judgment (Westbrook 1987); summary attribute phenomenon (Oliver 1992) or evaluative response (Day 1984). Given these complexities and the context-specific nature of satisfaction, it is impossible to develop a generic global definition. Rather, the definition of satisfaction must be contextually adapted.

Customer satisfaction has also been defined in the following ways.

- A level of happiness resulting from consumption experiences

- A cognitive state resulting from a process of evaluation of performance relative to previously established standards.

i) A subjective evaluation of the various experiences and outcomes associated with acquiring and consuming a product relative to a set of subjectively determined expectations.

ii) A two-factor process of evaluating a set of "satisfiers" and a set of "dissatisfiers" associated with the offer.

iii) One step in a complex process involving prior attitude towards a product or service, a consumption experience resulting in positive or negative disconfirmation of expectancies followed by feelings of satisfaction or dissatisfaction which mediate post-consumption attitude which subsequently influences future purchase behavior.

1. A) OBJECTIVES OF THE STUDY
i) To study the Profile of Indian Bank, Union Bank of India, and SBI;

ii) To compare the satisfaction level of customers of three banks towards the gold loan and educational loan services;

iii) To suggest the measures based on the findings to improve the satisfaction level of customers of three Banksregardingthe Gold loan and Educational Loans.

HYPOTHESIS

Ho: There is no difference among select banks' educational loan services and their functionalities.

1. B). SELECTION OF SAMPLE BANKS AND RESPONDENTS

The investigator wrote to several public sector banks that exist in the state capital of Telangana. With lots of effort, the researcher could get permission from the management of three public sector banks namely Indian bank, Union Bank of India, and State Bank of India to collect the necessary data. The banks also permitted the researcher to elicit the views of customers on their satisfaction about the various services rendered by the banks. Hence, the study is confined finally to three public sector banks namely Indian bank, Union Bank of India, and State Bank of India. A sample of 375 customers who include 125 customers of an Indian bank, 125 customers of Union Bank of India, and 125 customers of State Bank of India have been chosen from the bank's understudy. A random sampling technique or method has been used in the study.

1. C) SOURCES OF DATA COLLECTION

Data has been collected both from primary and secondary sources. Secondary sources of data were also used. They include annual reports, official records, files, brochures, and other published and unpublished material of the banks as well as magazines, journals, books, and Government reports. Primary data were collected through the principal tools of questionnaires, interviews, and observation. A questionnaire on customer satisfaction has been designed and developed after referring to various standard textbooks and magazines and it was used as the principal instrument for data collection. The interview techniquewas used to supplement the data obtained through questionnaires as well.

2. PROFILES OF INDIAN BANK, UNION BANK OF INDIA & SBI

Profile of Indian Bank

Indian Bank is an **Indian** state-owned financial services bank established in 1907 and headquartered in Chennai, India. It serves over 100 million customers with 20,924 employees, 6,089 branches with 5,022 ATMs, and 1,494 cash deposit machines and is one of the top-performingpublic sector **banks** in India. Indian Bank acquired Allahabad Bank.

Bankingactivities

Indian Bank offers a wide variety of Banking Products and Services to its customers, including various Deposit Schemes, Loan Options, Financial Services, Stock Investment Services, and several specialized services such as Remittance, Collection, 7 Day Banking Branches, Cash Management, and Electronic Funds Transfer. As of April 2009, the bank has Core Banking Solution (CBS) implemented in its 1642 branches and 66 extension counters. The bank has 755 connected Automatic Teller Machines (ATMs) installed in 225 locations nationwide.

Subsidiary Companies

Apart from its Regular Banking Services, the Indian Bank has also been offering various other services through its 3 subsidiary companies, which are Indbank Merchant Banking Services Ltd., IndBank Housing Ltd., and IndFund Management Ltd.

Profile of Union Bank of India

Union Bank of India is one of the leading public sector banks in the country. The Bank is a listed entity and the Government of India holds 89.07 percent ofthe Bank's total share capital. The Bank, having its headquarters in Mumbai (India), was registered on November 11, 1919, as a limited company. Today, it has a network of 9500+ domestic branches, 13300+ ATMs, 11700+ BC Points, serving over 120 million customers with 75000+ employees. The Bank also has 3 branches overseas in Hong Kong, Dubai International Financial Centre (UAE) & Sydney (Australia); 1 representative office in Abu Dhabi (UAE); 1 banking subsidiary in London (UK), 1 banking joint venture in Malaysia; 3 para-banking subsidiaries and 3 joint ventures (including 2 in the life insurance business). Union Bank of India is the first large public sector bank in the country to have implemented a 100% core banking solution. Recently, Andhra Bank and Corporation Bank were amalgamated into Union Bank of India with effect from 01.04.2020. with this, the Bank's total business as of 1st April 2020 stood at Rs.15,34,749 crore, comprising Rs. 868632 crore of deposits and Rs. 666117 crore of advances.The

Bank has received several awards and recognition for its prowess in technology, digital banking, financial inclusion, MSME, and development of human resources.

Profile of State Bank of India

SBI is an Indian multinational, Public Sector banking and financial services company. <u>SBI</u> is one of India's major banks and is an industry leader in terms of size, business sector promotion, and initiatives for the progress and economic enhancement of the Indian economy.

SBI is entering into many new businesses with strategic tie-ups – Pension Funds, General Insurance, Custodial Services, Private Equity, Mobile Banking, Point of Sale Merchant Acquisition, Advisory Services, organized items and so on – every one of these activities having massive potential for development.SBI is moving forward with forefront innovation and imaginative new saving money models, to strengthen its presence and widen its client base.The bouquet of services provided by SBI includes Personal Banking, International, Banking, Agriculture / Rural, and Corporate Banking, SME, Government Business, and Domestic Treasury. SBI is a universally acknowledged regional banking giant and has a 20% market share in deposits and loans among Indian commercial banks.

As of 31.03.2015 revenue earned by SBI was Rs. 2.573 trillion and Net Income was Rs. 175.2 billion. By the end of December 2013, SBI had assets worth US$388 billion and 17,000 branches, including 190 foreign offices, making it the largest banking and financial services company in India by assets.SBI has acquired local banks as part of rescue efforts. Bank of Bihar was acquired in 1969 along with its 28 branches. KrishnaramBaldeo Bank was acquired in 1975 and the Bank of Cochin in Kerala was acquired in 1985 along with its 120 branches. SBI share is listed in the NSE stock market by the symbol of SBIN

3. DATA REPRESENTATION AND DATA ANALYSIS

Table-3.1: Monthly Income of Sample Respondents

Sl.No.	Monthly income (In rupees)	Banks		
		Indian bank	**Union Bank of India**	**SBI**
1	Less than 10,000	5 (4.0)	18 (14.4)	23 (18.4)
2	10,000-20,000	34 (27.2)	27 (21.6)	14 (11.2)
3	20,000-30,000	31 (24.8)	30 (24.0)	34 (27.2)
4	30,000-40,000	30 (24.0)	20 (16.0)	19 (15.2)
5	40,000-50,000	14 (11.2)	17 (13.6)	13 (10.4)
6	50,000 & above	11 (8.8)	13 (10.4)	22 (17.6)
Total		125 (100)	125 (100)	125 (100)

Note: Figures in the brackets indicate percentages to their column totals

ANALYSIS

Table-3.1 denotes the monthly income of the sample respondents of the banks understudy. Among the sample respondents of an Indian bank, the majority of them account for 27.2 percent falls in the Rs 10,000-20,000 income group. Those who follow it and who account for 24.8 percent fall in the Rs 20,000-30,000 income group. An equal number of sample respondents who account for 24 percent falls in the 30,000-40,000 income group. In the remaining sample, people who fall in the Rs. 40,000-50,000 income group are relatively more than those who fall in the Rs above 50,000 and Rs less than 10,000 income groups.

Among the sample respondents of Union Bank of India, the majority of theiraccount for 24 percent falls in the Rs 20,000-30,000 income group. Those who follow it and who account for 21.6 percent fall in the Rs 10,000-20,000 income group. In the remaining sample, people who fall in the Rs 30,000-40,000 income group are relatively more than those who fall in the Rs less than 10,000, 40,000, 50,000, and above 50,000 income groups.

Among the sample respondents of SBI, the majority of them account for 27.2 percent falls in the Rs 20,000-30,000 income group. Those who follow it and who account for 18.4 percent fall in the less than Rs. 10,000

income group. In the remaining sample, people who fall in the above Rs. 50,000 income group are relatively more than those who fall in the Rs 30,000-40,000, 10,000-20,000 and Rs 40,000-50,000 income groups. From the above analysis, it can be concluded that the majority of the sample respondents of Indian bank falls in the Rs. 10,000-20,000 income group while the majority of the sample respondents of Union Bank of Indiaand State Bank of India falls in the Rs 20,000-30,000 income group.

Table-3.2: Annual Turnover of Business Enterprises

Sl.No.	Annual business turnover (In rupees)	Banks		
		Indian bank	Union Bank of India	SBI
1	Less than 1 crore	7 (43.75)	6 (60.0)	10 (52.63)
2	1-5 crores	9 (56.25)	4 (40.0)	8 (42.11)
3	5-10 crores	-	-	1 (5.26)
4	10-15 crores	-	-	-
5	15 crores and above	-	-	-
Total		16 (100)	10 (100)	19 (100)

Note: Figures in the brackets indicate percentages to their column totals

In the total sample, business enterprises are 16 for Indian Bank, 10 for Andhra Bank, and 19 for SBI

ANALYSIS

Table-3.2 shows th annual business turnover of sample respondents (Businessmen). Among the sample respondents of an Indian bank, the majority of them who account for 56.25 percent said that their business turnover falls between Rs 1 and 5 crores per annum. All the remaining sample respondents said that their business turnover is less than Rs 1 crore.

Among the sample respondents of Union Bank of India, the majority of them who account for 60 percent said that their business turnover is less than Rs one crore. All the remaining sample respondents who account for 40 percent said that their business turnover falls between Rs. 1 crore and 5 crores. More or less, similar opinions have been expressed by the sample respondents of SBI with little variation. The variation is that 5.26 percent of sample respondents said that their business turnover falls between Rs 5 crore and 10 crores that majority of the sample respondents of Indian bank has a business turnover that falls between Rs 1 crore and 5 crores while the majority of the sample respondents of Union Bank of Indiaand SBI has less than Rs 1 crore business turnover.

Table-3.3: Type of Account Operated by Sample Respondents

Sl.No.	Type of Account operated	Banks		
		Indian bank	Union Bank of India	SBI
1	SB A/c customers	74 (40.0)	80 (40.20)	77 (37.93)
2	Current A/c customers	16 (8.65)	10 (5.03)	19 (9.36)
3	Overdraft A/c customers	-	-	-
4	Home loan A/c customers	8 (4.32)	4 (2.01)	13 (6.40)
5	Mortgage loan A/c customers	11 (5.95)	7 (3.52)	7 (3.45)
6	Personal loan A/c customers	19 (10.27)	23 (11.56)	17 (8.37)
7	Gold loan A/c customers	22 (11.89)	30 (15.08)	18 (8.87)
8	Vehicle loan A/c customers	12 (6.49)	16 (8.04)	16 (7.88)
9	Educational loan A/c customers	3 (1.62)	4 (2.01)	9 (4.43)
10	Term deposit A/c FD/RD customers	16	25	21

		(8.65)	(12.56)	(10.34)
11	NRI A/c customers	4 (2.16)	-	6 (2.96)
	Total	185 (100)	199 (100)	203 (100)

Note: Figures in the brackets indicate percentages to their column totals

Responses are more than 125 for each bank due to multiple rankings

ANALYSIS

Table-3.3 denotes the type of account operated by sample respondents with the bank's understudy. Among the sample respondents of an Indian bank, the majority of them who account for 40 percent are SB A/C customers followed by Gold loan a/c customers (11.89%) and personal loan a/c customers (10.27%). Surprisingly, current a/c customers and term deposit a/c (FD/RD) customers are equal in number (8.65%). In the remaining sample, vehicle loan a/c customers constitute 6.49 percent followed by mortgage loan A/c customers (5.95%); home loan A/c customers (4.32%), NRI customers (2.16%), and educational loan A/c customers (1.62%) respectively.

Among the sample respondents of Union Bank of India, the majority of them who accounts for 40.20 percent is SB A/C customers followed by Gold loan a/c customers (15.08%), Term deposit a/c (FD/RD) customers (12.56%), and personal loan a/c customers (11.56%). In the remaining sample, vehicle loan a/c customers (8.04%) are relatively more than current A/c customers (5.03%). Surprisingly, home loan A/c customers and educational loan A/c customers though negligible are equal in number.

Among the sample respondents of SBI, the majority of them who accounts for 37.93 percent is SB A/C customers followed by Term deposit a/c customers (10.34%), Current a/c customers (9.36%), Gold loan a/c customers (8.87%), Personal loan a/c customers (8.37%) and Vehicle loan a/c customers (7.88%). The remaining sample respondents who are negligible in number operate Home loan a/c (6.40%), Educational loan a/c (4.43%), and NRI a/c customers (2.96%). From the above analysis, it can be concluded that the majority of the sample respondents are SB A/C customers. However, a considerable number of them operate gold loan a/c followed by personal loan a/c's in the banks under study.

4. HYPOTHESIS TESTING

H1 - There is a difference among select Bank services and their functionalities.

Chi-Square Tests

Table 4.1: Chi-square test

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.126[a]	12	.049
Likelihood Ratio	20.611	12	.056
Linear-by-Linear Association	.408	1	.523
N of Valid Cases	760		
0 cells (.0%) have an expected count less than 5. The minimum expected count is 5.00			

Table 4.1 indicates the calculated value of Chi-Square as 21.126 at a 5 percent level of significance and 12 (df) degrees of freedom, whereas the able value is 21.026.

It is concluded that the asymptotic value is 0.049 which is less than 0.05 and proves the Chi-square value is higher than the table value which strengthens the alternative hypothesis statement and rejects the null hypothesis. Hence it is concluded that there is a difference among selected banks' educational loan services and their functionalities. Even though customers are satisfied with respective Banks' services and functionalities because customers are experienced with respective Banks. Since the Alternative hypothesis is accepted, **the** study concluded thatdifference among select banks' educational loan services and their functionalities exists.

5. SUGGESTIONS BASED ON SUMMARY OF FINDINGS

i) Regarding the monthly income of sample respondents, it is found that the majority of the sample respondents of Indian bank falls in the income group of Rs 10,000-20,000 followed by Rs 20,000-30,000 while the majority of the sample respondents of Andhra bank falls in the Rs 20,000-30,000 income group followed by Rs 10,000-20,000 income groups. It is also noticed that the majority of the sample respondents of SBH falls in the 20,000-30,000 income group followed by less than Rs 10,000 income group.

ii) The annual turnover of Business enterprisers which operate their accounts with Indian bank (current Account customers) falls between Rs 1 crore and Rs 5 crores followed by less than Rs 1 crore while the annual turnover of Business enterprises which operate their accounts with Andhra bank and SBH is less than Rs 1 crore followed by between Rs 1 crore and 5 crores.

iii) It is concluded from the study that the majority of the sample respondents of the bank's understudy are SB A/C customers. It is also noted that a considerable number of sample respondents are gold loan A/C customers followed by personal loan A/C customers.

iv) The quantum of gold loans sanctioned by the bank's understudy is moderate. Banks sanction 60 percent of the value of the gold loan. In this regard, it is suggested to the bank's understudy to enhance the quantum of gold loans further.

v) Indian bank collects Rs. 200 as gold appraisal charges upto a loan amount of Rs .2 lakhs while Union Bank of IndiacollectsRs. 1,000 as appraisal charges upto a loan amount of Rs. 2 lakhs. SBI collects 0.35 percent of the loan amount as appraisal charges. Given this, it is suggested to Allahabad and SBI to reduce the appraisal charges on par with Indian banks.

vi) Indian bank collects 14.75 percent interest on gold loans while Union Bank of Indiacollects 12.9 percent interest on these loans. On the other hand, SBIis 15 percent on gold loans. In this regard, it is suggested to Indian banks and SBI to reduce the interest rate upto 12 percent. This measure certainly satisfied the customers.

vii) The banks understudy demand high security for granting educational loans. It is to be noted that lower-income people cannot give high security for taking educational loans. In given, it is suggested to the bank'sunderstudy to be liberal in terms of security for granting educational loans.

viii) Indian bank collects 0.25 percent as educational loan processing charges while Union Bank of India collects 0.5 percent as processing charges. SBI on the other hand collects 0.60 percent as educational loan processing charges. In this regard, it is suggested to the bank's understudy to discontinue the practice of collecting educational loan processing charges as these loans are given for a noble cause.

ix) Indian bank collects 12.5 percent interest on educational loans while Union Bank of India and SBI collects 12 percent interest rate on these loans. In this regard, it is suggested to the bank's understudy to reduce the interest upto 10 percent since these loans help in the growth and development of the nation.

x) The banks understudy inform their customers in advance about the maturity of their fixed deposits and recurring deposits. This is of great use to customers. In this regard, it is suggested to the banks to continue the practice of informing customers in advance.

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A SDN BASED DYNAMIC PRIORITY SCHEDULING ALGORITHM FOR MULTILEVEL QUEUES HAVING DIFFERENT PRIORITIES

NAFEES M. KAZI, UMESH S. BHADADE AND SHEKHAR R. SURALKAR

ABSTRACT

Consider a software-defined network (SDN) with multiple physically interconnected SDN switches and an SDN controller. The switches may have different processing capacity. The end hosts communicate with each other through the network. The rates of the data traffic generated by the end hosts vary with time. Sometimes, the data rates may be high can cause network congestion. During this work we have proposed modified RYU controller of SDN using Dijkstra's shortest path algorithm improving the performance in terms of scalability and network performance.

Performance of POX and RYU controller is evaluated and RYU controller is found to be best for increased network size also. We have proposed the use of shortest path algorithms in SDN. We have evaluated the performance of different shortest path algorithms in SDN and found\d that Dijkstra's shortest path algorithm is best among all. During this work we have proposed hassle free traffic engineering approach in SDN network based on multipath forwarding and switching of flows between paths. The presented approach relies on a dynamic selection of the best path in terms of network load. The path selection is made based on Dijikstraws shortest path algorithm The developed concept has been verified using the Mininet network emulator, and realistic network topologies. Simulations have shown that the proposed approach provides better results over plain multi-path traffic engineering approach.

Use of shortest path algorithm in the networks itself lead to high availability of networks. Less time is needed to send the packet from source to destination.

Keywords: SDN, POX, RYU, Mininet, Dijikstraws shortest path algorithm

1. INTRODUCTION

The traditional IP networks are complex and very hard to manage. It is very difficult to configure the network according to predefined policies, and to reconfigure it to respond to faults, load and changes. In current networks the control and data planes are bundled together. SDN is used for separating the network's control logic from the underlying routers and switches, promoting (logical) centralization of network control, and introducing the ability to program the network. The separation of concerns introduced between the definition of network policies, their implementation in switching hardware, and the forwarding of traffic, is key to the desired flexibility: by breaking the network control problem into tractable pieces, SDN makes it easier to create and introduce new abstractions in networking, simplifying network management and facilitating network evolution. A network in which the control plane is physically separate from the data plane and a single logically centralized) control plane controls several forwarding devices. Figure 1 is the simple architecture of SDN.
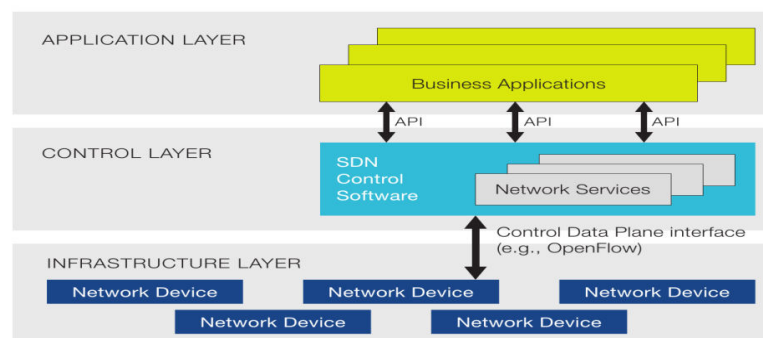
Figure 1: SDN Architecture

2. MOTIVATION

Consider a software-defined network (SDN) with multiple physically interconnected SDN switches and an SDN controller. The switches may have different processing capacity. The end hosts communicate with each other through the network. The rates of the data traffic generated by the end hosts vary with time. Sometimes, the data rates may be high can cause network congestion.

Consider end-to-end latency (T) is the sum of three components:

1. T_prop (propagation),

2. T_tx (transmission, processing...) &

3. T_buf (queuing).

T_propagation can be easily reduced if you route your traffic over the shortest path (this is usually implemented by SDN controllers using a Dijkstra-like Algorithm). T_tx may be considered as a fixed value proportional to packet length and line rate. Finally, T_buffer depends on several factors, not only line rate or congestion, but also onnode architecture (output queuing, combined input-output queuing, and so on), and hardly can be ensured (not only in average but also in variation).

Scope of the proposed research is limited to consider following issues with respect to SDN.

1. Priority is not assigned to input packets.

2. Only simple Dijkstra-like algorithm is used to route the traffic.

3. A single forwarding queue is used at switches.

This research will help how to design the best possible SDN dynamic traffic scheduling algorithm which in result will help scalability, less hardware and software requirements, centralized visibility, hassle free traffic engineering and high availability of network.

3. LITERATURE REVIEW

Current IoT devices support multi-homing to improve resilience and performance. Network switching helps to distribute the load and keep communication going. Therefore, it is essential to investigate how these heterogeneous interfaces behave if it is necessary to switch from one another (i.e., vertical handover). In particular, authors in [1] addresses the handoff time of IoT devices in Software-Defined Network (SDN) based environments. Using Raspberry Pis as a testbed, authors found out that there is a significant difference in handoff time depending on the source/destination interface and the switching direction, especially compared to simulation results.

Authors in [2] proposes a new Multi-Pathization method with SDN. In order to cope with both of the congestion and the packet losses caused by link quality degradation, the proposed method consists of the three controls and select dynamically one of them. This paper utilizes OpenFlow architecture as the SDN platform. The authors implement their proposal and evaluate it by actual experiments. From the experimental results, the authors confirm the effectiveness of the proposal.

Authors in [3] have proposed HARMLESS, a new SDN switch design that seamlessly adds SDN capability to legacy network gear, by emulating the OpenFlow switch OS in a separate software switch component. This way, HARMLESS enables a quick and easy leap into SDN, combining the rapid innovation and upgrade cycles of software switches with the port density and cost-efficiency of hardware-based appliances into a fully dataplane-transparent and vendor-neutral solution. HARMLESS incurs an order of magnitude smaller initial expenditure for an SDN deployment than existing turnkey vendor SDN solutions while, at the same time, yields matching, or even better, data plane performance for smaller enterprises.

The link failure recovery is important to the Internet. For improving the performance of link failure recovery in the IP network, the software defined networking (SDN) is applied to achieve this target. The SDN is effective on solving this kind of issue. However, considering the deployment cost, only a few IP routers can be replaced by the SDN switches. Thus, to minimize the number of SDN switches, the greedy-based approach is proposed to select the most appropriate deployment locations. But the greedy-based approach has disadvantages. For addressing these disadvantages, authors in [4] proposed the search-tree based SDN candidate selection (SCS) algorithm. In this algorithm, for achieving better performance than the greedy-based approach, three algorithms are proposed, which are the search-tree based feasible solutions calculation algorithm, the most appropriate feasible solution selection algorithm, and the most appropriate designated SDN switch selection algorithm. Based on these algorithms, the perforance of the search-tree based SCS algorithm is improved greatly compared with the greedy-based algorithms.

The use of multiple SDN controllers has been proposed to ensure both performance and security of SDN-based MTD systems for large-scale networks; however, the effect of using multiple SDN controllers has not been investigated in the state-of-the-art research. Authors in [5] have proposed the SDN based MTD architecture

using multiple SDN controllers and validate their security effect (i.e., attack success probability) by implementing an IP shuffling MTD in a testbed using ONOS SDN controllers.

Authors in [6] develop a framework which allows applications deployed in an SDN environment to explicitly express their requirements to the network. Conversely, it allows network controllers to deploy policies on end-hosts and to supply applications with information about network paths, salient servers and other relevant metrics. The proposed approach opens the door for fine grained, application-aware resource optimization strategies in SDNs.

Demo in [7] presents an ongoing prototype implementation of the Service Orchestrator (SO) building block of the 5G-TRANSFORMER (5GT) architecture. Within the 5GT-SO, we define the Service Manager (SM), which hosts the intelligence of the 5GT-SO and interacts with the other architectural blocks of the 5GT architecture through the defined APIs. The aim of defining the SM is to decouple the 5GT-SO implementation from the associated MANO platform, allowing the interoperability with other MANO platforms, hence increasing the scope of the 5GT solution. In this demo, authors show how the current ongoing implementation of the 5GT-SO, using the SM, is able to automate the orchestration of both computing and networking resources to deploy a virtualized mobile network service based on ns-3/LENA network simulator/emulator in minutes over an emulated environment consisting of a multi-point of presence infrastructure connected by a custom transport network.

In addition, the NFV architecture proposed by the European Telecommunications Standards Institute (ETSI) [8] released the latest SDN development roadmap by three major companies, Cisco, Juniper Networks and Extreme Networks. And OpenDaylight [9], which is supported by many IT companies. The goal is to promote the deployment and implementation of industry solutions through the development of SDN. Due to the compatibility requirements, OpenDaylight follows the ONN standard architecture of SDN, and OpenDaylight is also integrated into the NFV The structure of SDN is divided into network application and business process, control platform and physical and virtual network equipment three levels. OpenDaylight comes with a Java virtual machine that can directly implement the SDN control platform. To make it more compatible with third-party modules, the OpenDaylight controller also has plug-in modules that install itself to further enhance the functionality of SDN. The most prominent feature of the OpenDaylight controller is that the southbound interface not only supports the OpenFlow protocol but also supports the configuration protocols and routing protocols such as NETCONF [10] and BGP [11]. Proprietary protocols for each company, such as Cisco's OnePK protocol [12], are also compatible. OpenDaylight adds a layer of abstraction SAL that unifies different underlying protocol standards to ensure scalability and transparency of the underlying protocol

The proposed work in this paper will try to reduce the end to end latency by using dynamic priority scheduling algorithm for multilevel queues having different priorities.

- From the literature study it is identified that priority is not assigned to input packets. Hence the proposed solution will consider for the priorities of the incoming packets.

- In the previous studies, only simple Dijkstra-like algorithm is used to route the traffic. This algorithm is extended for handling packets traffic by considering multiple priority queues.

- A single forwarding queue is used at switches. This queue will be replaced by multiple priority based queues and scheduled using Dijkstra-like algorithm.

The work was carried out with following objectives

Objective 1: Addressing the Scalability issue of RYU Controller

Objective 2: Evaluating the performance of POX and RYU controller

Objective 3: Improving the performance of RYU controller with various shortest path algorithms and evaluating the performance of various shortest path algorithms.

Objective 4: Finding the maximum capacity path with Dijkstra's Algorithm in accordance with current network status using RYU Controller.

Objective 5: QoS Provision Under SDN using multiple priority queue at switches

4. Addressing the Scalability Issue of RYU Controller
During this work we have tried to address the scalability features of RYU controller. implemented different mininet topologies with increasing the scalability. Step wise explanation of creating and evaluating the mininet

topologies using RYU controller is provided. Also the methos for analysis of obtained statistical results is performed using D-ITG tool and iperf keeping the throughput performance as the central focus. Using single RYU controller we were able to scale up to 500 hosts using linear topology. But if we increase the number of switches, the throughput and performance of the network degrades. We have concluded with this research that we can improve with the network scalability as well as performance by increasing the number of controllers for linear and tree topology. But selection of appropriate number of controllers depends on the size and type of the network. Datacenter topology performs best with single controller only. The performance degrades for two or more controllers.

5. Evaluating the Performance of POX and RYU Controller

Research during these objective concerns about performance evaluation of POX and RYU SDN controllers. We have evaluated the performance of the controllers in terms of average delay, average jitter and average bitrate along with throughput. D-ITG tool and iperf is used for measuring the performance of the network. The experiment is carried out using different scenarios. In the first scenario we have created the linear topology with 5 switches and varying number of hosts per switch. In second scenario we have used linear topology with 5 hosts per switch and varying the number of switches. In third case we have used tree topology with increasing depth. In the last scenario we have created custom datacenter topology with increasing number of switches and hosts. After evaluating the performance, we have concluded that

1. For all topology under consideration, average delay, average jitter is, low for RYU controller as compared to POC controller. Hence RYU controller outperforms the POX controller.

2. Average bitrate and throughput is more for RYU controller as compared to POX controller.

3. Performance of the RYU controller does not vary with increasing number of hosts and switches in the network. Performance of POX controller degrades with increasing number of switches and hosts.

Although the performance of POX controller is low as compared to RYU controller, the selection of appropriate controller will depends on the requirement and specification of the application.

6. Improving the Performance of RYU Controller with Various Shortest Path Algorithms and Evaluating the Performance of Various Shortest Path Algorithms.

During this Research we have Proposed Modified RYU Controller of SDN Using Dijkstra's Shortest Path Algorithm Improving the Performance in Terms of Scalability and Network Performance.

This objective concerns about performance evaluation of different shortest path algorithms using RYU SDN controllers. The performance of shortest path algorithms in terms of throughput is depicted here. We have considered datacentre topology with varying number of hosts and racks. Average throughput of Dijkstra's algorithm is found better.

Number of Hosts and racks	Simple_switch	Dijkstra's Algorithm	Bellman-ford Algorithm	Floyd-Warshall Algorithm	A Star Algorithm
4	5.94	**8.23**	6.38	3.56	3.7
5	7.67	5.72	**7.72**	3.72	4.11
6	6.84	**7.74**	5.75	3.69	3.81
7	7.01	**8.26**	8.21	3.82	3.84
10	7.32	7.68	**7.82**	7.72	3.86
12	**7.09**	6.31	5.36	6.8	3.61
14	7.15	**7.56**	5.54	6.58	3.36
16	6.4	6.98	3.24	**7.43**	3.63
18	6.18	7.11	3.46	**8.51**	3.67
20	5.75	**7.34**	7.07	6.51	3.75
Average	6.735	**7.293**	6.055	5.834	3.734

7. **Finding the Maximum Capacity Path with Dijkstra's Algorithm in Accordance with Current Network Status Using RYU Controller.**

Consider the Topology as Depicted in Figure
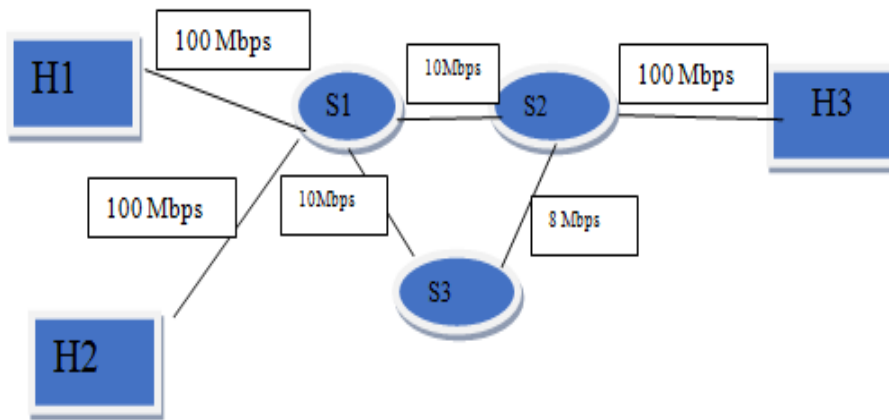
H2 will send traffic to H3 and H1 will also send traffic to H3. If we use Dijkstra's algorithm to find the shortest path. These two flows will go via s1 and s2 and they will compete for bandwidth.

So we will let the H2 send the traffic to H3 first. This flow will go via s1 and s2 and then reach H3. Following, we will let the flow sent from H1 to H3 use the modified version of Dijkstra's Algorithm to find the maximum capacity path. Therefore, this flow will go via s1,s3,s2, and then H3.
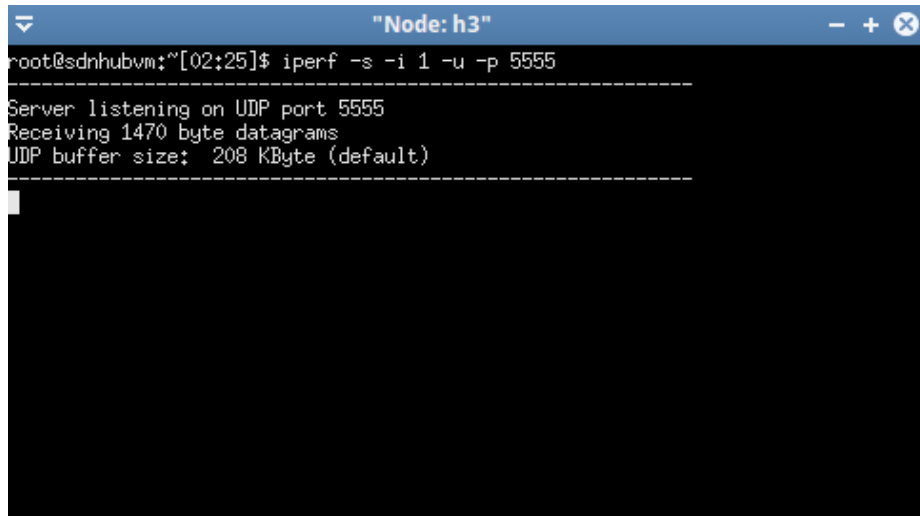
1. **Open a Terminal to Run Ryu Application**
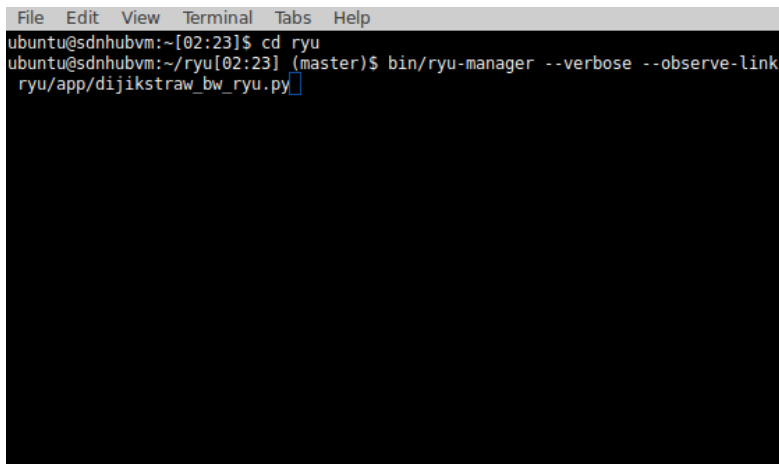
2. **Open Another Terminal to Run the Mininet Script**
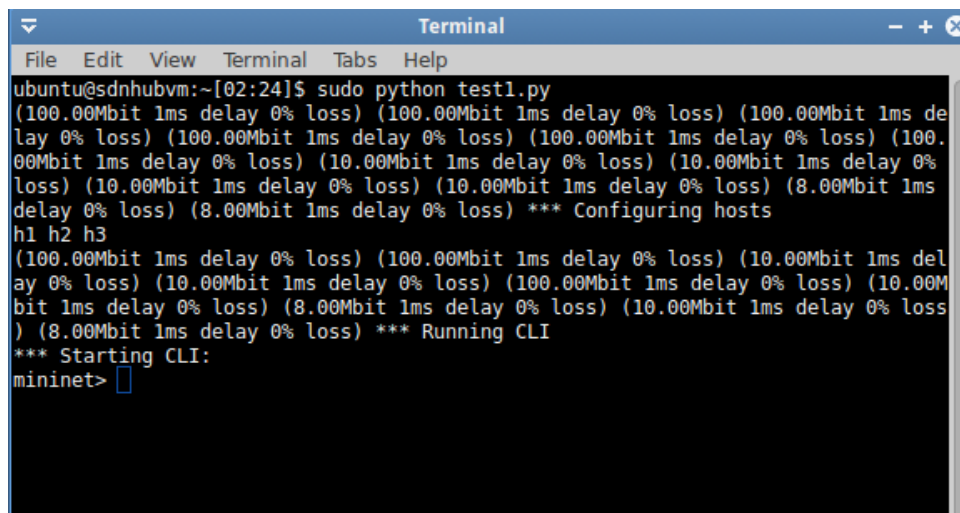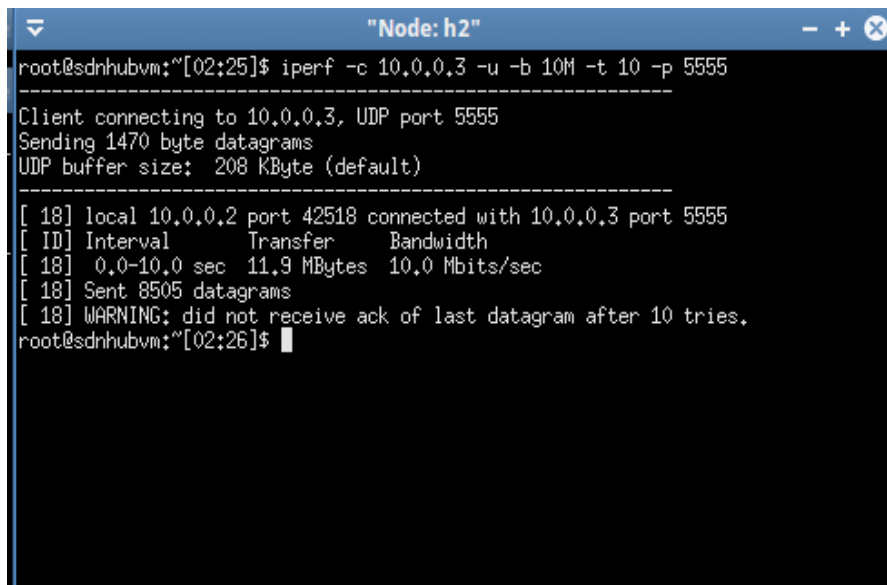
3. Use Xterm to Open H1 H2 H3 H3
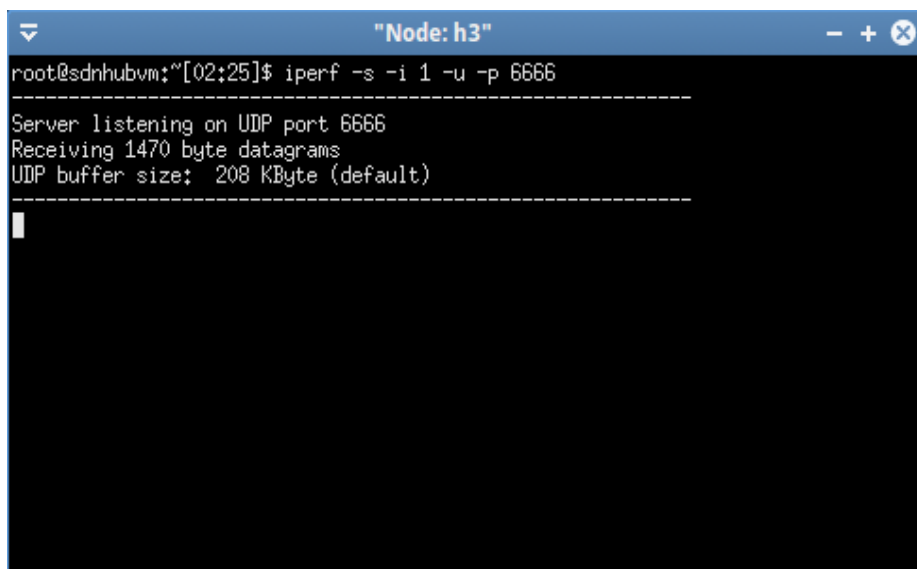
4. Send the Traffic From H2 First.

5. Then Send the Traffic from H1. From the Following we can see that the Flow from H2 will not be affected by the Flow of H1-H3. Because the Flow of H1-H3 Go Different Path (S1, S3, and then S2).

8. Qos Provision Under SDN Using Multiple Priority Queue at Switches

Consider the topology as depicted in figure. H1,H2,H3 are connected to S1, S1 is connected to S2, and S2 is connected to H4. H1,H2,H3,and H4 are hosts, and S1 and S2 are openvswitch.

In the beginning, the h1 is sending to h4. The throughput is around 9.71Mbps.

When the h2 starts to send the traffic to h4, the throughput of H1-H4 drops.

With Queue Management

When H1 is sending traffic to H4, this flow gets 2.92 Mbps.

When H2 starts to send traffic to H4, the flow of H1-H4 is not affected by H2-H4 flow.

With Queue Management + Ingress Policing

In the beginning, the h1 is sending to h4. The throughput is around 976kbps. (Due to the ingress policing: 1Mpbs at the ingress port 1 of s1.)
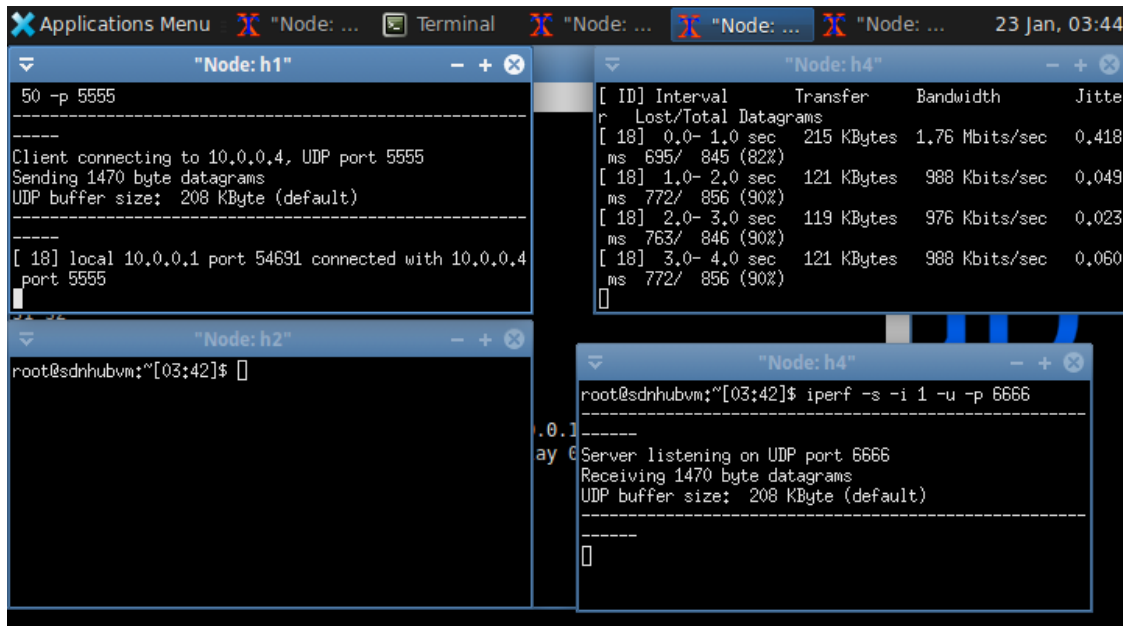
When h2 starts to send traffic to h4, the throughput of flow H1-H4 does not drop. (End to End QoS can be provided.)
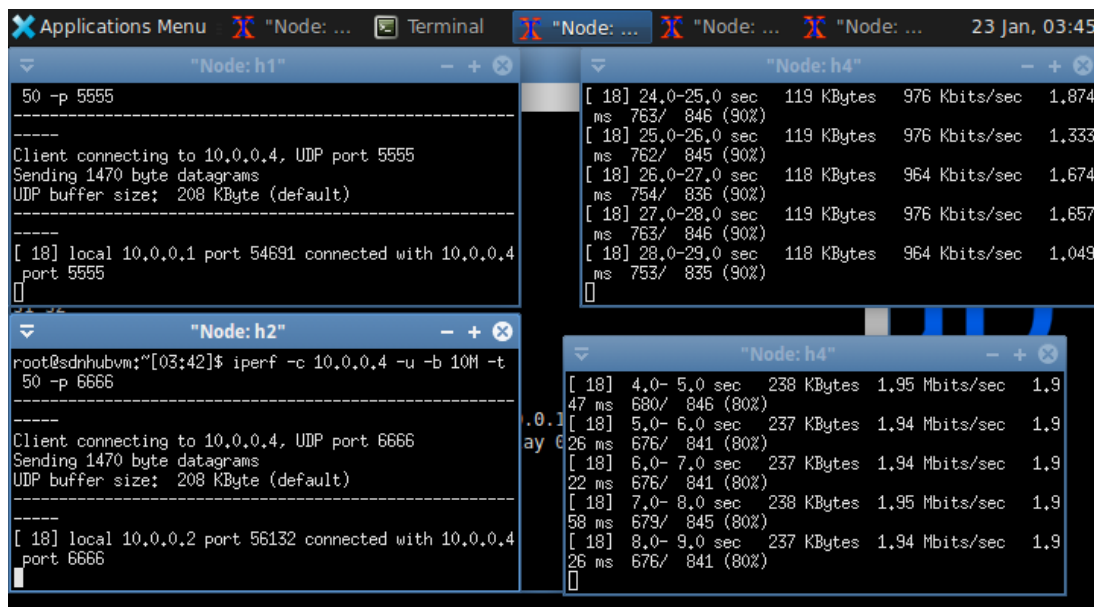
9. RESULT & CONCLUSION

During this research we have first addressed the scalability issue of RYU controller. Using single RYU controller we were able to scale up to 500 hosts using linear topology. But if we increase the number of switches, the throughput and performance of the network degrades. We have concluded with this research that we can improve with the network scalability as well as performance by increasing the number of controllers for linear and tree topology. But selection of appropriate number of controllers depends on the size and type of the network. Datacenter topology performs best with single controller only. The performance degrades for two or more controllers.

After evaluating the performance of POX and RYU controller, we have concluded that

1. For all topology under consideration, average delay, average jitter is, low for RYU controller as compared to POC controller. Hence RYU controller outperforms the POX controller.

2. Average bitrate and throughput is more for RYU controller as compared to POX controller.

3.   Performance of the RYU controller does not vary with increasing number of hosts and switches in the network. Performance of POX controller degrades with increasing number of switches and hosts.

4.   Although the performance of POX controller is low as compared to RYU controller, the selection of appropriate controller will depends on the requirement and specification of the application.

Performance of RYU controller is increased with incorporation of shortest path algorithm. During this research authors have tried to address the performance evaluation of different shortest path algorithms using SDN datacenter topology with RYU controller. Datacenter network topologies with varying number of hosts and racks are implemented in mininet. Step wise explanation of creating and evaluating the Mininet topologies using RYU controller is provided. The performance of Dijkstra's shortest path algorithm with RYU controller is better for all network topology under consideration in this study. The performance of the RYU controller does not affect with the increase in number of switches or hosts in the network.

During this research we have proposed modified RYU controller of SDN using Dijkstra's shortest path algorithm improving the performance in terms of scalability and network performance.

Dynamic routing is achieved by finding maximum capacity path along with Dijkstra's Algorithm in accordance with current network status using RYU Controller.

Multiple priority queue at switches are implemented for assuring QoS under SDN.

10. CONCLUSION AND FUTURE SCOPE
During this work we have designed the best possible SDN dynamic traffic scheduling algorithm which in result will help scalability, less hardware and software requirements, centralized visibility, hassle free traffic engineering and high availability of network.

Performance of POX and RYU controller is evaluated and RYU controller is found to be best for increased network size also.The performance of the RYU controller does not affect with the increase in number of switches or hosts in the network. While the performance of POX controller degrades with increase in number of switches and hosts. Hence during this work we have used RYU controller. We have evaluated the performance of different shortest path algorithms in SDN and found that Dijkstra's shortest path algorithm is best among all.

Use of shortest path algorithm in SDN networks will lead to less hardware and software requirements because less number of resources are used while sending a packet from source to destination. During this work we have proposed hassle free traffic engineering approach in SDN network based on multipath forwarding and switching of flows between paths. The presented approach relies on a dynamic selection of the best path in terms of network load. The path selection is made based on Dijkstra's shortest path algorithm The developed concept has been verified using the Mininet network emulator, and realistic network topologies. Simulations have shown that the proposed approach provides better results over plain multi-path traffic engineering approach. Use of shortest path algorithm in the networks itself lead to high availability of networks. Less time is needed to send the packet from source to destination.

Our future work will focus on improving the performance of SDN network. Also, several other topologies for controllers under SDN environment having more complex scenarios are required to be explored and the results have to be evaluated for some more parameter such as throughput and latency which are too suitable performance indicators to measure performance of SDN.

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IMMOBILIZATION OF ALCOHOL DEHYDROGENASE ON K-CARRAGEENAN BEADS & STUDIES OF ITS PROPERTIES: USE IN PURIFICATION OF FRUIT JUICE

HIRAL D. TRIVEDI, DINESH S. PATEL AND BIJAL D. PATEL

ABSTRACT

In thisWork immobilizationof Alcohol Dehydrogenase enzyme on k-Carrageenanwas done. K-carrageenanis a natural polysaccharide like cellulose obtained from seaweeds. ADH was immobilized byentrapment. Then forfurther study, various parameters were optimized and carriedout the comparison studies.Furthermore, FTIR analysis was done to prove that the enzyme was immobilized on the support bead. Andthe application was done with 3 different fruitjuices. i.e. sugarcane juice, pineapple juice, and watermelon juice. In addition, this study introducesa new achievement of the eco-friendly effect of immobilized enzyme.

Keywords: Alcohol Dehydrogenase, k-Carrageenan, Enzyme Immobilization, FTIR study of alcohol dehydrogenase.

1. INTRODUCTION

Enzymes are biocatalysts as they serve as the key to technology for chemical synthesis. In green chemistry, they are widely accepted due to their ecofriendly nature. Alcohol dehydrogenase (ADH) is from the group of dehydrogenase enzymes. Which occurs in many organisms and givesa good conversion facility between alcohol and aldehydes or ketone with the reduction of NAD^+ intoNADH.In humans and many other living organisms like animal alcohol dehydrogenase (ADH) break down alcohol, otherwise, it will be toxic that can harm living organisms. ADH catalyzesthe oxidation of primary and secondary alcohols.

Further consumption of alcohol often goes with food in living organisms. Fruits are an important nutritional resource for humans. It contains many natural antioxidants. Several fruits have been reported to have an inhibitory effect on ethanol. Thus this study ofthe effect of fruits on ethanol metabolism work really becomes very interesting and also important as it is connected with human health. In this work effect of three selected fruit juices on ethanol, metabolism was investigated.

In addition, whenthe enzyme was immobilizedon the support it will be used more than one time, but the free enzyme can not be used again as it getsdissolved in it. The immobilized enzyme used repeatedlyalso reduces the overall cost of the whole process and really proveseco-friendly.

1.2 CHEMICALS

Alcohol Dehydrogenase **(200U/mg)** from sisco research laboratories Pvt. Ltd. , Phenol, Hypo chloride solution from Qualikems Fine Chem. Pvt. Ltd., PEI polyethyleneimine solution and k-carrageenan from TCI.

2. EXPERIMENTAL

2.1 Preparation of Beads

Beads of k-carrageenan were Preparedwith solution (3%w/v) in water at 60˚C for 20-25 min and thencooled at ambient temperature. The resulting solution was droppedby 1.5%polyethyleneiminesolution. The hardening time was kept for 2 hrs. The resulting beads were taken for further studies.

Fig.1: Image of Support Alcohol dehydrogenase

2.2 Fourier Transform Infrared (FTIR) Analysis of Support (Beads)

For FTIR analysis some part of bead reactor was taken and KBr was used for preparing bead of support sample. In FTIR Spectrum Characteristic peak at 3446.41 cm^{-1} shows the Presence of –OH Stretching vibration. Pease peak pears at 1638.67m^{-1} shows stretching of C=O.This starching show that Alcohol dehydrogenase (ADH) was immobilized on the support. FTIR analysis was done from Charuset University laboratory,Changa.
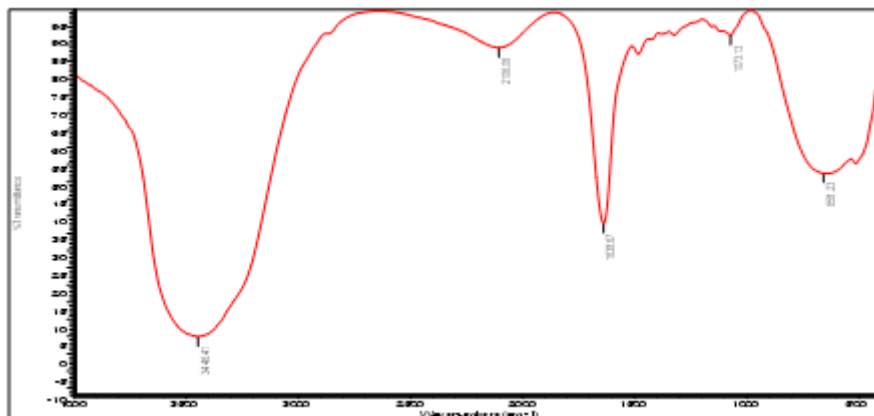
Fig-2: Fig shows the Spectra of support beads of bounded ADH.

2.3 Idiomatic Expression of Alcohol Dehydrogenase:

The movementof unbounded and immobilized Alcohol Dehydrogenase, based on the reduction of nicotinamide adenine dinucleotide (NAD+) by ethanol in the presence of YADH was determinedspectroscopically by the standard assay procedure of Colowick and Kaplan. Reduced NAD (NADH) has absorbance maxima at 340 nm, while NAD+ has no absorption at this wavelength. Therefore, all four reactants can be determined. The equilibrium lies to the left at pH 7.0. The reaction is completely displaced towards the right at alkaline pH .NADH formed can measure the amount of alcohol present. The reaction mixture consists of free YADH or immobilized YADH, 0.2 mL of 200 mM, ethanol, and 0.1 mL of NAD+ (6 mM). The reaction mixture is made up to 3.2 mL by adding semicarbazide-glycine buffer of pH 9.2 of the composition:3volumes of 0.1 N NaOH, 7 volumes of 0.1 N glycine in 0.1 N NaCl and volume of 0.1N semicarbazide in 0.1 N NaOH. The absorbance was measured at 340 nm after 35minutes at normal room temperature (28-32°C). Calibration plot obtainedfromdifferent concentrations of ethanol. The amount of aldehyde formed was measured for theom calibration plot. One unit of YADH converts 1 mole of ethanol to acetaldehyde at pH8.7 at 27°C.

2.3.1 Effect of PEI Concentration

Hardening and retention of enzymewere checked by using 1-5.0 % PEI concentration. The protein content of the bead and supernatant liquid was also calculated.Theactivity of the bounded enzyme was checkedas explained in the literature.

2.3.2 Ph Activity Profile

As enzymes consist of protein, the catalytic activity is markedly affected by environmental conditions, especially the pH of the aqueous medium. Thus, information on changes in pH-activity behavior caused by the immobilization of enzymes is useful for an understanding of the structure-function relationship of enzyme protein.Hence, the activity of the free and immobilized YADHhas been measured byincubating free and immobilized enzymes at 27 °C for 30 min in the 50 mM phosphate buffers of different pHs ranging from 4 to 10 and using ethanol as a substrate. The absorbance of the reaction mixture was measured at 340 nm and correlated to the concentration of the enzyme. From the calibration, plot activity of the enzyme was determined.

2.3.3 Thermal Stability

As a result of the immobilization of enzyme the heat stability is enhanced, it is advantageous for the industrial application of immobilized enzymesand is thus important in determining the feasibility of immobilized enzymes for a particular application. Therefore, the thermal stability of free and immobilized enzymes was investigated.Free and immobilized enzymes were placed in the optimum pH buffer andincubated at different temperatures (40 to 70 °C) for different time intervals,activity of the enzyme was then determined as described earlier Thermal deactivation constant (Kd) was calculated by using the thefollowing equation:

Ln At = InAo - Kd(t)

where'Ao' is the initial activity and 'At' is the activity after heat treat for minutes.

2.3.4 Depository Steadiness

The residual activities of the free and immobilized enzymes stored at room temperature (35°C) were determined and the activities were expressedas percentage retention of their residual activities at different times.

2.3.5 Reusable Capacity of Bounded Enzyme

The reusablecapacityof bound enzymes are themost important factors affecting the success of industrialization of an immobilized system. To evaluate the reusable capacityof the bounded YADH it was washed with water and buffered after each use and then suspended again in a fresh reaction mixture to measure the enzymatic activity. This procedure was repeated for ten cycles.The reusablecapacity ofboundedYADH was examined by using ethanol as a substrate. Leakage of the enzyme if any, was determined by measuring the enzyme activity in the washings.

2.3.6 Determination of Kinetic Constants

The Michaelis constant (Km) and maximum reaction velocity constant (V^ax) for the free and immobilized YADH were determined by measuring the velocity of the reaction varying ethanol concentrations from 50 to 500 mM and varying NAD concentrations from 2 to 10 mm. Free and immobilized enzymes in optimum pH buffer were incubated with substrates for 25 min at 30 °C. From the activity of the enzymes, *Km* and *Vmax*were calculated using the Lineweaver-Burk plot of 1/s vs. 1/v.

RESULT AND DISCUSSION

3.1 PEI Concentration

In many research as hardening agentsnt for k-carrageenan have used kCl. But the preservation activityof enzymes and hardening was not found to be desirable. Devi found that PEI is a good hardening agent it was also found that it is superior thenKCl. Hence we have used a 0.5 - 3.5 % solution of PEI for hardening of support beads. It is seen that maximum hardening is achieved at 1.5% PEI concentration and beyond that,there was no further increase in hardening as well as enzyme activity.

3.2pH Outline

Every enzyme has an optimum pH at which it shows optimum activity. **Figure 1**shows the pH activity of free and bounded Alcohol dehydrogenase. We have observed that free and entrapped enzyme was showing a maximumof 7 to5pH.During immobilization, results shows that there is no conformational change.
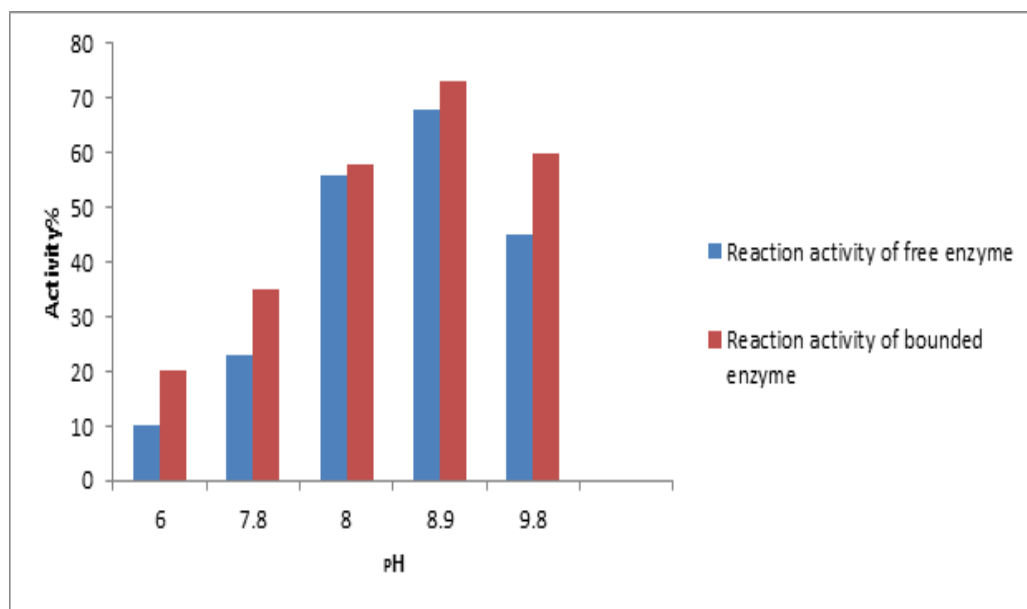
Fig-3: PH comparison Chart OD ADH

3.3 Thermal Stability

Enzymes is temperature-dependent. Whenthe temperatureincreases enzyme reactivity increasesand beyonda definite limit the enzyme, gets deactivated. **Figure 2** shows that entrapped enzyme show better thermal stability compared to free enzyme. The entrapped enzyme showed better thermal stability as they are encapsulated within the beads.
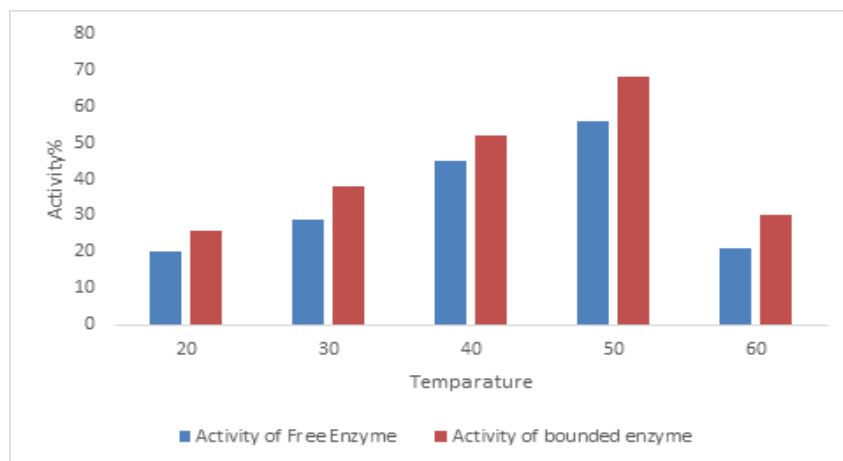
Fig:-4: Thermal stability of ADH

3.5 Reusability of Bead

Reusability has great importance in industries. It was checked byusing beads in the assay method in place of free enzyme solution. The reusabilityof entrapped enzyme beads was checked as shown in. **Figure-5**bounded enzyme employed 55% of its enzyme reactivity after 8 rotationsand 24 % activity after 10 cycles showing the advantage of immobilized enzyme and which increases its applicability. Fig-3
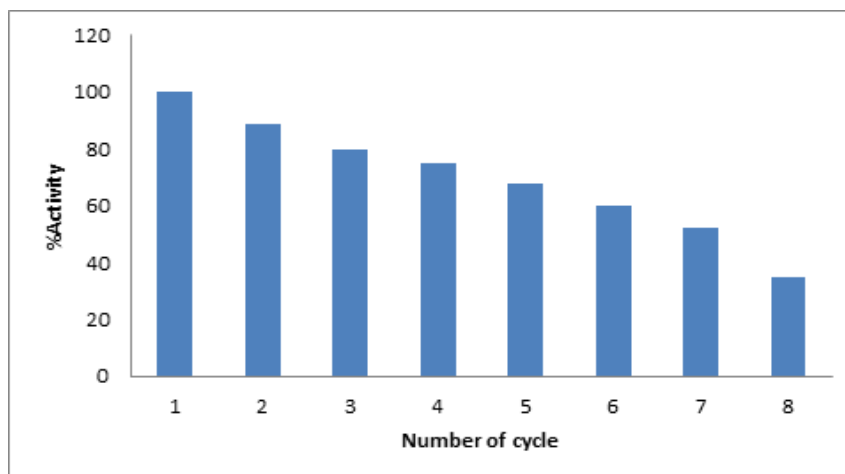
Fig:-5: Reusability graph of ADH

3.6 Kinetic Variables

The kineticvariables govern the reaction rate of the reaction. The following table showed the kinetic variables *Km*and *Vmax*. We have observed that there is not much change in the value of *Km* and *Vmax*for the unbounded and bounded enzymes.

Thermal deactivation Constant (Kd)(min-1)			
	50^0c	60^0c	70^0c
FreeAlcohol Dehydrogenase	$3.10\text{x}10^{-2}$	$2.6\quad 9\text{x}10^{-2}$	$5.1\text{x}10^{-2}$
Alcohol Dehydrogenase immobilized on k-carrageenan	$2.80\text{x}10^{-2}$	$3.36\text{x}10^{-2}$	$4.69\text{x}10^{-2}$
Kinetic Parameters			
	Michalis Constant Km(mM)	Maximum Reaction velocity Vmax(mM/min)	
FreeAlcohol Dehydrogenase	3.53	$0.58\text{x}10^{-5}$	
Alcohol Dehydrogenase immobilized on k-carrageenan	2.12	$0.49\text{x}10^{-5}$	

4. Use of Immobilized Alcohol Dehydrogenase. Juice Purification. (Oxidation)

Fresh pineapple juice, watermelon juice, sugarcane juice weaken. For this 5ml of juice was taken and added to the vial. Then entrapped enzyme semicarbazide-glycine buff ($_pH$=9.2) and 1 ml of alcohol and 1 ml of NAD^+ was added and the vial was incubated for 35 min at room temperature . Oxidation of alcohol was measured at 340 nm by spectrophotometer. First, the Practical was performed with a free enzyme for each sample of juice, OD (optical density). Then same process was done with immobilized enzyme (bed reactor).
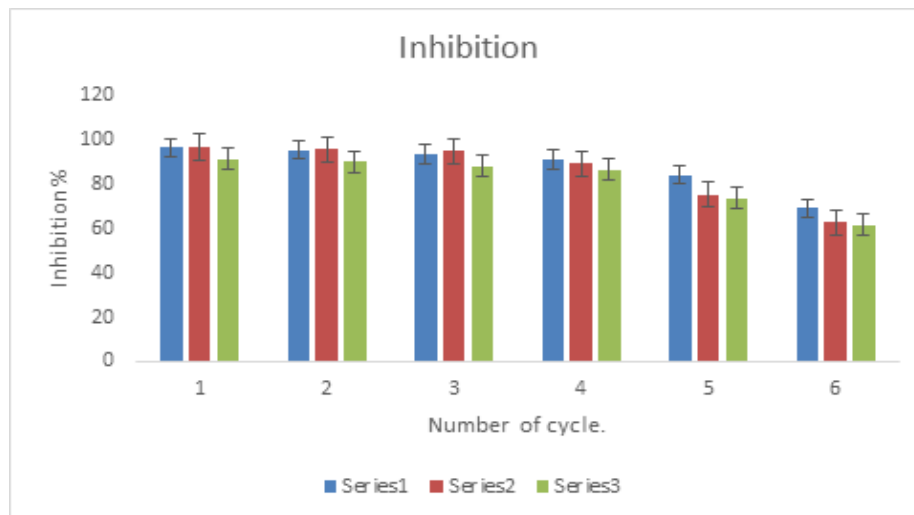
Fig:-6: shows the inhibition of juice (a) series 1 is for sugarcane juice (b) series 2 is for pineapple juice (c) series 3is for watermelon juice.

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THERMAL INSTABILITY OF VISCO-ELASTIC RIVLIN-ERICK SENNANO FLUID LAYER THROUGH A POROUS MEDIUM UNDER THE EFFECT OF COUPLE STRESS

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ABSTRACT

The impression of couple stress on thermal instability of visco-elastic Rivlin-Ericksennanofluid layer through a porous medium is observed for more realistic boundary conditions. By applying Perturbation method, Normal mode technique, the impression of the various physical parameters of the system namely Lewis number, modified diffusivity ratio, nano particle Rayleigh number and couple stress on the stationary convection have been investigated both analytically and graphically. The Lewis number, modified diffusivity ratio,nano particle Rayleigh number and couple stress are found to have stabilizing effect on stationary deportation.

Keywords: Nanofluid; Rivlin-Ericksenvisco-elastic fluid; Rayleigh number; Lewis number; modified diffusivity ratio; couple stress.

1. INTRODUCTION

The thermal instability of a Newtonian fluid has been explained in detail under the consideration of hydrodynamics and hydromagnetics by Chandrasekhar [1]. There exists many visco-elastic fluids that cannot obey Maxwell's constitutive relations. One such type of fluid is Rivlin-Ericksen fluid. Hydromagnetic instability of visco-elastic Walter's (modal B') nanofluid layer heated from below has been studied by D.Kapil and S. Kumar [2] and found that magnetic field has a stabilizing effect for stationary deportation. Rivlin and Ericksen [3] have presented a theoretical model for such one class of visco-elastic fluids.The effect of compressibility and suspended particles on thermal convection in a Walter's (modal B') visco-elastic fluid in hydromagnetics has been studied by Sharma and Aggarwal [4]. In recent years, the study of flow of fluids through porous medium pay an important role due the recovery of crude oil from the pores of reservoir rocks. The flow through porous medium having interest for petroleum engineers and geophysical fluid dynamists. Sharma and Sunil [5] have investigated the thermal impermanence of an Oldroydianvisco-elastic fluid with suspended particles in hydromagnetics in a porous medium.S. Kumar and D. Kapil [6] have discussedhydromagnetic instability of visco-elastic Walter's (modal B') nanofluid layer heated from below under the effect of rotation. Chand and Rana [7] have discussed the effect of rotation on thermal deportation in nanofluid layer saturating a Darcy- Brinkman porous medium. A solid with holes and characterized by the manner in which the holes are imbedded, is known as porous medium. The flow through the porous medium is governed by Darcy's law which states that the usual viscous term in the equation of motion of Rivlin-Ericksennanofluid is replaced by resistance term $\left[-\frac{1}{k_1}\left(\mu + \mu'\frac{\partial}{\partial t}\right)\right]\nabla^2 q_f$, where μ and μ' are the viscosity and visco-elasticity of incompressible Walter's (model B') fluid, $k_1$is the medium permeability and q_f is the Darcian velocity of the fluid.

Couple-stress theory has discussed by Stokes [8]. Couple-stress theory having a great importance in various industrial fluids, medical field such as lubrication mechanism, functioning of synovial joints during human locomotion and opened new ways in several fields of scientific and technical research. Sharma and Sharma [9] have studied the effect of suspended particles on couple-stress fluid heated from below in the presence of vertical rotation and vertical magnetic field and found that the effect of rotation is to stabilize the system, whereas suspended particles have destabilizing effects.Siddheshwar and Prakash [10] have made an analytical study of linear and non-linear deportation in couple-stress fluid layer.

Keeping in the mind the importance of couple-stress fluid, the present paper attempts to study the effect of couple-stress on thermal instability ofvisco-elastic Rivlin-Ericksennanofluid layer through porous medium.

2. MATHEMATICAL FORMULATION

Suppose an infinite horizontal layer of couple-stress visco-elastic Rivlin-Ericksennanofluid of thicknessd^* is bounded by $z = 0$ and $z = d^*$ and heated from below. The fluid layer is acting in upward direction under gravity force g (0, 0,-g). Suppose T_0 and φ_0 are the temperature and volumetric fraction of nano particles at $z = 0$ and$T_1, \varphi_1$are temperature and volumetric fraction at $z = d^*$ respectively.

The governing equation for couple-stress visco-elastic Rivlin-Ericksennanofluid

$$\nabla \boldsymbol{q}_f = 0 \tag{1}$$

$$\frac{\rho}{\epsilon} \frac{d\boldsymbol{q}_f}{dt} = -\nabla p + \rho g - \frac{1}{k_1}\left(\mu + \mu'\frac{\partial}{\partial t}\right)\nabla^2 \boldsymbol{q}_f - \frac{1}{k_1}(\delta + \delta'\nabla^2)\boldsymbol{q}_f \tag{2}$$

where $\frac{d}{dt} = \frac{\partial}{\partial t} + (\boldsymbol{q}_f.\nabla)$ stands for convection derivative, $\boldsymbol{q}_f$(u, v,w) is the velocity vector, p is the hydrostatic pressure, μ and μ' are the viscosity and visco-elasticity$\delta$and $\delta'$are fluid viscosity and couple-stress fluid viscosity and g(0, 0, -g) is acceleration due to gravity. The density ρ of nanofluid can be written as

$$\rho = \varphi \rho_p + (1 - \varphi)\rho_f \tag{3}$$

whereφ is the volume fraction of nano particles, ρ_p and ρ_f are the densities of nano particles and base fluid respectively.

The equation of motion for couple-stress visco-elastic Rivlin-Ericksennanofluid is given as:

$$\frac{\rho}{\varepsilon}\frac{d\boldsymbol{q}_f}{dt} = -\nabla p + \left(\varphi \rho_p + (1-\varphi)\{\rho\left(1 - \alpha(T - T_0)\right)\}\right)g - \frac{1}{k_1}\left(\mu + \mu'\frac{\partial}{\partial t}\right)\nabla^2 \boldsymbol{q}_f - \frac{1}{k_1}(\delta + \delta'\nabla^2)\boldsymbol{q}_f \tag{4}$$

whereα is the coefficient of thermal expansion.

The continuity equation for the nano particles is

$$\frac{\partial\varphi}{\partial t} + \frac{1}{\varepsilon}\boldsymbol{q}_f\nabla\varphi = D_B\nabla^2\varphi + \frac{D_T}{T_1}\nabla^2 T \tag{5}$$
whereD_B is the Brownian diffusion coefficient and D_T is the Thermoporetic diffusion coefficient of the nano particles.

The energy equation in nanofluid is

$$\rho_c\left(\frac{\partial T}{\partial t} + \boldsymbol{q}_f\nabla T\right) = k_m\nabla^2 T + \varepsilon(\rho_c)_p\left(D_B\nabla\varphi.\nabla T + \frac{D_T}{T_1}\nabla T.\nabla T\right) \tag{6}$$

Where ρ_c is the heat capacity of fluid,$(\rho_c)_p$is the heat capacity of nano particles and k_m is the thermal conductivity.

Introducing non-dimensional variables as:

$$(x', y', z') = \left(\frac{x, \ y, \ z}{d^*}\right),$$

$$\boldsymbol{q}_f'(u', v', w') = \boldsymbol{q}_f\left(\frac{u, \ v, \ w}{k}\right)d^*, \ t' = \frac{tk}{d^{*2}},$$

$$p' = \frac{p}{\rho k^2}d^{*2}, \ \varphi' = \frac{\varphi - \varphi_0}{\varphi_1 - \varphi_0},$$

$$T' = \frac{T - T_0}{T_0 - T_1},$$

where$\frac{k_m}{\rho_c} = k$ is the thermal diffusivity of the fluid.

Equations (1), (4), (5) and (6), in non-dimensional form can be written as:

$$\nabla \boldsymbol{q}_f = 0 \tag{7}$$

$$\frac{1}{p_r\varepsilon}\frac{\partial q_f}{\partial t} = -\nabla p - R_{a_m}\hat{e}_z - R_{a_n}\varphi\hat{e}_z - R_a T\hat{e}_z - \frac{1}{k_1}(1 + nF)\nabla^2 \boldsymbol{q}_f - \frac{1}{p_l}(1 + \gamma\nabla^2)\boldsymbol{q}_f \tag{8}$$

$$\frac{\partial\varphi}{\partial t} + \frac{1}{\varepsilon}\boldsymbol{q}_f\nabla\varphi = \frac{1}{L_e}\nabla^2\varphi + \frac{N_A}{L_e}\nabla^2 T \tag{9}$$

$$\frac{\partial T}{\partial t} + \boldsymbol{q}_f\nabla T = \nabla^2 T + \frac{N_B}{L_e}\nabla\varphi.\nabla T + \frac{N_A N_B}{L_e}\nabla T.\nabla T \tag{10}$$

[The dashes (ˋ) have been dropped for simplicity]

Here non-dimensional parameters are:

Lewis number $L_e = \frac{k}{D_B}$, Prandtl number $p_r = \frac{\mu}{\rho k}$,Thermal Rayleigh number$R_a = \frac{\rho g\alpha d^{*3}}{\mu k}(T_0 - T_1)$,Basic-density Rayleigh number$R_{a_m} = \frac{[\rho_p\varphi_0 + \rho\,(1-\varphi_0)]g\,d^{*3}}{\mu k}$, Nano particle Rayleigh number

$R_{a_n} = \frac{(\rho_p - \rho)(\varphi_1 - \varphi_0) g \, d^{*3}}{\mu k}$, Kinematic visco-elasticity parameter $F = \frac{\mu'}{\rho d^{*2}}$, Modified diffusivity ratio $N_A = \frac{D_T}{D_B T_1(\varphi_1 - \varphi_0)}(T_0 - T_1)$, Modified particle density increment $N_B = \frac{\varepsilon(\rho_c)_p (\varphi_1 - \varphi_0)}{(\rho_c)_f}$, Modified couple-stress parameter $= \frac{\mu'}{\mu d^{*2}}$, dimensionless medium permeability $p_l = \frac{k}{d^{*2}}$.

We assume that temperature and volumetric fraction of nano particles are constant on boundaries. Thus the dimensionless boundaries conditions are

$w = 0, T = 1, \varphi = 0 \ at \ z = 0$

And $w = 0, T = 0, \varphi = 1 \ at \ z = 1$ (11)

2.1) Basic States and its Solution
The basic state of nanofluid is supposed to be time independent of time and can be written as $q_f'(u, v, w) = 0$, $p' = p(z)$, $T' = T_b(z)$, $\varphi' = \varphi_b(z)$, Equations (7) to (10) using boundary conditions (11) give solution as:

$T_b = 1 - z$ and $\varphi_b = z$ (12)

2.2) Perturbation Solution
The stability of the system can be studied by introducing small perturbations to primary flow, and written as

$q_f'(u, v, w) = 0 + q_f''(u, v, w), T' = T_b + T'', \varphi' = \varphi_b + \varphi'', p' = p_b + p''$, with $T_b = 1 - z$ and $\varphi_b = z$ (13)

Using equation (13) in equation (7) to (10) and linearize by neglecting the product of the prime quantities, we obtain the following equations:

$\nabla \boldsymbol{q}_f = 0$ (14)

$\frac{1}{p_r \varepsilon} \frac{\partial w}{\partial t} \hat{e}_z = -\nabla p - R_{a_m} \hat{e}_z - R_{a_n} \varphi \hat{e}_z - R_a T \hat{e}_z - \frac{1}{k_1}(1 + nF)\nabla^2 w \hat{e}_z - \frac{1}{p_l}(1 + \gamma\nabla^2) w \hat{e}_z$ (15)

$\frac{\partial \varphi}{\partial t} + \frac{1}{\varepsilon} w = \frac{1}{L_e}\nabla^2\varphi + \frac{N_A}{L_e}\nabla^2 T$ (16)

$\frac{\partial T}{\partial t} - w = \nabla^2 T + \frac{N_B}{L_e}\left(\frac{\partial T}{\partial z} - \frac{\partial \varphi}{\partial z}\right) - 2\frac{N_A N_B}{L_e}\frac{\partial T}{\partial z}$ (17) The dashes ($''$) have been dropped for simplicity.

Since R_{a_m} is just a measure of basic static pressure gradient so it is not involved in these and subsequent equations. Now by operating Eq. (15) with $\hat{e}_z$.curl curl, we get:

$\left[\frac{1}{k_1}(1 + nF) + \frac{\gamma}{p_l}\right]\nabla^4 w + \frac{n}{p_r\varepsilon}\nabla^2 w + \frac{1}{p_l}\nabla^2 w = R_a\nabla_H^2 T - R_{a_n}\nabla_H^2\varphi$ (18)

Where $\nabla_H^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}$ is the two dimensional Laplacian operator on horizontal plane.

3. NORMAL MODE OBSERVATION
For observing the disturbances in to normal modes and assuming that the perturbed quantities are of the form:

$[W, T, \varphi] = [W(z), T(z), \varphi(z)]\exp(ik_x x + ik_y y + nt)$ (19)

Where k_x and k_y are wave numbers in x and y directions respectively, while n is growth rate of disturbances.

Using eq. (19), eq. (16), (17) and (18) become:

$\frac{1}{\varepsilon}W - \frac{N_A}{L_e}(D^2 - a^2)T - \left[\frac{1}{L_e}(D^2 - a^2) - n\right]\varphi = 0$ (20)

$W + \left[(D^2 - a^2) - n + \frac{N_B}{L_e}D - \frac{2N_A N_B}{L_e}D\right]T - \frac{N_B}{L_e}D\varphi = 0$ (21)

$\left[\left\{\frac{1}{k_1}(1 + nF) + \frac{\gamma}{p_l}\right\}(D^2 - a^2)^2 + \frac{n}{p_r\varepsilon}(D^2 - a^2) + \frac{1}{p_l}(D^2 - a^2)\right]W + a^2 R_a T - a^2 R_{a_n}\varphi = 0$ (22)

Where $D = \frac{d}{dz}$ and $a = \sqrt{k_x{}^2 + k_y{}^2}$ is the dimensionless the resultant wave number. The boundary conditions of the problem in view of normal mode are written as

$$W = 0, D^2 W = 0, \ T = 0, \varphi = 0 \text{ at } z = 0 \text{ and } W = 0, D^2 W = 0, \ T = 0, \ \varphi = 0 \text{ at } z = 1 \qquad (23)$$

4. LINEAR STABILITY ANALYSIS

Consider the solution in the form w , T , φ is given as:

$$w = w_0 \sin \pi z, T = \ T_0 \sin \pi z \ , \varphi = \ \varphi_0 \sin \pi z$$

Equations (20),(21) and (22) reduced as

$$\frac{1}{\varepsilon} w_0 \ + \ \frac{N_A}{L_e} J T_0 + \left[\frac{1}{L_e} J + n\right] \varphi_0 = 0 \qquad (24)$$

$$w_0 - (J + n) T_0 = 0 \qquad (25)$$

$$\left[\left\{\frac{1}{k_1}(1 + \text{nF}) + \frac{\gamma}{p_l}\right\} J^2 - \frac{n}{p_r \varepsilon} J - \frac{1}{p_l} J\right] w_0 \ - a^2 \text{R}_a T_0 - a^2 \text{R}_{a_n} \varphi_0 = 0 \qquad (26)$$

From equation (24) & (25), we get

$$\left[\frac{1}{\varepsilon}(J + n) + \frac{N_A}{L_e} J\right] T_0 + \left(\frac{1}{L_e} J + n\right) \varphi_0 = 0 \qquad (27)$$

From equation (25),(26) & (27), we get

$$R_a = \frac{1}{a^2}\left[\left\{\frac{1}{k_1}(1 + \text{nF}) + \frac{\gamma}{p_l}\right\} J^2 - \frac{n}{p_r \varepsilon} J - \frac{1}{p_l} J\right](J + n) + \frac{\left\{\frac{1}{\varepsilon}(J \ + \ n) + \frac{N_a}{L_e} J\right\}}{\frac{1}{L_e} J + n} \text{R}_{a_n} \qquad (28)$$

Where $J = \pi^2 + \ a^2$

For neutral stability, the real part of n is zero. Hence, on putting $n = i \, \omega$, (ω is the real and dimensionless frequency of oscillation) in eq.(28), we get:

$$R_a = \ \Delta_1 + i \, \omega \, \Delta_2 \qquad (29) \qquad \text{Where}$$

$$\Delta_1 = \ \frac{J}{a^2}\left[\left(-\frac{J}{p_l} + \frac{\omega^2}{p_r \varepsilon}\right) + \left\{\left(\frac{1}{k_1} + \frac{\gamma}{p_l}\right) J^2 - \frac{\omega^2 F}{k_1} J\right\}\right] + \frac{1}{\left\{\left(\frac{J}{L_e}\right)^2 + \omega^2\right\}}\left[\frac{J^2}{L_e}\left(\frac{1}{\varepsilon} + \frac{N_a}{L_e}\right) + \frac{1}{\varepsilon} \omega^2\right] \text{R}_{a_n} (30)$$

and imaginary part

$$\Delta_2 = \ \frac{1}{a^2}\left[\left\{\frac{1}{k_1} + \frac{\gamma}{p_l} - \frac{1}{p_r \varepsilon}\right\} J^2 + \frac{F J^3}{k_1} - \frac{1}{p_l}\right] + \frac{J\left[\frac{1}{\varepsilon}\left(\frac{1}{L_e} - 1\right) - \left(\frac{N_A}{L_e}\right)\right]}{\left\{\left(\frac{J}{L_e}\right)^2 + \omega^2\right\}} \text{R}_{a_n} \qquad (31)$$

R_a will be real since it is a physical quantity Hence, it follow from Eq.(29) that either $\omega = 0$ (exchange of stability, steady state) or $\Delta_2 = 0$ ($\omega \neq 0$ overstability or oscillatory onset).

5. STATIONARY CONVECTION

When the stability occurs in as stationary convection, the marginal state will be characterized by $\omega = 0$. the Eq.(29) reduces as:

$$(R_a)_s = \ \frac{(\pi^2 + a^2)}{a^2}\left[\left(\frac{1}{k_1} + \frac{\gamma}{p_l}\right)(\pi^2 + \ a^2)^2 - \frac{(\pi^2 + a^2)}{p_l}\right] + \left(\frac{L_e}{\varepsilon} + \ N_A\right) \text{R}_{a_n} (32)$$

Here R_a is independent of both the prandtl numbers and the parameters containing the Brownian effects and the thermophoretic effects and presented in the thermal energy equation and the conversation equation for nano particles.

Take $x = \frac{a^2}{\pi^2}$ in Eq. (32), then we have

$$(R_a)_s = \ \frac{(1 + x)}{x}\left[\left(\frac{1}{k_1} + \frac{\gamma}{p_l}\right)(1 + \ x)^2 \pi^4 - \frac{(1 + x)\pi^2}{p_l}\right] + \left(\frac{L_e}{\varepsilon} + \ N_A\right) \text{R}_{a_n} \qquad (33)$$

To study the effects of Lewis number L_e, modified diffusivity ratio N_A, and nano particles Rayleigh number R_n and couple-stress on stationary convection. We examine the nature of

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$\frac{\partial R_a}{\partial L_e}$, $\frac{\partial R_a}{\partial N_A}$, $\frac{\partial R_a}{\partial R_{a_n}}$, $\frac{\partial R_a}{\partial \gamma}$ analytically.

From eq. (33)

$$\frac{\partial R_a}{\partial L_e} > 0, \ \frac{\partial R_a}{\partial N_A} > 0, \ \frac{\partial R_a}{\partial R_n} > 0 \ , \frac{\partial R_a}{\partial \gamma} > 0$$

It implies that for stationary convection Lewis number, modified diffusivity ratio, nano particle Rayleigh number and couple-stress has stabilizing effect on the fluid layer.

6. RESULTS AND DISCUSSION

The effect of couple-stress on thermal Instability of visco-elastic Rivlin-Ericksennanofluid layer through a porous medium is investigated under realistic boundary conditions.

Figure 1 represents the variation of stationary Rayleigh number with Lewis number L_e for different values of k_1. The stationary Rayleigh number R_a is plotted against Lewis number for fixed values of $N_A = 10$, $\varepsilon = .1, L_e = 10, \gamma = 5$ and different values of $R_{a_n} = 10, 20, 30, k_1 = 1, 2, 3$ The Rayleigh number increases with increases in Lewis number, which shows that Lewis number has stabilizing effect on the stationary deportation.

Figure 2 represents the variation of stationary Rayleigh number with modified diffusivity number N_A for different values of L_e. The stationary Rayleigh number R_a is plotted against N_A for fixed values of $N_A = 5$, $\varepsilon = .1, k_1 = 1, \gamma = 5$ and different values of $R_{a_n} = 5, 10, 15, L_e = 1, 2, 3$ The Rayleigh number increases with increases in N_A , which shows modified diffusivity number N_A has stabilizing effect on the stationary deportation.

Figure 3 represents the variation of stationary Rayleigh number with nanoparticle Rayleigh number R_{a_n} for different values of L_e. The stationary Rayleigh number R_a is plotted against R_{a_n} for fixed values of $p_l = 1$, $\varepsilon = .1, k_1 = 1, R_{a_n} = 10 , \gamma = 1$ and different values of $N_A = 10, 20, 30, L_e = 5, 10, 15$ The Rayleigh number increases with increases in R_{a_n} , which shows nanoparticle Rayleigh number R_{a_n} has stabilizing effect on the stationary deportation.

Figure 4 represents the variation of stationary Rayleigh number with couple-stress parameter γ for different values of L_e. The stationary Rayleigh number R_a is plotted against γ for fixed values of $p_l = 1$, $\varepsilon = .1, k_1 = 1, R_{a_n} = 10 , \gamma = 1$ and different values of $N_A = 10, 20, 30, L_e = 5, 10, 15$ The Rayleigh number increases with increases in γ , which shows couple-stresshas stabilizing effect on the stationary deportation.

Figure 5 represents the variation of stationary Rayleigh number with couple-stress parameter γ for different values of K_1. The stationary Rayleigh number R_a is plotted against γ for fixed values of $p_l = 1$, $\varepsilon = .1, N_A = 10, R_{a_n} = 10 , \gamma = 1$ and different values of $K_1 = 1, 2, 3, L_e = 5, 10, 15$ The Rayleigh number increases with increases in γ , which shows couple-stresshas stabilizing effect on the stationary deportation
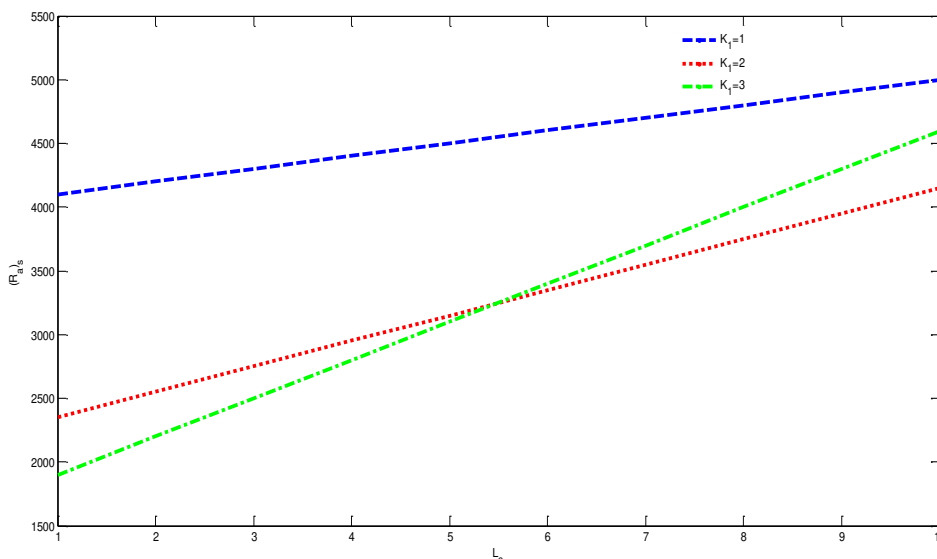
Fig.1: Variations of stationary Rayleigh number with Lewis number
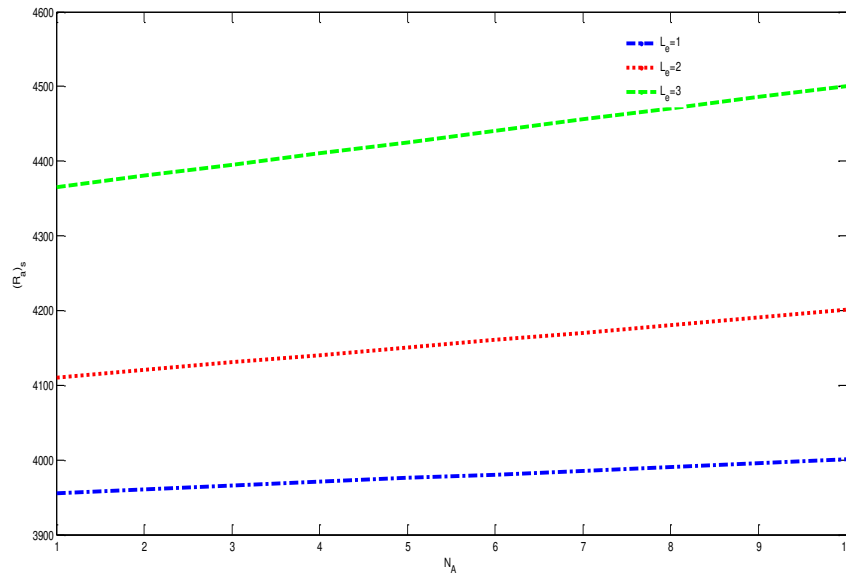
Fig.2: Variations of stationary Rayleigh number with Modified diffusivity ratio number
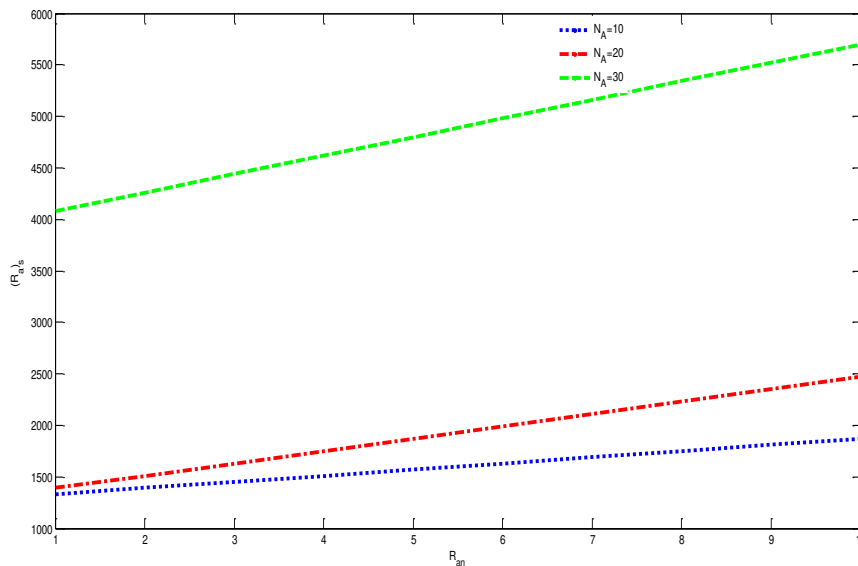
Fig.3: Variations of stationary Rayleigh number with nanoparticle Rayleigh number
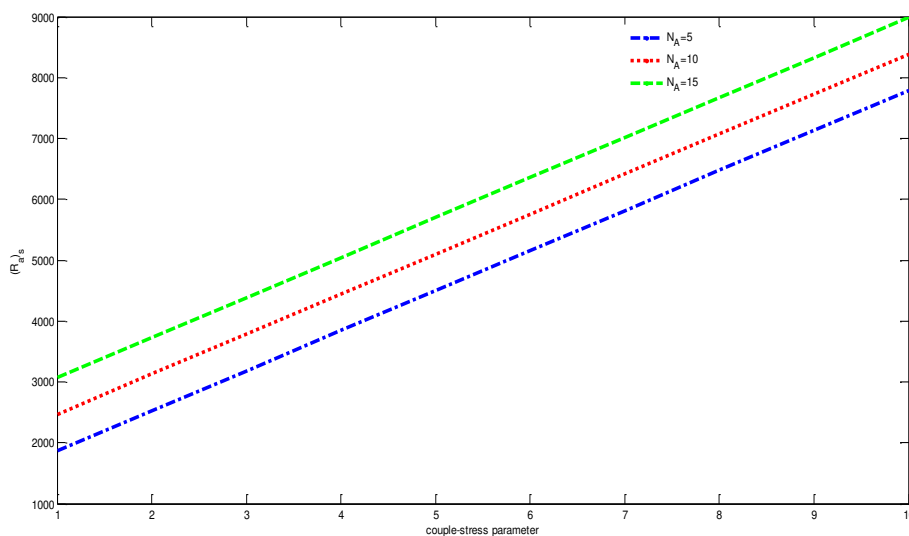
Fig.4: Variations of stationary Rayleigh number with couple-stress parameter
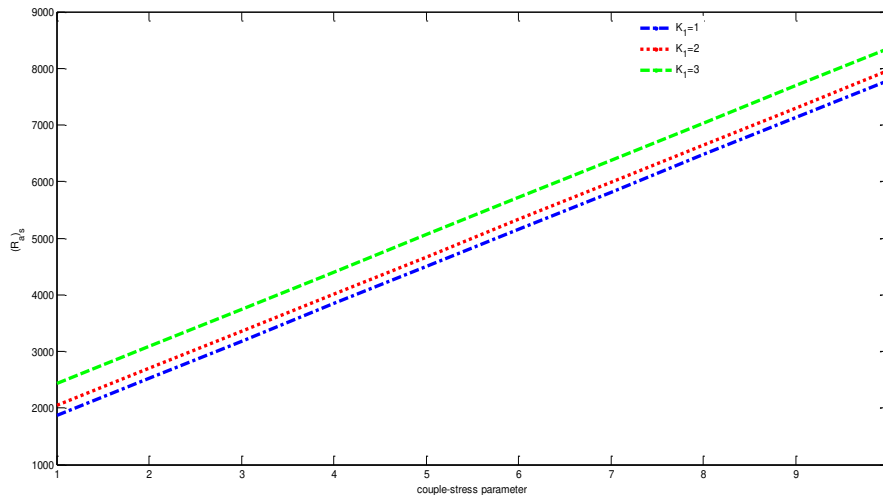
Fig.5: Variations of stationary Rayleigh number with couple-stress parameter

7. CONCLUSIONS

The effect of couple-stress on thermal instability of visco-elastic Rivlin-Ericksennanofluid layer through a porous medium is investigated by using linear instability analysis. The main conclusions from the analysis of this paper are as follows:

(1) For the stationary convection couple-stress has stabilizing impression on the system.

(2) Lewis number, modified diffusivity ratio and nano particle Rayleigh number have stabilizing impression on the stationary convection.

8. NOMENCLATURE

a	dimensionless resultant wave number	**Greek symbols**	
d^*	Thickness of nanofluid layer	α	Thermal expansion coefficient
D_B	Brownian diffusion coefficient	μ	Viscosity
D_T	Thermophoretic diffusion coefficient	ε	Porosity
ρ	Density of nanofluid$p$ Hydrostatic pressure		
g	acceleration due to gravity	μ'	Kinematic visco-elasticity
γ	Modified couple stress parameter	$(\rho_c)_p$	Heat capacity nanoparticles
n	growth rate of disturbances	$(\rho_c)_f$	Heat capacity of base fluid
k_1	Medium permeability	φ	volume fraction nanoparticle
q_f	Velocity vector	ρ_p	density of nanoparticles
R_a	Rayleigh number	ρ_f	density of base fluid
R_{a_m}	Density Rayleigh number	k	Thermal diffusivity
R_{a_n}	Nano particle Rayleigh number v Kinematic Viscosity		
T	Temperature	v'	Kinematic visco-elasticity
T_1	Reference temperature	**Superscripts**	
t	time	`	non-dimensionless variables
P_r	Prandtl number	$''$	perturbed quantities
δ	Fluid viscosity		
δ'	Couple-stress fluid viscosity		
L_e	Lewis number		

N_A Modified diffusivity ratio

N_B Modified particle-density increment

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COMBINED EFFECTS OF PIEZO-VISCOUS DEPENDENCY AND NON-NEWTONIAN COUPLE STRESSES ON THE SQUEEZE FILM CHARACTERISTICS OF LONG POROUS PARTIAL JOURNAL BEARINGS

BIRADAR KASHINATH, NEMINATH B. NADUVINMANI AND ADINATHA C. UPADHYA

ABSTRACT

Barus experimental research showed that the dependency of liquid viscosity on pressure is exponential. Therefore, an attempt has been made to study the combined effect of piezo-viscous dependency and non-Newtonian couple stresses on the squeeze-film characteristics of long porous partial journal bearings. The most general modified Reynolds equation for stokes micro-continuum theory of couple stress fluids accounting for the pressure dependent viscosity is mathematically derived for the problem under consideration. The standard perturbation method is used to solve Reynolds equation and approximate analytical solution is obtained for the squeeze film pressure, load carrying capacity and squeeze film time. A fourth-order Runge-kutta method is used to solve the nonlinear differential equation between lubricant film thickness and time. According to the results, it is found that, the effect of viscosity pressure dependency on the squeeze film lubrication of porous journal bearings with couple stress fluids is to improve the load carrying capacity significantly and lengthen the squeeze film time as compared to the classical Newtonian iso-viscous lubricant.

Keywords: Squeezing Films, Piezo-viscous dependency, Couple stress fluids, Porous.

1. INTRODUCTION

Nowadays, the squeeze film technology has numerous applications in different fields of industry, ranging from disc clutches to rotating devices such as ball bearings, matching gears, rolling gears, damping films, aircraft engines and mechanics of synovial joints in human beings and animals etc. The squeeze film phenomenon arises when the two lubricating surfaces move towards each other in the normal direction and generates a positive pressure, and hence supports a load. This is due to the fact that a viscous lubricant present between the two surfaces cannot be instantaneously squeezed out when the two surfaces move towards each other and this action provides a cushioning effect in bearings. Many authors have discussed squeeze film journal bearings with Newtonian Lubricants such as Pinkus and Sternlicht [1], Cameron [2], Hamrock [3], Bujurke et. al. [4]; Naduvinmani and Siddanagouda [5]. But the classical Newtonian theory does not give satisfactory results for many engineering problems. Studies based on experiments shows that there is enhancement on the bearing characteristics with the addition of small amount of additives into a non polar fluids. Since the classical Newtonian theory cannot accurately describe the rheological behaviour of lubricants blended with various additives. The use of non-Newtonian fluids as lubricants is of growing interest in recent times. In particular, the addition of long chain polymer solutions to the lubricant enhances the bearing performance. These lubricants are fluids with microstructures. The failure of the classical continuum theory in representing the flow behaviour of such fluids adequately has led to the development of the micro -continuum theories [Ariman et. al. [6,7]]. Among, One of these theories is couple stress theory proposed by Stokes [8]. Stokes theory was the simplest generalization of the classical theory of fluids which allows polar effects such as the presence of couple stresses and body couples. This theory describes the peculiar behaviour of fluids containing substructure and is intended to account for particle size effects. Couple-stress fluids consist of rigid, randomly oriented particles suspended in a viscous fluid such as electro rheological fluids and synthetic fluids. Couple stresses may appear particularly in problems where thin films exist. The striking feature of couple stress fluid is the introduction of the size dependent effect that is usually neglected in the classical continuum mechanics. Over the years, tremendous achievements have been made on non-Newtonian fluid flow under couple stresses. Some of these studies include Ramanaiah [9], Ramanaiah and Sarkar [10], Oliver [11], Spike[12], Bujurke and Jayaraman [13], Bujurke and Naduvinmani [14], Lin [15,16] and Naduvinmani et. al [17] and K. Biradar[18] have shown that the pressure distribution, load carrying capacity and response time increase for smaller values of couple stress parameter.

In all the analysis referred above the lubricant viscosity μ is assumed to be the constant value. According Barus [19] and Bartz and Ether [20], the dependency of viscosity pressure has taken a form,

$$\mu = \mu_0 e^{\alpha p} \tag{1}$$

where viscosity is taken as ' μ ' , pressure as '*p*' , pressure dependent viscosity (PDV) as 'α' , the viscosity at ambient pressure as μ_0 is and taking temperature to be constant. The relation (1) indicates the lubricant viscosity is increasing exponentially and it could alter the predicted performance of squeeze film bearings. According to the earlier research study, the viscosity pressure dependence is more significant in analysing the phenomenon of high pressure in lubrication. In modern years, researchers are more interest to describe the dependency of viscosity pressure through which phenomenon of lubrication could be studied. Lin et al. [21] predicted the combined effects of non-Newtonian rheology and viscosity pressure dependency in the sphere plate squeeze film of circular plates. Lin *et. al.* [22,23] studied the effect of viscosity pressure dependency on the non-Newtonian squeeze film of wide parallel plates and parallel circular plates and have observed that the non-Newtonian couple stress fluid as lubricant and the effect of viscosity dependent pressure causes an increase in the film pressure, load carrying capacity and lengthens the squeeze film time. Jayachandra Reddy *et. al.*[24] studied the effect of viscosity variation on the squeeze film performance of narrow hydrodynamic journal bearings operating with couple stress fluids , G.A.Hiremath *et. al.*[25] analyzed the effects of viscosity variation and surface roughness on the couple strees squeeze film characteristics of short journal bearings. Recently, K.R. Vasanth et.al. [26] investigated Combined Effect of Piezo viscous Dependency and Non-Newtonian Couple Stress on Squeeze-Film Porous Annular Plate. B. Vijaykumar et.al [27] studied the combined effects of squeeze film characteristics with Non-Newtonian couple stress fluid and Piezoviscous Dependency between porous parallel circular plates. S.Sangeetha and Sundarammal Kesavan [28] studied effect of Load Carrying capacity and Pressure Distribution with Viscosity Variation and Velocity Slip using couple stress fluid for Porous Triangular plates with MHD. Bilal Boussaha et.al [29] examined Non-Newtonian couple-stress squeeze film behaviour between oscillating anisotropic porous circular discs with sealed boundary.

Considering all the above discussed aspects of importance of porous facing on the squeeze film behaviour and their applications, in the present article, the authors' worked on Squeeze Film Characteristics of Long Porous Partial Journal Bearings with Combined Effects of Piezo-Viscous Dependency and non-Newtonian couple stresses.

2. MATHEMATICAL FORMULATION AND SOLUTION OF THE PROBLEM

Figure 1 shows the geometrical configuration of the squeeze film configuration of a long porous partial journal bearing lubricated with a non-Newtonian couple stress fluid considering pressure-dependent viscosity. The journal with radius R is approaching the porous partial bearing with a squeezing velocity $V_\theta \left(i.e. -\dfrac{\partial h}{\partial t} \right)$. The film thickness h is a function of θ and is given b*y*

$$h = C - e \, \cos\theta \tag{2}$$

where C denotes the radial clearance and e is the eccentricity of the journal centre. The lubricant in the film region and also in the porous region is assumed to be a Stokes [8] couple stress fluid. Under the usual assumptions of fluid film lubrication applicable to thin films (Cameron[2]), the equation of motion of an incompressible couple stress fluid within the film region, when the body forces and body couples are absent, are given by
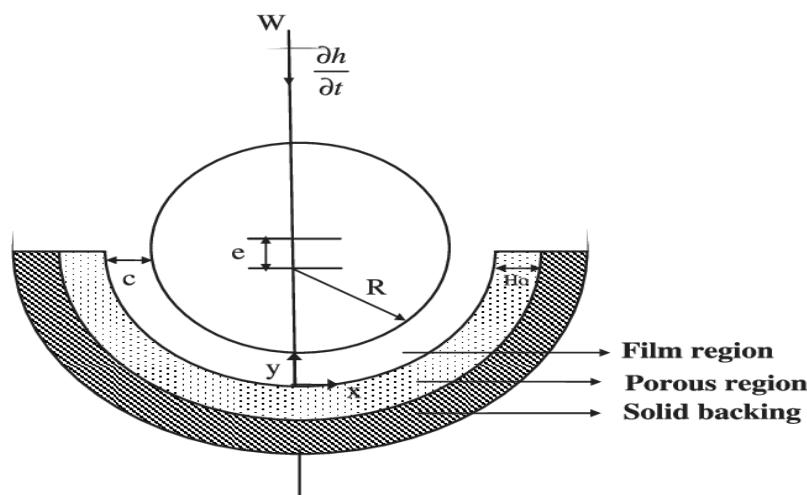
Figure 1: Geometrical configuration of the squeeze film between porous journal bearings.

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{3}$$

$$\mu \frac{\partial^2 u}{\partial y^2} - \eta \frac{\partial^4 u}{\partial y^4} = \frac{\partial p}{\partial x}, \tag{4}$$

$$\frac{\partial p}{\partial y} = 0 \tag{5}$$

where u and v are the velocity components in the x and y directions respectively, p is the pressure, μ is the dynamic viscosity and η represents a new material constant responsible for the couple stress fluids.

The relevant boundary conditions are

(i) At the Porous Journal Surface Y = 0.

$$u = 0, \frac{\partial^2 u}{\partial x^2} = 0 \tag{6(a)}$$

$$v = -v^* \tag{6(b)}$$

(ii) At the Boundary Surface Y = H.

$$u = 0, \frac{\partial^2 u}{\partial x^2} = 0 \tag{7(a)}$$

$$v = -V_\theta \tag{7(b)}$$

The flow of couple stress fluid in a porous matrix is governed by the modified Darcy law, which account for the polar effects.

$$u^* = \frac{k}{\mu(1-\beta)} \frac{\partial p^*}{\partial x} \tag{8}$$

$$v^* = \frac{k}{\mu(1-\beta)} \frac{\partial p^*}{\partial y} \tag{9}$$

Where, $\beta = \frac{(\eta/\mu)}{k}$ and the parameter κ is the permeability of the porous material and is known as pore size and β is the ratio of microstructure size to the pore size and is represented as $\beta = \frac{\eta}{\mu\kappa}$ and $\frac{\eta}{\mu}$ represents the microstructure size. For a couple stress fluid, the material constant η is similar to μ (viscosity). The ratio can be expressed $\frac{\eta}{\mu} = \sqrt{l}$ and is known as couple stress parameter. The physical concept of Darcy's flow visualization provides $\beta = 1$ or $\frac{\eta}{\mu} = \kappa$, the pores of the porous media are blocked by the microstructure additives in the lubricant. In another situation, if the microstructure additives pass through porous material then $\beta \square 1$. The pressure in the porous region is defined as p* and in consideration of steady state condition given by Laplace's equation:

$$\frac{\partial^2 p^*}{\partial x^2} + \frac{\partial^2 p^*}{\partial y^2} = 0 \tag{10}$$

To find the total pressure in a porous region, Morgan and Cameron's [2] approximations are applied. The surface y = - δ is taken as non-porous and at y = 0 as porous and pressure within porous region is taken as p = p*. Integration with respect to y to both sides of equation (10) up to the thickness of porous region gives;

$$\left(\frac{\partial p^*}{\partial y}\right)_{y=0} = -\int_{-\delta}^{0} \frac{\partial^2 p^*}{\partial x^2}\, \partial y = -\delta\left(\frac{\partial^2 p^*}{\partial x^2}\right) = -\delta\left(\frac{\partial^2 p}{\partial x^2}\right) \tag{11}$$

Then, the vertical component of the modified Darcy velocity, v^* at the interface y= 0 is given by

$$v^*\big|_{y=0} = \frac{k\delta}{\mu.(1-\beta)}\frac{\partial^2 p}{\partial x^2} = \frac{k\delta e^{-\alpha p}}{(1-\beta)}\frac{\partial^2 p}{\partial x^2} \tag{12}$$

The solution of the equation (4) using the expression (1) with the relevant boundary conditions 6(a) and 7(a) obtained in the form

$$u = \frac{e^{-\alpha p}}{2\mu_0}\cdot\frac{\partial p}{\partial x}\left[y(y-h) + 2l^2\left\{1 - \frac{\cosh\left[\dfrac{(2y-h)}{e^{-0.5\alpha p}2l}\right]}{\cosh\left[\dfrac{h}{e^{-0.5\alpha p}2l}\right]}\right\}\right] \tag{13}$$

where, $l = \sqrt{\dfrac{\eta}{\mu_0}}$ is the couple stress parameter.

Integrating equation (3) across the fluid film and utilizing boundary conditions 6(b) and 7(b) and expressions in (12) and (13) in the modified Reynolds type equation is obtained in the form

$$\frac{\partial}{\partial x}\left\{\left[f(h,l,\alpha,p) + \frac{12k\delta e^{-\alpha p}}{(1-\beta)}\right]\frac{\partial p}{\partial x}\right\} = -12\mu_0 V_\theta, \tag{14}$$

where,

$$f(h,l,\alpha,p) = e^{-\alpha p}h^3 - 12l^2 e^{-2\alpha p}h + 24l^3 e^{-2.5\alpha p}\tanh\left[\frac{e^{0.5\alpha p}h}{2l}\right].$$

And

$$V_\theta = -\frac{dh}{dt} = c\frac{d\in}{dt}\cos\theta \tag{15}$$

Introducing the non-dimensional variables and parameters,

$$h^* = \frac{h}{C} = 1-\in\cos\theta, l^* = \frac{l}{C}, \theta = \frac{x}{R},\ \psi = \frac{k\delta}{C^3},\ p^* = \frac{pC^2}{\mu_0 R^2\left(\dfrac{d\in}{dt}\right)},\ \upsilon = \frac{\alpha\,\mu_0\,R^2\left(\dfrac{d\in}{dt}\right)}{C^2}$$

substituting these in equation (14), the non-dimensional modified Reynolds equation is obtained in the form

$$\frac{\partial}{\partial\theta}\left\{ f^*\left(h^*,l^*,\upsilon,p^*,\psi\right)\cdot\frac{\partial p^*}{\partial\theta}\right\} = -12\cos\theta \tag{16}$$

where, $f^*(h^*,l^*,\upsilon,p^*,\psi) = e^{-\upsilon p^*}h^{*3} - 12l^{*2}e^{-2\upsilon p^*}h^* + 24l^{*3}e^{-2.5\upsilon p^*}\tanh\left[\dfrac{e^{0.5\upsilon p^*}\cdot h^*}{2l^*}\right] + \dfrac{12k\delta e^{\upsilon p^*}}{1-\beta}$

The non-dimensional Reynolds equation (16) is observed to be highly non-linear. To obtain the first order analytical solution for small values of viscosity parameter $0\le\upsilon\ll 1$, a small perturbation method for the film pressure adopted by putting in to the Reynolds equation (16) and neglecting second and higher order terms of υ, we obtain the following two equations responsible for pressure p_0^* and p_1^* reply.

$$p^* = p_0^* + \upsilon p_1^* \tag{17}$$

$$\frac{\partial}{\partial \theta}\left\{\frac{\partial p_0^*}{\partial \theta}\right\} = -\frac{12\cos\theta}{f_0^*(h^*, l^*, \psi)}, \tag{18}$$

$$\frac{\partial}{\partial \theta}\left\{\frac{\partial p_1^*}{\partial \theta}\right\} = -\frac{f_1^*\left(h^*, l^*, \psi\right)}{f_0^*\left(h^*, l^*, \psi\right)}\frac{\partial}{\partial \theta}\left\{p_0^*\frac{\partial p_0^*}{\partial \theta}\right\}, \tag{19}$$

where, $f_0^*(h^*, l^*, \psi) = h^{*3} + 24l^{*3}\tanh\left[\dfrac{h^*}{2l^*}\right] - 12h^*l^{*2} + \dfrac{12\psi}{(1-\beta)}$

$$f_1^*(h^*, l^*, \psi) = -h^{*3} + 6l^{*2}h^*\operatorname{sech}^2\left[\frac{h^*}{2l^*}\right] - 60l^{*3}\tanh\left[\frac{h^*}{2l^*}\right] + 24h^*l^{*2} - \frac{12\psi}{(1-\beta)^2}$$

Solving the equations (18) and (19) under the pressure boundary conditions

$$\frac{dp^*}{d\theta} = 0 \quad \text{at} \quad \theta = 0,$$

$$p^* = 0 \quad \text{at} \quad \theta = \pm\frac{\pi}{2}, \tag{20}$$

The expression for dimensionless pressure developed in the film region is obtained in the form

$$p^* = \frac{12\cos\theta}{f_0^*\left(h^*, l^*, \psi\right)} - 72\upsilon\left(\frac{f_1^*\left(h^*, l^*, \psi\right)}{f_0^{*3}\left(h^*, l^*, \psi\right)}\right)\cos^2\theta \tag{21}$$

The load carrying capacity w^* can be obtained by integrating the film pressure over the squeeze film area as follows

$$w = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} p\, \mathrm{R}\cos\theta\; d\theta \tag{22}$$

This in the non-dimensional form is given by

$$w^* = \frac{wc^2}{\mu_0 R^3\left(\dfrac{d\in}{dt}\right)} = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} p^*\cos\theta\; d\theta \tag{23}$$

using expression (23) the above equation becomes

$$w^* = \frac{6\pi}{f_0^*(h^*, l^*, \psi)} - 96\upsilon\left\{\frac{f_0^*(h^*, l^*, \psi)}{f_0^{*3}(h^*, l^*, \psi)}\right\} \tag{24}$$

Then, the differential equation governing the non dimensional film thickness can be expressed as

$$\frac{d\in}{dt^*} = \left\{\frac{-1}{W^*}\right\} \tag{25}$$

Equation (25) is first order nonlinear differential equation. The initial condition for $\in$ is;

$\in = 0$ at $t^* = 0$

Using fourth order Runge-Kutta method with a step interval $\Delta t = 0.5$, we can obtain a numerical solution of $\in$.

3. RESULTS AND DISCUSSION

Based on the Stokes[8] couple stress fluid model for lubricants and Barus [19] analysis for pressure dependent viscosity, this paper predicts the combined effects of non-Newtonian couple stresses and viscosity pressure dependency on the performance of long porous partial journal bearings. All required characteristic features of squeeze film bearings such as the pressure distribution, load-carrying capacity, and squeezing time. have been determined. The non dimensional pressure P*, load carrying capacity W* and squeeze film time T* are functions of the couple stress parameter l^*, the step length h* and permeability parameter ψ. The squeeze film characteristics of porous journal bearings discussed as below for different values of l^*, θ, β, ψ, υ and ϵ. Results are presented graphically from figures 2 -10.

3.1 Squeeze Film Pressure

Figure 2 presents the variation of non-dimensional film pressure p^* as a function of circumferential coordinate θ for different values of l* (0.0,0.2,0.3,0.4) and υ = (0.0,0.02,0.04,0.06). At the eccentricity ratio ϵ = 0.1, the effects of non-Newtonian couple stresses (l*=0.2) provide a higher pressure distribution as compared to the Newtonian-lubricant situation (l*=0.0). Figure 3 presents the variation of non-dimensional film pressure p^* as a function of circumferential coordinate θ for different values of l* (0.0,0.2,0.3,0.4) and υ (0.0,0.02,0.04,0.06). At the eccentricity ratio ϵ = 0.3, further higher distributions of the pressure are obtained. When the bearing operating at a larger eccentricity ratio ε = 0.3, the effects of PDV and non-Newtonian rheology on the film pressure. Figure 4 presents the variation of non-dimensional film pressure p^* as a function of circumferential coordinate θ for different values of ψ (0.0001,0.001,0.01,0.0) with ϵ = 0.3, l* = 0.3, υ = 0.02, β = 0.02. This gives a clear observation that as ψ value increases the pressure decreases.

3.2 Load Carrying Capacity

Figure 5 presents the load-carrying capacity W* as a function of the eccentricity ratio ε for different values of l*(0.0,0.2,0.4,0.4) and υ = 0.0. the bearing with non-Newtonian couple stress fluids provides higher loads as compared to the Newtonian-lubricant (l*= 0.0) situation. Figure 6 presents the load-carrying capacity W*as a function of the eccentricity ratio ε for different values of l*(0.0,0.2,0.3,0.4) and υ=0.02. The bearing with non-Newtonian couple stress fluids When the lubricant with the PDV (υ =0.02) are considered, the effects of pressure-dependent viscosity provide further increments in the load capacity, especially for larger values of the non-Newtonian couple stress parameter l*. Figure 7 presents the load-carrying capacity W*as a function of the eccentricity ratio ε for different values of ψ (0.0001,0.001,0.01.0.0) with l* = 0.3, θ = π/3, υ = 0.02, β = 0.02. This gives a clear observation that as ψ value increases the load carrying capacity decreases.

3.3 Squeeze Film Time

Figure 8 presents the squeeze film time t* as a function of the eccentricity ratio ε for different values of l*(0.0,0.2,0.3,0.4) and υ = 0.0, the effects of non-Newtonian rheology (l*= 0.2) are observed to provide a longer response time as compared to the Newtonian-lubricant situation (l*= 0.0). Figure 9 presents the squeeze film time t* as a function of the eccentricity ratio ε for different values of l*(0.0,0.2,0.3,0.4) and υ = 0.02. When the effects of PDV (υ =0.02) are also considered, further values of there response time are lengthened for the partial-bearing squeeze films with non-Newtonian couple stress lubricants. Figure 9 presents the squeeze film time t* as a function of the eccentricity ratio ε for different values of ψ (0.0001,0.001,0.01,0.0) with l* = 0.3, θ = π/3, υ = 0.02, β = 0.02. This gives a clear observation that as ψ value increases the squeeze film time decreases.
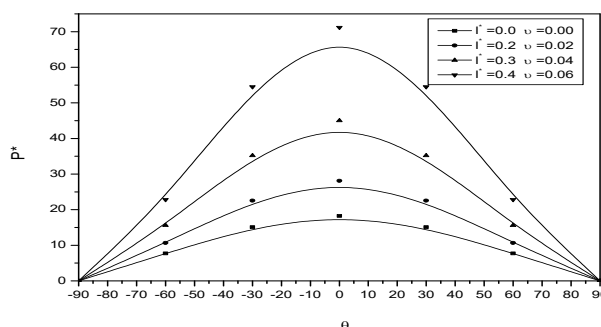
Figure. 2: Variation of the film pressure p^* with circumferential coordinate θ for different values of l^* and υ with ϵ = 0.1, β=0.02 and ψ =0.01
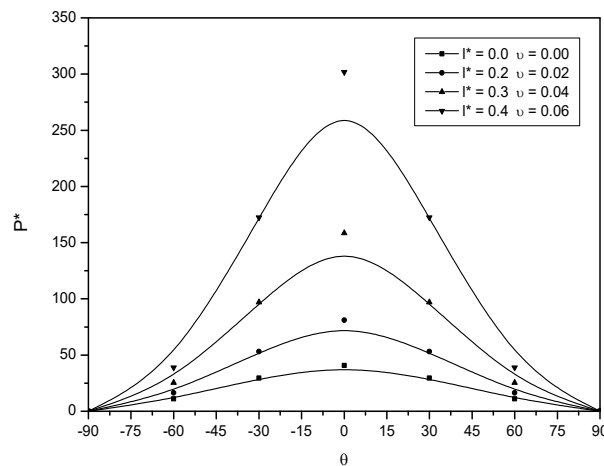
Figure 3: Variation of the film pressure p^* with circumferential coordinate θ for different values of l^* and υ with $\epsilon = 0.3$, $\beta = 0.02$ and $\psi = 0.01$
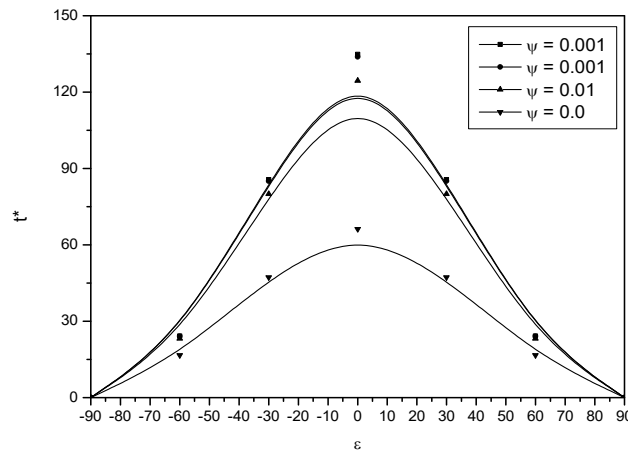
Figure 4: Variation of the film pressure p^* with circumferential coordinate θ for different values of ψ with $l^* = 0.3$, υ 0.02, $\beta = 0.02$ and $\epsilon = 0.1$.
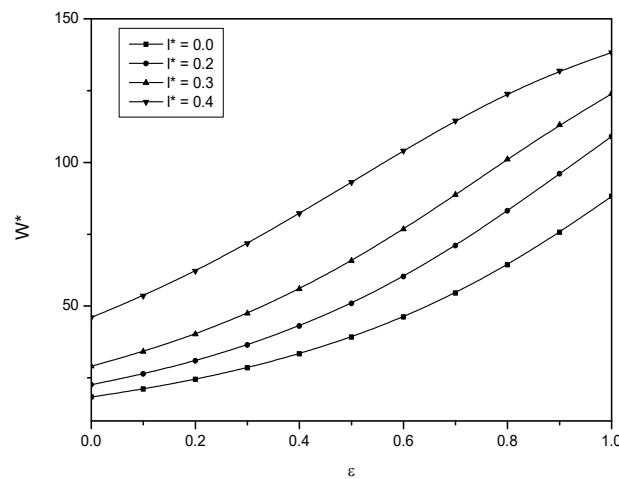
Figure 5: Variation of load carrying capacity W^* with eccentricity ratio ϵ for different values of l^* with $\upsilon = 0.0$, $\beta = 0.02$, $\psi = 0.01$ and $\theta = \pi/3$.
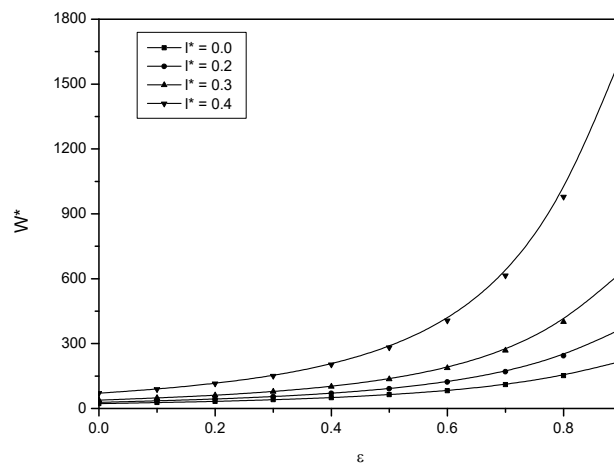
Figure 6: Variation of load carrying capacity W^* with eccentricity ratio ε for different values of l^* with υ = 0.02, β=0.02, ψ =0.01 and $\theta = \pi/3$.
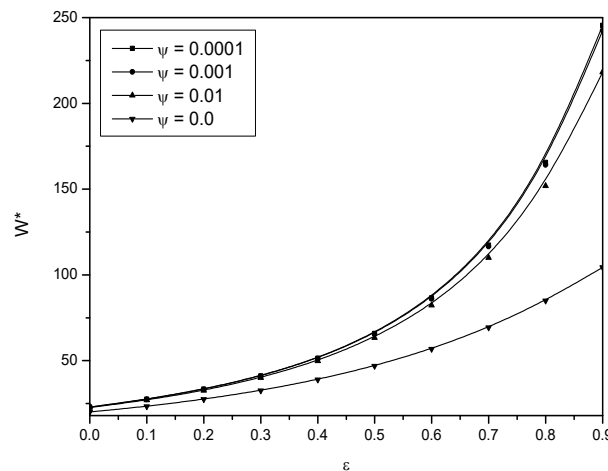
Figure 7: Variation of the load carrying capacity W^* with eccentricity ratio ε for different values of ψ with l^* =0.3, υ =0.02, β=0.02, ϵ = 0.1 and $\theta = \pi/3$.
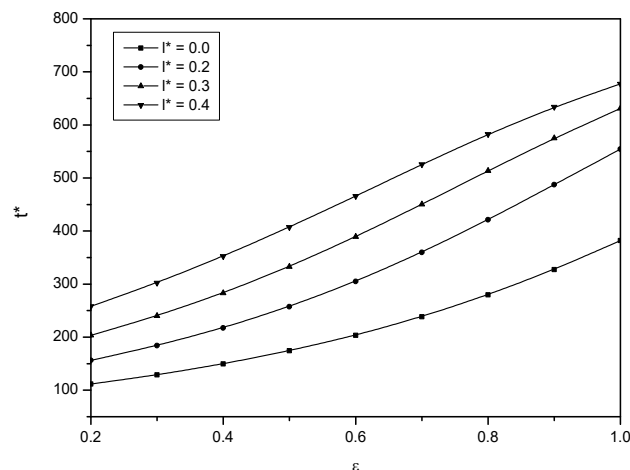
Figure .8: Variation of squeeze film time t^* with eccentricity ratio ε for different values of l^* and with υ = 0.02, β=0.02, ψ = 0.01 and $\theta = \pi/3$.
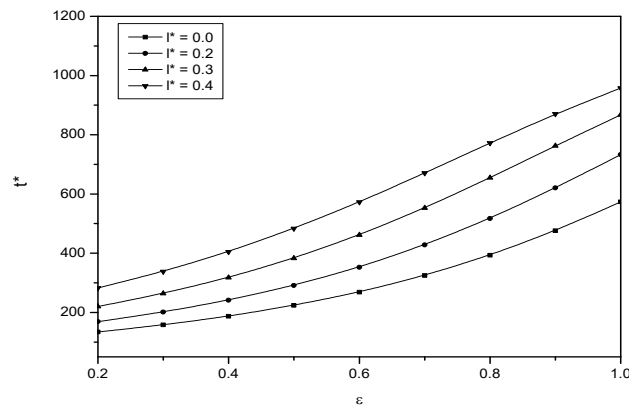
Figure .9: Variation of squeeze film time t^* with eccentricity ratio ε for different values of l^* and $\upsilon = 0.02$, β = 0.02, $\psi = 0.01$ and $\theta = \pi/3$.
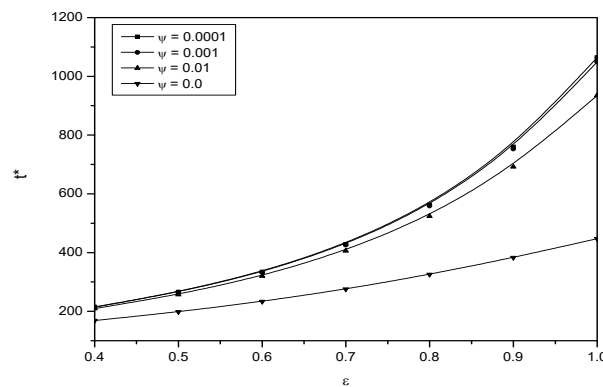
Figure 10: Variation of squeeze film time t^* with eccentricity ratio ε for different values of ψ with $l^* = 0.3$, $\upsilon = 0.02$, β=0.02, $\epsilon = 0.1$ and $\theta = \pi/3$.

4. CONCLUSIONS

A theoretical study of non-Newtonian couple stress fluids are examined by considering the influence of pressure dependent viscosity effects in the squeeze film between porous journal bearings. Squeeze film has been presented in this paper based on the Stokes [8] couple stress fluid theory and Barus [19] analysis for pressure dependent viscosity. According to the before mentioned analysis and results the conclusions can be drawn as follows.

1. The effect of pressure dependent viscosity provides an increase in the squeeze film pressure, load carrying capacity and the elapsed squeeze film time for the porous journal bearings as compared with iso- viscous lubricants.

2. The pressure, load, squeezing time decreases with increasing values of ψ.

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APPENDIX

Notation

C   radial clearance

e   eccentricity

υ viscosity-pressure parameter

h film thickness

h^* non-dimensional film thickness

l characteristic length of the additives.

l^* couple stress parameter

p squeeze film pressure

p^* pressure in the porous region

u,v velocity component in the x, and y directions, resply.

W load carrying capacity

W^* non–dimensional load carrying capacity

t response time

t^* dimensionless response time

x^* non-dimensional co-ordinate

y^* non-dimensional co-ordinate

μ lubricant viscosity

μ_0 viscosity at ambient pressure and a constant temperature

α pressure-viscosity coefficient,

β ratio of microstructure size of polar additives to the pore size

η material constant responsible for couple stress fluids

R   radius of the journal

ψ non dimensional permeability parameter.

ϵ eccentricity ratio.

θ circumferential coordinate

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IMPACT OF MERCURIC CHLORIDE TOXICITY ON HEMATO-BIOCHEMICAL STUDIES ON LABEO ROHITA FINGERLINGS

D. MERIN EMERALD AND M. SOUNDARARAJAN

ABSTRACT
Aquatic toxicology is a fundamental and essential task for risk assessment in aquatic ecosystems and water resource management. Sensing disturbance (e.g., pollutants or toxicants) in aquatic system is a crucial issue for early warning of water quality. Heavy metals are significant environmental pollutants and toxicity of theirs is major problem for ecological, evolutionary, nutritional and environmental balances. Toxicity risk also depends on the inherent toxic potential of the metal itself; thus, mercury, a nonessential metal, a metal essential for physiologic function Metal toxicity affects all organ systems and can result in wide-ranging and nonspecific symptoms; however, the central nervous system (CNS) is especially susceptible to damage from metals. Present study conclude the Mercury chloride exposed fish statistically significant difference compared with control fish. Overall Mercury chloride has been proved to be harmful to Labeo rohita fish which cause oxidative stress mediated liver damage.

Keywords: Labeo rohita, Mercury toxicity, Heavy metals.

INTRODUCTION
Metals constituting important class of the toxic substances encountered day to day life during occupational and environmental circumstances. The impact of such toxic agents on human health is presently an area of passionate interest because of ubiquity of its exposure, by increasing the use of wide verity of the metals in industry and in daily life work hood (Christoforidis *et al* 2009). Heavy metals are significant environmental pollutants and toxicity of theirs is major problem for ecological, evolutionary, nutritional and environmental balances (Goyer, 2001 and Wang *et al*. 2001).

Toxicity risk also depends on the inherent toxic potential of the metal itself; thus, mercury, a nonessential metal, a metal essential for physiologic function. Metal toxicity affects all organ systems and can result in wide-ranging and nonspecific symptoms; however, the central nervous system (CNS) is especially susceptible to damage from metals. Mercury, named for the planet Mercury, was known to the ancient Chinese and has been discovered in Egyptian tombs dating back to 1500 BCE. It was also used to treat syphilis in the 15th-century European syphilis pandemic (Graeme and Pollack, 1998). All forms of mercury are toxic to humans. Their effects are organ-specific and depend on the chemical form of the mercury and the exposure level, duration, and route (Zalups, 2000). Different forms of mercury deposit preferentially in different tissue compartments, which explains their different toxic profiles. In the present study of biochemical analysis of Mercury chloride exposer fish in *Labeo rohita*.

MATERIALS METHOD

Collections and Acclimatization of Experimental Animal
Fingerlings of *Labeo rohita* of average weights of 3.5gm and 5.60 g, total lengths of 65 mm were collected from a fish seed hatchery, Thittai, Thanjavur district, Tamil Nadu. Fish were fed with pelleted feed and water was renewed every day.

Experimental Design
Group I: Control and **Group II:** Mercury chloride (75 µg//L) exposed fish. The experiments were carried out with the help of small square type glass troughts of 10-liter capacity, which were covered with in iron wire gauge to avoid the jumping of the fish from the trough. To provide proper supply of oxygen an aerator was used. The test media was changed daily with fresh addition of the toxicant. The test media was changed daily with fresh addition of the toxicant. Fish were treated with Mercury chloride (75µg//L) for 3 days in static tank containing water. At the end of the experimental period (After 24 hours), the fishes were sacrificed by decapitation. Blood with and without EDTA was collected and allowed to clot at room temperature and then centrifuged at 3000 rpm at 4°C for 20 min to obtain serum.

Haematological Analysis
Experimental and control fish blood samples were obtained from the caudal circulation with heparinised disposable syringe. Blood samples were used for the analysis of haematological parameters. Haemoglobin was

estimated by Cyanmethemoglobin method (Dacie and Lewis, 1968); RBC and WBC counting of the fish blood samples was carried out by the method of Ochei and Kolhatkar, (2000).

Biochemical Estimations

Malondialdehyde was estimated by the thiobarbituric acid assay method of Beuge and Aust (1978); The SGOT and SGPT was estimated by the method of Reitman and Frankel (1957).

Statistical Analysis

Values are expressed as Mean ± SD for 10 fish. Data was calculated by student *t*-Test (Independent sample, *P* value two tail) using MS-excel ver. 2013. Statistically significant level 0.05.

RESULT AND DISCUSSION

Oxidative Stress Markers

Oxidative stress disturbs the oxidant-antioxidant balance of the organism. This results in the reduction of intracellular antioxidants and the intense exposure of the cells to oxygen radicals. Oxidative stress is defined as an increase in free radicals, a decrease in the level of antioxidants, or a condition which results when both occur and is harmful to the organism. Molecules, which are known as reactive oxygen species/ metabolites, that the form together with oxidative stress, damage cellular components especially such as lipids, proteins and DNA. in order to prevent the damage to cells caused by free radicals, all organisms in the biological system try to control the levels of free radicals (Abdelmeguid *et al.*, 2002). Formation of oxidative stress begins with the breakdown of a hydrogen atom from methylene groups of fatty acids by a radical reactive during the oxidation of fatty acids. Polyunsaturated fatty acids (PUFA) which contain two or more double bonds are particularly susceptible to oxidation with free radicals and other highly reactive agents. Present study on MDA was estimate was control fish 1.65±0.26 and Mercury chloride exposed fish 3.37±0.21 was presence, statistically significance difference at 0.05. Mercury chloride exposed fish overall MDA level was increased in the present experiment (fig 1).
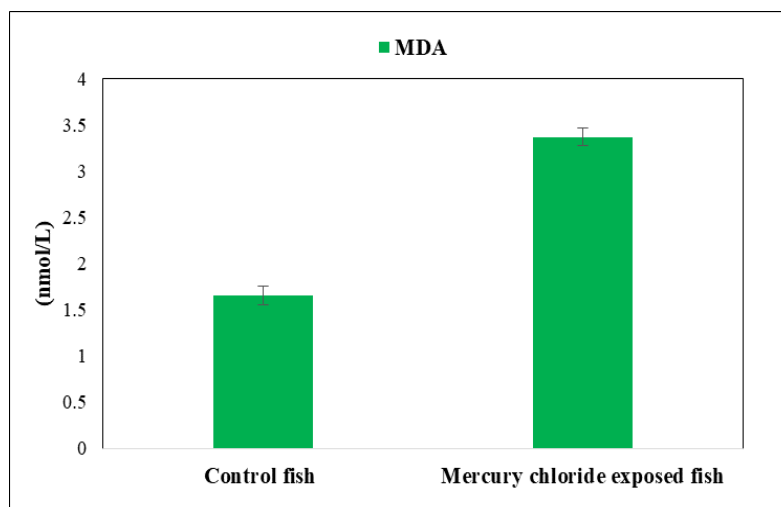
Figure 1: Oxidative stress marker in Labeo rohita fingerlings of control and Mercury chloride exposed fish.

MDA is one of the low molecular weight end products of lipid hydroperoxide degradation. It is one of the final products of lipid peroxidation and is often used as a biomarker of the oxidative stress. The most common method used to assess MDA production for this purpose is thiobarbituric acid reactive substances (TBARS) marker. In the present study was statistically significance difference at 0.05, control fish 1.65±0.26 and Mercury chloride exposed fish 3.37±0.21 was presence. Similar to other living beings, oxidative stress is not a disease for fish; but it is an important factor that can cause or accelerate the disease. Due to the absence of any significant symptom of oxidative stress, it is very difficult to detect or rehabilitate the disease in fish (Castellini and Rea, 1992). MDA is one of the end products of lipid hydroperoxide degradation with very low molecular weight and is often measured by the lipid peroxidation index (Dheer et al., 1987). As in other higher vertebrate organisms, lipid peroxidation or MDA in fish also results from the oxidation of unsaturated fatty acids and is the most important indicator of oxidative stress in the cellular components (Donaldson, 1981).

Liver Function Analysis

SGOT and SGPT belong to the plasma non-functional enzymes which are normally localized within the cells of liver, heart, gills, kidneys, muscle and other organs. Their presence in blood plasma may give information on

tissue injury or organ dysfunction. In the present study was AST and ALT was statistically significant difference at 0.05. AST and ALT was highly increased in Mercury chloride exposed fish compared with control fish following fig 2. A significant decrease in the activities of serum SGOT and SGPT in the acidic medium exposed as compared with control fish (Raghavendra Kulkarni and Vinayak Barad, 2015). Present study was similarly decrease in control fish compared with Mercury chloride exposed fish.
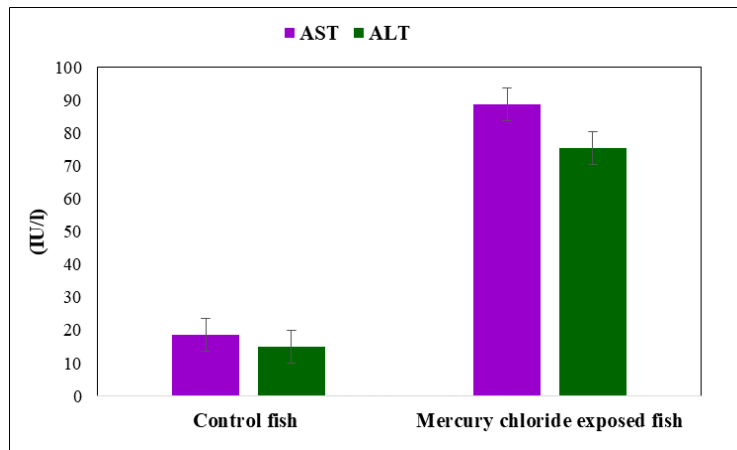
Figure 2: Liver function analysis in Labeo rohita fingerlings of control and Mercury chloride exposed fish.

Hematological Changes

Haematological characteristics are an important tool that can be used to understand as an effective and sensitive index to monitor physiological and pathological changes in fishes. Changes in haematological parameters depend upon the aquatic biotope, fish species, age, and sexual maturity and health status (Patriche *et al.* 2011).

Hb was control fish 5.29±0.53 and Mercury chloride exposed fish 1.46±0.78 Hb were statistically significant differences at 0.05. Hb was decrease in Mercury chloride exposed fish compared with control fish. Control fish 1.65±0.11 and Mercury chloride exposed fish 1.26±0.11 presence in RBC decrease in Mercury chloride exposed fish compared with control fish, statistically significant difference at 0.05. WBC was present in control fish 6459.00±43.31 and Mercury chloride exposed fish 7383.33±25.16 were statistically significant difference at 0.05. WBC was increase in Mercury chloride exposed fish compared with control fish.
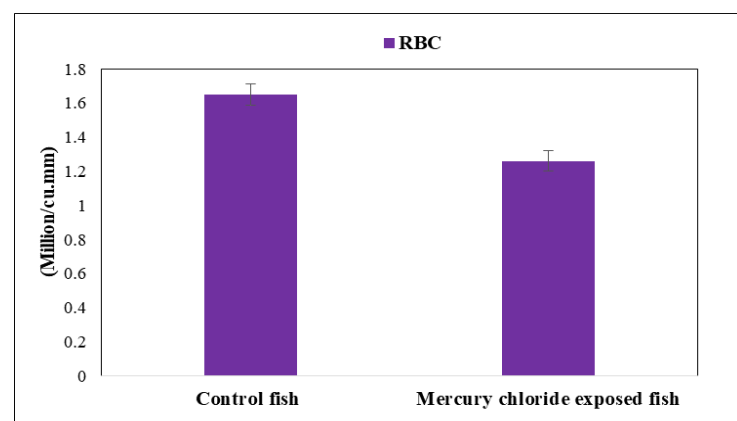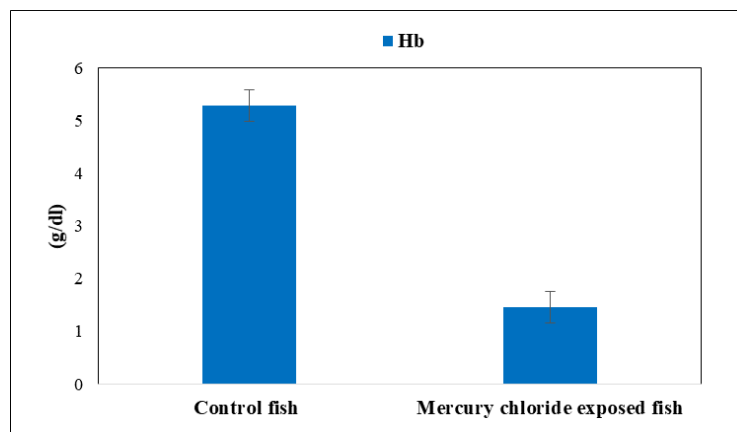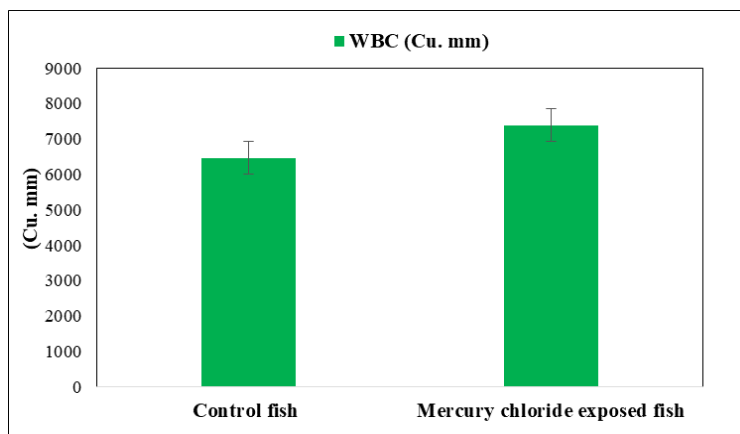
Figure 3: Hematological changes in Labeo rohita fingerlings of control and Mercury chloride exposed fish.

Haematological and biochemical studies help in understanding the relationship of blood characteristics to the habitat and adaptability of the species to the environment. The fish haematological parameters such as RBC, WBC, Hb and PCV values etc., are thus shown to be influenced by many factors include environmental factors (Pandey, 1977). Present study was Hb content in control fish 5.29±0.53 and Mercury chloride exposed fish 1.46±0.78. Control fish 1.65±0.11 and Mercury chloride exposed fish 1.26±0.11 presence in RBC. WBC were present in control fish 6459.00±43.31 and Mercury chloride exposed fish 7383.33±25.16.

However RBC value was lower other fresh water fishes like *Clarias batrachus 2.1* x 106 /mm3 and *Labeo rohita 2.0* x 106 /mm3 (Sudha Summarwar and Santosh Verma, 2012), *Sparus aurata 3.06* x 106 /mm3 and *Dicentrarchus labrax 3.49* x 106 /mm3 (Fazio et al 2013). WBCs are the suspicious cells of the body. their levels have implications for immune responses and the ability of the animal to fight infection. Species with higher levels of WBC will be able to fight infection more effectively than other species. The same inverse relationship between WBCs and RBCs was found by Satheeshkumar *et al.* 2012.

Highest Hb and Hemotocrit (Hct) or PCV concentrations were highest value are corresponding due to the high value of cellular component of the blood; in the fishes probably indicated anemia orhemodilution (Wedemeyer *et al.,* 1976). Overall in the study was carried on Mercury chloride exposed fish with control fish was statistically significant difference was recorded.

CONCLUSION

Mercury chloride has been proved to be harmful to *Labeo rohita* fish which cause oxidative stress mediated liver damage. Therefore, the information obtained may be useful for management and monitoring of fertilizer contamination in the aquatic environment.

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AN INVESTIGATION OF SICK BUILDING SYNDROME

DEVSHREE AND AR. ISHWAR CHANDRA VIDYA SAGAR

ABSTRACT
Buildings should offer inhabitants clean, secure, or pleasant surroundings, allowing users to perform at their best in line with the function of the building without disruption or disturbance, causing major architectural conditions. The World Health Organization has classified Sick Building Syndrome (SBS) as an illness. Since 1986, the topic has gotten a lot of attention, and it's been a top priority to figure out what's causing it and get it out of buildings that are either in use or are in the planning stages. SBS, on the other hand, is anticipated to influence a substantial number of new structures. Sick Building Syndrome causes a wide range of symptoms in people, the majority of which have been seen and documented in professional settings such as companies or academic institutions. Itching, loss of focus, a runny nose, headache, dry skin, lethargy, dryness or irritation of the throat, and dry eyes are the most prevalent symptoms of "Sick Building Syndrome". This research focuses on understanding of building sickness syndrome, a building sickness that has been prominent since the 1970s, particularly in workplaces and schools. This study focuses on the symptoms of sick building syndrome. Sick building syndrome has lot of negative consequences, and reasonable advice or cures are also suggested.

Keywords: building sickness, built environment, sick building syndrome (SBS).

1. INTRODUCTION
My first encounter with non-specific, building-related health issues occurred when I was in my bachelor's. As I am a student of architecture, I read articles and research papers where I came to know about some mysterious illnesses in constructed buildings in the community. The following day, I discussed the article with my colleagues, and one of them informed me that it is widespread in the United States since research has revealed that individuals spend 90% of their time indoors, and there are no government health recommendations relevant to indoor environment as a criterion for good Indoor air quality in the United States. (Andrea Apter, 1994) In Europe, however, specific criteria have been developed. (Organization, 1987) According to 1984 World Health Organization Committee study, up to 30% of new and rebuilt buildings globally might be the topic of excessive complaints about Indoor air quality.

On November 20, 2013, I came across the headline "Sick Building Syndrome causes viral outbreaks in Kolkata" in the newspaper Times of India. Then I learnt that not only other nations, but also India, are dealing with similar building-related illness issues, and I learned from other studies that India is suffering 10 times more than the United States, since people in India spend more time indoors in extremely cold or hot temperatures. As a result, occupant exposure to airborne pollutants is linked to indoor pollution (Robert Dales MD, 2008). Indoor environmental quality is comprised of three components: the physical environment (humidity, temperature, noise, workstation design), the chemical environment (biological agents and chemical), and the social environment (management and work organization). As a consequence, the significance of human exposure to air pollution has changed from outside to within. As a result, assessing indoor air quality is essential for creating indoor environmental quality control methods for a safe atmosphere. Indoor air quality is quickly becoming a major occupational health and safety concern. (P. S. Hui, 2007)

However, most people are unaware of this issue, which arouse my interest and prompted me to conduct a more systematic research of construction situations, which finally led to the completion of my research.

2. THE ORIGINS OF SICK BUILDING SYNDROME
Residents in newly constructed houses, businesses, and nurseries were thought to be checking for broad indications of SBS in the 1970s. On social media, it was dubbed "office sickness." The term "sick building syndrome" was created in 1986, after it was determined that 10-30% of newly constructed office buildings in the West had issues with indoor air quality. (STENBERG, 1994).

Poor interior spaces have been taken into account. As I worried, the Swedish allergy study referred to "sick buildings" as a source of an allergic pandemic. Along these lines, extensive research on the "sick building" issue was conducted in the 1990s. On a large scale, many chemical and physical constituents in the structures were discovered. The point was repeatedly emphasized in the media. It was referred to a "ticking time bomb." Buildings have been the site of numerous researches and testing.

In the 1990s, the term "sick buildings" was contrasted with "healthy structures." The chemical composition of construction resources was mentioned. The majority of construction material makers were striving to get control of the chemical components in order to shift the alleged increased burdens. The ventilation industry was drawn to more suitable and sufficient ventilation. Various solutions were proposed, such as the use of natural materials, ecological building, and fundamental approaches (Rayner, 1997).

Around the end of the 1990s, there was a growing doubt regarding the idea of "sick building." An analysis at Stockholm's "Karolinska" institution examined prior study methodology, and a Danish revision from 2005 empirically demonstrated these contradictory concepts.

They proposed that sick building illness was not a separate condition and should not be considered a distinct illness. In the medical journal Lakartidningen in 2006, the Swedish National Advisors on Health and Welfare stated that "sick building syndrome" should not be used as a clinical evaluation. Following that, it appears that phrases such as "Sick Building Syndrome" and "sick buildings" are becoming less popular in investigations and research. In any event, the notion has persisted in popular culture, where it is used to characterize a position of symptom connected with a bad working or living environment. As a result, "sick building" is a word use to describe the effective environment's health.

3. SICK BUILDING SYNDROME CAUSES AND SYMPTOMS

According to WHO, up to 30% of renovation of existing buildings throughout the world are potential SBS carriers. Since then, there have been several incidences of SBS, most of which have occurred in sealed office buildings. Even though inadequate Indoor Environmental Quality is frequently blamed for SBS, it is empirically difficult to verify or isolate the primary cause responsible for promoting the development of a certain symptom. Following a review of prior research investigations on SBS in buildings, the report highlights the key sources of SBS, which are outlined below:

a) **Physical contributors:** These are the physical characteristics of buildings that might cause SBS indicators to develop. These factors can have a significant impact on one's health, happiness, and comfort. In fact, providing physical comfort in the workplace is critical to improving occupant performance by supporting a healthier and more productive work environment.

- Temperature
- Humidity
- Ventilation
- Illuminance level
- Noise
- Air quality

b) **Biological contributors:** The growth of moulds, fungus, and mites inside buildings can have an impact on Indoor Air Quality. Residents who are exposed to these sick settings may develop respiratory and allergy disorders. Local mouldy scent was discovered to be a substantial risk factor for nasal discomfort. They evaluated the frequency of SBS in workers in two buildings and its connection with fungal exposure in the workplace in one attempt.

c) **Chemical contributors:** The vast majority of indoor air pollution is created by sources within the structure. Adhesives, carpets, upholstery and other cleaning chemicals can release volatile organic compounds (VOCs). VOCs have been shown to produce chronic and acute health impacts at high doses.

d) **Psychosocial contributors:** Sick Building Syndrome can endanger occupants' psychosocial well-being by causing anxiety, sadness, environmental discomfort, job pressure, and lowering performance. The repetitive work environment is one of the psychosocial elements thought to be effective in the development of SBS. Employees who are required to repeat activities or duties on a regular basis are said to be subjected to monotonous employment. Employee productivity may suffer as a result, since they may become psychologically disconnected with their job. The effect of job stress in the emergence of SBS symptoms is strongly connected. Nonetheless, despite the enormous influence of psychosocial factors, the amount of existing research by an emphasis on analyzing their effects is very limited.

4. SURVEYS

According to the "American Standards for Heating, Refrigeration, and Air-Conditioning Engineers," a building is considered "sick" if 20% or for more than two weeks, one or more of its user record or complaint of disruption symptom, and infected users recover from reported symptoms quickly after leaving the facility. This

is a prevalent misconception (Jansz, 2011).To determine the occupants' perceptions, questionnaires were distributed to commercial and institutional building occupants. A questionnaire that took into consideration a diversity of aspects was created. Table 1 lists the various questionnaire constituents. The SBS was evaluated by the contributors.

Table 1: Constituents of Sick Building Syndrome questionnaire.

Constituents 1	**Purpose and background information**
Constituents 2	Description of workplace condition
Constituents 3	Indoor environmental condition
Constituents 4	Health condition

Table 2 shows the analysis of the primary study, which is the Interior Architecture Department studios of Eastern Mediterranean University, and the secondary study of the building, which includes the Institute of Architecture and Town Planning, Bundelkhand University, Faculty of Architecture & Planning, Lucknow, Sahara India Life Insurance Co., Ltd., Lucknow, and how the SBS contributors are affecting the buildings.

Building occupants reported SBS symptoms that occurred "often" or "sometimes." In Interior Architecture Department studios at Eastern Mediterranean University building in studio A18, the occupants had the maximum incidence of dry throat (33%), headache (48%), and tiredness (68%), whereas in studio A27, the occupants had the highest incidence of dry throat (38%), headache (45%), tired (61%), and dizziness (42%). (Soleimanipirmorad, 2018)

The Institute of architecture and town planning, Bundelkhand University, Jhansi building occupants had the highest incidence of stress (36.4%) and lethargy/tiredness/drowsy (43.3%), and at the Faculty of Architecture & Planning, Lucknow, occupants had the highest incidence of stress (37%), lethargy/tiredness/drowsiness (32%), and at Sahara India Life Insurance Co., Ltd., Lucknow, building occupants had the highest incident of stress (35%).

Table 2: Analysis of the Case Studies.

Contributor		Eastern Mediterranean University, Northern Cyprus	Bundelkhand University, Jhansi	Faculty of Architecture & Planning	Sahara India life insurance co. ltd.
Physical	Spatial and Dimensional Features	Classroom size is 107 sq.m for 30 students, thus 70 sq.m is minimum required.	Classroom size is 135.56 sq.m for 20 students, thus 40 sq.m is minimum required	Classroom size is 199 sq.m for 60 students, thus 138 sq.m is minimum re-	Shop size is 6.9 sq.m for 2 occupants, thus 4.6 sq.m is min required and in shop size is 23.80 sq.m for 4 occupants, thus 9.2 sq.m is min required
	Air quality	They use a central degree system, which makes it difficult for users to adjust the degree according to conditions.	Ceiling fans are installed, although they are insufficient. Jhansi is classified as humid subtropical with a dry winter (Cwa).		Fixed windows are placed, resulting in a lack of thermal comfort and ventilation.
	Illuminance level	Windows face south-west and west, which is not a good daylight condition for a classroom.	Windows face south-west and west, which is not a favourable daylight condition for a classroom	LED tubelights are used	Natural and one fluorescent light bulb and two LED tube lights providing lighting.
	Noise	As the air conditioner ages, it creates a very strong background noise that causes problems for teachers and students.		Doors towards the cafeteria and fenestration on the road side of the wall, which creates noise from heavy running vehicles or the fare that is held near the college.	
Biological		The studios are near to the building's cafeteria which attracts bad odours and smells.	Dampness is the cause of having odour-related illness which suspected in the studio.		Unsanitary areas and dampness in the structure is suspected of having odour-related illnesses.
Chemical		Students using glues, sprays, and colour sprays after lecture hours at night which cause harmful pollutants		Students using glues, sprays, and colour sprays after lecture hours at night which cause harmful pollutants	
Psychosocial		Juries and practical tests are generally held in studios, where students already spend long hours throughout the week.			Occupational stress has been found to have a negative influence on employee health and well-being.
Inferences	Positive Aspect		The classroom is spacious enough for the students, and they may create models for the submission in the studio.	In the studio, enough LED tubelights have been installed.	There is more than enough natural light in the room.
	Negative Aspect	Students do not have adequate ventilation or daylighting, and there is a strong odour in the studio, which distracts both students and teachers from concentrating on the lectures, which may cause irritation, fatigue, headache and respiratory	Students are underperforming as Jhansi has a humid subtropical climate with a dry winter (Cwa), which is insufficient for this environment and produces headaches and dizziness, especially in the summer. The studio is in poor condition; moisture is suspected.	The studio's contamination by outside noise might cause irritation and headaches. Bad odours and scents from sprays and glues utilised by students in their studio project models.	Molds, fungus, and unhygienic conditions can all cause fatigue, respiratory and allergy disorders, skin issues, and nasal irritation. The building contains stress, as well as a lack of safety and security.

5. RECOMMENDATION AND SUGGESTION

a) Increase the pace of ventilation and air dispersion. Thermal, venting, and air-conditioning units should be designed to meet local building code ventilation requirements. To achieve the necessary ventilation rates, the HVAC system must be correctly controlled and maintained. When there are large impurities inside the atmosphere, the air may have to be vented directly to the outside. This procedure is particularly useful for removing contaminants that build in specific places such as restrooms, copy rooms, and printing facilities. The ASHRAE recommends at least 8.4 air exchanges every 24 hours.

b) Repetitive HVAC system inspections, substituting water-stained ceiling panels also floor coverings with ceramic, stone or hardwood flooring, adequate water proofing, attempting to avoid chemically synthesised or handled furniture fabrics, reducing electrical items and unplugging inactive devices, venting contaminants to the outside, storing paints, solvents, pesticides, and adhesives in close containers in well-ventilated areas, and storing paints, cleaning agents, pesticides, and adhesives in close containers in well-ventilated areas.

c) Air filtration may be an effective weapon in the battle against pollution. Uncluttered interiors with open office designs, frosted glass and skylights for natural light, terrace gardens, community areas, and indoor plants that trap carbon monoxide and formaldehyde might all help with air purification. Air filters may remove some, if not all, toxins from the air.

d) Communication and education are critical components of any air quality management programme in order to prevent and address health concerns more effectively and efficiently.

e) The prohibit of smoking in the workplace or the restricting of smoking to certain well-ventilated places away from workstations, as well as the construction of no-smoking zones through the employment of regulations.

F) CONSTRUCTION CONCEPTS

- Natural, clean, and nontoxic construction materials should be employed. Mold and fungus should not grow on the walls, floors, or ceilings. The basement should be watertight and well-ventilated. The natural magnetic field of the Earth should not be changed or modified. Building materials should not pollute the environment during their manufacture, installation, or disposal. Building operations should not result in the depletion of nonrenewable resources.

- Interiors should be made of natural, non-toxic materials and be intended to be cost-effective. There should be no harmful off-gassing or unpleasant odours. Indoor humidity should be controlled by nature. Pollutants in the air need to be filtered and neutralised. Heat retention should be balanced with thermal insulation, and ozone should be used.

6. CONCLUSION

"Sick Building Syndrome" has attracted the interest and concern of academics in architecture, building construction, and related subjects. SBS causes a significant decrease in productivity, an increase in absence due to illness, and a loss of valuable time spent on recognizing and attempting to fix problems. Despite the gravity of the topic, there is a lack of information and understanding about it among the general public.

To do this, the research starts with a short overview of the issue, conceptual features of the issue, the introduction of different classifications and descriptions through various studies, and its severe health effects. Following that, the chapter explored and detailed the many aspects and reasons that lead to SBS and the solutions are presented at the end of the chapter and techniques for preventing the issue were presented. Finally, after being acquainted with the issue and its many dimensions, this knowledge was applied to chosen case studies in order to examine and notice indicators of SBS.

According to the overall conclusion, the study's findings led to a better understanding of "Sick Building Syndrome." However, in this research field, it should be evident.

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ASSESSMENT OFSTATUS OF FINANCE IN HERITAGE CONSERVATION THROUGH SURVEY OF PRACTITIONERS IN INDIA

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ABSTRACT
This paper is a part of the Ph.D. research of the first author titled, Conservation of Built Heritage in Delhi through Corporate Social Responsibility. The hypothesis of the study is to explore the CSR as a potential financealternativefor the conservation of built heritage and propose a framework and guidelines for effective partnership between government and private organisations for the same using Delhi as a case. In order to explore whether CSR can prove to be an effective tool to find a solution to lack of funding, human resource, maintenance and management of heritage sites of Delhi author conducted a survey of conservation professionals to determine the state of finance in the conservation projects. Such a survey is a first to be ever conducted in India among the conservation practitioners. The following article contains the descriptive and inferential analysis of the survey.

INTRODUCTION
The Capital City of Delhi is a testimony to the diversified history spanning over centuries. Various civilisations were born, thrived, flourished and diminished here. Therefore the built heritage of Delhi is interspersed with various monuments and remains that link the present with the past. Some of these monuments are protected by government while others are not. Even the government protected monuments face a unique challenge in Delhi of having multiplicity of organisations as custodians. Moreover there is no consolidated data base of the heritage of Delhi that raise the heritage concerns in the future planning process of Delhi. Further physical status of these monuments and sites are also observed to be deteriorating due to lack of funding and awareness. Many common goals such as heritage need to be achieved by having public and private organisations together. Tools like Corporate Social Responsibility have been formulated to achieve such common goals

There are four survey that have been undertaken by the author for the research. Survey one was about studying and evaluating the state of built heritage of Delhi to determine the state of their preservation. One hundred built heritage properties owned by various agencies surveyed. In this survey various projects that were receiving CSR projects were also identified. Survey one led to survey two wherein the identified CSR project sites were further studied to study the possibilities of effective conservation of Built heritage of Delhi. It also helped in determining the impact of CSR funding on the conservation of heritage. A purposive sampling of fourteen properties was done in this survey. Survey three was designed in a manner to understand the status of the financing mechanism in the Heritage Conservation through the lens of conservation practitioners in India. Conservation Architects are the primary stakeholders associated with the built heritage of the country. This survey was conducted with practicing conservation architects in India in order to obtain opinions from them on the prevalent conservation practices in India. There are about 250 Conservation Architects practicing in different parts of the country.A google form based questionnaire with closed ended MCQ questions was circulated. Response from 60 conservation architects i.e 25% sample size as random cycling were collected to obtain unbiased opinions from them and to determine the qualitative aspects of experience and opinions. This Survey is a crucial parameter to understand the over-arching objective of the research of studying the heritage and possibility of assessing the efficiency of funding through CSR. Twelve questions were framed in a manner to get focussed responses on the status of conservation and funding in different parts of the country. Apart from the introductory questions, specific questions to understand the categories of projects and funding with different site owning agencies, sufficiency of funds vis-a-vis the requirements of monuments and sites, number of CSR projects, present and expected roles and responsibilities of the CSR partners and perspective on the private/ unprotected properties of heritage were framed. A final survey four was conducted to validate the findings of the research.

STRUCTURE OF QUESTIONS
The questionnaire consists of five part with total twelve questions. The first part deals with three introductory questions to know the name, number of years of practice and approximate number of projects of the respondents. The objective here to ascertain the professional experience from a varied range of respondents so as to determine the credibility of the responses. Part two of the questionnaire comprises of three questions in which the categories of projects types, funding of the projects and sufficiency of the funds for these projects

were enquired. The objective of this part is to determine the variation and level of funding in the built heritage conservation projects. This section starts withquestion four to indirectly know about the possible source of funding i.e. government or private and question five about the exact source of funding. This part aims to know the penetration of CSR funding in the built heritage conservation projects.The third part comprises of two questions pertaining to information related to the CSR funding to find the number of projects that have received CSR funding and if yes, whether it covered full or partial funding. The section aims to know the quantum of CSR in conservation projects. Aim of part four is to comprehend the nature of CSR practices in heritage. It comprises of three questions pertaining to information related to the CSR funding to find the scope of work in CSR projects of the partners involved, whether CSR funding added to the value to the project implementation and effectiveness of CSR funding.The last part is basically a single question, where in the respondents were directly asked to share their affirmation or not for including private or unprotected properties under the purview of CSR act.

ANALYSIS OF SURVEY

Part 01: First question is to know the name, the second being the number of years practicing whether full time or free lance and the third one was to know the number of conservation projects until date. The number of experience years of these professionals in the question has been chosen to be varying from 0 to more than 10 years so that the data collected is representative of at-least past 20 years. There were sixty respondents of the question. The responses received were varied and covered both younger and older practicing professionals. The 2/3 older respondents were from the long and diverse experience of and 1/3 young respondents with novelty of ideas. It was found that the 68% respondents are the professionals working in the heritage sector for more that 10 years. While 20% were working in the range of 5-10 years and 12% are working for less than 5 years. Majority i.e 63% - 68% of the respondents are senior conservation architects with an experience of more than 10 years and 10 conservation projects. The rest i.e. 32% - 37% are young and middle level experienced and thus bring variegated range in the survey.

Part 02: On asked in question four about the categories of projects worked upon, it was found that the respondents have worked on a large diversity of projects and multiple site owning agencies in their careers. 51% of the respondents have worked on World Heritage Site and National protected sites of ASI, 67% have also worked on sites that are under the ownership of State departments of Archaeology, 78% have worked on other property owning agencies like Municipalities and Wakf Board. 87% of projects are under private owners. There is wide variation in the ownership of the projects. While a most of the respondents have worked on the Government owned projects under WHS, ASI, SAD, Municipalities etc, it is surprising to know that an overwhelming 87% of the respondents have worked on private properties as well. This implies that the major segment of the conservation projects is privately owned properties which falls in the unprotected category and not funded by any government agency. Further, with the increase in the awareness as well as various government schemes for heritage conservation, it is expected to see an increase in the conservation of private properties.

Question five was about selecting categories of funding in the projects ranging from various government to private funding. It was found that the major funding agency depends on the owner of the sites. Out of 60 respondents only 19 respondents i.e 32% have confirmed that the CSR funding has been achieved for their projects. For the remaining major source i.e 67% of funding is by the Central government through Ministry of Culture, Ministry of Tourism directly or through schemes like HRIDAY, JNNURM, AMRUT etc. State Government has funded for 73% of the projects of the respondents. 53% have been funded through local municipalities. For 77% projects, private funding has been achieved for privately owned projects. The significant inference here is that only 1/3 of the heritage conservation projects have received CSR funding. This implies that the role of CSR is less in the heritage conservation and can be enhanced. Second significant finding is that, the majority of the ongoing (and possibly future) projects is private properties which are not eligible for either for the government or the CSR funding.

On asked whether the funds that were provided for the projects were sufficient to undertake holistic conservation initiatives, 37% of respondents have confirmed that the funds provided were sufficient for 100% execution of the project. 39% of respondents confirm that the funds provided could fulfil a little over 50% of the actual funding required for the site while 18% confirm that only 50% of the required amount was fulfilled and 7% say that less than half of the actual required funding was achieved. The major inference of this question is that only 37% of the projects received sufficient funding to complete the conservation work. A majority of the projects i.e. 73% are experiencing fund deficit. It is more striking is to know that 57% of the projects received

only about 50% or less than that of the funding requirements. This finding is also corroborating with the findings of the secondary study and another survey where 100 heritage properties in Delhi by the author.

Part 03: In this section majorly pertaining to CSR it was found that the 58% of the respondents have confirmed that they have not undertaken a single project with CSR funding in their careers. 22% confirm that only oneof their several projectshas received CSR funding, 10% have worked on two such projects while 3% have worked each on 3, 5, and 7 projects receiving CSR fund. The finding is this question further details the findings of the question no 5 where only 33% projects received a CSR funding. Here it is found that less than half of the conservation professionals have ever worked on a project funded by the CSR. And only a very few i.e. 6% have worked on more than five projects. The finding of this question corroborates and reinforces the lack of CSR funding in the heritage conservation projects.

Out of 55 responses for question seven above, only 23 chose to answer question eight. Out of which 36% respondents confirm that the CSR funding approximately covered 100% of the projects. 25% each have been able to cover both about 75% or 50% while 14% cover less than 50% of funding requirements of the project. The number of responses itself shows that only 1/3 respondents have worked on projects receiving CSR funding. It further reveals that a little above 1/3 of the CSR fund receiving projects could receive 100% funding while remaining 2/3 could not cover the entire scope of work of the projects. This shows that the CSR funding serves only partial scope of work mostly in conservation projects. The scope of work should be defined in detail, customised and to cover all the requirements of the site.

Part 04: In question nine the scope of work of CSR was enquired. It is arrived that the projects that have received CSR funding mostly had spend on the restorations and renovations of the site i.e 49%, while site development and providing visitor amenities receive 30% funding each. However, 36% is spend on providing the heritage interpretation like museums, signages, publications and awareness programs. There are 33% respondents that have worked on projects including all the major heads of restoration, site development, tourist and visitor amenities & heritage interpretation.There are four responses where the CSR funding was used for preparation of DPR only, research & heritage assessment, mapping and for writing book for visitors. 1/2 of the heritage projects receiving CSR funding cover the restoration and renovations of the monuments. In 1/3 of projects development and provision of visitor amenities is included and little more than 1/3 spend on site interpretation. Ideally the project should include all the three parameters in addition to the specific requirements of each site which all should be included in the detailed scope of work in the MoUs. But only 1/3 projects have of the CSR funded projects have all the components included. Very few projects have included overarching requirements that are pertinent for comprehensive conservation of particular site.

On asked in question ten about the CSR funding added value to the project, he respondents also confirm in the further question that CSR companies have added some value to the projects. 38% respondents confirm that CSR donors have been part of the consultant hiring process. 31% respondents agree that the CSR partners are a part of monitoring and evaluation of the work done, while 28% of respondents have agreed that the CSR partner have been a part of evaluation of conservation report and hiring of contractor processes. 22% of respondents have also experienced that the CSR partners are involved in the post conservation works. 35% denied the role of CSR partner to anything more than providing funds while 2% remain unsure. The CSR partners were involved in the process of consultant hiring processing in little over 1/3 cases while the role during the evaluation of conservation report and for contractor hiring process was only about 1/3 of the projects. Less than 1/3 of the projects reported to be including the CSR partners in monitoring and evaluation work. Less than 1/4 of the projects included CSR partners for works related to post conservation and regular maintenance. Mostly the CSR partners role gets over when it comes to consultation, evaluation, hiring, monitoring of the projects. On the contrary, the CSR partners should be more welcomely included to undertake these roles in order to instil more confidence of the CSR partners in the project that is mostly missing.

Further, 30% of respondents have confirmed in question eleven wherein the extent of CSR funding to be included in future, it was arrived that CSR should further ensure the quality of conservation work by involving in the selection of competent conservation consultant and contractor. 23% say that it is relevant for the funding only as heritage Conservation always experiences deficit. 13% of the respondent confirmed that CSR should include post conservation maintenance and upkeep of the monuments. 3% also say that the implementation of CSR is not effective while 5% have suggested that funding and maintenance should be included while 14% have not commented. Only 1/3 of the projects funded by CSR received complete funding to execute the conservation work. And 40% projects received less than 50% of the funding from CSR. So the major inference is that while only 33% of the projects are funded by the CSR (as found in Q 5), among that only 33% received

complete funding. So this finding furthers ratify the lack of CSR funding not only in the number of projects but also in the amount of funding with respect to the project estimate. Hence, CSR should not merely be a funding mechanism but its role should extend to areas like assessment of quality conservation work, involved in selection process to hire competent consultants and contractors, post conservation maintenance and upkeep and monitoring and evaluation.

Part 05: When asked directly about the respondents view on whether the CSR Act should include the privately owned properties, 53 responses were received. 78% of the respondents agree that CSR Act should include funding and benefits for privately owned properties while 10% say that the private properties should come under the purview of CSR and 1% have no say about the CSR inclusions. It can be arrived that CSR Act should include the private owned properties with considerable cultural significance. As also observed in the question four that there are many unprotected private properties and their ownershave been observed to be providing adequate private funding. Hence it can be surmised that the domain of having private funding should increase by including these properties in the CSR Act.

CONCLUSIONS

With the help of the analysis of the responses, the author could find information unavailable so far. The primary outcome of survey ratify the observation that there is deficiency of funds at present when it comes to heritage. However this can be rectified by diverting substantial CSR funding here. In addition to make it effectively implemented from both sides, the sector of heritage conservation should be promoted more with companies for CSR implementations. Further it is observed that the monuments which are already famous are prioritised and get more government funding. This priority should be shifted to the smaller and less significant structures. These kind of monuments are also present in both protected and notified list of government bodies. The present scenario is that the CSR companies majorly spends on providing the visitor amenities and structural conservation does not often come under their scope of work. Hence it has to be made sure that the CSR funding prioritises projects requiring structural restoration over only providing visitor amenities. The companies should be encouraged to undertake structural restoration before taking up site development and visitor amenities work. The roles and responsibilities of the CSR partners to be expanded so that the project is perceived as 'ço-responsibility' only then the quality conservation works will be achieved. The proposal of the author to demonstrate that the private properties to be included in the CSR act also is affirmed in the findings.

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ORGANISATIONAL COMMITMENT AMONG BANK EMPLOYEES: A SYSTEMATIC LITERATURE REVIEW

DEEPIKA UPADHYAY AND NISHA MEGHWANSHI

ABSTRACT

The term "organizational commitment" has been used to describe a wide range of phenomena while numerous authors explored the topic from different perspectives. Organizations also regard organizational commitment as a top employee issue because it leads to great outcomes. The current study aims at understanding the past research on the topic of Organizational Commitment specifically where bank employees are the focus of the studies. This is a first of its kind of study which undertakes bibliographic information to analyze the status of research on the organizational commitment of the bank employees. The study uses the Scopus database for bibliometric analysis and bibliographic data visualisation, as well as the VOSviewer software for cluster analysis. The study shows that the research on OC in the context of bank employees developed enormously in the previous decade. Current trends, emerging fields and theories in the subject of OC of bank employees have been identified and discussed. The findings, as well as the suggested research areas, can assist academics and researchers in conducting future research in order to advance the scientific development of OC of bank employees.

Keywords: Organizational commitment, Bank employees, Bibliographic, Review, VOSviewer

INTRODUCTION

In a society dominated by services and intellectual capital, experts have long debated the strategic importance of human resources. Earlier cutting down human resources was viewed as a primary step in reducing operational costs during difficult times (Gill et al., 2018). Recent emerging trends considers human resource to be the most important factor in an organization's success. Human Resource is also viewed as a crucial resource for an organization, particularly for those who are in the technology space, banking, or education. People are being taken of strategic significance in this new organizational narrative, therefore how they engage with the workplace plays a crucial role in keeping the businesses successful (Fiorito et al., 2007). Employee impression will decide how long they will stay with the organization and how much effort they will put in for it, both from a resource-based and psychological contract standpoint. While the psychological contract promotes a fundamentally inherent shift from "control to commitment," the resource-based view assumes that knowledge, skills, and abilities contribute significantly to the organization's strategic value, thereby making it inimitable (Boselie et al., 2005). In these circumstances, the role of organizational commitment is a prerequisite not only for the proper implementation of present procedures but also for reconsidering organizational values and changing customer needs (Yahaya and Ebrahim, 2016).

Employees that are dedicated and proactive can help firms maintain their competitiveness (Yen and Teng 2013). "The state in which an employee feels linked to the organization and its goals, and his allegiance with the organization remains intact, is referred to as Organizational Commitment (OC)" (Miller 2003). OC is the visible conduct of an individual when he or she is dedicated to the existing group within the organization, according to the behavioral method (Reichers, 1985). The creation of positive working environments is critical for the growth of committed teams and their performance (Haque, et al. 2019). The role of effective and productive human resource management in turning a company into a successful one is vital. One essential goal is to gain a deeper understanding of why and how employees choose to stay with the company and commit to the company's obligations and problems (Jeppesen and Jonsson, 2013). An organization's human resource should be able to attract, recruit, and maintain a dynamic and competitive workforce. Employees, according to the literature, are the primary factor that gives businesses a competitive advantage. Employees that are happy and committed to their jobs perform better on the job and have lower absence and withdrawal rates (Mir and Rainayee, 2015). The difficulty facing the banking industry on a larger scale is the management of human resources as well as the management of financial risks in businesses. Because the banking business is service-oriented, human resource management has become increasingly important. The financial risks that banking firms must take on a regular basis can only be managed by satisfied and committed human resources in the sector. The finding of such brilliant human resources and their placement in the appropriate jobs inside organizations is the responsibility of senior management. They pay special attention to employees who lack enthusiasm for their jobs and strive hard to assist them in improving their performance for the bank's benefit.

Therefore, understanding various factors involved in determining the commitment of bank employees towards the banks is significant.

The current study aims at understanding the past research on the topic of Organizational Commitment specifically where bank employees are the focus of the studies. Policymakers and educators who are interested in studying the various issues associated with the organizational commitment of the bank employees will find this study helpful in their research. In our view, this is a first of its kind of study which undertakes bibliographic information to analyze the status of research on the organizational commitment of the bank employees.

Understanding Organization Commitment

In the previous studies numerous attempts have been made in distinct fields and domain to express and understand the term "Organizational Commitment". The outcomes of these studies suggests that organizational commitment (OC) is a vast term describing wide range of phenomena. Attraction of Researchers and academicians belonging to differend fields such as psychology, management, social sciences, behavioral sciences, etc shows its multi-disciplinary nature. The significance of OC in bringing positive outcome like enhanced efficiency in a job, increased performance, and commitment, to an organization or its human resource has been validated in the past studies (Meyer et al., 1998; Fiorito et al., 2007; Ohana and Meyer, 2016). Employee commitment to the organization is referred to as organizational commitment in general, and it entails "a strong belief in and acceptance of the company's goals and ideals" (Porter et al., 1974). Organizational commitment, according to Meyer and Allen (1991), is a psychological state that reflects an employee's engagement with the organization and has implications for the decision to stay or quit. Allen and Meyer stated that organizational commitment is a psychological relationship between the employee and the organization that makes the worker less likely to depart freely in their following study in 1996.

With time, the role of OC in an organizations operation and performance has only increased. As a result, firms must regard organizational commitment as a top employee issue because it leads to great outcomes. The impact of employees' organizational commitment on their performance and attendance was highlighted in early research findings (e.g., Dessler, 1999; Yousaf et al., 2015). Over the last two decades, researchers have looked into predictors of organizational commitment, uncovering links between organizational support, psychological contract, organizational climate, organizational values, and workplace attachment (Kalliath et al., 1999; Meyer, Stanley et al., 2002; Le Roy and Rioux, 2012).

Meyer, Allen, and Smith (1993) define organizational commitment constitutes mainly three aspects: emotional commitment, continuation commitment, and normative commitment. These three aspects of commitment (affective, continuous, and normative commitment) are separate and can be felt by employees. Varied experiences have an impact on each component, which has a different impact on how employees interact with the company. Individual identification and involvement in the organization, as well as the employee-organization interaction, form the foundation of the employee-organization link (Gardner et al., 2011). Affective organizational commitment signifies a mindset that has been associated with positive outcomes, such as increased organizational citizenship behaviors (OCBs), lower voluntary turnover, and reduced absenteeism), and thus contributes to optimal productivity (Harrison et al., 2006).

Employees of an organization (bank) stay because they feel required to do so, rather than because they want to or have to, according to the idea of normative commitment, which has been the subject of numerous research. Normative commitment, according to Meyer, Allen, and Smith (1993), arises when employees stay with a company because they believe they should. Gonzalez and Guillen (2008), for example, found a relationship between normative commitment and ethical behavior. The dimension of normative commitment in OC represents a responsibilty as pursued by an employee and defined as a total of all the internal normative restrictions experienced by an employee (weiner, 1982).

RESEARCH METHODOLOGY

A bibliometric analysis was performed to track the knowledge base on the organizational commitment of bank employees over the last several decades and to test the above-mentioned research trends as they emerged over time. Bellis (2009) explained the bibliometric analysis as a quanititative study of various publications, such as in books and journals. More in-depth bibliometric investigations, on the other hand, allow for transparent quantitative and qualitative evaluations of a given information stream (Zupic and Cater, 2015). For example, Researchers can employ software-based data aggregation to uncover essential information such as social networks, geographic areas of debate, keywords, authors, and co-citations, allowing researchers to create tailored representations of study topics (Secinaro et al., 2021).

This systematic review of the literature is being carried out in order to contribute to the systematization of scientific research on the subject of organizational commitment of bank employees. In this regard, we employed the Scopus database, which is well-known in the scientific realm and currently holds more than 27 million abstracts, making it the largest collection of scientific literature (Burnham, 2006). Scopus (www.scopus.com) is a thorough and comprehensive database that illustrates the world's research output in the most important sectors of science, such as technology, social science, arts and humanities, and medicine, with over 22,000 titles from over 5,000 international publishers (Veer and Khiste, 2017).

The Research Questions We Address Are:

RQ1. Identifying the Authors, Articles and Journals, who have published highest no of papers with citation score and Journals publishing this impactful research?

RQ2. What are the important institutions, geographic areas, and publication trends on OC of bank employees' research?

RQ3. What are the current and emerging issues of interest among academicians in OC of bank employees' research?

An advanced search was performed, not applying any chronological or language filter, and used research terms: (Organizational*) AND (Commitment*) AND (Bank*) AND (Employees*) . The search was confined to papers classed as "Articles" in order to best reflect the output of original research and peer-reviewed studies; therefore, books, chapters of books, and proceedings were eliminated. This is because articles are the materials that best reflect the output of the original research. Using the advanced search, we selected the title, abstract, and keywords in the field option, and only published articles were selected as a document type with no language, publication year restriction, and no time margin. The bibliographic search ended in February 2022, yielding a total of 238 papers published between 1987 and 2022 related to the subject.

As a first step, the researchers rigorously revised all of the selected publications to ensure that the material was connected to the organizational commitment of bank employees. Papers were identified by reading abstract to include all papers pertaining to our research objective and to exclude papers which were not relevant to our study on OC of bank employees.. We would obtain and screen whole texts if we were unsure. We excluded conference papers, as recommended by Ahl (2002), because many of them will be published in journals later. This exercise limited our research to only 132 articles that focussed on our research subject i.e., the Organizational commitment of Bank Employees. In our further analyses, we mined out the information such as publication year, authors proficiency, and institutional and geographical prolificity. Further, making use of VOS software and program developed by the (Van Eck and Waltman, 2010), to analyse the co-occurrence between the keywords was performed, which show the network of co-occurrence and strength of the co-occurrence. Thickness of network line indicate the strength between the keywords. Higher the thickness of node, stronger the link. Similarly, network circle's also show link strength. Higher the size of circle, higher the occurrence of keywords. Finally, clusters analysis was performed to identify already developed study fields as well as potential research trends for the coming years.

RESULTS AND DISCUSSION

Yearly Output

According to search results, no paper on the subject of organizational commitment of bank employees was published before 1987. The first research on the subject was published in 1987, titled "Attitudes to the Job and the Organization among New Recruits: Influence of Perceived Job Characteristics and Organizational Structure,". As indicated in Table 1, only 26 articles were published in 28 years from 1987 to 2014. A total of 132 studies were published between 1987 and 2022. Out of these 132 articles, 105 articles were published only in the last 6 years that shows in recent years interest of researchers on the topic has grown significantly. This finding suggests that exploring bank employees' organizational commitment is a relatively recent subject of study, and it confirms that, prior to 2014, the organizational commitment of bank employees was merely a topic that is not studied much. The growing number of publications in recent years also represents a rising interest among academicians in Banking sector-specific studies while exploring the field of organizational commitment. Researchers were eager to explore the impact of covid-19 and the resulting working conditions on the organizational commitment of Bank workers, therefore the year 2020 saw the most publications. Because of the growing interest in the discipline, numerous well-known journals are now publishing regular and special editions on the subject. It's worth noting that the journals cover a wide range of topics, including marketing,

economics, social sciences, psychology, and more. Figure 1 shows the publication year trend on the subject OC of bank employees.

Figure 1: Number of Publications on OC of bank employees.
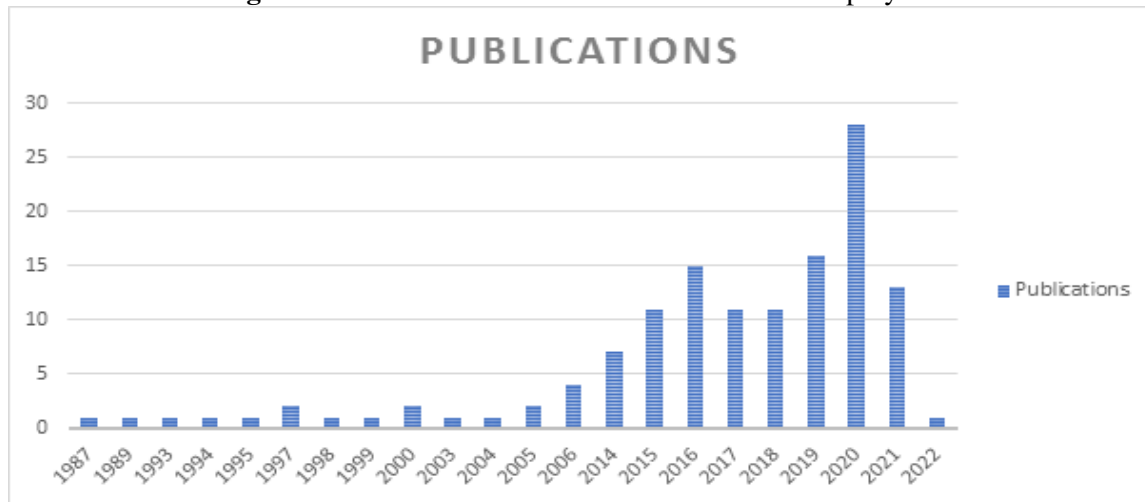
Source: Author(s)

Table 1: Number of Publications year wise from 1987-2022.

Year	Publications	Year	Publications
1987	1	2005	2
1989	1	2006	4
1993	1	2014	7
1994	1	2015	11
1995	1	2016	15
1997	2	2017	11
1998	1	2018	11
1999	1	2019	16
2000	2	2020	28
2003	1	2021	13
2004	1	2022	1

Source: Author(s)

The Most Influential Journals

The International Journal of Bank Marketing is the leading journal in terms of publications on the organizational commitment of bank employees, as seen in table 2. Both the International Journal of Applied Business and Economic Research and the International Journal of Economic Research include five articles on the topic. Similarly, four studies have been published in international publications of human resource management, managerial psychology, sociology, and social policy. In the citation column, the number of publications and total number of citations obtained by these papers are also listed.

Table 2: List of most productive journals published studies on OC of bank employees.

Journal	Publications	Citations
International Journal Of Bank Marketing	8	353
International Journal Of Applied Business And Economic Research	5	10
International Journal Of Economic Research	5	8
International Journal Of Human Resource Management	4	237
Journal Of Managerial Psychology	4	95
International Journal Of Sociology And Social Policy	4	84
Advances In Environmental Biology	3	0
Management Science Letters	3	22
Cogent Business And Management	3	16
Human Resource Management	2	46
Asian Social Science	2	11
Journal Of Services Marketing	1	172

Human Relations	1	152
Journal Of Organizational Behavior	1	139
Applied Psychology	1	96

Source: Author(s)

The Most Influential Countries

The most productive countries and areas, as determined by the number of publications and citations, are listed in Table 3. With 19 and 14 publications published, respectively, the Indonesia and United States are the most productive countries, followed by India (13), Malaysia (13), the United Kingdom (12), Iran (9), and Finland (33). The United States (596), United Kingdom (534), and Norway (204) are the most influential countries in the field of organizational commitment of bank employees on the number of citations.

Table 3: List of most productive countries where studies on OC of bank employees undertaken.

Country	Publications	Citations
Indonesia	19	49
United States	14	596
India	13	62
Malaysia	13	56
United Kingdom	12	534
Iran	9	43
Australia	7	86
Pakistan	7	58
Ghana	5	72
Turkey	4	139
Saudi Arabia	4	112
Jordan	4	78
United Arab Emirates	4	49
Bangladesh	4	44
Nigeria	4	3
Norway	1	204

Source: Author(s)

The Most Influential Authors and Articles

According to the research, the 132 pieces were written by 309 different authors. Table 4 depicts the most productive authors based on the number of articles and the degree of impact they have on the organizational commitment of researchers. The frequency of citations and citation analysis determined when they cited each other. Insigh, K. is the most prolific author in research on organizational commitment of the bank employees, having published 3 articles. Benkhoff, B., Durkin, M., Marquez, E., Loi, R., Mensah, H.K., Jehanzeb, K., Ansari, A.H., Malik, M.I., Ashfaq, M., Irum, S., Sudiro, A., Sumiati Astuti, S.D., have authored 2 articles each.

Table 4: Authors with the most publications from 132 OC of bank employees research.

Author	Publications	Citations
Ingsih, K.	3	4
Benkhoff, B.	2	192
Durkin, M.	2	74
Marquez, E.	2	50
Loi, R.	2	33
Mensah, H.K.	2	27
Jehanzeb, K.	2	25
Ansari, A.H.	2	15
Malik, M.I.	2	10
Ashfaq, M.	2	6
Irum, S.	2	6
Sudiro, A.	2	4
Sumiati	2	4
Astuti, S.D.	2	1

Source: Author(s)

To find the most influential authors in our collection, we used the TCS to rank the 309 authors in a top-10 authors list. The number of times the article was cited in the exported data collection is represented by the Total citations score (TCS). Kuvaas, B.'s paper having title "Performance appraisal satisfaction and employee outcomes: Mediating and moderating roles of work motivation" published in 2006 took first place with a TCS of 204, followed by Benkhoff, B. and Malhotra, N. who received a score of 192and 172 respectively. It's interesting to note that an author with fewer publications have high citations and drew the attention of the academic community.

Table 5: Most productive authors from 132 OC of bank employees' publications according to their publication citations.

Author	Publications	Citations
Kuvaas, B.	1	204
Benkhoff, B.	2	192
Malhotra, N.	1	172
Mukherjee, A.	1	172
Kinicki, A. J.	1	139
Vecchio R. P.	1	139
Calleya, P.	1	107
Caruana, A.	1	107
Karatepo, O.M.	1	98
Tekinkus, M	1	98
Castro, S.I.	1	96
Schriesheim, C.A.	1	96
Yammarino, F.J.	1	96
Bennett H.	2	74
Durkin, M	2	74

Source: Author(s)

The Most Influential Institutions

Institutions also concentrated on the topic's advancement. Table 6 shows institutions that are the most productive in terms of publications. University Utara Malaysia (3), University Teknologi Malaysia (3), Brawijaya University (3), Covenant University (3), and Universitas Dian Nuswantoro (3) had the most documents published in the bibliographic data sample. Furthermore, the University of Pennsylvania (3843 citations), Bradford University (172), Pennsylvania State University (172), and London School of Business (152) are the most influential universities on the topic of Organizational commitment of Bank employees based on their number of citations. The University of Notre dame (139 citations), Arizona State University (139 citations), and University of Malta (107 citations) are among the other influential institutions.

Table 6: Most productive institutions from 132 OC of bank employees' publications according to their publication citations.

Institution	Publications	Citations
Universiti Utara Malaysia	3	26
Universiti Teknologi Malaysia	3	8
Brawijaya University	3	9
Covenant University	3	3
Universitas Dian Nuswantoro	3	4
London School of Economics and Political Science	2	192
Ulster University	2	74
University of South Africa	2	34
Chinese University of Hong Kong	2	33
University of Macau	2	33
GIFT University	2	25
Jamia Millia Islamia	2	15
University of Chittagong	2	5
Payame Noor University	2	0
Islamic Azad University	2	0

Source: Author(s)

KEYWORD ANALYSIS

A co-word analysis was carried out to determine the patterns in bank employees' OC research, and network visualization maps were created using the VOSviewer software. First, the co-occurrence of terms allowed us to determine the present state-of-the-art in the subject, as well as the most relevant research themes. Then, using density and overlay visualizations, it found the most developed terms in the field, as well as those that may require additional research and development. Second, a cluster analysis was performed based on keyword co-occurrence, which aids in the identification of research patterns. The network interaction is depicted in Figure 2 in terms of total link strength and number of links. The image depicts the keywords as circles with curved lines connecting them, clustering the items in various hues and circles' size represents the keyword total link strength. Figure 2 depicts the most important subjects while studying the organizational commitment of bank employees as well as their impact on other topics. The keywords organizational commitment, job satisfaction, commitment, banking sector, organizational justice, transformational leadership, and employee performance have the highest occurrences and strong connection strength, according to this initial map.

Figure 2: Network visualization of Keywords co-coccurence in OC of bank employees research according to their network strength.
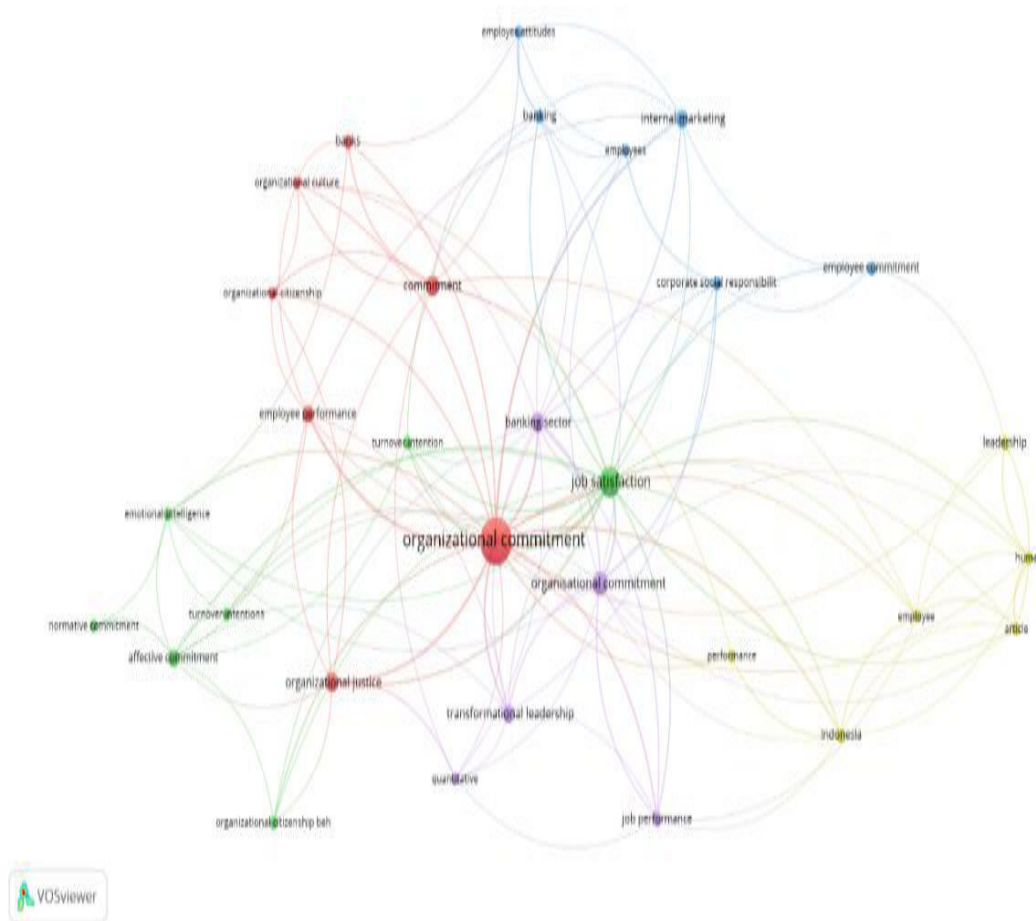
Sourse: VOSviewer.

The list of the most connected keywords in the OC of bank employees research is shown in Table 7. It displays the overall number of linkages, occurrences, and link strength. The top themes in the research field include job satisfaction, commitment, banking sector, organizational justice, and employee performance. The Figure 3 shows the overlay visualisation which visualises themes in OC of bank employees research over the period 1987-2022. The organizational commitment and bank as keywords have a large number of occurrences, as well as a higher total link strength created in recent years, indicating that they have a strong influence on other study topics. Organizational culture, emotional intelligence, employee attitudes, and corporate social responsibility are also important topics. Two important theories related to the subject are employee commitment and organisational citizenship behaviour.

Figure 3: The Figure 3 shows the overlay visualisation which visualises themes in OC of bank employees research over the period 1987-2022.
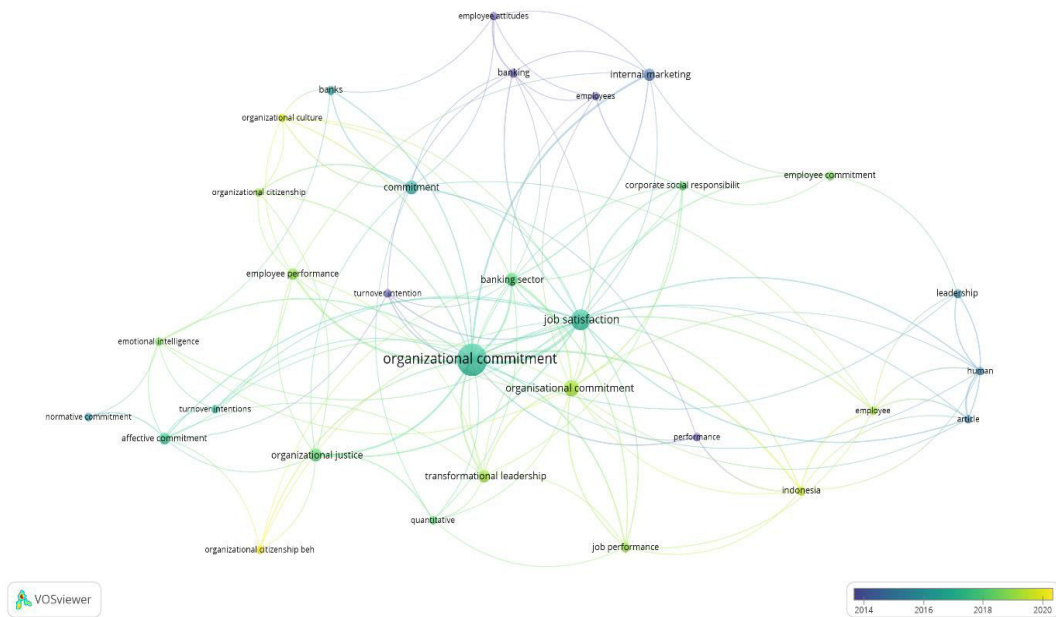
Source: VOSviewer.

Figure 4 depicts a density visualization of keyword co-occurrence. The evolution of the topic has been linked to job satisfaction and organisational fairness. Employee attitudes and turnover intentions, banking, and performance were among the themes highlighted. Some of the field's more developed subjects, on the other hand, will demand more attention in terms of development and study. Theoretical grounds for the topic include commitment, employee commitment, performance, emotional commitment, and normative commitment, to name a few. Previous research on bank employees' organizational commitment has focused on transformative leadership, emotional intelligence, and corporate social responsibility. The density graph shows the keywords' co-occurrence over time and the subject's most recent advancements within other themes including organizational citizenship behaviors, organizational culture, and organizational citizenship.

Figure 4: Depicts a density visualization of keyword co-occurrence.
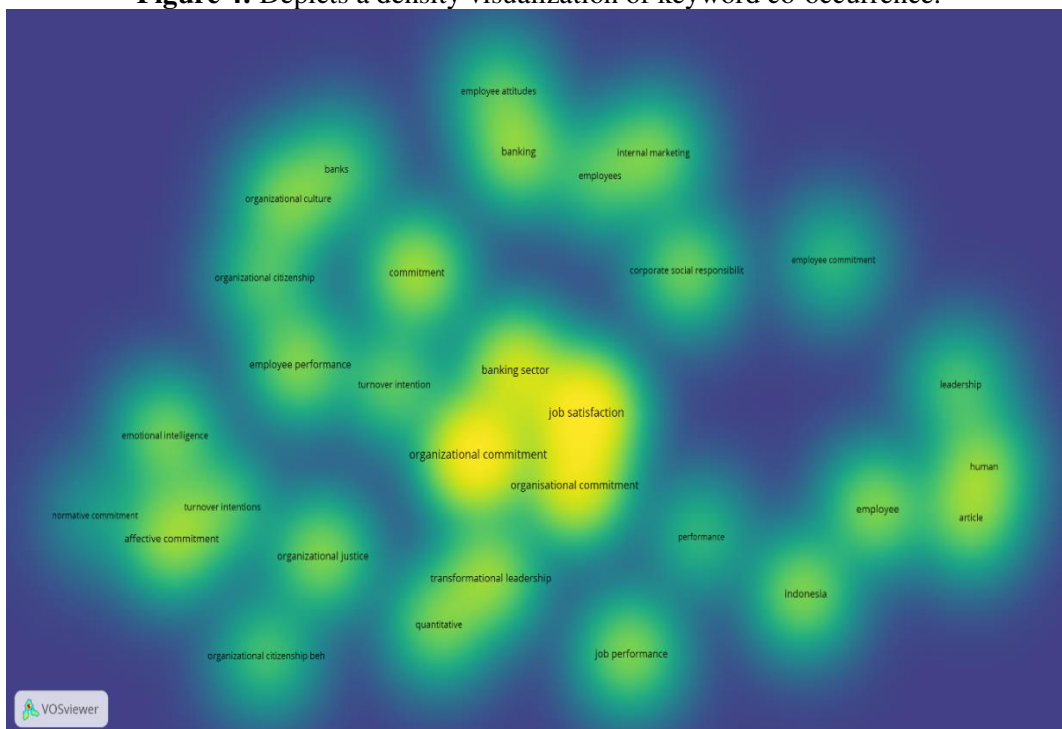
Source: VOSviewer.

These visualizations give a high-level summary of the organizational commitment of bank employees' research, highlighting the most relevant keywords that have appeared in the area in recent years. This data enables us to identify topic-specific research trends as well as research topics that require additional attention.

Table 7: Keywords with their frequency used in OC of bank employees' research.

Keyword	Cluster	Links	Total Link Strength	Frequency
Organizational commitment	1	22	67	55
Job satisfaction	2	22	48	24
Organizational commitment	5	13	23	14
Commitment	1	10	13	11
Banking sector	5	13	23	9
Organizational justice	1	8	15	9
Transformational leadership	5	9	13	8
Internal marketing	3	7	12	8
Employee Performance	1	8	13	7
Affective commitment	2	9	11	7
Job performance	5	8	13	6
Banks	1	5	7	5
Indonesia	4	8	14	5
Banking	3	8	11	5
Corporate social responsibility	3	7	10	5
Employee commitment	3	4	5	5
Leadership	4	5	7	5
Article	4	7	13	4
Human	4	7	13	4
Employee	4	8	12	4
Organizational culture	1	7	9	4
Emotional intelligence	2	7	8	4
Quantitative	5	7	8	4
Turnover intention	2	6	8	4
Organizational citizenship	1	5	7	4
Employee attitudes	3	5	7	4
Organizational citizenship behavior	2	5	6	4
Employees	3	5	6	4
Performance	4	4	6	4
Turnover intentions	2	5	5	4
Normative commitment	2	2	3	4

Source: Author(s)

CLUSTER ANALYSIS

Out of 409 keywords, 31 meet the requirement of appearing at least four times. The cluster created between the keywords, based on the VOSviewer keyword analysis gives further information and understanding of the variables studied. Table 8 shows clusters of keywords according to their co-occurrence in cluster. Five clusters are indicated with five distinct colors in Figure 2. In cluster 1, Banks, Commitment, Employee Performance, Organizational citizenship, Organizational commitment, Organizational culture, Organizational Justice have co-occurred. From the literature, it can be understood that organizational commitment is most studied with these five elements. Job Satisfaction shows the highest weightage, followed by organizational justice, employee performance, and transformational leadership. Affective commitment, emotional intelligence, job satisfaction, normative commitment, organizational citizenship behavior, turnover intention, and turnover intentions are all included in cluster 2. As organizational commitment in the banking sector is the main focus of this study, this cluster's elements are more of interest. The linking of affective commitment and normative commitment with emotional intelligence, job satisfaction, OCB, and turnover intentions constitutes the focus of various studies in the field. In Cluster 3, the various relationship between Banking, Corporate Social Responsibility, Employee attitudes, Employees, and Internal marketing is highlighted. Leadership and performance in the banking sector are some of the main subjects in studies on organizational commitment as visualized in cluster 4 and cluster 5.

Table 8: Clusters of keywords according to their co-occurrence in cluster.

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Banks	Affective Commitment	Banking	Article	Banking Sector
Commitment	Emotional intelligence	Corporate Social Responsibility	Employee	Job Performance
Employee Performance	Job satisfaction	Employee Attitudes	Human	Organizational Commitment
Organizational citizenship	Normative commitment	Employee Commitment	Indonesia	Quantitative
Organizational commitment	Organizational citizenship behavior	Employees	Leadership	Transformational leadership
Organizational culture	Turnover intention	Internal Marketing	Performance	
Organizational Justice	Turnover intentions			

Source: Author(s)

CONCLUSION

By using bibliometric and network analysis, this paper provided an overview of the distribution of publications on Organizational commitment specifically in the context of Bank employees. By querying the Scopus database with predefined keywords, a set of 132 publications exploring various aspects of organizational commitment of bank employees were recovered. To enable an analytical approach, the most common contributing authors, affiliations, and keywords have been retrieved. These findings reveal some clusters of prominent keywords identified in the literature, which may be used as a reference for new researchers interested in learning more about growing topics of research on OC in the context of bank employees.

The study shows that the research on OC in the context of bank employees developed enormously in the previous decade. According to a review of the research, OC can play a critical role in the execution of organizational strategies based on a set of practices that can achieve a balance between needs and desires in an organization such as banks. According to the bibliometric analysis based on bibliographic data mapping, its study has been incorporated into a variety of disciplines and research topics. Organizational justice, job satisfaction, and commitment are among the most relevant fields in the subject. In domains like human resource performance, Job performance, Corporate social responsibility, employee attitudes, organizational citizenship, and organization environment, the literature on OC of bank employees is developing. In terms of conceptualization, typologies, frameworks, applications, and the field's ongoing theory development, the topic is considered to be in a developing and consolidating phase. According to bibliographic data, the most important institutions are in the United States, the United Kingdom, Indonesia, Malaysia, and India, while the most productive publications on the subject focus on strategic management, innovation, and clean production. The most significant authors are affiliated with leading internationally known business schools in the domains of business and strategy. According to research trends, the topic will evolve into issues of organizational citizenship and behavior, as well as leadership and performance, which will result in the emergence of new insights in the field of bank staff's organizational commitment. It indicates that these emerging issues have the ability to foster organizational commitment by creating a supportive environment for team members, earning their trust, motivating them, and disseminating moral ideals.

The goal of this study is to show how to organize and consolidate the issue of bank employees' OC within the academic literature, as well as to identify research areas for future development and consolidation in the subject. There are certain limitations to this research. The data for this study comes from Scopus, a database of reasonably high-quality papers with a significant number of papers in the database. Still, many research findings from other publications are not included in the Scopus database and hence were not included in this analysis. The restriction to a particular database created a limitation to this research. Second, the co-occurrence of keywords and citation activity is based solely on the articles from the total records, resulting in a small number of clusters and prominent keywords. Nonetheless, the descriptive statistical data and graphical maps provide useful insights into the topic's current state of knowledge, evolution, and future directions. It would be required to assess the quality of the articles and the methodological issues used in future studies. It would be worthwhile to undertake a qualitative analysis of publications using content analysis as a future research direction to confirm the findings. It would be interesting to investigate each relevant topic in OC of bank employees'

research in greater depth, or to conduct a bibliometric study in a specific journal that is supplemented by other mapping techniques such as co-citations etc. for the further development of the field.

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PAYMENT BANKS – A NEW MILESTONE FOR BANKING PENETRATION IN INDIA

RAJNISH KLER

ABSTRACT

The purpose of the banking sector in the country is to provide banking services to all the people with simple and easy manner with this view, financial inclusion scheme and PMJDY was introduced to provide bank account to unbanked people at free of cost and with simplification of KYC norms. All the incentives and monetary benefits to the targeted people will reach only through direct benefit transfer scheme which is linked with bank account and Aadhar number. Banks also concentrate to urban and unbanked area through single window banking and post office savings bank scheme. With this view payment banks play a key role in banking penetration in the country. This paper made an attempt to discuss performance of payment banks with respect to financial performance.Study revealed that payment banks are playing a commendable and hassle-free role in financial delivery for banking penetration in the country.

Keywords: Aadhar, KYC norms, payment banks, small finance banks, banking penetration

INTRODUCTION

Banking in India is one of the established and regulated mechanisms with appropriate authorities to monitor and control in a proper manner. It is an age old tradition in the banking sector with respect to modern and multidimensional aspects. Banking sectors in India transformed into various categories such as commercial banks, co-operative banks, regional rural banks, small finance banks and payment banks. The evolving economic landscape and fancies of the people have driven the government to plan seamlessly for inclusive banking for realising the opportunities that lie within. 21 percent chunk of Indian population are unbanked according to World Bank Report. Payment banks can favourably achieve inclusion goals of the Indian banking regulator by engaging with marginalised and migrant groups within the population pie, as envisaged by the banking regulator. The role of digitisation in making basic financial services available to such excluded groups has been explored within the study. Financial inclusion has been a need of the hour for more than three decades, with efforts being taken from the nationalization of banks, as of the present, it is necessary to ensure additional measures are taken to raise awareness amongst the masses that may not have access to all the information required to be considered financially literate.

PAYMENT BANKS

Payment's bank is an Indian new model of banks conceptualized by the Reserve Bank of India (RBI). These banks can accept a restricted deposit, which is currently limited to 100,000 per customer and may be increased further. These banks cannot issue loans and credit cards. Both current account and savings accounts can be operated by such banks. Payments banks can issue ATM cards or debit cards and provide online or mobile banking. Bharti Airtel set up India's first payments bank.The following is the list of active payments banks:

1. Airtel Payments Bank

2. India Post Payments Bank

3. Fino Payments Bank

4. Jio Payments Bank

5. Paytm Payments Bank

6. NSDL Payments Bank

1. Airtel Payment Bank

Airtel Payments Bank is a public limited company with its headquarters in New Delhi, India. The company is a subsidiary of Bharti Airtel. It is the first company in India to receive a payments bank license from the Reserve Bank of India and it became the first live payments bank in the country.

2. India Post Payments Bank

India Post Payments Bank (IPPB) is a wholly owned subsidiary of Indian Post and a payments bank from India operated by the India Post. Opened in 2018, the bank had acquired about 4.0 crore customers by December 2020.

3. Fino Payment Banking

Fino Payments Bank comes to from an institution that has served the country's banking needs for over a decade.Fino Payments Bank continuous endeavour to provide with an unmatched banking experience, through simple products & services that can easily be accessed anytime, anywhere.

4. Jio Payments Bank

Jio Payments Bank is an Indian payments bank owned by Reliance Industries, headquarters in Mumbai, India. It started operating in 2018.Jio Payments Bank Limited is a joint venture between the Reliance Industries and the State Bank of India with the stake of 70:30.

5. Paytm Payments Bank

Paytm is an Indian multinational e-commerce payment system and financial technology company, based in Noida, Uttar Pradesh, India. Paytm is currently available in 11 Indian languages and offers almost all kind of online use-caseswith the Paytm QR code.

6. NSDL Payments Bank

National Securities Depository Limited (NSDL) is an Indian central securities depository under the jurisdiction of Ministry of Finance, Government of India based in Mumbai. It was established in August 1996 as the first electronic securities depository in India with national coverage.

REVIEW OF LITERATURE

The following are the major review of literature which help to understand the growth, origin and performance of payment banks in India.

Pande.J.C. (2015). Found that Payment Banks in India is a major positive disruption to the banking sector and would certainly see the cost associated with transfer of money or settlements reduce dramatically for end users. Payment banks have been restricted in banking operations, as they will not be allowed to carry out normal lending activities. RBI suggests that Payment Banks will serve as a bridge to allow people to eventually migrate to full-service banks, which is quite likely.

MadhaviDamle., PushpendraThenuan., &JimitRaval. (2016). Mentioned thatPayment banks are a good way of reaching the masses for the even the smallest of payment at the odd hours, which defiantly makes the payment systems viable for the masses. Another aspect of Indian system is that the masses majorly deal in cash and this system becomes the pseudo cash handling system and so it is digitally capturing even the smallest transactions.

SabaAbid. (2016). Concluded that Payment Banks in India is a big positive disruption to the banking sector and would surely see the cost associated with transfer of money or settlements diminish dramatically for end users. Payment banks have been bounded in banking operations, as they will not be allowed to do a business of lending activities. Indeed there is a question about who will take care of the credit needs of the unbanked.

Chanderprabha. (2017). Suggested that the evolving economic landscape and fancies of the people have driven the government to plan seamlessly for inclusive banking for realising the opportunities that lie within. 21 percent chunk of Indian population are unbanked according to World Bank Report.

PallabSikdar., &Amresh Kumar. (2017). Noted that payment banks can favourably achieve inclusion goals of the Indian banking regulator by engaging with marginalised and migrant groups within the population pie, as envisaged by the banking regulator. The role of digitisation in making basic financial services available to such excluded groups has been explored within the study.

BhansaliShrey., Bhatt Tanmayee., ChhatwaniMohak., Deshpande Animesh., &IyerGeetha. (2018). Concluded that payment banks in India, a latest initiative taken up by the Reserve Bank of India and the Government of India. Non-inclusion of the banking sector in rural India is one of the major challenges faced by the Indian economy, today. Payment banks are also being set up to focus on high volume but low value transactions by low income households and small businesses.

Priyamvada Mishra., Ujjwal Singh., &SiddeshWali. (2018). Suggested that the current market scenario, as the Payments Bank is still in its initial stages there are a lot of regulations put on their operations by the Reserve Bank of India (RBI) which has restricted their operating freedom and has not allowed them to find other innovative solutions to the challenges that they face.

Sandesh D'souza. (2018). Found that Payment banks are becoming the most popular medium of digital transactions. India is moving towards a cashless and digital economy, which is more feasible and adaptable in

relation to the recent technological and economic trends. It viewed as a wise strategy towards financial inclusion.

Sriharsha Reddy. K. (2018). Pointed that markets perceived announcement of Payment Banks as a serious competition to existing commercial banks in the payment services line of business and deposit mobilization. It is imperative that payment banks would be reaching out to large number of unbanked customers by leveraging technology.

Anahita Singh., &SonalikaBhadouria. (2019). Concluded that financial inclusion has been a need of the hour for more than 3 decades, with efforts being taken from the nationalization of banks, as of the present, it is necessary to ensure additional measures are taken to raise awareness amongst the masses that may not have access to all the information required to be considered financially literate.

Paramasivan. C. (2019). Concludesproper distribution of assistance and subsidiary to the needy beneficiaries is one of challenging task to success the government programme particularly in financial aspects. The Digital India programme is a flagship programme of the Government of India with a vision to transform India into a digitally empowered society and knowledge economy. The following are the major initiatives of the central government taken to stronger then the digital financial inclusion in the country.

Kishore Kumar Das., &RupsaMahapatra. (2019). Observed that new model of banks conceptualized by the Reserve Bank of India (RBI) is popularly known as Payment Bank. As these banks cannot issue loans and credit cards, but both current and savings accounts can be operated by such banks. Money is the life blood of every economy. Now-a-days cash transactions are much simpler due to the popularization of internet, smart phones and other digital technologies.

Kokila.M.S.,& GokulaKrishnan.S. (2019). Mentioned thatPayment banks have been introduced with the primary objective of increasing the impact of financial inclusion drive. The payment banks play a significance role in implementing government's direct benefit, transfer schemes, where subsidies on health care, education and gas are paid directly to beneficiaries account.

Neha Mehta., &Sweety Shah. (2020). Suggested that Payment gateways, e-commerce applications and other benefits boost smart phone users towards digital transactions. This study focuses on identifying factors important for customers to use payment banks for transaction. The identified dimensions for the usage of payment banks are; usr friendly, convenience, cost effectiveness, security and easy cash management.

Statement of the Problems
Banking sectors play a significant role in socio-economic transformation of the people in the country which directly related with savings, income generation, flow of investment, distribution of income etc. India is one of the well-established Countries in the world with systematically organised and regulated baking system with traditional background since 1991, banking sector in India transformed into technology enabled services. Computerisation, establishment of ATM, online banking, digitalisation of banking services, innovative banking is the major milestone with the help of enhanced technology. Payment Banks in India is a major positive disruption to the banking sector and would certainly see the cost associated with transfer of money or settlements reduce dramatically for end users. Payment banks have been restricted in banking operations, as they will not be allowed to carry out normal lending activities. RBI suggests that Payment Banks will serve as a bridge to allow people to eventually migrate to full-service banks, which is quite likely.Now a day's banking penetration is one of the growing trends owing that emerging needs of banking services. PMJDY and DBT one of the key factors for increasing demand of banking services among the people. With this aspect, how the payment bank performs in the banking industry with the competitive era. Success of newly emerged payment banking system enabled to speedy and systematic banking services to all the people in the country.

OBJECTIVE OF THE STUDY
Primary objective of the study is to measure the performance of the payment banks in India.

RESEARCH METHODOLOGY
The present paper is descriptive in nature using secondary data from the official website of RBI. Simple percentage method of were applied to understand the value of the variables.

Table No: 1 Consolidated Balance Sheet of Payments Banks Amount in Rs. Crore

Sl.No	Items	March-2018	March-2019	March-2020
1	Total Capital and Reserves	1,848	1,899	1,862
2	Deposits	438	882	2,306

3	Others Liabilities and Provisions	2,606	4,392	4,256
	Total Liabilities/Assets	4,892	7,172	8,425
1	Cash and Balance with RBI	358	712	785
2	Balances with Banks and Money Market	1,243	1,375	2,101
3	Investment	2,449	3,136	4,077
4	Fixed Assets	236	638	353
5	Other Assets	606	1,311	1,108

Source: Off-site returns (domestic operations), RBI.

Table no: 1 shows that Consolidated Balance Sheet of Payment Banks as regards total capital and reserves, as on March 2020, it amounted to Rs.1862 crore as against Rs.1848 crore in March 2018, Deposit, as on March 2020, amounted to Rs.2,306 crore as against Rs.438 crore in March 2018, Other Liabilities and Provisions as on March 2020, amounted to Rs.4,256 crore as against Rs.4,892 crore in March 2018, Cash and Balance with RBI as on March 2020, amounted to Rs.785 crore as against Rs.358 crore in March 2018, Balances with Banks and Money Market as on March 2020, amounted to Rs.2,101 crore as against Rs.1,243 crore in March 2018, Investment as on March 2020, amounted to Rs.4,077 crore as against Rs.2,449 crore in March 2018, Fixed Assets as on March 2020, amounted to Rs.353 crore as against Rs.236 crore in March 2018.

Chart No-1: Consolidated Balance Sheet of Payments Banks
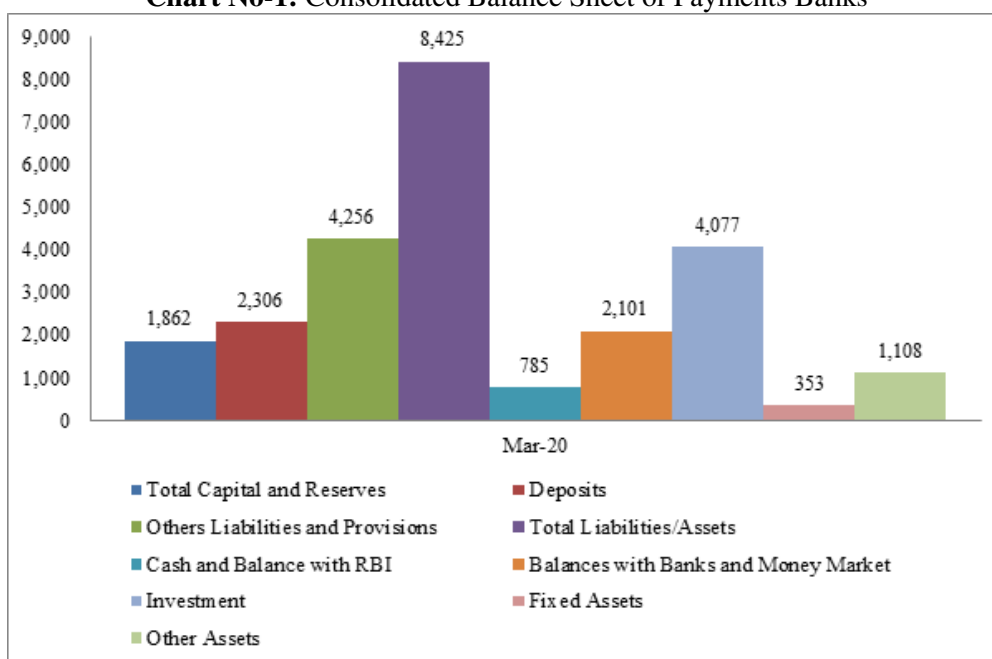
Table No: 2 Financial Performance of Payments Banks Amount in Rs. Crore

			March-2018	March-2019	March-2020
A.		Income (i+ii)			
	i.	i. Interest Income	175.6	290.8	349.3
		ii. Non-Interest Income	1,003.6	2,099.1	3,115.0
B.		Expenditure			
	ii.	i. Interest Expenses	24.5	35.4	62.3
		ii. Operating Expenses	1,676.8	3,265.3	4,337.4
		Provisions and Contingencies of which			
		Risk Provisions	-6.6	2.3	2.7
		Tax Provisions	1.0	16.1	-107.1
C		Net Interest Income	151.2	255.4	287.0
D		Profit			
	iii.	i. Operating Profit (EBPT)	-522.0	-910.8	-935.3
		ii. Net Profit	-517.2	-937.1	-833.0

Source: Off-site returns (domestic operations), RBI.

Table no: 2 shows that Financial Performance of Payments Banks as regards total interest income amounted to Rs.175.6 crore in March 2018 which increased to Rs.349.3 crore in March 2020, Non-Interest Income amounted to Rs.1003.6 crore in March 2018 which increased Rs.3,115 crore in March 2020, Interest Expenses amounted to Rs.24.5 crore in March 2018 which increased to Rs.62.3 crore in March 2020, Operating Expenses amounted to Rs.1,676.8 crore in March 2018 which increased to Rs.4,337.4 crore in March 2020, Risk Provisions amounted to Rs.-6.6 crore in March 2018 which increased to Rs.2.7 crore in March 2020, Tax Provisions amounted to Rs. 1.0 crore in March 2018 which increased Rs.-107.1 crore in March 2020, Net Income Interest amounted to Rs.151.2 crore in March 2018 which increased to Rs.287.0 crore in March 2020, Operating Profit (EBPT) amounted to Rs.-522.0 crore in March 2018 which increased to Rs.-935.3 crore in March 2020, Net Profit amounted to Rs.-517.2 crore in March 2018 which increased to Rs.-833.0 crore in March 2020.

Chart No-2: Financial Performance of Payments Banks
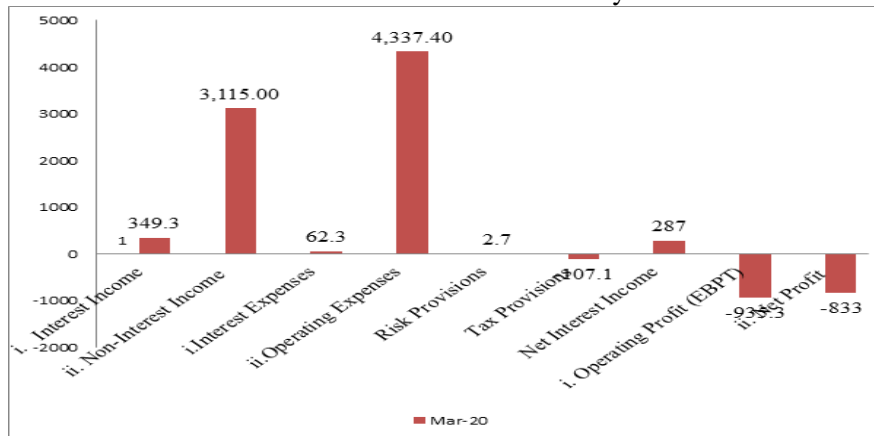
Table No: 3 Select Financial Ratios of Payments Banks

Sl.No	Items	March-2018	March-2019	March-2020
1	Return on Assets	-10.6	-13.1	-9.9
2	Return on Equity	-28.0	-49.4	-44.7
3	Investments to Total Assets	50.1	43.7	48.4
4	Net Interest Margin	4.5	6.1	4.8
5	Efficiency(Cost-Income Ratio)	142.2	136.6	125.2
6	Operating profit to working funds	-10.7	-12.7	-11.1
7	Profit Margin	-43.9	-39.2	-24.0

Source: Off-site returns (domestic operations), RBI.

Table No: 3 shows that Select Financial Ratios of Payments Banks, Return on Assets in March 2020 indicates ratio of -9.9 where as in March 2018, it was -10.6, Return on Equity in March 2020 indicates ratio of -44.7 where as in March 2018, it was -28.0, Investments to Total Assets in March 2020 indicates ratio of 48.4 where as in March 2018, it was -50.1, Net Interest Margin in March 2020 indicates ratio of 4.8 where as in March 2018, it was 4.5, Efficiency (Cost-Income Ratio) in March 2020 indicates ratio of 125.2 where as in March 2018, it was 142.2, Operating profit to working funds in March 2020 indicates ratio of -11.1 where as in March 2018, it was -10.7, Profit Margin in March 2020 indicates ratio of -24.0 where as in March 2018, it was -43.9.

Chart No-3: Select Financial Ratios of Payments Banks
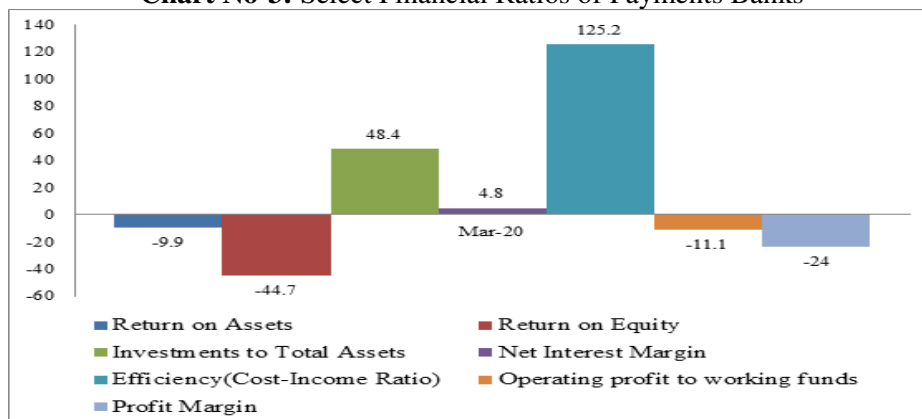
Table: 4 Remittances through Payments Banks (Number in thousand, amount in Rs. crore)

Sl.No	Channel	2019-20			
		Inward Remittances		**Outward Remittances**	
		Number	**Amount**	**Number**	**Amount**
1	NEFT	8,980 (0.4)	19,398 (5.3)	14,084 (0.6)	43,593 (10.1)
	i) Bill Payments	633 (0.0)	6,103 (1.7)	4,218 (0.2)	8,151 (1.9)
	ii)Other than Bill Payments	8,348 (0.4)	13,296 (3.6)	9,870 (0.4)	35,442 (8.2)
2	RTGS	198 (0.0)	81,411 (22.2)	73 (0.0)	56,794 (13.2)
3	IMPS	1,40,688 (6.8)	34,309 (9.3)	3,45,218 (15.0)	1,05,366 (24.5)
4	UPI	14,42,274 (69.4)	1,70,998 (46.6)	14,53,701 (63.2)	1,60,976 (37.4)
5	E-Wallets	3,39,601 (16.3)	23,427 (6.4)	4,03,157 (17.5)	41,274 (9.6)
6	Micro ATM (POS)	47,362 (2.3)	16,746 (4.6)	694 (0.0)	229 (0.1)
7	ATM	- -	- -	3,749 (0.2)	1,169 (0.3)
8	Others	1,00,450 (4.8)	20,740 (5.7)	78,402 (3.4)	21,515 (5.0)
	Total	20,79,551	3,67,030	22,99,078	4,30,918

Source: Off-site returns (domestic operations), RBI.

Table No: 4 shows that Remittances through Payments Banks as regards NEFT, there are 8980 inward remittances with Rs.19,398 crore and 14,084 outward remittances with Rs. 43,593 crore, Bill Payments, there are 633 inward remittances with Rs.6,103 crore and 4,218 outward remittances with Rs.8,151 crore, Other than Bill Payments, there are 8,348 inward remittances with Rs.13,296 crore and 9,820 outward remittances with Rs.35,442 crore, RTGS there are 198 inward remittances with Rs.81,411 crore and 73 outward remittances with Rs.56,794 crore, IMPS there are 1,40,688 inward remittances with Rs.34,309 crore and 3,45,218 outward remittances with Rs.1,05,366 crore, UPI there are 14,42,274 inward remittances with Rs.1,70,998 crore and 14,53,701 outward remittances with Rs. 1.60,976 crore, E-Wallets there are 3,39,601 inward remittances with Rs.23,427 crore and 4,03,157 outward remittances with Rs. 41,274 crore, Micro ATM (POS) there are 47,362 inward remittances with Rs.16,746 crore and 694 outward remittances with Rs.229 crore, ATM there are 3,749 outward remittances with Rs.1,169 crore, Others there are 1,00,450 inward remittances with Rs.20,740 crore and 78,402 outward remittance with Rs.21,515 crore.

Chart No: 4 Remittances through Payments Bank
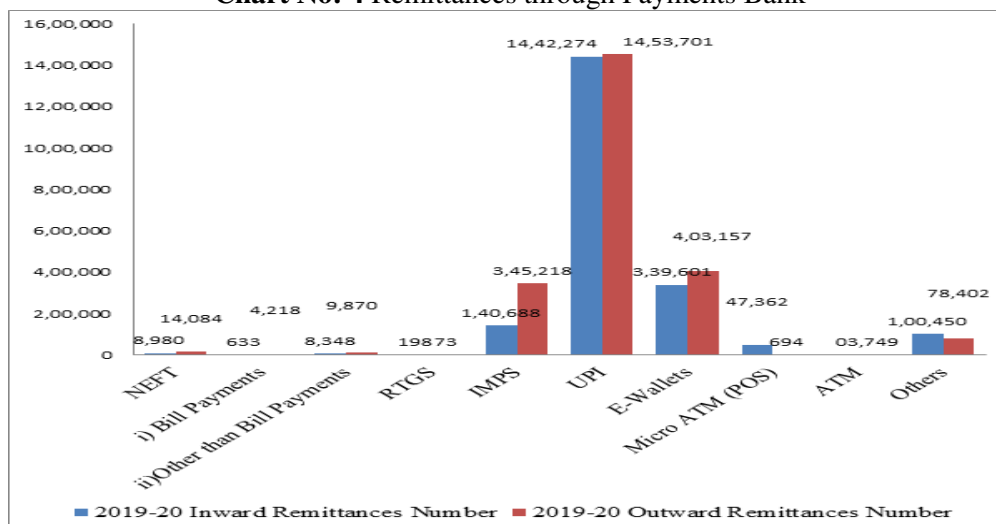
FINDINGS AND SUGGESTIONS

Total investments of payment banks amounted to Rs.4,077 crore in 2020 which has been increased from Rs.2,449 crore in 2018. It shows hat investment of payment banks has been increasing due to increasing of bank accounts and its efficient performance.

Income of the payment banks amounted to Rs.349.3 crore in 2020 where as net profit found that Rs.-833 crore which indicates operating expenses increased to Rs.4,337.4 crore in 2020 owing that there is a need of establishment of infrastructure and other facilities for smooth financing of payment banks.

Return on assets (-9.9), return on equity (-44.7), operating profit to working found   (-11.1) and profit margin (-24) are shown in negative significance where as investment to total assets (48.4), net interest margin (4.8) and cost income ratio (125.2) are shown in possible significance. Therefore operational performance of payment banks can be assess only after its 10 year performance.

UPI (Rs.1,60,976 crore) and IMPS (Rs.1,05,366 crore) are the major remittances through payment banks during the year 2019-20. Its shows that, payment banks are more secure and simple in transfer of money to anyone from their mobile phone. This kind of practices has been increasing consistently. Therefore, role of payment banks in transfer of money is unavoidable in the country.

CONCLUSION

Payment banks are new entity in the banking sector with the combination of information and innovative technology. Growth of payment banks depends on availability of infrastructure facilities and internet connectivity to speed and quick manner. Banking penetration through payment banks are increasing which reaches banking and financial services to the unbanked and unreached people. Aadhar and mobile phone connectivity are the major factors for penetration of payment banks. These banks are part and partial of everybody financial life. Payment through G-Pay or Pay-tm is more convenient, safe, speed and affordable while compare to conventional banking system. Therefore, payment banks are playing a consistent and comfortable role in financial delivery for banking penetration in the country.

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COST OF SOLID WASTE MANAGEMENT IN THOOTHUKUDI DISTRICT: USING CONTINGENT VALUATION METHOD

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ABSTRACT
Municipal solid waste is a result of economic productivity and consumption and includes wastes from households, commercial establishments, institutions, markets, and industries and its handling and disposal is a rising environmental and public-health concern. Population growth and economic development have brought increasing amounts of solid waste to urban areas. Solid waste management contains a wide range of actions including, Collecting refuse; collection, organization recyclable materials; collection and processing of commercial and industrial waste. The CV method is a widely used non-market valuation method especially in the areas of environmental cost–benefit analysis and environmental impact assessment (see Mitchell and Carson, 1989; Cummings et al., 1986). The ability to place a monetary value on the consequences of pollution discharges is a cornerstone of the economic approach to the environment. If this cannot be done, it undercuts the use of economic principles, whether to determine the optimal level of pollution or to implement this via Pigouvian taxes or Coase style liability rules. First, the model has a good fit. The chi-square value is 26.10, which is highly significant at 1 percent. Pseudo R^2 value is 0.23, which means that about 23 percent of the variations in WTP are explained by the included independent variables. Almost all the independent variables have positive influence on WTP except the variables of occupational classifications. Age variable is positively related to WTP. As the age goes up, the probability of getting a positive response also increases.

Keywords: Cost Benefit Analysis, Contingent valuation Method, Willingness to Pay, Non market valuation, solid waste

INTRODUCTION
Solid wastes constitute a serious problem in most cities. Municipal Solid Waste (MSW) includes commercial and residential wastes generated in municipal or notified areas, in either solid or semi-solid form excluding industrial hazardous wastes, but including treated bio-medical wastes (MoEF, 2000). The quality and quantity of MSW generated by a particular community will vary according to their socio-economic status, cultural habits, urban structure, population and commercial activities. Asian countries are facing Municipal Solid Waste Management (MSWM) problems due to the rapid growth in MSW generation rate. The total quantity of waste generated by 23 metro cities in India was 30,000 tpd in 1999, which has increased considerably to about 52,000 tpd (Inance et al, 2004). Government bodies at all levels (central, state and municipal) are taking proactive steps to improve the municipal solid waste scene in India. The Government of India issued new rules that regulate the MSWM (MoEF, 2000) at the local level. The mandatory requirements of the rule are,

- Source segregation and storage at source

- Door to door collection

- Abolition of open storage

- Daily sweeping of the street

- Transportation of waste in covered vehicles

Solid Waste Management is crucial and inevitable in the modern world. In case of Thoothukudi, the 10th Municipal Corporation in Tamil Nadu which generates more solid waste in recent days due to increasing urbanization and consequent urban growth with more and more new colonies and extension areas, and changing life style of the people have tremendously increased the solid waste problems. Corporation found it difficult to clean all areas regularly. Based on the discussion in various forums, Corporation started concept of promoting residential associations to take up sanitation in their colonies by engaging private sanitary workers.

Under this circumstances, this kind of environmental problems cause greater concern over the solid waste management which stimulate to carry out research and thereby to promote effective and efficient way of maintaining solid waste management by the Municipal corporation. This study would also estimate further to introduce Willingness to Pay (WTP) in order to improve solid waste management services provided to the public by way of introducing contingent valuation survey. However, survey results would also significantly

facilitate to fix tariff ceiling to each and every household based on the service provided towards solid waste management by the Corporation.

Municipal solid waste is an outcome of economic productivity and consumption and includes wastes from households, commercial establishments, institutions, markets, and industries and its handling and disposal is a growing environmental and public-health concern. Population growth and economic development have brought increasing amounts of solid waste to urban areas. Solid waste management encompasses a wide range of activities including, Collecting garbage; collection, sorting recyclable materials; collection and processing of commercial and industrial waste. According to the United Nation's Centre for Human Settlements, only between 25 and 55 per cent of all waste generated in large cities is collected by municipal authorities. For instance, waste generation every day in Tirunelveli Corporation was estimated to be 218 M.T. out of which 50% M.T. was left uncollected. The remaining uncollected solid waste creates huge environmental problems to city dwellers and this becomes a daunting task to the Corporation.

REVIEW OF LITERATURE

Dichotomous choice contingent valuation questions have gained popularity over the last several years. This is due primarily to their purported advantages in avoiding many of the biases known to be inherent in other formats used in the contingent valuation (CV) method. Two standard references which discuss different CV techniques are Cummings, Brookshire, and Schulze (1986) and Mitchell and Carson (1989). Whereas several varieties of bias may be minimized by dichotomous choice valuation questions, this elicitation method can be highly statistically inefficient in that vastly larger numbers of observations are required to identify the underlying distribution of resource values with any given degree of accuracy. An alternative questioning strategy, intended to reduce this inefficiency, was first proposed and implemented by Carson, Hanemann, and Mitchell (1986). They advocate introducing a second offered threshold in a "follow-up" dichotomous choice CV question which elicits a second discrete response. In practice, if a respondent indicates a willingness to pay the first offered amount, the new threshold is about double the first one. If the respondent is unwilling to pay the first offered amount, the second threshold is reduced to about half the original amount. This questioning strategy has also been called a "double-bounded referendum" approach.

Arrow et al. (1992) advocate discrete choice contingent valuation questions over other formats in their assessment of the reliability of CV techniques for quantifying passive use values in the context of oil spills. However, they note parenthetically that "If a double-bounded dichotomous choice or some other question form is used in order to obtain more information per respondent, experiments should be developed to investigate biases that may be introduced". This research addresses these possible biases for this double-bounded case. Carson and Mitchell (1987) employ survival analysis statistical techniques to analyze dichotomous choice with follow-up data. These methods were originally conceived to handle product failure data collected at irregular intervals. Much of this literature has emphasized Weibull distributions for the variable in question. Hanemann, Loomis, and Kanninen (1991) use maximum likelihood models to analyze double-bounded referendum contingent valuation data under an assumption of normality. Both of these papers, however, maintain the hypothesis that a single implicit true valuation drives respondents' answers to both of the questions in this survey format. This paper proposes a more-general maintained hypothesis. Our estimation method allows the valuation information elicited at each of the two stages to be the same, or different, as the data dictate.

METHODOLOGY

To give equal representation to every zone and to every ward of the Thoothukudi Corporation, it was decided to cover 700 sample households (200 households for each zone which is having more or less 40,000 households and 100 households were chosen from the zone which is having less than 25,000 households) in Thoothukudi Corporation.   The CV method is a widely used non-market valuation method especially in the areas of environmental cost–benefit analysis and environmental impact assessment (see Mitchell and Carson, 1989; Cummings et al., 1986). The CV method was originally proposed by Ciriacy-Wantrup (1947) who was of the opinion that the prevention of soil erosion generates some 'extra market benefits' that are public goods in nature, and therefore, one possible way of estimating these benefits is to elicit the individuals' willingness to pay for these benefits through a survey method (see Portney, 1994; Hanemann, 1994). However, Davis (1963) was the first to use the CV method empirically when he estimated the benefits of goose hunting through a survey among the goose-hunters.

The CV method is a survey based elicitation technique to estimate WTP values of a good that is not traded in the conventional market. The CV method is often referred to as stated preference method, in contrast to revealed preference methods, which use actual revealed behaviour of consumers in the market. The CV method directly

asks consumers' WTP for a non-marketed good under a given condition or prescribed circumstances. To elicit consumers' WTP values for non-marketed goods, a hypothetical market scenario should be formulated and described to the survey respondents. Thus, the elicited WTP values of a good are "contingent upon" the hypothetical market prescribed in the survey questionnaire.

Since a CV survey always asks WTP questions, it has been commonly called a "WTP study". Subsequently, the key fundamentals of "Contingent" market scenarios are often overlooked by practitioners as the term "WTP" predominates over "CV method". In this research, WTP and CV method has been distinguished: WTP as a concept referring to the economic value of a good, and CV method (replacing the commonly called WTP study) as the survey based technique to estimate welfare loss based on CVM models through various econometric regression models like Logit and Tobit estimation.

The specification of the Logit equation is as follows:

$WTP = \alpha + X1AGE + X2SEX + X3MS + X4INCOME + X5DIS + X6RUPWTP$

$+ X7HCOST + X8WLOSS + X9PRIEDU + X10HEDU + X11DEDU + X12PRI + X13GOVT + X14BUSI + X15PQUAL + X16MQUAL + 17FAIRLY + 18HIGHLY + Ei$

Where,

Dependent variable WTP=1; if willing to pay for solid waste improvement=yes

= 0 otherwise

Dummy Independent variables (Description)

ANALYTICAL FRAMEWORK
The CV method is a widely used non-market valuation method especially in the areas of environmental cost–benefit analysis and environmental impact assessment (see Mitchell and Carson, 1989; Cummings et al., 1986). Its application in environmental economics includes estimation of non-use values (e.g. Walsh et al., 1984; Brookshire et al., 1983), non-market use values (e.g. Choe et al., 1996; Loomis and duVair, 1993) or both (e.g. Niklitschek and Leon, 1996; Desvousges et al., 1993) of environmental resources. In recent years, this method is commonly used in developing countries to elicit the individuals' preferences for the basic infrastructural projects such as water supply and sanitation (see Whittington, 1998; Merrett, 2002). Though a popular non-market valuation method, a group of academicians criticise this method severely for not being a proper method of estimating the non-market values (see Hausman, 1993). Hence, the major objective of the concept which is being used to portray the Willingness to Pay to improve the River water quality in the study area based on empirical aspects of CV method.

The CV method was originally proposed by Ciriacy-Wantrup (1947) who was of the opinion that the prevention of soil erosion generates some 'extra market benefits' that are public goods in nature, and therefore, one possible way of estimating these benefits is to elicit the individuals' willingness to pay for these benefits through a survey method (see Portney, 1994; Hanemann, 1994). However, Davis (1963) was the first to use the CV method empirically when he estimated the benefits of goose hunting through a survey among the goose-hunters. This method gained popularity after the two major non-use values, namely, option and existence values have been recognised as important components of the total economic values in environmental economics literature, especially during the 1960s. While the conventional revealed preference methods such as travel cost method are not capable of capturing these non-use values (Smith, 1993), the only method that is identified for estimating these values is the Contingent Valuation Method (CVM) (see, Desvousges et al., 1993). Hence, a considerable amount of studies on CVM - both theoretical and empirical in nature - have emerged in the economic valuation literature, including a large number of studies criticising the CV method. The overall objective of the study is to empirically study the solid waste management problem in Thoothukudi City using primary and secondary data and a methodology based on contingent valuation technique.

Contingent Valuation Method (Cvm)
In this study, we will use regression models in which the dependent or response variable itself can be dichotomous in nature. Basically, it is a 'Yes' or 'No' type answer received from the respondents with regard to improvement of Solid Waste Management in Thoothukudi Corporation. We use 1 or 0 value to measure this. In this question, some of the respondents are willing to pay and some are not. To estimate and infer the WTPs, we will use Logit model. We have to classify all categories according to their actual contribution in terms of rupees to improve solid waste maintenance. To measure the actual contribution for the respondent's solid waste

improvement, we will use Tobit model. This paper estimates using econometric methods like Logit and Tobit Models in order to introduce Willingness to Pay (WTP) to improve solid waste management. The primary data collected through household surveys were used in the estimation model. We analysed how the monetary value of health benefits could be increased by reducing solid waste dumping, which will be useful to policymakers to reduce the incidence of vector borne diseases in the urban population of Thoothukudi City of Tamil Nadu. Thus, this study addresses the current status and consequences of solid waste, which causes concern in rapid urban city.

Table – 1: Logit Estimates of WTP for Improvement of Solid Waste Management Dependent variable: WTP
(Willingness to Pay to improve solid waste management)

Independent Variable	Co-efficient	Marginal Effects
CONSTANT	0.96421 (3.670)	0.0003
AGE	-0.18129 (-0.750)*	0.4534
SEX	-0.58977 (-0.054)**	0.9570
MS	-0.65792 (-0.342)*	0.7321
INCOME	0.27032 (0.780)**	0.4356
DISTANCE	0.15182 (0.805)*	0.4208
RUPWTP	-0.18252 (-0.738)*	0.4606
HCOST	0.21734 (0.916)**	0.3599
WAGE LOSS	0.11130 (1.005)*	0.3148
PRIMARY	-0.23570 (-1.920)**	0.0549
HIGH	-0.21910 (-2.224)**	0.0262
DEGREE	0.12822 (-1.015)*	0.3099
PRIVATE	0.27066 (2.062)***	0.0392
GOVT	0.33959 (2.518)***	0.0118
BUSINESS	0.14532 (0.991)***	0.3216
POOR	-0.00644 (-0.15)***	0.8793
MIDDLE	0.04714 (1.04)**	0.2980
FAIRLY	-0.69419 (-0.717)**	0.4735
GREATLY	0.40903 (0.443)*	0.6578
Log likelihood	7.9589	
Restricted log likelihood	-5.3023	
Chi-square	26.10672	
Pseudo R^2	0.232	

Source: Computed from primary data

Note: figures in parenthesis show the t-values

*Statistically significant at the 1% level;

** Statistically significant at the 5% level;

*** Statistically significant at the 10 % level

The actual estimation in the logit model will capture a simple Yes/No answer on whether a respondent's would pay to improve municipal solid waste management in Thoothukudi city. The data from all the sample households were used at this stage in order to understand a broad perspective of the factors underlying a respondent's decision. First, the model has a good fit. The chi-square value is 26.10, which is highly significant at 1 percent. Pseudo R^2 value is 0.23, which means that about 23 percent of the variations in WTP are explained by the included independent variables. Almost all the independent variables have positive influence on WTP except the variables of occupational classifications. Age variable is positively related to WTP. As the age goes up, the probability of getting a positive response also increases.

Table – 2: Tobit Estimates of WTP for Solid Waste Management Improvement Dependent variable: Willingness to Pay (WTP)

Independent Variables	Co-efficient	Marginal Effects
CONSTNAT	1.06689 (10.78)	0.2865
AGE	-0.00035 (-0.37)*	0.7078
SEX	-0.03282 (-1.44)*	0.1478

MS	-0.07721 (-108)***	0.2783
INCOME	-1.52004 (-1.49)*	0.1357
DISTANCE	8.75767 (0.90)**	0.3668
RUPWTP	-9.14336 (-0.75)*	0.4513
HCOST	1.51179 (1.36)***	0.1733
WAGE LOSS	4.079 (0.73)**	0.4607
PRIMARY	-0.05785 (-1.40)**	0.1600
HIGH SCHOOL	-0.02822 (-0.87)**	0.3796
DEGREE	0.02785 (0.59)*	0.5512
PRIVATE	0.02426 (0.65)***	0.5152
GOVERNMENT	0.01056 (0.24)**	0.8081
BUSINESS	-0.01414 (-0.29)***	0.7666
POOR	0.02530 (0.78)***	0.8834
MIDDLE	0.04340 (1.37)**	0.2720
FAIRLY	-0.04283 (-1.16)**	0.2436
GREATELY	-0.00359 (-0.10)*	0.9173
South Zone	-0.03363 (-1.07)*	0.2839
East Zone	-0.02134 (-0.57)**	0.5649
North Zone	-0.03124 (-0.84)**	0.3989
Sigma	0.281	
Likelihood function	-188.6018	
N	677	

Source: Computed primary data

Note: figures in parenthesis show the t-values

*Statistically significant at the 1% level;

** Statistically significant at the 5% level;

*** Statistically significant at the 10 % level

Under this Tobit model, the actual magnitude of the monetary value of WTP is directly linked with the respondent's willingness to pay for improving municipal solid waste management. If the coefficient sign were positive, one unit increase in age when other things remain constant would increase the WTP amount by about 0.7078 percent. Sigma value (0.281) is highly significant. Because of this OLS is an unbiased estimate, which is highly significant, and it shows that leaving the sample would lead to selection bias. It is the case with that of the variable sex. It would increase the probability of WTP by about 0.1478 percentages for 5 percent. If the distance decreases, the probability of WTP increases by 0.3668 percent. Health cost and wage loss have negative influence on WTP and some extent variable health has got positive influence at 5 percent level of significance. It would increase the probability by 0.1733 percent and 0.4607 percent respectively. Education has much stronger influence. As expected, it had improved the WTP amount at each level of education, namely, primary, high school and degree level, by about 0.1600 percent, 0.3796 percent and 0.5512 percent respectively. Occupation does not have any influence on the WTP amount for improving solid waste management. Therefore, as predicted in theory, there are many factors that influence the WTP amount to deviate. It has negative sign and insignificant too. However, the variables government employees and business group have a positive effect on WTP. In contrast, one unit increase in the business group variable will influence WTP by 0.7666 percent as against the government employee, which is just 0.8081 percent. The respondents have responded well to the personal health loss due to solid waste as a subjective variable that influences an increase in the WTP amount by 0.2436 and 0.9173 percent, respectively, for fairly affected and highly affected variables. Thus, the estimated Tobit Model is a realistic in explaining the role of different socio-economic factors in the levels of WTP by the respondents. Respondents who lived closer to the dustbin were expected to be willing to pay more than those who lived farther away. This pattern holds for distance of up to 500 meters, with households who lived within 50 to 250 meter were willing to pay between Rs.200 and Rs.150 more than those who lived within 250 to 500 meters. However, those who lived more than 500 meters from the dustbin were not willing to pay significantly less than those who living within 200 meters. They were, in fact, willing to pay significantly more than those households located within 300 to 500 meters.

These findings reported above are valuable to policymakers for several reasons. First, since Thoothukudi Corporation is about to develop comprehensive waste management plans, it could use the approach adopted here for evaluating the external costs or benefits of all wastes disposal alternatives including the use of street dustbins, landfill disposal, incineration and recycling. If such expenditures are to be made in a cost-effective manner, a more complete analysis is needed to compare the total costs of all solid waste disposal alternatives. Second, if minimizing the overall costs was the only objective and if similar results were found to hold for other areas, one might conclude that landfills should be sited in areas with fewer degree holders in higher income classes. However, equity considerations would likely limit an explicit statement of such a strategy publically.

Table – 3: Mean value of WTP, health cost, and day's lost, annual income and per capita wage and wage loss derived from the statistical analysis

S	Variables	Total	Std. Deviation	Mean
1	Rupee WTP	18500	198.08	185
	Health cost	617035	22329.08	6170.35
	Days lost	1750	117.725	17.50
	Annual Income	5584154	59185.28	55841.54
	Wage	12559.33	162.15	125.59
	Wage loss	87242.16	2603.29	872.4216
2	Rupee WTP	7450	112.47	74.50
	Health cost	130640	7244.60	1306.40
	Days lost	1842	14.66	18.42
	Annual income	4733040	108293.53	47330.40
	Wage	12967.23	296.69461	129.67
	Wage loss	52464.41	1011.084	524.64
3	Rupee WTP	10275	174.79	102.75
	Health cost	57554	2257.31	575.54
	Days lost	1834	12.97	18.34
	Annual income	4225334	40837.90	42253.34
	Wage	11576.26	111.88	115.76
	Wage loss	88213.79	1608.31	882.13
4	Rupee WTP	8425	150.69	84.25
	Health cost	75590	3180.18	755.90
	Days lost	11000	15.73	110
	Annual income	4833740	70706.02	48337.40
	Wage	13243.12	193.71514	132.43
	Wage loss	185399.70	5518.47	1853.99

Source: Computed from primary analysis

The data given in table-3 clearly shows about the sample household population of that particular solid waste dumping site areas. This cost has arrived only based on vector borne diseases and not about the chronic diseases such as cancer, which requires intensive study. The total health cost due to solid waste dumping was estimated to be Rs.8, 80,819/-. This cost did not include the costs of premature mortality. The data results given in the table is only for the total household sample population. The average annual income, health cost, days lost wage losses has been calculated based on each zones done through field survey, which is not, included the total population. Since, the study has proved that the municipal solid waste management in Thoothukudi City is poor and that the associated health and economic impact are significant.

Fig. 1: Municipal Solid Waste Generation rate kg/ capita/day in Indian cities
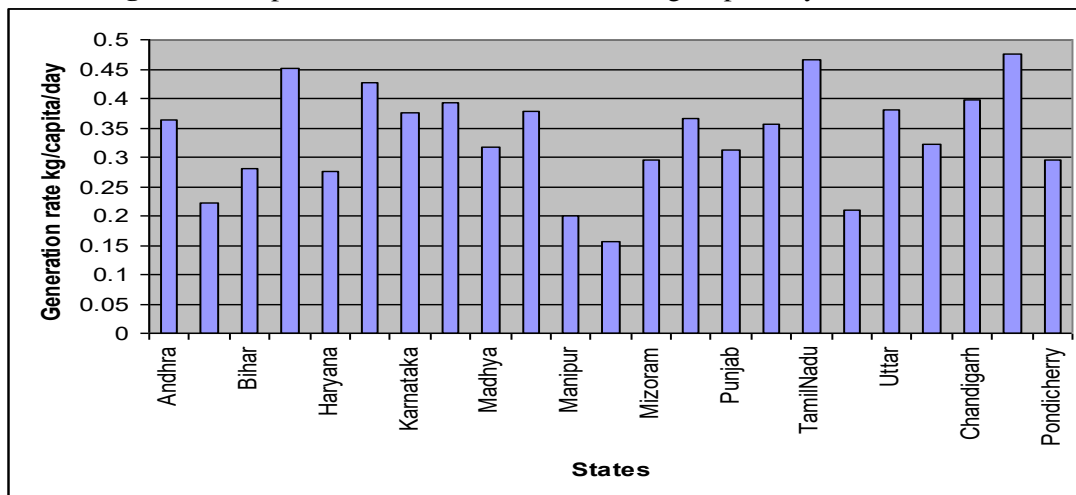
It can be seen from the above figure that the per capita generation rate is high in some states like Gujarat, Delhi and Tamil Nadu and cities like Madras, Kanpur, Lucknow and Ahmedabad. This may be due to the high living standards, the rapid economic growth and vast expansion of urbanisation in these states and cities. However, the per capita generation rate is observed to be low in other states like Meghalaya, Assam, Manipur and Tripura and cities like Nagpur, Pune and Indore.

FINDINGS AND CONCLUSION:

Inadequate supply of solid waste management workers have always been a main environmental problem in the city. The major cause of this problem is inadequate finance for this service. Hence, the main objective of this study is to see the possibility of cost recovery by looking at the demand side of solid waste management in Thoothukudi city through service charges. For that the Contingent Valuation Method (CVM) is used to estimate the value of households in Thoothukudi City give for an attempt to improve solid waste management. The elicitation technique used was closed ended with an open ended follow-up. Information gathered from the survey was also analysed using descriptive statistics and econometrics models like Logit and Tobit. From the interviewed households, 374 (53.43%) reported to practice other mode of dumping by throwing the refuse into an open space, street or nearby water resources (river). This is increasing the cost of street sweeping in all main roads of the city and also the nearby water body is carrying various wastes into the city side with its own implications on the health of the people who use the river water for various activities including drinking without any treatment. Illegal dumping is more common in all income categories of the respondents in all zones. This may be due to low responses towards willingness to pay to improve municipal solid waste management. Based on the nature of the data, a Tobit Model is used to identify factors explaining the amount a household is willing to pay. Tobit mode was selected due to the censoring of willingness to pay amount at zero. The Probit model is also used to identify factors responsible for being willing or not willing to pay for the proposed improvement.

The Tobit Model shows that the willingness to pay amount is affected by various factors. Income of household, time spent in the area, quantity of waste generated, responsibility of solid waste management, education dummies, being the owner of the house in which on is living and the number of children in the household have positive and significant effects on willingness to pay. Respondent's age has a negative and significant effect on willingness to pay amount. The starting price does not significantly affect the willingness to pay suggesting there is no starting point bias. Research initiatives and various studies on waste management should be continued to have deeper understanding about this phenomenon with different samples cover various parts of Thoothukudi Corporation as well as with other variables not included in this study to strengthen the model in explaining household's willingness to pay. Currently, at all level of waste generation and collection, there is no source segregation of compostable waste from the other non-biodegradable and recyclable waste. Proper segregation would lead to better options and opportunities for scientific disposal of waste. Recyclables could be straightway transported to recycling units that in turn would pay a certain amount to the corporations, thereby to increase revenue for SWM collection.

Most of the MSW in Indian cities are dumped open space or nearby roadside in an uncontrolled manner. Such inadequate disposal practices lead to problems that will impair human and animal health and result in economic, environmental and biological losses. An open dump or an uncontrolled waste disposal area should be rehabilitated. It is advisable to move from open dumping to sanitary land filling in a phased manner. The

current regulations (MSWM rules, 2000) are very stringent. Norms have been developed to ensure a proper MSWM system. Unfortunately, clearly there is a large gap between policy and implementation. The producer responsibility is to avoid having products on the market that cannot be handled effectively and environmentally correctly when they become waste products. A new survey should be carried out on the generation and characterization of MSW in India.   Since the MSW is heterogeneous in nature, a large number of samples have to be collected and analyzed to obtain statistically reliable results. Finally, the study concluded that the lack of resources such as financing, infrastructure, suitable planning and data, and leadership, are the main barriers in MSWM. Therefore, this study would recommend to the Corporation of Thoothukudi to adopt minimum user fee based on the results obtained from the city dwellers by the way of willingness to pay analysis towards MSW.

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TOURISM SOCIAL ENTREPRENEURSHIP: A BIBLIOMETRIC ANALYSIS OF ACADEMIC CONTRIBUTIONS

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ABSTRACT

Tourism is an economic and social phenomenon that has exploded in recent decades as a result of increased human connectivity. Covid -19 pandemic affected this industry disproportionally, necessitating the sustainability of the industry The role of tourism in the promotion of entrepreneurship and social development is well known. In the tourism and hospitality industries, social entrepreneurship has a systematic, strategic, and tactical scope. Using the Web of Science (WOS) database, 37 peer-reviewed articles published between 2007 and 2022 were examined for this study. Bibliometric information such as authors name, publications frequency, year, journals, and citations were exported and analyzed with HistCite. Most influential papers, authors, and publications as generated by Histcite are compiled systematically into representable tables and discussed. We used of VOSviewer software to analyse the co-occurrence between the keywords, which show the network of co-occurrence and strength of the co-occurrence. We also looked at keyword co-occurrence throughout a network, as well as density and overlay representations, using VOSviewer software. Finally, a clusters analysis was performed to identify both existing study topics and future research trends for the coming years. In the topic of tourism social entrepreneurship, current trends, new disciplines, and theories have been discovered and analyzed. Academics and researchers can use the findings, as well as the suggested research areas, to help them undertake future research to improve the scientific development of the tourism social entrepreneurship field.

Keywords: Social Entrepreneurship, Tourism, Hospitality, Sustainable tourism, Responsible tourism

INTRODUCTION

The covid-19 Pandemic impacted the tourism industry mostly due to large-scale lockdowns across the country and restrictions on mobility. An industry that employed 10% of the people that are in jobs across the globe is still thriving to get back from the shocks of the pandemic. The dependency of a large number of people on the tourism sector made it an important part of the economy. Restoring the sector is among the priorities of many economies Globally, the process to revive the industry has been started with countries relaxing travel bans and facilitating the tourists. But the emergence of the new coronavirus variant Omicron is again haunting the industry. New mutations of the virus continue to keep the tourism industry vulnerable. Therefore, the tourism industry needs to become more sustainable and resilient in the future (Fagadar et al., 2021).

In recent, the tourism sector has seen significant change and continues to adapt to market needs. Low energy prices, cheap finance, an expanding population, and rising disposable incomes supported the industrial model of production and consumption, which was adopted from manufacturing after World War II (Sheldon et al., 2017). Tourism-related companies are continuing to flourish and serve as a foundation for bringing previously marginalized people on board as hosts and guests. International tourist promotes local cuisine, handicrafts, forex companies, guides, and tour operators, along with domestic tourism, all of which contribute to the improvement of rural communities, the creation of capital, and jobs. (Evelyn and Tsoka, 2018). Social change and innovation as a component of social entrepreneurship have the potential to incorporate the required transformation in tourism.

In the tourism and healthcare sector, the scope of social entrepreneurship is systematic, strategic, and tactical. Although much of the scope is still unexplored, few stakeholders made efforts to endeavor tourism with the intention to create social value or employ social innovation. For instance, a position of vice-president is created in the executive team of Scandic and Rezidor groups to promote sustainable business and community development (Ergul and Johnson, 2011). The need and opportunity for the realization of a social cause over an economic cause for the tourism sector have been a concern of different stakeholders in the field. Although, Social entrepreneurship has piqued the curiosity of academics, businesses, and the business discourse (Dzisi and Otsyina, 2014) social entrepreneurship injection in the tourism sector is still in its nascent stage. The current study examines the status of academic developments in the area of tourism social entrepreneurship. The purpose of this article is to trace the development of the field by undertaking the bibliometric analysis of the previous studies in the field of tourism social entrepreneurship. Also, this study focussed on looking at the primary

corpus of literature on tourism social entrepreneurship as detailed in selected publications published over the last decades to analyze the emerging trends and themes and provide future research direction in social entrepreneurship in hospitality and tourism.

Social Entrepreneurship in Tourism and Hospitality

Though tried by scholars, no definite definition has been reached so far due to the complex interrelationship of variables and stakeholders. A big chunk of previous studies suggests that identifying opportunities in social problems and providing their solution is a core of social entrepreneurship. Thus, simply it can be said that it is a form of entrepreneurship where the social outcome and social change out of an enterprise are most important. Various authors explored the concept of social entrepreneurship. Campbell (1997) emphasizes employing entrepreneurship in activities that can't generate revenue but are important for societies and communities is an early idea of social entrepreneurship. Entrepreneurs have a responsibility to give back to society (Cornwall, 1998; Wallace, 1999). Prabhu (1998) emphasized the role of social enterprises in bringing social changes. Innovation is a key to entrepreneurship and is equally important for business solutions to social problems (Chell et al., 2010), and investment in social entrepreneurship leads to positive returns in social and economic terms, (Canadian center for social entrepreneurship, 2001). Hibbert et al., (2001) explored the entrepreneurial behavior of a social entrepreneur and this behavior for the good of the society more than profit. Battilana and Lee (2014) linked social change with charity. Entrepreneurship is also associated with inclusive growth and creating social value by reinvesting in social business generated a profit (Azmat and Ferdous, 2015)). The potential of social entrepreneurship to address issues like unemployment, sustainable development, community development, inclusive growth, etc makes it more important in the current situation.

Entrepreneurship is important for economic gains and growth. Combining the possibilities of entrepreneurship with social value creation provides an enormous opportunity for the development of society (Austin and Stevenson, 2006). Tourism and hospitality is one of the sectors with a huge scope for employing social entrepreneurship practices for overall development (Dzisi and Otsyina, 2014; Aquino et al., 2018). The same tourism and hospitality sector also has the potential to drive economies and steer the development of communities and localities (Scheyvens, 2002). Earlier research found that backward and disadvantaged communities have the necessary tourism assets and provide the desired experiences and spaces that tourists want (Beeton, 2006; Dolezal & Burns, 2014). This leads to the goal of comprehensive and sustainable community development, which is typically achieved through community-based and pro-poor tourism programs that aim to provide regenerative economic and social riches, and advantage of the environment (Guzman et al., 2011). The disruption caused by the Covid-19 in a global economy and the devastating impact of Covid-19 on societies and the tourism and hospitality sector particularly increased the need for sustainable development. At this time, social entrepreneurs and social enterprises can act as an agent of change and can become torchbearers of development in the tourism and hospitality sector.

RESEARCH METHODOLOGY

A bibliometric analysis was performed to track the knowledge base on tourism social entrepreneurship over the last several decades and to test the above-mentioned research trends as they emerged over time. Bellis (2009) explained the bibliometric analysis as a quantitative analysis of various publications, such as in books and journals. More in-depth bibliometric investigations, on the other hand, allow for transparent quantitative and qualitative evaluations of a given information stream (Zupic and Cater, 2015). For example, Researchers can employ software-based data aggregation to uncover essential information such as social networks, geographic areas of debate, keywords, authors, and co-citations, allowing researchers to create tailored representations of study topics (Secinaro et al., 2021). This systematic review of the literature is being carried out to contribute to the systematization of scientific research on the subject of tourism social entrepreneurship. In this study, the authors selected the Web of Science (WoS) database, as it has search, filtering, and tools to analyze. WoS is among the most reliable database, containing vast records of publications.

The Research Questions We Address Are:

RQ1. Identifying the Authors, Articles, and Journals, who have published the highest no of papers with citation scores and Journals publishing this impactful research?

RQ2. What are the important institutions, geographic areas, and publication trends on tourism social entrepreneurship research?

RQ3. What are the current and emerging issues of interest among academicians in tourism social entrepreneurship research?

An advanced search was performed, not applying any chronological or language filter, and used research terms: (Social*) AND (Entrepreneurship*) AND (Tourism*) AND (Hospitality*) . The search was confined to papers classed as "Articles" to best reflect the output of original research and peer-reviewed studies; therefore, books, chapters of books, and proceedings were eliminated. This is because articles are the materials that best reflect the output of the original research. Using the advanced search, we selected the title, abstract, and keywords in the field option, and only published articles were selected as a document type with no language, publication year restriction, and no time margin. The bibliographic search ended in February 2022, yielding a total of 402 papers published between 2007 and 2022 related to the subject.

As a first step, the researchers rigorously revised all of the selected publications to ensure that the material was connected to tourism social entrepreneurship. Papers were identified by reading the abstract to include all papers on our research objective and to exclude papers that were not relevant to our study of social entrepreneurship. We would obtain and screen whole texts if we were unsure. We excluded conference papers, as recommended by Ahl (2002) because many of them will be published in journals later. This exercise limited our research to only 37 articles that focussed on our research subject i.e., tourism social entrepreneurship. To evaluate the systematic literature review, a record of papers was obtained from the database, including the cited references. In our analyses using HistCite, we mined out the information such as publication year, authors proficiency, and productivity using TLCS and TGCS ranking. HistCite is a quantitative tool for evaluating systematic literature reviews and for the explanation of the publication's dynamics in greater detail. Further, making use of VOS software and a program developed by Van Eck and Waltman (2010), to analyze the co-occurrence between the keywords was performed, which show the network of co-occurrence and strength of the co-occurrence. The thickness of the network line indicates the strength between the keywords. Higher the thickness of the node, the stronger the link. Similarly, the network circle also shows link strength. Using the colors and layout of the circles, the items are grouped. We also looked at the co-occurrence of keywords across a network, as well as density and overlay representations. Finally, using this data, a clusters analysis was performed to identify already developed study fields as well as potential research trends for the coming years.

FINDINGS AND DISCUSSION

We addressed the research question and classified the most influential publications, and journals relevant to the study by extracting the data imported into HistCite and employing the bibliometric data obtained from the program.

Yearly Output

The HistCite results reveal that no paper on tourism social entrepreneurship was published before 2007. Pattieu S. is an author who wrote the first study on the subject in 2007 and titled "We have nothing in Katmandu," as appeared in our analysis. It focused on the transformation of a tourist project into a tourism social enterprise in Nepal. As indicated in Figure 1, 37 publications were published from 2007 to 2022, with 10 of them appearing in just one year, notably in 2016. This finding suggests that tourism social entrepreneurship is a relatively recent field of study, and it confirms that, before 2007, tourism social entrepreneurship was only in its concept form that has not been investigated. The low number of articles indicates that it is still a largely unexplored domain.

Figure 1: Yearly output of publications on tourism social entrepreneurship.
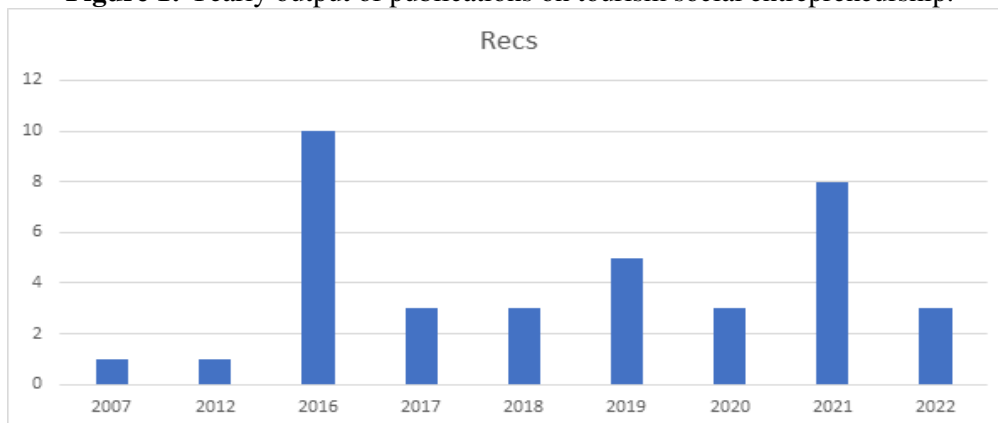
Source: Retrieved from Hist Cite

The Most Influential Authors, Articles, and Journals

According to the analysis, 37 articles on tourism social entrepreneurship have been written by 89 authors. Sigala M. is the most prolific author in tourist social entrepreneurship research, having published three articles, two in

2016 and one in 2019. Table 1 lists the top authors in the field of tourism social entrepreneurship, ranked by the number of publications, and it is observed that most of the top scorers will appear in all of the lists presented in the article.

Table 1: Ranking of the most productive authors from 37 tourism entrepreneurship publications.

Author	Publications
Sigala M	3
Altinay L	3
Aquino RS	2
Luck M	2
Schanzel HA	2
Aksoy L	1
Alegre I	1
Alkire L	1
Alrawadieh Z	1
Alvarez-Garcia J	1

Source: Retrieved from Hist Cite

To find the most influential authors in our collection, we used the TLCS (Total Local Citations Score) to rank the 89 authors in a top-10 authors list. The total local citations score (TLCS) depicts the number of citations received by the publications in the retrieved data set. As shown in table 2, here also, Sigala M. took first place with a TLCS of 20, followed by Altinay L. and Waligo V., who received a score of 12,12 each for a paper they co-authored with Sigala titled "Social value creation through tourism enterprise." (Altinay, et al., 2016). Also, the article "Social value creation through tourism enterprise" is found to be the most cited paper in our data collection having citations locally and globally.

Table 2: Most productive authors from 37 tourism social entrepreneurship publications according to publication citations-TLCS.

Author	TLCS	TGCS	Publication
Sigala M	20	103	3
Altinay L	12	75	3
Waligo V	12	69	1
Alegre I	8	36	1
Berbegal-Mirabent J	8	36	1
Aquino RS	7	49	2
Laeis GCM	7	20	1
Lemke S	7	20	1
Luck M	7	49	2
Schanzel HA	7	49	2

Source: Retrieved from Hist Cite

In the next step, the most influential authors are ranked using TGCS (Total Global Citation Score). This bibliometric criterion tracks how many times an article has been cited by other articles all around the world, not just those in the collection. Some top authors of the TLCS list (Sigala, Altinay, Waligo, Aquino, Luck, Schanzel) are in the TGCS list as well. Their Global Citation Score is much higher than the local ones because citations from outside the collection were taken into consideration as depicted in table 3. Here again, Sigala M., topped with 117 TGCS, followed by Altinay, and Waligo with a score of 75 and 69 each. It's interesting to note that an article (Kimbu and Ngoasong) with a high TGCS of 58 has a low TLCS (the article has a TLCS of 3). In 2016, Kimbu AN. and Ngoasong MZ. co-authored a study titled "Women as vectors of social entrepreneurship," which looked at the role of women as social entrepreneurs in small tourism firms. We can assume that this article and our collection have little or no connection. When an article has a multidisciplinary impact, the TGCS score can be quite high (Garfield, et al., 2006).

Table 3: Most productive authors from 37 tourism social entrepreneurship publications according to publication citations-TGCS

Author	TLCS	TGCS	Publication
Sigala M	20	103	3
Altinay L	12	75	3

Waligo V	12	69	1
Kimbu AN	3	58	1
Ngoasong MZ	3	58	1
Aquino RS	7	49	2
Luck M	7	49	2
Schanzel HA	7	49	2
Cochrane J	0	47	1
Von der Weppen J	0	47	1

Source: Retrieved from Hist Cite

We used TLCS/t (Total Local Citation Score/Year) and subsequently TGCS/t (Total Global Citation Score/Year) to rank the most significant research publications in our collections. Because two writers functioning together do not generate more than one article, it is important to understand how the overall number of articles published per year grows while researching co-authorship. With one publication co-authored with Altinay and Waligo (Altinay, et al., 2016) and two articles as a lone author, Sigala achieved a TLCS/t of 2.96 (Table 4). The citation of paperwork (Altinay, et al., 2016) drew the attention of the academic community, and as a result, it grew exponentially, eventually being cited in 81 articles with an LGCS/t of 12. Waligo, and Altinay L, who have co-authored one publication and three publications each, have a TLCS/t of 1.71.

Table 4: Most productive authors from 37 tourism social entrepreneurship publications according to publication citations-TLCS/t.

Author	TLCS/t	Publication
Sigala M	2.96	3
Altinay L	1.71	3
Waligo V	1.71	1
Aquino RS	1.40	2
Luck M	1.40	2
Schanzel HA	1.40	2
Dahles H	1.33	1
Khieng S	1.33	1
Manders I	1.33	1
Verver M	1.20	1

Source: Retrieved from Hist Cite

Table 5 shows the TGCS/t (Total Global Citation Score/Year) ranking of the authors. Here also, Sigala M tops the ranking with 16.64 TGCS/t followed by Altinay L and Waligo V with 11.86 and 9.86 Tgcs/t each. Furthermore, from a single co-authored article titled "A conceptual framework of tourist social entrepreneurship for sustainable community development," Aqunio RS., Luck M., and Schanzel, share the same TGCS/t score of 9.80. In their articles, the three authors (Aquino, Luck, and Schanzel) focussed on the sustainable development of local communities through adopting tourism entrepreneurship strategies.

Table 5: TGCS/t Ranking of the most influential authors from 37 tourism entrepreneurship publications.

Author	Publication	GCS/t
Sigala M	3	16.64
Altinay L	3	11.86
Waligo V	1	9.86
Aquino RS	2	9.80
Luck M	2	9.80
Schanzel HA	2	9.80
Kimbu AN	1	8.29
Ngoasong MZ	1	8.29
Aksoy L	1	5.25
Alkire L	1	5.25

Source: Retrieved from Hist Cite

The Top Journals in the Tourism Social Entrepreneurship Research Domain.
Because of the growing interest in the discipline, numerous well-known journals are now publishing regular and special editions on the subject. It's worth noting that the journals cover a wide range of topics, including

sustainability, management, social sciences, environmental sciences, hospitality, and more. The results of the research in the fields of tourism and social entrepreneurship were found in 22 academic journals. Table 6 shows a list of the top ten journals ranked by the number of papers published: As shown in table 6, the International Journal of Contemporary Hospitality Management is the leading journal in terms of tourism social entrepreneurship articles. With 5 publications, the Journal of Sustainable Tourism came in second. Each of the journals Annals of tourist research, Journal of hospitality and tourism management, sustainability, and tourism management has two articles on the topic. Actes de la recherche en sciences sociales, Annals of public and cooperative economics, Corporate social responsibility and environmental management, and Current issues in tourism are just a few of the prominent tourism social entreprenurship research publication journals.

Table 6: List of journals that published studies on tourism social entrepreneurship

Journal	Recs
International Journal Of Contemporary Hospitality Management	8
Journal Of Sustainable Tourism	5
Annals Of Tourism Research	2
Journal Of Hospitality And Tourism Management	2
Sustainability	2
Tourism Management	2
Actes De La Recherche En Sciences Sociales	1
Annals Of Public And Cooperative Economics	1
Corporate Social Responsibility And Environmental Management	1
Current Issues In Tourism	1
Entrepreneurship And Regional Development	1
International Entrepreneurship And Management Journal	1
International Journal Of Hospitality Management	1
Journal Of Quality Assurance In Hospitality & Tourism	1

Source: Retrieved from HistCite

Table 7 classifies the journals published articles on tourism social entrepreneurship according to their Global citations score (GCS). As seen in table 7, the leading journal in both rankings (number of publications and TGCS ranking) is the same, namely, the International Journal of Contemporary Hospitality Management. Eight articles having a total TGCS of 158 were published in the top-ranked journal (the highest score). All of these publications were published in the same year, 2016, and they were all published in the same journal. With Only 2 publications and a GCS of 69, Tourism management ranked 2nd in our TGCS ranking of journals. The journal focussed on the creation of social enterprises for promoting tourism social entrepreneurship.

Table 7: Most Influential Journals- TGCS Ranking

Journal	Recs	GCS
International Journal Of Contemporary Hospitality Management	8	158
Tourism Management	2	69
Journal Of Sustainable Tourism	5	65
Annals Of Tourism Research	2	61
Journal Of Hospitality And Tourism Management	2	49
Annals Of Public And Cooperative Economics	1	23
Journal Of Service Management	1	21
Marketing Theory	1	18
International Entrepreneurship And Management Journal	1	14

Source: Retrieved from Hist Cite

We also aimed to find the most referred references in the collection after selecting the most prominent periodicals. The number of articles in which the references are mentioned is displayed in the Publications column. As shown in Table 8, the most cited references are published in two journals i.e., the journal of world business, and the journal of sustainable tourism. Both these referenced articles discussed the scope of social entrepreneurship and social enterprises in the tourism and hospitality sector.

Table 8: Most cited references from 37 tourism social entrepreneurship publications - TGCS/t ranking

Cited References	Recs
Mair, 2006, J WORLD BUS	16
von der Weppen, 2012, J SUSTAIN TOUR,	16
Zahra, 2009, J BUS VENTURING,	13
Altinay, 2016, TOURISM MANAGE,	12
Peredo, 2006, J WORLD BUS,	11
Sheldon, 2017, TOURISM VERGE,	11
Sloan, WORLDW HOSP TOUR THE,	11
Austin, 2006, ENTREP THEORY PRACT,	10
Kline, 2014, TOUR PLAN DEV,	10

Source: Retrieved from Hist Cite

KEYWORD ANALYSIS

A co-word analysis was carried out to determine the patterns in tourism social entrepreneurship research, and network visualization maps were created using the VOSviewer software. First, the co-occurrence of terms allowed us to determine the present state-of-the-art in the subject, as well as the most relevant research themes. Then, using density and overlay visualizations, it found the most developed terms in the field, as well as those that may require additional research and development. Second, a cluster analysis was performed based on keyword co-occurrence, which aids in the identification of research patterns. The network interaction of co-occurrence of keywords based on total link strength and number of links is depicted in Figure 2. The image depicts the keywords as circles with curved lines connecting them, clustering the items in various hues, and the circle's size represents the link strength. Figure 2 depicts the most important subjects while studying the organizational commitment of bank employees as well as their impact on other topics. The keywords social entrepreneurship, hospitality, tourism, social enterprise, entrepreneurship, social innovation, and sustainability has the highest occurrences and strong connection strength, according to this initial map. The list of the most connected keywords in tourism social entrepreneurship is shown in Table 9. It displays the overall number of linkages, occurrences, and link strength. Figure 3 shows the overlay visualization which visualizes themes in tourism social entrepreneurship research over the period 2007-2022. The top themes in the research field include social innovation, community development, sustainable development, social value, and value creation. Social entrepreneurship and tourism as keywords have a large number of occurrences, as well as a higher total link strength created in recent years, suggesting that they have a significant impact on other research topics. Other Significant keywords include performance, governance, business, policy, framework, and models. Developing frameworks and models to increase the adaptability of theories into practice also has been focused upon by the researchers in the field.

Figure 2: Network visualization of Keywords co-occurrence in tourism social entrepreneurship research according to their network strength.
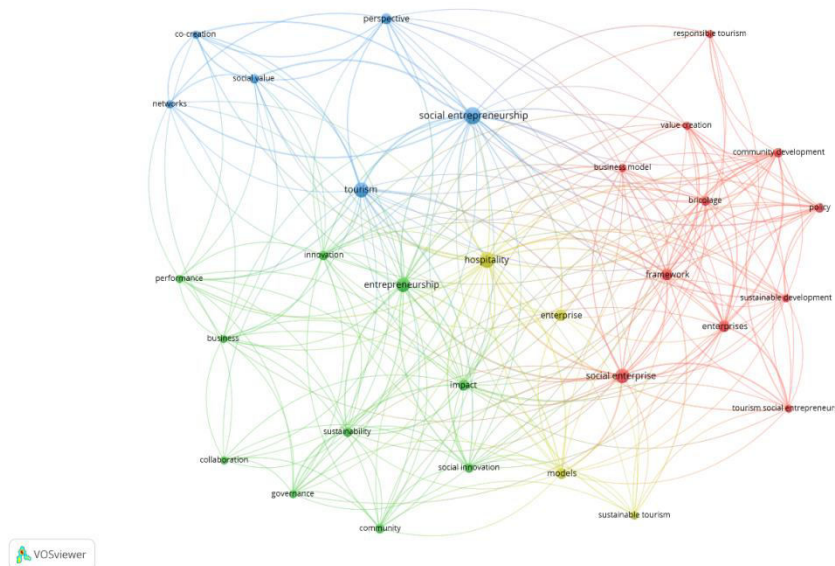
Source: VOSviewer.

Figure 3: Figure 3 shows the overlay visualization which visualizes themes in tourism social entrepreneurship research over the period 2007-2022.
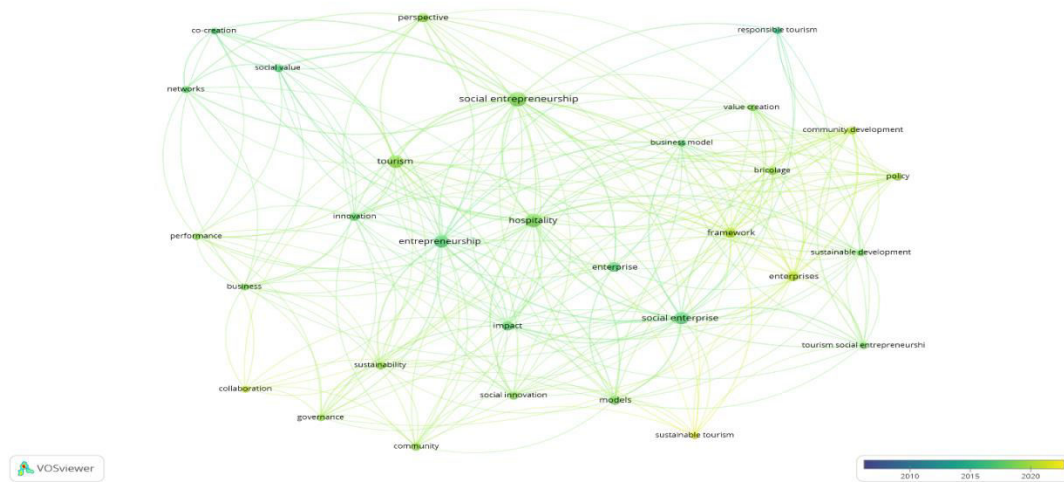
Source: VOSviewer.

Figure 4 depicts a density visualization of keyword co-occurrence. Social innovation and sustainability have been related to the topic's evolution. Among the topics discussed were business model, networks, co-creation, collaboration, and responsible tourism. Some of the field's more developed subjects, on the other hand, will demand more attention in terms of development and study. Theoretical grounds for the topic include social entrepreneurship, hospitality, tourism, and social enterprises. Social innovation, community development, social value, and sustainable development were the focus of previous studies on tourism social entrepreneurship. The density graph shows the keywords' co-occurrence over time and the subject's most recent advancements within other themes including value creation, sustainability, business, tourism, and hospitality.

Figure 4: Depicts a density visualization of keyword co-occurrence.
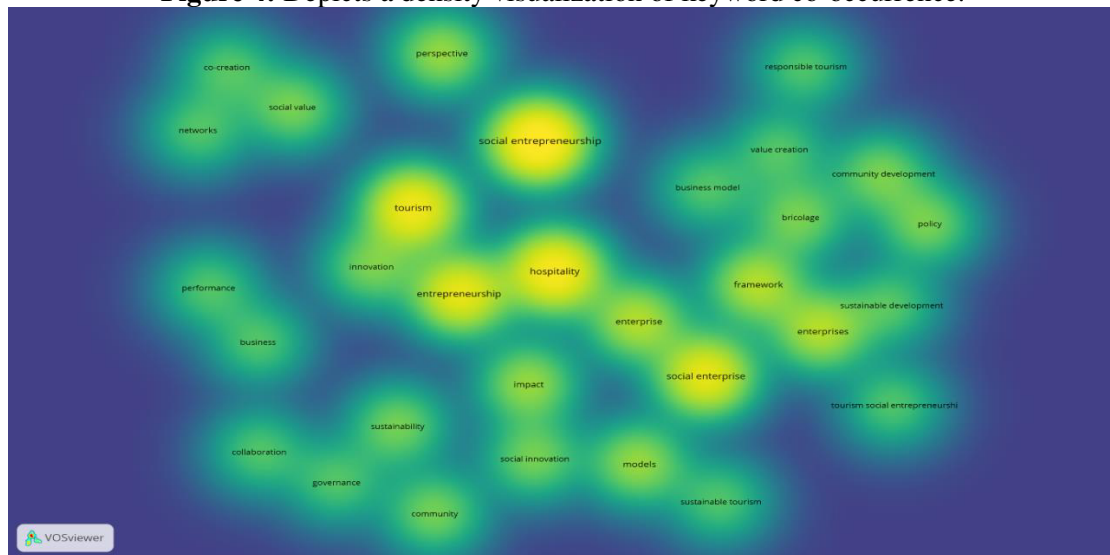
Source: VOSviewer.

These visualizations give a high-level summary of tourism social entrepreneurship research, highlighting the most relevant keywords that have appeared in the area in recent years. This data enables us to identify topic-specific research trends as well as research topics that require additional attention.

Table 9: Keywords with their frequency used in tourism social entrepreneurship research.

Keywords	Cluster	Links	Total Link Strength	Frequency
Social Entrepreneurship	4	22	48	13
Hospitality	3	26	55	11
Tourism	2	21	36	10
Social Enterprise	1	20	35	9
Entrepreneurship	2	20	32	9

Framework	1	18	30	6
Enterprises	1	17	30	6
Enterprise	3	10	14	6
Models	3	18	24	5
Innovation	2	19	22	4
Social Innovation	2	18	22	4
Sustainability	2	15	19	4
Community Development	1	14	25	4
Policy	1	14	21	4
Community	2	14	14	4
Social Value	4	10	18	4
Business	2	15	16	3
Sustainable Development	1	14	17	3
Value Creation	1	13	17	3
Governance	2	13	16	3
Performance	2	13	15	3
Tourism Social Entrepreneurship	1	12	18	3
Business Model	1	12	16	3
Sustainable Tourism	3	11	13	3
Co-creation	4	9	16	3
Networks	4	9	13	3
Collaboration	2	9	9	3
Responsible Tourism	1	8	9	3

Source: Author(s) based on VOSviewer

CLUSTER ANALYSIS

Out of 220 keywords, 28 meet the requirement of appearing at least 3 times. The cluster created between the keywords, based on the VOSviewer keyword analysis gives further information and understanding of the variables studied. Table 10 depicts keyword clusters based on their cluster co-occurrence. Four clusters are highlighted by four different colors as shown in Figure 2. In cluster 1, the Business model, Community development, Enterprises, Framework, Policy, Responsible tourism, Social Enterprise, Sustainable development, Tourism social entrepreneurship, and Value creation have co-occurred. From the literature, it can be understood that tourism social entrepreneurship is most studied with these elements. Sustainable development shows the highest weightage, followed by community development, responsible tourism, and social enterprise. Similarly, cluster 2 includes Business, Collaboration, Community, Entrepreneurship, Governance, Innovation, Performance, Social innovation, Sustainability, and Tourism. As social entrepreneurship in the tourism and hospitality sector is the main focus of this study, this cluster's elements are more of interest. The linking of social innovation, entrepreneurship, and sustainability with collaboration, community, tourism, and performance constitutes the focus of various studies in the field. Cluster 3 represents the researchers' investigation of enterprise models in hospitality for sustainable tourism In Cluster 4, the scope of social entrepreneurship in co-creation and networks development for social value generation has been explored by the researchers as indicated by the cluster analysis.

Table 10: Clusters of keywords according to their co-occurrence in a cluster.

Cluster 1	Cluster 2	Cluster 3	Cluster 4
Business Model	Business	Enterprise	Co-creation
Community Development	Collaboration	Hospitality	Networks
Enterprises	Community	Models	Social Entrepreneurship
Framework	Entrepreneurship	Sustainable Tourism	Social Value
Policy	Governance		
Responsible Tourism	Innovation		
Social Enterprise	Performance		
Sustainable Development	Social Innovation		
Tourism Social Entrepreneurship	Sustainability		
Value Creation	Tourism		

Source: Author(s) based on VOSviewer

CONCLUSION

The current study adds to a deeper understanding of the literature on tourism social entrepreneurship by applying precise segmentation and methodical grouping of bibliometric data to create a picture of this research issue. Bibliometric information such as authors name, publications frequency, year, journals, and citations were exported and analyzed with HistCite. Based on the bibliographical data acquired, general descriptive statistical information was presented, detailing the evolution of the publication activity, the top journals in the field, the most relevant authors. We used VOSviewer software to analyse the co-occurrence between the keywords, which show the network of co-occurrence and strength of the co-occurrence. We also looked at the co-occurrence of keywords across a network, as well as density and overlay representations. Finally, using this data, a clusters analysis was performed to identify already developed study fields as well as potential research trends for the coming years.

The study shows that the research on tourism social entrepreneurship developed enormously in the previous decade but it is still in its nascent stage. According to a review of the research, in the tourism and hospitality sector the scope of social entrepreneurship is very vast and with the execution of social entrepreneurship strategies based on a set of practices balance between economic and social benefits can be achieved particularly in developing countries. According to the bibliometric analysis based on bibliographic data mapping, its study has been incorporated into a variety of disciplines and research topics. Among the most notable fields are responsible tourism, sustainable development, and sustainable tourism. On issues like business models, framework, policy, collaboration, and co-creation, the literature on tourism social entrepreneurship is developing. In terms of conceptualization, typologies, frameworks, applications, and the field's ongoing theory development, the topic is considered to be in a developing and consolidating phase. According to bibliographic data, the most productive publications on the subject focus on social value creation, entrepreneurship, social innovation, performance, and networks. The most significant authors are affiliated with leading internationally known business schools in the domains of business and strategy. According to research trends, the topic will evolve into issues of community development and sustainable tourism, as well as responsible tourism and value creation, which will result in the emergence of new insights in the field of tourism social entrepreneurship. It indicates that these emerging issues can foster tourism social entrepreneurship by creating a supportive environment for all the stakeholders.

We can acknowledge the topics highlighted in the literature review as areas in need of more detailed investigation or as hot spots in future research - or both - with these gaps and trends detected by bibliometric research. The uniqueness of the current era, which includes a worldwide pandemic that has had a significant impact on the tourism industry, makes this study a welcome addition to the tourism social entrepreneurship knowledge base and a backdrop for future comparable endeavors. Even though the research concentrated on locating all published publications in WoS with tourism and social entrepreneurship keywords in the title, keywords, and abstract, there may be more relevant tourism social entrepreneurship studies that did not fit the search criteria. The specified platform (i.e., Web of Science), research type (i.e., articles), and publishing language are the primary constraints (i.e., English). While the scope of this study has been explicitly defined, future research can expand the study's amplitude by incorporating other scientific publications from other similar platforms.

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COASTAL ENVIRONMENT IN THOOTHUKUDI DISTRICT – AN ECONOMIC STUDY

SACRATEES J* AND SHANMUGAPRIYA A

ABSTRACT

The intensive human activities have induced extensive degradation of sea-water and coastal habitats globally. In particular, the near-shore marine ecosystems often suffer by man-made threats such as sedimentation, eutrophication, pollution, and overexploitation of fishing resources in the areas of Thoothukudi coastal belt. Abundant industries, urbanization, and municipal sewage and overexploitation of coastal resources are the major causes of pollution in every domain of the environment. According to Jones et al. (2018) about 87–90% of the ocean surface worldwide has been affected by humans. In the past few decades, fishing for livelihood has resulted in dwindling fishery resources and in degrading such vital habitats as coral reefs, sea grasses and mangroves.

INTRODUCTION

The etymology of the word "Thoothukudi" can be traced back to the period when the locals used to tap drinking water by digging small ponds (oothu in Tamil). Oothukudi, meaning to dig and drink, later came to be known as Thoothukudi. Thoothukudi District is located in extreme Southern Parts of Tamil Nadu and it was carved out of Tirunelveli District on 20th October 1986. It has certain rare features. The mixed landscape of the sea and the 'their (waste) lands has imbibed some special traits in the character of the sons of the soil. The district is located between 0.8 and 45 of the northern latitude and 780 and 110 of the eastern longitudes. The district is roughly triangular in shape and is bounded by Virudhunagar and Ramanathapuram districts in the north, Gulf of Mannar in the east and Tirunelveli District in south and west.

Thoothukudi is traditionally known as "Pearl City" on account of the prevailing Pearl fish in the past has a fascinating History. Forming part of the Pandian Kingdom between 7th and 9th Century A.D, Thoothukudi remained in the hands of the Cholas during the period between 9th and 12th century. The emergence of Thoothukudi as a maritime port attracted travellers, adventures, and eventually colonizers. The Portuguese were the first to arrive in Thoothukudi in 1932 A.D., followed by the Dutch in 1658 A.D. The English Captured Thoothukudi from the Dutch in 1782 and East India Company established their control over Thoothukudi in the same year. Thoothukudi became the citadel of freedom struggle in the early in the 20th century. It was in Thoothukudi that the illustrious patriot V. O. Childambaram established the first swadesi Stream Navigation Company, sailing the first steamer S.S.Gaelia to Thoothukudi on 1st June 1907.

The minor port Thoothukudi anchorage port with lighter age facilities has had flourished traffic for over a century. The first wooden Jetty of this port was commissioned in 1864. This port was being used for export of salt, cotton yarn, senna leaves, palmyrah stalks, palmyrah fibers, dry fish, country drugs, etc. to neighbouring countries and for import of coal, cotton, copra, pulses, and grains. The minor port of the Thoothukudi had the distinction of being an intermediate port, handling the highest traffic tonnage of over 1 million per annum. The salient feature of the district includes its lengthy curvy and scenic sea coast, which was an international cynosure from the days of yore for its pearl fisheries; beautiful coastal villages with their sacred temples, churches and mosques like Tiruchendur, Manappadu and Kayalpattinam respectively. Adhichanallur, one of the cradles of the ancient civilizations, Korkai, an ancient port of the Sangam Pandyas, Kayal, the confluence of the river Tamirabarani with the Bay of Bengal, one of the five illustrious rivers of Tamil Nadu. Panchalamakurichi, the capital of Veerapandiya Kattabomman, an early martyr, for the cause of freedom, Ettayapuram, the birth place of the great poet Subramanya Bharathi, Ottapidaram, the home town of V.O. Chidambaram Pillai, who dared to sail ships as a measure to combat British Imperialism; Maniyachi, where Vanchinathann assassinated Ashe, the British Collector for this high – handedness against the leaders during Swadeshi Movement; Kulasekarapattinam and Kurumbur where patriots showed their anger against alien rule, temple towns like Srivaikundam, Meignanapuram, one of the cradles of Christianity. Thoothukudi besides, being a major port, the earliest settlement of the Portuguese and the Dutch, the tall and dense Palmyra groves and the bushy Odai trees, the Teris and the adjacent coral islands. Idayankudi and Manappadu and the adjacent places which became the headquarters of great missionaries like G.U. Pope, Veeramamunivar, Caldwell and others who besides their missionary work contributed a lot to the development of Tamil Language and literature and above all the enterprising and hard working people who now constitute a major trading community in the State.

Thoothukudi district is situated in the extreme South-Eastern corner of Tamil Nadu. It is bounded on the north by the districts of Tirunelveli. The district of Virudhunagar and Ramanathapuram is located on the east and southeast by the Gulf of Mannar and on the west and southwest by Tirunelveli district. The total area of the district is 4621 Sq. Km. The administrative headquarters is an urban agglomeration and is also one of the taluk headquarters within. Thoothukudi district was bifurcated from Tirunelveli district in 1986.

The district of Thoothukudi was carved out of a separate district on 20th October 1986 and as a result of bifurcation of the Tirunelveli district of Tamil Nadu State. Thoothukudi is a port town situated in the Gulf of Mannar about 125 km North of Cape Comorian and 720 km south of Thoothukudi and its environs from part of the coastal belt which forms a continuous stretch of the flat country relieved here and there by small rock out crops. The region, surrounding Thoothukudi is liberally dotted with rain fed tanks. Red soils found on the southern side of the Thoothukudi town are composed of quartz and variable quantities of fine red dry dust. The port is an all weather one. The bay is formed by the Hare Island.

The district is a fast growing industrial belt of South India. Realizing the importance of the town, the Department of Town and country Planning notified Thoothukudi city and its surrounding 29 villages as Local Planning Area and constituted the Thoothukudi Local Planning Authority to guide and control the development in an orderly manner.

In 2011, Thoothukudi had a population of 1,750,176 of which male and female were 865,021 and 885,155 respectively. In the 2001 census, Thoothukudi had a population of 1,572,273 of which males were 766,823 and remaining 805,450 were females. The density of population per Sq.km is 376 as against the 555 for the State. The sex ratio is 1024 females for every 1000 males and become the ranking first in the Sex Ratio in Tamil Nadu. The percentage of literacy is 86.52. The district has 20% of SC population to the total population as per 2011 population census. The average literacy rate of Thoothukudi in 2011 was 86.16 compared to 81.52 of 2001. If things are looking out at gender wise, male and female literacy were 91.14 and 81.33 respectively. For the 2001 census, same figures stood at 88.32 and 75.13 in Thoothukudi district. Total literate in Thoothukudi district was 1,349,697 of which male and female were 703,106 and 646,591 respectively. In 2011 census, the child sex ratio is 963 girls per 1000 boys compared to figures of 953 girls per 1000 boys.

According to the 2011 Census, the Thoothukudi district population is approximately 1.74 million as opposed to 1.57 million in 2001. The sex ratio works out to 1023 in 2011 as compared to 1050 in 2001. The decadal (2001-2011) growth rate is 10.56 per cent. The density of population in Tamil Nadu, a true indicator of population distribution, is 340 persons per sq. km in 2001, as against 369 in 2011. Thoothukudi district is today the most urbanized district in the State with 50.15 percent of its population living in urban areas.

Thoothukudi has a host of industries including power, chemicals, and fisheries. The industries in Thoothukudi are Sipcot Estate, SIDCO Industrial Area and Co-operative Industrial Estate; Tuticorin Thermal Power Station (TTPS) has five 210 megawatt generators. The first generator was commissioned in July 1979. The thermal power plants under construction include the coal based 1000 MW NLC TNEB Power Plant. In addition to this there are several private plants like India Barath Power Limited, Coastal Energen and Captive Power plant. SPIC (fertilizers and chemicals), TAC fertilizer plan, Dharangadhara Chemicals (chemicals) and Kilburn Chemicals (titanium dioxide), heavy water plant, (A unit of BARC), NFC (Nuclear Fuel Complex) – Titanium and Zirconium sponge plant, Trans world Garnet Industries, AVM Jumbo Bags (SIPCOT), Sterlite (copper), Ramesh Flowers, Nila Sea Foods, St. John Freight Systems Limited, Kilburn Chemicals, Madura Coats, Export of Senna leaves (medicinal value) and Salt industry. Thoothukudi city is the headquarters Tamil Nadu Merchantile Bank Limited. It is one of the fastest growing banks in India during the period of 2007-12. Its total business is worth of 360 billion. The bank targets a total business of 500 billion INR in 2014-15. The city also has a research institute set up by Central Marine Fisheries Research Institute and Spices laboratory set up by Spices Board of India. Such activities contribute a lot of pollution load to the coastal area and almost entire basin. The coastal area of Thoothukudi receives waste water via. 20 numbers of sewage outfalls. Sewage, aquaculture and non-aquaculture industries contribute major pollution loads. The urban effluents of Thoothukudi including significant industrial effluents contained loads of organic matter and anthropogenic metals.

The city generates waste water of around 18 MLD which consists of a mixture of domestic sewage and industrial waste water of some small scale industries. It has been observed that no treatment facilities are available for sewage treatment and is disposed off directly into the sea through canals. Major industries situated along the coastal stretch include: Thoothukudi Thermal Power Station (TTPS), Southern Petro Chemical Industries (SPIC), and ThoothukudiAlkali Chemicals (TAC) 5. These industries are the manufacturers of

various chemicals including caustic soda and fertilizers. They contribute waste water quantity of around 11MLD. Thoothukudiis basically a harbour city which attracts a lot of tourists and industrialists. This leads to the development of numerous recreational spots and resorts which automatically discharges plastic and other wastes near the coast.

The quality of marine water is of utmost importance as it has an immense impact on aquatic ecosystems including marine life. Hence, data on the quality of coastal water is very important for understanding the environmental conditions. When pollutant inflow into sea breaches the threshold level, the coastal organisms are threatened (Puthiya Sekar et al., 2009). In recent years, Thoothukudi coast has remarkably affected by various pollution activities which altering the coastal ecosystem rapidly and this trend have been prevails not only in the coastal area of Thoothukudi but also at the global scale. Further, the issue of marine debris has assumed enormous proportions in the wake of growing coastal human population and fast industrialization in the past few decades (Critchell and Lambrechts, 2016). Sweet et al. (2019) reported that plastics constitute about 60–80% of the marine debris. Being cheap and durable, plastic is produced and used on an ever increasing scale (Rocha-Santos and Duarte, 2015). Plastics have the potential to cause ecological damages. Plastic litter entering the marine systems affects at least 800 marine and coastal species in several ways like ingestion, entanglement and harmful alteration of surroundings (Sweet et al., 2019).

Growing human population and escalating demand for plastic have brought about the present plight. However, there is only paucity of measures to conserve and manage the environment (Lotze et al., 2011). Timely intervention initiatives have recovered many ecosystems in the past (Moreno-Mateos et al., 2017).

The coast of Gulf of Mannar (GoM) is 365 km long, extending from Rameswaram in the north to Kanniyakumari in the south bordering the districts of Ramanathapuram, Thoothukudi (Tuticorin), Tirunelveli and Kanniyakumari. This coast harbours a rich biodiversity of 4223 species of marine plants and animals (Balaji et al., 2012). It is endowed with key coastal habitats like coral reefs (with 117 coral species), sea grass meadows (with 14 seagrass species) and mangrove forests (with 11 species). There are 21 islands in GoM surrounded by coral reefs (Edward et al., 2007). The reef region of GoM is one of the four major reef areas in India. In 1986 Government of Tamil Nadu created Gulf of Mannar Marine National Park comprising these islands and the coastal waters surrounding them. In 1989 Government of India formed Gulf of Mannar Marine Biosphere Reserve out of the entire GoM. Small-scale fishermen, numbering over 100,000, depend solely on the coral and sea grass associated fishery resources of the coast for livelihood (Edward et al., 2012). Due to the increasing demand, livelihood-linked destructive fishing activities such as trap fishing, shore seine, purse seine and bottom trawling are common in GoM (Patterson et al., 2016; Raj et al., 2017).

OBJECTIVES

1. To physico-chemical parameters of surface water in the coastal areas of Thootukudi district

2. To estimate marine fish production in Thoothukudi compared with Tamil Nadu

METHODOLOGY

The study was focusing on the coast of Thoothukudi district, which is located between latitude 9° 5′37.63″N to 8°20′11.65″N and longitude 78°23′10.20″E to 77°58′37.31″E in the southeast of India. Endowed as it is with a wealth of biota including the once famous pearl oysters, chanks, coral reefs, seagrasses, and mangroves apart from the perennial Punnakayal estuary, the 164-km long Thoothukudi coast is important not only to GoM but also to the entire state of Tamil Nadu as the district is commercially finest and important with a major port, fishing harbour, thermal power plants, fertilizer and chemical industries, heavy water and desalinization plants, many seafood processing units and salt pans. The city of Tuthoothukudi has a population of 237,830 as per 2011 census. With dense habitation the city produces around 18 MLD of domestic sewage, which, untreated, continuously flows into the sea (Meiaraj and Jeyapriya, 2019), aggravating the condition of the already stressed marine environment. Further, the coast has very important pilgrimage/tourist destinations (Tiruchendur and Manapad), local recreational beaches (Harbour and Muthu Nagar) and fish-landing sites.

The ocean covers approximately 70% of the earth's total surface area. In the total water content of the earth, 97% is present in the oceans. Oceans are rich source of biodiversity in which population may exceed in trillions. Oceans are the main regulatory agent of the earth's climate. About 60% of the world's population live within 60 km of coastline and use the coastline for their livelihood. It was thought that human being, living only on one-third of the portion of globe, cannot pollute this vast amount of water, as the marine ecosystems are capable of serving as sink for all the pollution caused by us. However, in reality this is not true. We have come to realize that our waste, even in small quantities, has huge effect on ocean communities and species. However, it is

difficult to believe that something so massive and seemingly resilient can really be adversely affected by our activities. Environmental pollution of the coast, inshore water and deep ocean is one of the important topical issues in the context of human health and global warming. The major pollutants like oil in coastal and marine environments and their source are shown in Figure 1. Coastal environment plays a main role in nation's wealth by virtue of the resources, productive habitats and rich biodiversity. The contamination of seawater, including trace metal concentration affects marine organisms and then people consuming them causing some carcinogenic and non-carcinogenic impacts in their body. Hence, pollution prevention and cleanup activities are required to be taken. The seawater quality should be upgraded to meet the clean seawater standards and to make the seawater suitable for fishing. The main objective of this work was to study the physical and chemical characteristics of seawater in and around Thoothukudi coastal area at the fishing harbour, thermal power station and new harbour area for the months of August and September and October 2021.
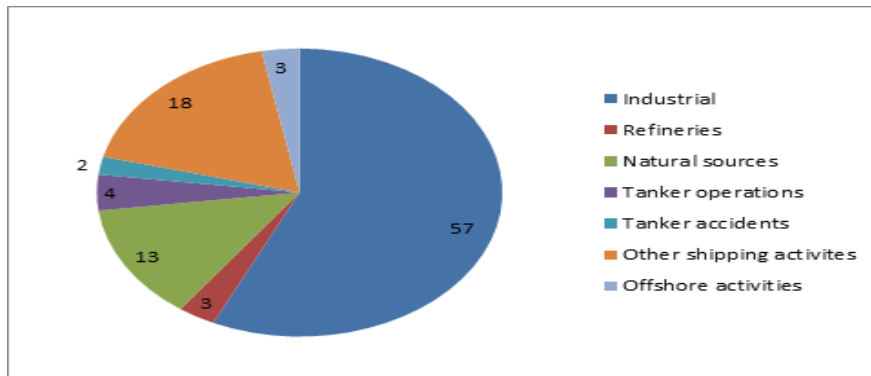
Shipping activities is also high near the coast, which contribute a considerable pollution load to the coast. Materials and Methods The surface water sample was collected on September 2015 and October 2015 for all the stations as per the standard methods mentioned by CPHEEO1 manual on water supply and treatment. The sample container was cleaned by 1.0 mol/L of nitric acid and left for two days followed by thorough rinsing by distilled water. The samples were collected in clean polythene bottles without any air bubbles. The bottles were rinsed before sampling and tightly sealed after collection and labeled in the field. The sample collection was carried out for the three stations shown in Figures 2a and 2b. Station 1: Near fishing harbour area in which the sewage of the Thoothukudi corporation population area is usually discharged into the sea. Station 2: Near the Thoothukudi Thermal Power Station area. Station 3: Near the ThoothukudiNew Harbour area in which the major port activities take place. The temperature was measured in the field itself at the time of sample collection as per standard methods. The pH value, calcium, magnesium, sodium, potassium, EC, carbonate, bicarbonate and chloride were analyzed as per the standard methods for the above collected samples and the average values are listed in Table 1.

Table:-1 Average values (August 2021 and September 2021) of the surface water quality for the selected sampling sites of Thoothukudi coastal areas.

Parameters	Site 1	Site 2	Site 3
Temperature (^{o}C)	29.1	30.1	31.3
PH	7	7.52	8.13
Sodium (mg/l)	7824	7219	7532
Calcium (mg/l)	356	372.3	391
Magnesium (mg/l)	996	953	1037
Potassium (mg/l)	245	248	272
Carbonate (mg/l)	26	26	26
Bi-Carbonate (mg/l)	62.7	58.2	72.13
Chloride (mg/l)	18748	17988	18857
Oil and grease (mg/l)	10	11.22	11.21
EC dS/m)	46.13	43.87	44.10
Sodium absorption ratio	47.18	45.62	44.78
Calcium carbonate (meq./l)	0.81	0.81	0.81
Calcium bicarbonate (meq./l)	1.23	0.99	1.56
Magnesium chloride (meq./l)	89.01	87.64	92.53
Sodium chloride (meq./l)	332.78	362.81	362.11

Source: Primary sample tested at different sites.

Table: -2 Marine Fish Production in Thoothukudi District (Quantity in Tones)

Year	Tamil Nadu	Thoothukudi	Average Growth Rate
1992	307349	39575	--
1993	317716	39137	-1.11
1994	330729	37201	-4.95
1995	341317	33658	-9.52
1996	350790	34478	2.44
1997	356487	33609	-2.52
1998	377483	48140	43.23
1999	373926	41678	-13.42
2000	372402	41275	-0.97
2001	373861	41423	0.36
2002	379214	31587	-23.75
2003	381148	32910	4.19
2004	307693	28246	-14.17
2005	389713	50190	77.69
2006	392191	44326	-11.68
2007	393267	46359	4.59
2008	391677	48512	4.64
2009	397312	49000	1.01
AAGR			**3.11**

Source: Statistics of Marine Products Exports Development Authority

2008, Cochin, India,

FAO Year Book of Fishery, USA,

Statistics and Commissioner of Marine Fisheries, Chennai

The above table-2 reveals that the total marine fish production in Thoothukudi district increased from 39,575 tonnes in 1992-1993 to 49,000 tonnes in the year 2009-2010. The sudden increase of total marine fish production noticed in the year 1998-1999 was due to the favourable fish catching. The AAGR has not been consistent during the reference period as the fish catch varied widely and the annual average growth rate is 3.11 per cent.

Species-Wise Marine Fish Production in Thoothukudi

The species-wise marine fish production in Thoothukudi district is depicted in the following table 4.30. It reveals that, species-wise marine fish production in 2007-2008 is 46,359.15 tonnes in Thoothukudi district. The total marine fish production in Tamil Nadu is 3,93,267 tonnes in 2007-2008. The share of species-wise marine fish production in Thoothukudi is 11.79 per cent for the year 2007-2008. The 100 per cent share of Oil sardines is produced in Thoothukudi district during 2007-2008 followed by Ribbon Fish, it contributes 52.06 per cent.

Table:-3 Species-wise Marine Fish Production in Thoothukudi District during 2007-2008

Name of the Species	Tamil Nadu	Thoothukudi	Percentage of share
Sharks	7085.63	1258.85	17.77
Skates & Rays	11990.76	3037.69	25.33
Eels	350.73	33.85	9.65
Cat Fishes	3954.68	457.57	11.57
Chirocentrus	24328.56	4619.62	18.99
Oil Sardines	4870.80	4870.80	100.00
Lesser Sardines	31506.81	4773.92	15.15
Hilsa Llisha	181.48	3.56	1.96
O. illisha	9.93	1.73	17.42
Anchoveilla	13609.42	1042.64	7.66
Thrissocles	2653.71	82.56	3.11
Clupeids	18245.80	1502.32	8.23
Saurida & Saurus	652.86	0	0.00
Hemirhampus	2273.47	167.22	7.36

Flying Fish	1614.14	102.36	6.34
Perches	20032.14	901.24	4.50
Red Mullets	8996.23	402.36	4.47
Polynemids	1809.72	120.36	6.65
Sciaenids	10918.86	1160.57	10.63
Ribbon Fish	3206.46	1669.36	52.06
Caranx	11533.72	1193.92	10.35
Chironemus	1526.72	535.80	35.09
Trachynotus	863.81	2.33	0.27
Ceryph aena	5.63	0	0.00
Elacate	499.28	0	0.00
Silver bellies	31365.97	2494.02	7.95
Lactarius	311.00	41.25	13.26
Pomfrets	2015.33	225.69	11.20
Mackerel	11632.20	271.58	2.33
Seerfish	5959.12	1120.35	18.80
Tunnies	4833.22	215.37	4.46
Spyreana	2160.97	811.54	37.55
Mullets	2497.49	0	0.00
Bregmaceres	992.67	2.35	0.24
Soles	7091.80	0	0.00
Panaeid Prawns	21701.39	2128.71	9.81
N.P. Prawns	948.65	0	0.00
Lobsters	628.28	41.66	6.63
Crabs	24268.55	2518.35	10.38
Cephalo pods	6325.24	1781.58	28.17
Miscellaneous	69316.19	2874.74	4.15
Drepane	324.17	0	0.00
Lethrinus	6570.41	1235.62	18.81
Sillago	4748.25	3.20	0.07
Balisteres	5712.89	2652.51	46.43
Ora	230.62	0	0.00

Source: Commissioner of Marine Fisheries, Chennai.

Table:-4 Species-wise Marine Fish Production in Thoothukudi District during 2008-2009

Name of the Species	Tamil Nadu	Thoothukudi	Percentage of share
Sharks	8459.00	1034	12.22
Skates & Rays	8022.00	980	12.22
Eels	399.00	49	12.28
Cat Fishes	4130.00	505	12.23
Chirocentrus	23883.00	2989	12.52
Oil Sardines	5242.00	641	12.23
Lesser Sardines	31695.00	3873	12.22
Hilsa Llisha	198.00	24	12.12
O. illisha	10.00	1	10.00
Anchoveilla	15926.00	1946	12.22
Thrissocles	4529.00	553	12.21
Clupeids	18546.00	2266	12.22
Saurida & Saurus	1112.00	136	12.23
Hemirhampus	2424.00	296	12.21
Flying Fish	3891.00	476	12.23
Perches	22923.00	2917	12.73
Red Mullets	11185.00	1611	14.40
Polynemids	1865.00	228	12.23
Sciaenids	12629.00	1543	12.22

Ribbon Fish	2424.00	296	12.21
Caranx	11677.00	1427	12.22
Chironemus	1747.00	214	12.25
Trachynotus	953.00	116	12.17
Ceryph aena	8.00	1	12.50
Elacate	518.00	63	12.16
Silver bellies	31770.00	3882	12.22
Lactarius	318.00	39	12.26
Pomfrets	2065.00	252	12.20
Mackerel	9557.00	1412	14.77
Seerfish	8938.00	1092	12.22
Tunnies	4845.00	592	12.22
Spyreana	2224.00	272	12.23
Mullets	2542.00	311	12.23
Bregmaceres	2065.00	252	12.20
Soles	7197.00	869	12.07
Panaeid Prawns	17951.00	2193	12.22
N.P. Prawns	5162.00	631	12.22
Lobsters	636.00	78	12.26
Crabs	26868.00	3283	12.22
Cephalo pods	6115.00	747	12.22
Miscellaneous	52230.00	6369	12.19
Drepane	238.00	29	12.18
Lethrinus	6475.00	791	12.32
Sillago	4646.00	568	12.23
Balisteres	5202.00	636	12.23
Ora	238.00	29	12.18
Total	**3,91,677.00**	**48,512**	**12.39**

Source: Commissioner of Marine Fisheries, Chennai.

The species-wise marine fish production in Thoothukudi district is depicted in above table-4. It reveals that, species-wise marine fish production in the year 2008- 2009 is 48,512 tonnes. The total marine fish production in Tamil Nadu is 3, 91,677 tonnes in the year 2008-2009. The share of marine fish production in Thoothukudi district is 12.39 per cent during 2008-2009 when compared with the total production of Tamil Nadu. However, the highest share of species-wise marine fish production is Lactarius and Lobsters, it contributes 12.26 per cent each.

Table:- 5 Species-wise Marine Fish Production in Thoothukudi District during 2009-2010 (Quantity in tones)

Name of the Species	TamilNadu	Thoothukudi	Percentage of share
Sharks	8538.85	1044.08	12.23
Skates & Rays	8097.88	990.16	12.23
Eels	440.06	53.92	12.25
Cat Fishes	4171.22	509.79	12.22
Chirocentrus	24700.02	3019.50	12.22
Oil Sardines	5331.10	651.94	12.23
Lesser Sardines	31996.38	3911.63	12.23
Hilsa Llisha	47.46	5.21	10.98
O. illisha	10.45	1.28	12.25
Anchoveilla	14033.95	1715.63	12.22
Thrissocles	4531.45	553.90	12.22
Clupeids	18644.04	2279.33	12.23
Saurida & Saurus	1160.91	142.15	12.24
Hemirhampus	2447.41	299.01	12.22
Flying Fish	3929.24	480.38	12.23
Perches	24180.86	2964.54	12.26
Red Mullets	12635.06	1620.03	12.82

Polynemids	1923.77	235.29	12.23
Sciaenids	12710.27	1553.87	12.23
Ribbon Fish	2485.19	303.94	12.23
Caranx	11789.41	1441.13	12.22
Chironemus	1803.86	220.58	12.23
Trachynotus	1001.63	122.54	12.23
Ceryph aena	6.80	0.83	12.21
Elacate	560.37	68.63	12.25
Silver bellies	32319.63	3950.84	12.22
Lactarius	359.76	44.12	12.26
Pomfrets	2086.76	254.89	12.21
Mackerel	11668.78	1426.42	12.22
Seerfish	9020.37	1102.90	12.23
Tunnies	4891.90	598.02	12.22
Spyreana	2284.51	279.40	12.23
Mullets	2886.95	352.93	12.23
Bregmaceres	2124.15	259.79	12.23
Soles	7176.35	877.42	12.23
Panaeid Prawns	30071.55	3676.34	12.23
N.P. Prawns	8058.57	985.26	12.23
Lobsters	719.81	88.23	12.23
Crabs	27064.55	3308.71	12.23
Cephalo pods	6815.47	833.30	12.23
Miscellaneous	34541.61	4566.58	13.22
Drepane	561.49	68.63	12.22
Lethrinus	6616.60	808.80	12.22
Sillago	5052.03	617.63	12.23
Balisteres	5413.09	661.74	12.22
Ora	400.07	49.02	12.25
Total	**3,97,311.64**	**49,000.26**	**12.33**

Source: Commissioner of Marine Fisheries, Chennai.

The above table-5 reveals that, species-wise marine fish production in the year 2009-2010 is 49,000.26 tonnes in Thoothukudi district. The total species-wise marine fish production in Tamil Nadu is 3,97,311.64 tonnes in the year 2009-2010. However, the share of Silver bellies is 12.22 per cent in 2009-2010. It is the maximum quantum of fish production in Thoothukudi district. The average share of Thoothukudi district is 12.33 per cent for the year.

RESULTS

The physico-chemical parameters of the collected surface water samples were analysed for the period of August 2021 and September 2021 as per the standard methods mentioned by the CPHEEO1 manual on water supply and treatment. The average values (August 2021 and September 2021) of the physicochemical parameters of the water samples were recorded and are tabulated in Table 1. During the study period, the average water temperature for the months of August and September 2021 varied from 30.1 ˚C to 31.3˚C for the three stations. The average minimum temperature was recorded at Site 1 and average maximum temperature was recorded at site 3. From these observations, it could be understood that the water temperature is governed by the atmospheric temperature of the area. The average pH value for the months of August and September 2021 of the water samples in the study area ranged from 7.52 to 8.13. The site 1 recorded average minimum pH value, while Site 3 recorded the average maximum pH value. Generally, during north-east monsoon period the pH value is slightly decreased, may be due to dilution effect of rainfall. The average value of sodium concentration for the months of August and September 2021 varied from 7824 mg/l to7532 mg/l. The average minimum was recorded at Site 2 and the average maximum was recorded at Site 3 due to cluster of industries located in those areas. The maximum value observed in Site 3 may be due to the discharge of untreated sewage and marine activities in the area. The average values of calcium concentration varied from 356 mg/l to 391 mg/l. The average minimum calcium concentration was recorded at site 1and the average maximum was recorded at site 3. The average values of magnesium concentration varied from 996 mg/l to 1037 mg/l. The average values of

potassium concentration varied from 245 mg/l to 272 mg/l. The average values of chloride concentration varied from 18798 mg/l to 18857 mg/l. From the study, it was found that sodium and chlorides values are found rich in coastal water. The average values of oil and grease and all other chemical parameters are found to be within the permissible limits as per Environmental Protection Agency (EPA), US Federal standards for harbour water.

There is a recognized connection between fisheries and marine ecosystem but gaps exist in the scientific knowledge of the impact of fisheries upon the ecosystem and of the impact of the environmental changes and pollution on fisheries. About 75% of world marine fish stocks are declining due to anthropogenic activities. Fish may be impacted by all human activities that alter the marine environment such as pollution by hazardous substances, industrial effluents and radioactive substances, excessive input of nutrients, introduction of alien species The responsible factors attributed are over-fishing, loss of spawning ground and introduction of anthropogenic material. The regulatory measures such as declaration of closed season, protection of endangered species and prohibition of destructive fishing methods by all maritime states will help in protecting the fishery resources for future generation (Shenoy and Biradar, 2005).

The seas around India have become quite vulnerable to man's destructive forces of pollution (Qasim and Kureishy, 1986). Where coastal land or waters are altered for human activities the habitat of other resident species (terrestrial, freshwater and marine) is also altered. Some of these habitat changes may completely remove resident species. Others may harm some species and benefit others, altering the ecosystems themselves. Pressures from coastal pollution may affect the quality of life of estuarine and coastal waters. Large inputs of wastes of domestic and industrial nature including oil pollution has burdened the marine environment, the effect of which can be seen in reduced biodiversity at several hot spots and decline in fish catches. Coastal developmental activities contribute to habitat loss in a number of ways (Menon and pillai, 1996). A number of exotic species, their larval and larger forms are brought and introduced to our water bodies through ballast water. The projected climate change could have multiple effects, including changes in ocean currents, salinity and surface temperature. Marine environment and its associated fauna and flora needs constant vigil and monitoring.. The following points appears to be important in this regard.

CONCLUSION
The research results reveal the quality of surface water present in and around Thoothukudi district coastal area. The physico-chemical characteristics of the collected seawater samples were analysed for the period of August and September 2021 and it was observed that all physico-chemical parameters and oil and grease values were found to be within the permissible limits as per marine water standards and the waste water was suitable for marine organisms at present in that area. This can be maintained by proper management and disposal of wastewater.

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PRE-DEPARTURE CROSS-CULTURAL TRAINING OF INDIAN EXPATRIATES ON INTERNATIONAL ASSIGNMENTS

SUNAYANA AND NADIA ASHRAF KHAN

ABSTRACT

The study explores the pre-departure training requirements among Indian expatriates relocated on international assignments to various locations across the world by delving into their narrative and experiences. Thematic analysis was applied to in-depth interviews with 21 Indian expatriates across seven countries. Respondents described their expatriation experiences and the challenges they faced in the host countries even after receiving some form of pre- move training. As a result critical areas in which the parent organizations ought to have imparted training were identified, thereby, laying a foundation for the organizations to redesign their training programs and focus on the identified training gaps.

INTRODUCTION

One of the biggest and most complex challenges faced by organizations is managing the international human resources. The ever evolving business world, unprecedented world politics, wars, economic integration and disintegration as well as natural disasters like the recent COVID-19 pandemic, all impact multinational organizations and hence, management of their international workforce. Assignment failure rates due to expatriate failure are high and cost the organizations a lot (Scullion & Brewster, 2001) and it is a looming concern for MNCs to mitigate this failure. 16% to 40% of expatriates experience what is known as cultural shock. This is due to lack of cultural awareness and cross-cultural competence (Andreason, 2003; Chen & Chiu, 2018) . One of the most important ways to do that is pre- departure training of expatriates. Although the benefits of such training programs are widely known, there is still an inadequacy in the effectiveness of these programs. "A vital aspect of any CCT (Cross-Cultural Training) program involves determining how training effectively enhances expatriates' cultural knowledge and skills and facilitates expatriates' adjustment to the host country's culture (Tarique & Caliguiri, 2004). However, there is very little clear guidance in the existent literature to design the best cross-cultural training (CCT) programs so that employees can develop effective cross-cultural management knowledge, skills, and abilities (Taras, Liu, Mehta, Stackhouse, & Gonzalez-Perez, 2020). Interviews revealed that the organizations imparted some form of training but it lacked effectiveness and adequacy. The training programs were either too short to benefit or not tailored as per requirements. As a result the expatriates faced a lot challenges and hence based on their personal experiences were able to provide feedback on their respective training programs.

Pre-Departure Training of Expatriates

It was as early as 1981 that (Tung, 1981) classified cross-cultural training programs into six categories based on, 'the rigour with which the program seeks to impart knowledge and understanding of a foreign country'. These categories include: Factual information about geography, climate, housing and schools; Cultural orientation, providing information about the cultural institutions and value systems of the new country; Cultural assimilation training, consisting of brief episodes describing intercultural encounters; Language training; Sensitivity training to develop attitudinal flexibility; Field experience, where candidates can undergo some of the emotional stress of living and working with people from different cultures. Later on in 1990 (Black & Mendenhall, 1990) and after that so many researches emphasised the importance of cross-cultural training for a better enhanced as well as effective performance by expatriates in completing the international assignment. All these studies contributed to what is cited today as a widely accepted fact that training adds to skills and knowledge to understand and successfully function in the new unfamiliar host culture. It reduces miscommunication, leads to management of cultural differences so that it doesn't become a hindrance in the way of performance. These are the reasons why cross- cultural training is very important in the context of expatriation as stated by (Selmer, Tobiorn, & de Leon, 1998) and (Bennett, Aston, & Colquhoun, 2000). (Evans, Pucik, & Barsoux, 2002) stated that there are three main concerns regarding training of expatriates. First is the different training methods; second, the timing of training; and third regarding preparation of the spouse and family. Previous studies indicate Cross-Cultural Training (CCT), preliminary visits, language training and assistance with practical day-to-day matters as essential components of pre-departure training programs that contribute to a smooth transition to a foreign location include (Dowling, Schuler, & Welch, 2004). (Okpara, Kabongo, & Lau, 2020) surveyed 198 Chinese expatriates in Nigeria and found that both pre-departure and post-arrival trainings have significant and positive

influences on their adjustment. The results also demonstrated that language training and previous overseas experience to have positive effects on adjustment. Another recent study by (Tahir, 2021) investigating the cross-cultural training (CCT) provided to European expatriate executives relocated to New Zealand indicated that at least some form of CCT was provided to all interviewees. Results revealed that the training content seemed to be strongly job related, with little focus on the culture of the host country. However, spouses or children did not receive any training before or after their arrival in New Zealand which led to dissatisfaction and unadjustment among both expatriates as well as their trailing families. The literature on pre-departure training directs towards the following conclusions (Forster, 2000). One, even though there are a wide array of definitions of an 'Expatriate', most researchers recommend the same or similar types of training for an international workforce. Two, the training policies recommended by these authors are always more rigorous and wide ranging than those actually employed by most of the multinational organizations. Three, most researches are critical of the lack of or the quality of training. Four, most of the evidence cites that cross-cultural training positively effects cross-cultural adjustment, however varied this effect may be. Five, assessments of how effective cross-cultural training has been is based on either anecdotal evidence or on self-report questionnaires after the assignment, rather than looking at the effectiveness of training before and during the international assignment.

METHODOLOGY

In- depth interviews which are a great tool for qualitative research, (Lindolf & Taylor, 2002) were conducted with 21 Indian expatriates working in various countries. The countries of relocation included USA, Mexico, Germany, Austria, England, Sweden, Kenya and UAE. Like many previous studies carried out by researchers in the area of expatriates, this study too used purposive snowball sampling method to identify Indian employees that had relocated to countries across the world for international assignments. Time period of data collection lasted from April 2020 to September 2020. Telephonic interviews were conducted in English and covered questions about the demographic profile of the respondents; age, gender, tenure in the organization, duration of the current assignment, previous international experience, relationship status and educational qualification. Focus was on training related details. Questions were asked about the pre-departure training imparted by the parent organization, perception of adequacy of the training program, challenges faced by the expatriates in the host country location, and the areas that should have received more focussed training before relocation. 8 expatriates were accompanied by spouses while 13 were single and/or travelling alone. The average age of respondents was 30 years. 50% respondents had previous international experience and 90% of the expatriates had worked abroad for more than two years. Participants were interviewed individually for around 30 minutes on an average. Unstructured interviews are cited to be as most significant for extracting peoples' narratives (Kaasila, 2007). The sample size in narrative research is usually kept as less in numbers to collect extensive information (Butina, 2015; Overcash, 2003); hence we restricted the number to twenty- one expatriates. The interviews were then transcribed for qualitative analysis. Table 1 depicts the demographic profile of the respondents.

Table 1: Demographic Profile of Respondents

S. No	Age in Years	Gender	Host Country	Accompanied by partner/Spouse	Previous International Experience
1.	28	M	USA	No	Yes
2.	30	M	USA	No	No
3.	30	M	USA	Yes	No
4.	28	M	England	No	No
5.	30	M	Austria	No	Yes
6.	27	M	Kenya	No	No
7.	31	M	Germany	No	No
8.	30	M	USA	No	Yes
9.	35	M	Mexico	Yes	Yes
10.	33	M	UAE	Yes	No
11.	28	M	Germany	No	Yes
12.	29	M	Germany	No	Yes
13.	29	M	Austria	No	No
14.	31	M	Germany	No	Yes
15.	28	M	USA	No	No
16.	28	M	Mexico	Yes	No

17.	28	F	Kenya	No	Yes
18.	27	F	England	Yes	Yes
19.	31	M	UAE	Yes	No
20.	28	M	USA	Yes	Yes
21.	30	M	Sweden	Yes	No

Participants provided narratives that included their own life experiences and challenges as expatriates in host countries. The study was centred around two questions; identifying the main critical areas of pre-departure training at the time of relocation of expatriates and identifying the advantages of a good comprehensive pre-departure cross- cultural training program.

DATA ANALYSIS

Thematic analysis was performed on the data using NVIVO 12 which is a qualitative data analysis software program. The analysis was carried out manually to determine significant themes (Braun & Clarke, 2014). Transcripts were exhaustively coded which led to identification of six themes broadly summarizing critical areas of pre- departure training for expatriates. Data analysis also identified main advantages of pre-departure training. Themes, supported by statements and extracts from the interviews as evidence, are presented in the following sections of the study. Table 2 gives details of the thematic analysis.

RESULTS AND DISCUSSION

Interviews revealed that a looming concern among expatriates is an inadequate training imparted by the parent organization before relocation. A good comprehensive training program is believed to enable better adaptation and adjustment as well as successful completion of assignments. Familiarity with the host country culture, language, workplace culture and work ethic as well as general living conditions is viewed as very crucial by the respondent expatriates.

Participants that had moved to non- English speaking countries like Kenya, Mexico, Germany and UAE strongly emphasised on the importance of comprehensive language training for themselves as well as their partner or spouse. These countries were seen as ethnocentric countries that did not prefer the use of English over their local languages. A respondent relocated to Austria, when asked about what he wished to have known before relocation, stated:

"If you are sent on a year long assignment, you sometimes have to interact with people from other departments, local staff etc that do not speak English and hence, hindering communication."

Another respondent stated: *"During my stay in Germany I realised, you will not be able to put in 100% effort in your work if you do not know the language, even if you want to. It is important to have some social etiquette training, training in non- verbal communication and to know what's acceptable in their culture and what's not."*

"It was difficult to go even grocery shopping without knowing at least a few common words and phrases", stated Indian expatriates in Germany and UAE.

An interesting finding revealed that respondents relocating to even English speaking countries laid strong emphasis on communication training; verbal as well as non- verbal, to ensure they were well versed with the socially appropriate and acceptable behaviours.

"While I was yet to receive a permanent housing arrangement, I stayed in a hotel where I learnt that you were supposed to make the bed yourself. I asked the hotel staff to do it only to realise later on that it was weird and unacceptable.", stated a respondent from Germany.

An Indian manager relocated to Germany stated that it was inappropriate to make jokes in the work setting while it was totally acceptable in the United States of America.

Respondents from Mexico complained of an inadequate training program from their parent organization which lacked the basic language training, non- verbal communication as well as training in social behaviour. The same respondent went on to state:

"There was a situation when my boss asked me for coffee.I replied I was good and turned him down only to realise later that he wanted to talk about my work and that in American culture that's how your boss will initiate if he wants to talk about your work". Hence, emphasising the importance of training in social norms and etiquettes.

Respondents from Kenya pointed out the importance of *"knowledge regarding the social background, history and social situation of the place as well as a political understanding especially when the host country is culturally so distant from the parent country."*

Hence, it is important to understand how culturally distant is the host country from the home country and then devise training programs accordingly. If the country is farther in terms of cultural distance, it is important to impart a well rounded 360 degree training on historical background, political as well as cultural understanding of the place.

For expatriates moving to the US or UK, work and work ethic related training was very important.They pointed out the need for training on how to work in a team environment, how to hold a team together, how to play leadership roles in a multicultural workplace and higlighted the need for technical job-related training. They also emphasised need for training in social norms and etiquette so that an expatriate is well aware of how to conduct oneself in the foreign culture.

"Some countries encourage task and goal oriented approach at work places with a strict mechanic work ethic while in others there is a more free and friendly workplace atmosphere, and pre-departure trainings need to equip expatriates with such information."

Anoher interesting theme identifies from the interviews is the importance of training regarding general living conditions and way of life in the host country; climatic conditions, housing, travel, healthcare etc. Expatriates if not familiarised with this information end up being frustrated and unadjusted thereby leading to unsuccessful completion of assignments, and desire to repatriate early.

A very important antecedent of expatiate adjustment and completion of international assignments is spousal adjustment and satisfaction stated (Caligiuri, Hyland, Joshi, & Bross, 1998; Takeuchi, Yun, & Tesluk, 2002; Linehan, 2002; Cole & McNulty, 2011; Lauring & Selmer, 2010). This includes language training for the spouse, verbal as well as non-verbal communication, career opportunities for the spouse as well as education opportunities for the children. The same is cited to have crossover and spillover effects on the adjustment of expatriates themselves (Takeuchi, Yun, & Tesluk, 2002). The same findng was revealed by the current study. Respondents stated that one important area that needs more detailed and adequate training is imparting training to the partner/ spouse.

"Your spouse also cannot adjust and fit into the community if she doesn't speak the local language."

"In contemporary era of dual career couples, it is imperative that my spouse is provided equal support and employment opportunities. Why would she leave a career behind and relocate otherwise!"

"While I have a fulltime job and know people from work, my partner goes around exploring the place, shopping or travelling locally and for that she needs to have a knowhow of the local language, without which it's unimaginable difficult to adjust to an alien culture."

While the world has started to close down due to COVID 19 and nowhere to go, it looks probable that the only interaction there is going to be is with a select few neighbours and the local grocer and if there is no local language training, it is going to be even more difficult."

Interviews revealed another important finding. While relocating, expatriates want the parent company to help them nerwork with other expatiates at the host location. Networking with other expatriate groups and families help them build familiarity in an otherwise unknown territory. This ensures the expats and their partners/ spouses do not find themselves alone and struggling and also receive help with settlement and adjustment process.

"It was easy on us after relocation because of the other Indian families we came to know here in sweden. They have become like family, took us around to explore the city. I didn't have to go looking where to buy clothes or groceries from. While I am away at work, my partner is spending good time with other expattiate wives."

Table 2: Thematic Analysis

Themes	Evidence
Communication (Verbal/ Non verbal)	"If you are sent on a year long assignment, you must interact with people from other departments, technicians etc who do not necessarily speak the common language English and hence, there are hurdles in communication. Your spouse also cannot adjust and fit into the community if she doesn't speak the local language."

General Living Conditions (Cilmate, housing, healthcare, travel)	"I moved on to Mexico and the apartment allotted by the company could not be reached the same night as it was too far away. I had to spend the night at a hotel with my wife. The next day we were told the apartment wasn't available for some reason and were provided a makeshift place which did not even have heating. One of the taps was leaking and we woke up in the middle of the night to a flooded apartment. That night my car was stolen. My wife was horrified and the first thing I did was to make arrangements to send my wife back home."
Work culture, work ethic	"If you are sent on a year long assignment, you must interact with people from other departments, technicians etc who do not necessarily speak the common language English and hence, there are hurdles in communication. Your spouse also cannot adjust and fit into the community if she doesn't speak the local language." "Some countries encourage task and goal oriented approach at work places with a strict mechanic work ethic while in others there is a more free and friendly workplace atmosphere, and pre-departure trainings need to equip expatriates with such information."
Cultural training (cultural norms, etiquettes, social norms)	"It is important to have knowledge regarding the social background, history and social situation of the place as well as a political understanding especially when the host country is culturally so distant from the parent country."
Training to spouse/ partner	"In contemporary era of dual career couples, it is imperative that my spouse is provided equal support and employment opportunities. Why would she leave a career behind and relocate otherwise" "While I have a fulltime job and know people from work, my partner goes around exploring the place, shopping or travelling locally and for that she needs to have a knowhow of the local language, without which it's unimaginable difficult to adjust to an alien culture"
Networking with other expat groups	"It was easy on us after relocation because of the other Indian families we came to know here in sweden. They have become like family, took us around to explore the city. I didn't have to go looking where to buy clothes or groceries from. While I am away at work, my partner is spending good time with other expattiate wives."

Word Cloud of Cross- Cultural Training Requirements of Expatriates

A word cloud was generated using NVIVO 12 for a better visual understanding of the training requirements of Indian expatriates relocating abroad. The word cloud depicted in Figure 1 is based on the 1000 most frequently appeared words in the narratives of participants. The words language, work, spouse took the centre. In a word cloud the size of a word depicts the number of times it appeared in the narrative and its significance in the study. Language, work culture and ethic as well as spouse are the major factors affecting the adjustment of expatriates and hence also demand greater attention in terms of pre- departure cross- cultural training.

Fig 1: Word Cloud based on training requirements of Expatriates

Word Tree Analysis

The word tree was generated in NVIVO 12, centred on the word "Training". It helped to understand visually the importance of pre- departure training of expatriates and helped identify the crucial areas that require training, hence addressing the research question of the current study. The word tree is depicted in Figure 2. Word trees visually display the connection of words in the dataset, providing a context to their use. Words that are more frequently or strongly associated with a given word are displayed in a larger font. Hence, word trees don't only categorize associations but also depict the strength of these associations. A word tree also shows how frequently certain words appear together for example in the current study the word "training" is commonly preceded by 'language', 'general living', 'non- verbal communication', 'work ethic' and 'social etiquette'. Similarly, it is followed by 'for' and 'in' in most cases depicting the importance of the word in the given context. It elaborates and shows an inclination of expatriates towards training programs inclusive of the above mentioned areas. The word 'training' is also followed by 'parent organization' highlighting the importance of role of parent organization. Another interesting finding is the appearance of the word 'spouse' in the word tree. It emphasises how important partner or spouse training is through the prism of expatriates.

Implications and Limitations

The current study contributes to the existing literature on the importance of pre- departure training for expatriates. Although there has been massive research in the area of expatriate training programs and their importance, there is very little research conducted on Indian workers relocating to various countries around the world. The study conducted one on one interviews and heard the narrative from expatriates themselves. Although the respondents did receive some form of training prior to their relocation, yet they reported the training to be inadequate, thereby giving organizations an insight into how to redesign their pre-departure training programs. The study also pinpoints major important training areas as experienced by expats post arrival at the host location. The study could provide a foundation for quantitative research and the interviews could be used to support quantitative findings as done in data triangulation.

There are, however, a few limitations in the current study which leave way for future research. The research can be further enriched by increasing the sample size. Furthermore, various other host countries where Indian workforce relocates can be identified and included in the study.
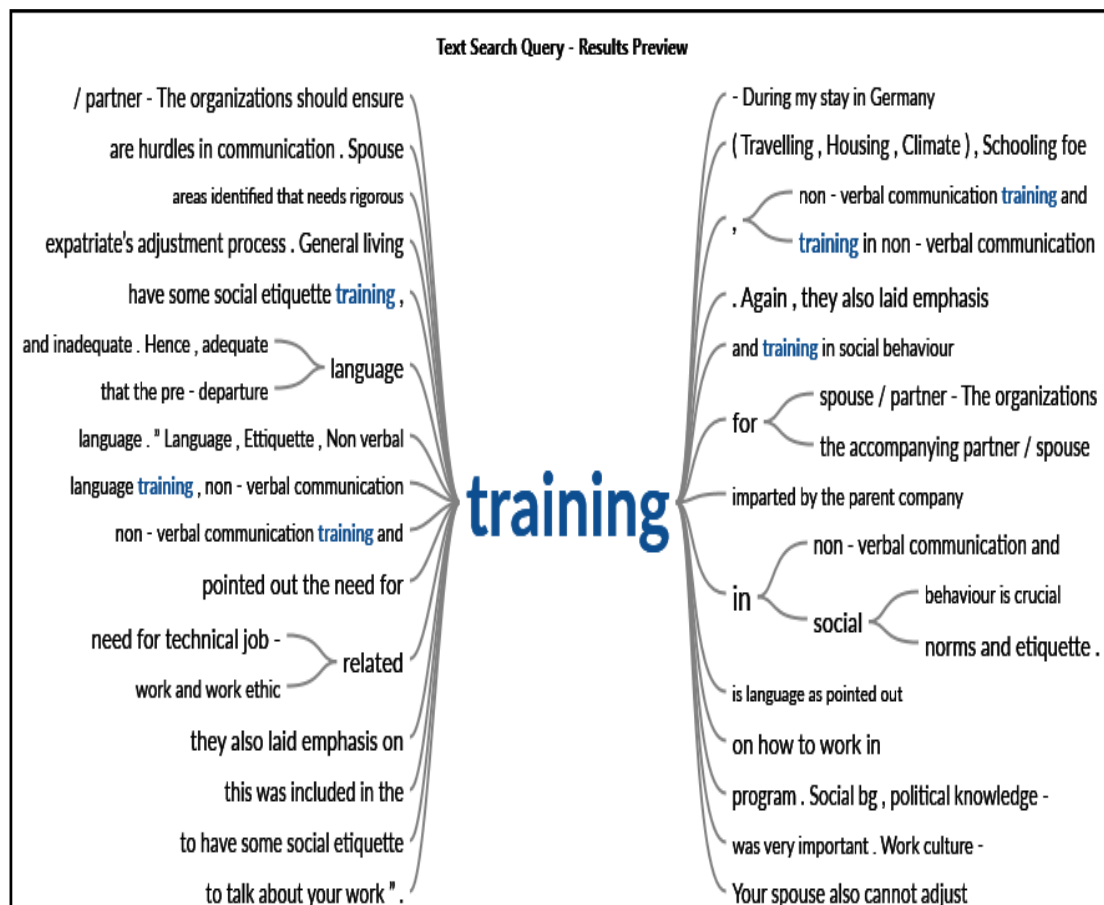
Fig 2: Word tree centred around the word 'Training'

The data for the current study was collected in the initial COVID-19 pandemic period, just when the pandemic had started. However the pandemic brought massive changes in the way workforce operates and the way organizations deal with international human resource. These are very important factors that need to be identified and incorporated in future research.

Figure 3: Diagrammatic Representation of Identified Themes

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CROP PREDICTION BASED ON NOVEL HYBRID DEEP LEARNING MODEL AND IOT

DR. KRISHAN KUMAR GOYAL AND DR. SANDEEP KUMAR JAIN

ABSTRACT

Agriculture is one of the most significant economic sectors in every country. The goal of "smart agriculture" is to achieve precise control of agricultural farming practises including irrigation, fertiliser use, disease and pest avoidance, and so on. Wireless sensor networks, often known as WSNs, are put to use in the agricultural industry to collect data and then transmit that data to servers through a wireless connection. This work presents a multiclass model based on a hybrid deep learning classifier approach (CNN + LSTM). Eighteen input characteristics were utilised to create the model, and crop yield was found and organised into three key components. When creating the multiclass model, the relative significance of the components is taken into account. For categorization of 3 crops: rice, groundnut and sugarcane, an objective function is defined. Furthermore, data visualisation analysis is utilised to identify essential approaches in progress of smart agriculture that may efficiently increase efficacy of production and assure agricultural product quality. Smart agriculture is progressively being incorporated into agricultural production, and advent of the Internet of Things (IoT) is giving it a technological boost. Agricultural tasks may be precisely accomplished using the IoT' detecting, ID, transmission, observing, and input capacities, which saves farmers' time and enhances crop yields and advantages them in long run. We installed Smart Agriculture IoT equipment in the farm for monitoring reasons and used the algorithm in our research to do an actual-scenario analysis; the findings show that this suggested scheme is actually practical. The categorization findings are compared to the results acquired from on-the-ground agricultural specialists.

Index Terms: data visualization analysis, deep learning classifier, hybrid classification, smart farming.

I. INTRODUCTION

For individuals in India, agriculture is a primary source of income, and it is essential to the development of the regional livelihoods. Despite the widespread use of information technology in other sectors of society, such as manufacturing, pollution monitoring, and other areas of life, conventional agriculture production is still mostly reliant on manual labour [1]. The extensive use of wireless sensor networks (WSNs) in agriculture is evidenced by the fact that they are useful in monitoring soil information in appropriate locations and supporting its use of conventional irrigation systems, among other things. This technology has the potential to improve irrigation practises and make agriculture more intelligent [2] by collecting data throughout the agricultural production system [1].

WSNs are an essential component of the idea of "smart agriculture" due to the fact that they monitor and collect data of interest from agricultural areas for use in a variety of applications. Smart agriculture requires significant effort to accomplish highly precise irrigation, fertilisers, and pesticides based upon that crop approach to development and WSNs in agriculture. This is done to reduce wastage of water, fertilizer application, fertiliser abuse, and illnesses. Smart agriculture also uses WSNs in agriculture. WSN sensor nodes located in fields are able to gather soil data and wirelessly transmit it to the sensor nodes [3]. In [4], the authors use WSNs to collect data on temperature, humidity, soil moisture content, and wind speed.

Because of mediators' lack of knowledge about crop production and yield, the farmers who laboured during the full growing season get paid less (agents for bargaining). Farmers' hard labour would not be in useless if they were given proper instruction or support in crop cultivation, yield pricing, and crop selling. If not, crop output will be diminished, affecting the country's economy. As a result, if the government provides appropriate support for these abilities in addition to the conventional manner of conducting agricultural, the country's economy will considerably improve [5].
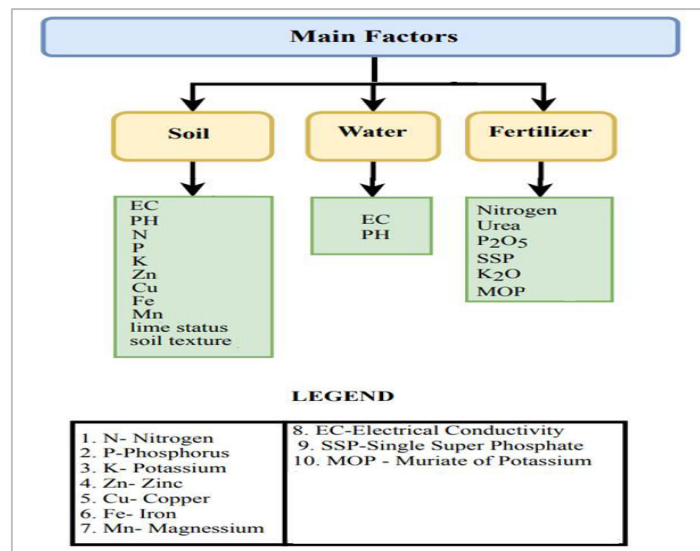
Fig 1: Primary factors and comparing sub-factors distinguished for the multiclass model.

This research suggests using Intelligent Agriculture to analyse farm data. The following are some of the characteristics of our Intelligent Agriculture platform: (1) IoT sensors for temperature, humidity, illumination, atmospheric pressure, irrigation and electrical conductivity of soil, with data sent to the platform every 10 minutes by the system; (2) A Python-based online application that aids in the collection of data from IoT devices. The suggested Intelligent Agriculture system makes use of inexpensive sensors, which makes Intelligent Agriculture systems more popular. This study analyses the data collected from the Intelligent Agriculture system and also makes use of publicly accessible datasets. The analysis' objectives include examining a farm's environmental conditions and selecting appropriate crops for development. In addition, the study investigates the environmental features of farms in order to get a better understanding of how different weather conditions influence changes in the environment and to determine which crops are suitable for the farm based on the sequence in which they are grown. For creation of the multiclass model, data on the chosen primary components, namely soil, water, and fertiliser were collected for multiple crops from three different regions of Maharashtra, India.

The following principles are included in our suggested data analysis approach: (1) IoT sensors are used to collect data from farm fields. (2) Using WSN, data may be sent from a farm field to a device. (3) data collection and standardisation; (4) data analysis to examine the relationship between various environmental factors and, as a result, the farmers' rules of thumb; (5) determining if a chose crop has been planted in the proper soil; and (6) setting a basic worth in cluster dependent on future conditions and exhorting on whether a harvest is appropriate for farm (7) The hybrid multiclass classifier system is compared to the outcomes of other traditional classifiers including Nave Bayes, Random Forest, and SVM.

The proposed data analysis technique has been put to the test, and it has helped determine if locally grown crop is a good fit. The suggested method is feasible, and helps farmers comprehend their farm's environmental indices, according to results of the experiments. The temperature of the air, the pressure in the atmosphere, the humidity, the amount of soil moisture present, the amount of light, and the electrical conductivity of the soil may all be measured by IoT devices. Sensors will be used to assess soil macronutrients such as nitrogen, phosphorus, and potassium, as well as other soil parameters such as moisture, pH, and temperature.

Organisation of paper as section 1 gives introduction about smart agriculture, section 2 presents literature review, section 3 depicts the proposed system model, Section 4 discusses result and discussion, section 5 concludes the paper.

II. LITERATURE REVIEW

Foreign developed nations began collecting agricultural data earlier, and their study and implementation of intelligent agriculture is more advanced. The agricultural environment monitoring service system was conceived and constructed by Jeonghwan Hwang et al. [9]. The system collected photos of soil and crops using wireless sensor technology and GPS positioning technology, allowing for remote crop monitoring and crop management, as well as the utilisation of solar power to assure the equipment's proper operation. The Climate Corporation used climate, geographic location, and other factors to give natural catastrophe insurance to farmers, ensuring that agricultural production was protected to some extent [10].

Various sensors are used to measure soil factors including as temperature, pH, light, humidity, and moisture [8]. Utilizing an Analog to Digital Converter, the values are converted to digital and serially transferred to cloud using a Raspberry Pi. Outcome is shown on a laptop or through a mobile app. With the use of IoT, the system monitors the entire soil parameters. Soil factors such as pH, soil moisture, humidity, and temperature are continually monitored utilizing sensors in order to ensure effective crop yield. The creation of an optical transducer [11] is used to construct a system in which soil fertility is improved and soil quality is improved. Low, medium, and high levels of NPK are achieved. The data is collected using an Arduino microcontroller, and the analogue output is transformed to digital.

People are presented with a greater data system as information advances that has drew the attention of domestic and foreign academics that specialise in agricultural data analysis. Lamehari et al. fostered the rural construction by examining farming ecological information [13] that help makers and middle person organizations in settling on better choices, smoothing out the dynamic interaction, and accomplishing the objective of expanded horticultural usefulness and logical normal asset the executives. Gabriel, and colleagues created and implemented a system for monitoring soil and analysing soil fertility, as well as giving farmers with actionable advice for soil improvement. Li Xiufeng et al. proposed a visual intuitive framework that could convey network information administrations to clients and make information examination more straightforward [14].

Kursa et al. [11] used Boruta, an all-relevant feature selection approach that aggregates all features that are crucial to the result in certain situations. Most classic feature selection algorithms, on the other hand, use a minimally optimum strategy in which they rely on a limited group of characteristics that produce the least amount of error on a chosen classifier. Marcano Cedeno et al. [12] suggested a component choice procedure dependent on consecutive forward choice utilizing a feed forward neural organization to decide forecast mistake as choice models.

Sensor technology, Quick Response (QR) Code technology, RFID technology, and embedded system technology have all been created for the practical implementation of the Internet of Things. The use of sensors is one of them. It is a type of sensing device that can detect information from objects and convert it into signals or other forms for output based on particular criteria, in order to meet information transmission, recording, processing, and control needs [15].

III. PROPOSED METHODOLOGY

A. System Architecture

When it comes to the concept of "smart agriculture," the application of Internet of Things (IoT) innovation results in a significant crop manufacturing process administration, environment that impact on production and aquaculture, as well as handle of both the safety and quality of agricultural commodities and feed. All of these benefits come as a direct result of smart agriculture. It has the capacity to identify issues as well as provide a management system for crop output, animal rearing, and aquaculture in key places, so guaranteeing that agricultural products are of a high quality. The proposed design for a smart agricultural Internet of Things system is depicted in Diagram 2.
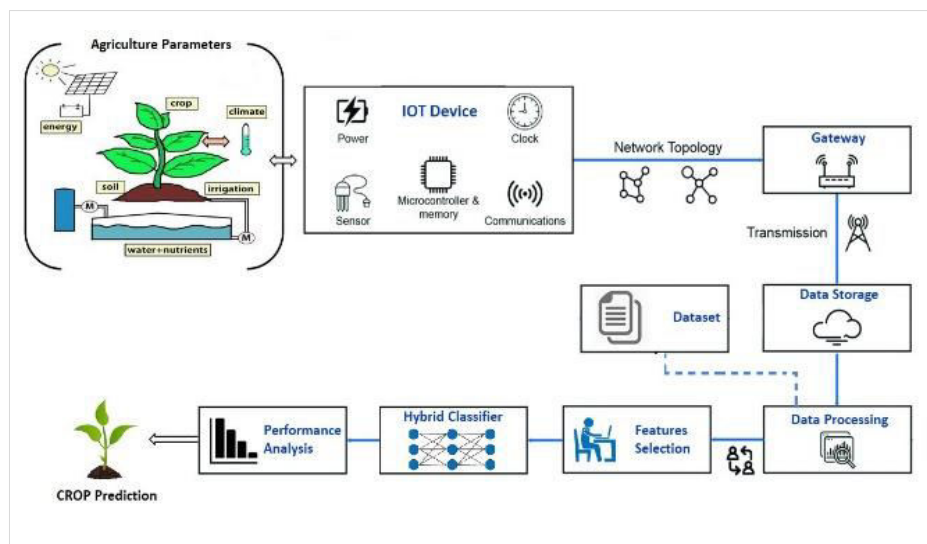
Fig 2. The proposed architecture of a smart agricultural IOT system

B. Components Used in Proposed System

The device monitors the farm and gives the farmer several forms of information about the present condition based on the readings of various sensors such as temperature, humidity, soil moisture, UV, IR, and soil nutrients. Farmers' can take quick action which will help them in increasing the farming production and make the most use of natural resources, making their product (crop yield) ecologically friendly. By appropriately monitoring the many current conditions, our proposed system will boost the amount and quality of the crops. It's an IoT device that uses the "Plug and Sense" principle. Laptops and smart phones can display real-time data for several factors. Following are several important sensors details which are used to get live farm reading. Figure 3 shows the organisation of various sensors to andrino device and laptop / computer to get live farm reading.

1. Soil Moisture Sensor

The soil moisture sensor is used to determine the volumetric water content of soil. On basis of which soil moisture is measured, parameters such as electrical resistance and dielectric constant are determined. Two probes are included in the soil moisture sensor. These probes are inserted into the soil to acquire the moisture value. Farmers may use the data generated from sensor as a support system to better manage their irrigation system.

2. Soil Temperature Sensor

The soil temperature sensor is used to determine the temperature of the soil. Thermocouples and thermistors are used in a variety of designs for these sensors. The functioning base of the sensor is revealed by the voltage measurement across the diode. Electrical signals are transmitted by the sensors, which are translated into other units of measurement such as Kelvin, Celsius, and Fahrenheit. The voltage differences are amplified, and the gadget generates an analogue signal that is proportional to temperature.

3. Soil pH Sensor

The pH of soil dictates whether it is acidic or basic. The availability of nutrients and microbes is influenced by the pH of the soil. The pH scale ranges from 0 to 14, with 7 indicating neutrality. Severe acidity is indicated by a pH less than 5.5, moderate acidity by a pH less than 6.5, neutrality by a pH between 6.5 and 7.5, alkalinity by a pH above 7.5, and strong alkalinity by a pH over 8.5.
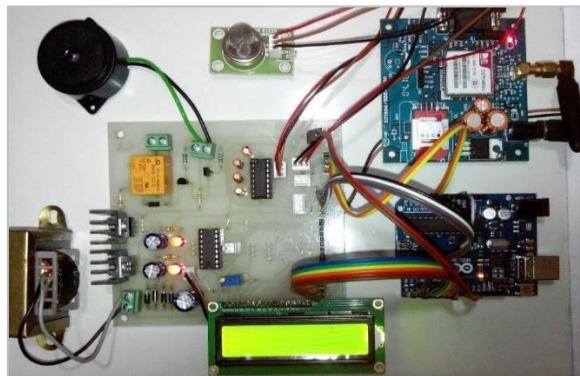
Fig. 3: working model of IOT sensors for Smart Agriculture

C. System Module

Following are several important modules which are used during the execution of proposed work for crop prediction.

1. Data Cleaning and Normalization

Data cleansing and normalisation are the initial steps in data analysis. For IoT data transfer, our system leverages 4G networks, which assures consistent network quality. The data is cleaned first; as farm environments often change in a linear rise or decline pattern, it seldom fluctuates dramatically. Normalization rescales a dataset so that each value falls between 0 and 1. It uses the following formula to do so:

$$x_{new} = (x_i - x_{min}) / (x_{max} - x_{min})$$

where:

x_i: The ith value in the dataset

x_{min}: The minimum value in the dataset

x_{max}: The maximum value in the dataset

2. Features Selection

After performing the pre-processing important features are selected from the dataset. Given that the decision tree model, it divides the sample data by selecting the best features from all of the features. It has been used in the decision tree classifier to determine the importance of attributes by calculating their value of information gain, their information gain ratio, their Gini index, and other metrics. With the help of the tree model, the feature selection process can draw specific higher-importance features [7], which will aid in the selection of significant characteristics from among the many other opportunities available. In recent years, integrated woodlands including such random forest and generalised backward differentiation and training (GBDT) have emerged, partially overcoming the problem of decision tree overfitting. A random forest-based feature selection method is used as a result in this system as part of its feature selection. The following is the formula for calculating the model:

By employing the convenient sampling of returning, the random forest produces the sub-data collection that is then used to form the decision tree model, which is then used to predict the future. As a consequence, some data will be missed out on throughout the sampling procedure as a result. It is necessary to evaluate the out-of-bag calculating the associated error, which is saved as OOB error1. The newly built decision tree model can be utilized to do so.

(a) Select all of the data that corresponds to one of the features from the data that was taken just outside of the bag, and then randomly adjust the value of a portion of the data, i.e., introduce some noise to the system to cause interference.

(b) Suppose the number of selected trees in the random forest is n. For each decision tree model, calculate OOB error1 prior to actually adding noise and OOB error2 after introducing noise interference before and after introducing noise interference

(c) Calculate the significance of features based on the inaccuracy in the formula error

$$\frac{1}{n}\sum_{i=1}^{n}(OOB\_error1_i - OOB\_error2_i)$$

It is logical to assume that the more essential the characteristic, the worse the prediction impact after noise is. As a result, the formula may be used to determine that the higher the value, the more important the trait is.

(d) Repeat steps (a), (b), and (c) for each characteristic to arrive at a calculation of its relevance.

(e) Feature filtering is carried out using the computed feature significance. After sorting all of the qualities, choose the most important ones using one of two methods: selecting a specific number of features or creating a feature priority threshold.

Figure 4 shows the features with their features importance value in descending order. Cu has the highest features importance while the pH has the lowest feature importance among all.

Cu	0.164475
P	0.154644
Mn	0.147950
EC	0.134915
S	0.128977
N	0.091529
B	0.049403
Zn	0.047928
Fe	0.037074
K	0.022646
OC	0.014967
pH	0.005491

Figure.4: Feature Importance Calculation

3. Machine Learning Classification

To extract and identify essential information from massive data, data mining and machine learning techniques are utilised. To our knowledge, the majority of existing works that recognise sardonic text employ Naive Bayes or Support Vector Machine. Random Forest and Weighted Ensemble are two alternative methods to this problem that we offer.

a) Random Forest (RF):

RF is a supervised learning approach that uses smaller portions of the training dataset to generate multiple decision trees. The output class is the mode or mean average of each output class [8].

b) Naive Bayes (NB):

Based on Bayes' theory, NB classifiers are probabilistic in nature. This classifier assumes that classes are conditionally independent. It is assumed by the NB classifier that the existence or absence of a class characteristic (feature) is unrelated to other features. The formula for determining the odds of a positive or negative output is

$$P(s|E) = \frac{P(s) * P(E|s)}{P(E)}$$

Where s is the output of the predicted class and E denotes the test data, the class of which is being predicted. During the course of training, one will earn both P and PE. When calculating the mean and variance of the classification-essential variables, the NB classifier makes use of fewer training data than other classifiers. [16].

c) SVM

SVM is a pattern recognition machine learning approach for regression and classification. A collection of training dataset is assigned to another one of n classes. SVM learning creates a model that categorises new data. The SVM supervised learning model represents samples as dimensions of space. These locations are mapped so that samples from different classes are further apart. New samples are translated into the very same space and assigned to classes based on their position. SVMs can classify non-linearly as well as linearly. The kernel technique to non-linear classification involves transforming signals towards large number of features spaces. To use the higher dimensional space with the maximum distance towards the training sample data point improves separation [17].

d) Hybrid Deep Learning Classifier (CNN + LSTM)

CNN is a popular tool in classification techniques because it has the quality of concentrating on one of the most obvious objects inside the line of sight, which is particularly useful. This technique is widely applied in time series analysis since it has the virtue of growing in proportion towards the succession of time data. A forecasting model that is based on CNN and LSTM is built and evaluated based on the properties of CNN and LSTM. This model is called CNN-LSTM. The fundamental framework of the model is made up of CNN and LSTM layers, each of which consists of an input layer, a 1D convolution layer, and a pooling layer. The model also includes an output layer.
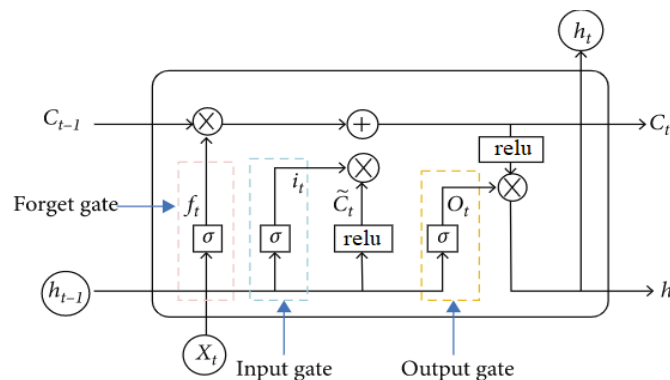
Fig 5: LSTM hidden layer, and complete connection layer

ALGORITHM

(1) Input: Farm dataset with multiple features is given as input to the CNN-LSTM model.

(2) Data Normalisation: As there is a wide gap in the input dataset, the data normalisation technique is used to normalise the data in order to improve the train the model output, following formula is used for data normalisation:

$$y_i = \frac{x_i - \overline{x}}{s},$$

$$x_i = y_i * s + \overline{x},$$

Where yi represents the normalised value, xi represents the data that was input from the dataset, x bar is the average of the data that was entered, and s represents the standard deviation of the data that was input.

(3) During the initialization of the network, the weights and biases of each layer of the CNN-LSTM will need to be initialised.

(4) Calculation of the CNN layer: First, the input data is feature extracted, then the input data is processed sequentially through the CNN layer's convolution layer and pooling layer. Finally, the output value is obtained.

(5) Calculation of the LSTM layer: After passing the output data of the CNN layer through the LSTM layer, the output value is obtained.

(6) Calculation of the output layer: In this step, the output value of the LSTM layer is fed into the complete connection layer so that the output value may be determined.

(7) An error in the calculation is assessed by examining the output value that was computed by the activation function with the actual value of this particular set of data. This comparison is how the mistake is determined.

(8) To determine if the end condition has been reached, a predetermined number of cycles must be performed, the weight must be below a specific threshold, and the forecasting error rate must be below a specified threshold. The training will be completed, the CNN-LSTM network will be updated, and step 10 will be executed if one of the end conditions is met; otherwise, step 9 will be performed.

(9) Error backpropagation: Carry on with the training of the network by moving the missing error mean in the other direction, modifying the weights and biased of each layer, and going back to step 4 each time.

(10) Save the model: Save all the trained classifier so that it may be used for predicting crops using new data.

(11) Output result: To finish the forecasting procedure, output the repaired results.

Figure 6 shows the CNN + LSTM model which is used for training and testing purpose for crop prediction. It includes several layers namely convolution, max pooling, flatten, dense and dropout. Additionally, it used two LSTM layers after max pooling layer. Model uses relu as activation function. And dropout probability is set to 0.01. The complete system runs for 10 epoch and accuracy and loss are calculated to get the performance of proposed hybrid model.

```
Model: "sequential"
_____
Layer (type)                 Output Shape              Param #
=================================================================
conv1d (Conv1D)              (None, 15, 64)            1664
_____
max_pooling1d (MaxPooling1D) (None, 14, 64)            0
_____
conv1d_1 (Conv1D)            (None, 14, 32)            6176
_____
max_pooling1d_1 (MaxPooling1 (None, 13, 32)            0
_____
lstm (LSTM)                  (None, 13, 128)           82432
_____
lstm_1 (LSTM)                (None, 13, 128)           131584
_____
flatten (Flatten)            (None, 1664)              0
_____
dense (Dense)                (None, 64)                106560
_____
dropout (Dropout)            (None, 64)                0
_____
dense_1 (Dense)              (None, 16)                1040
_____
dropout_1 (Dropout)          (None, 16)                0
_____
dense_2 (Dense)              (None, 1)                 17
=================================================================
```

Fig.6: CNN-LSTM model.

IV. RESULT AND DISCUSSION

A. Dataset Description
Soil dataset to predict the crop for Maharashtra district (Pune / Raigad / Nagpur) is downloaded from https://soilhealth.dac.gov.in/PublicReports/NSVW_total. It contains pH, EC, OC, N, P, K, S, Zn, Fe, Cu, Mn, B, etc. features and has time period of 2020 - 2021.

B. Experimental Setup
All the experiments are performed on environment of Intel i5, 3.2 GHz, 8 GBs of RAM, 1 TB of hard disk, 512 GB of SSD and Windows 10 operating system. Anaconda (Jupiter Notebook) IDE is used and Python 3.7 technology is used.

C. Performance Parameters
The proposed hybrid deep learning models (CNN +LSTM) results are compared to Naive Bayes, Random Forests, and SVM. These classifiers, together with the suggested multiclass model, were used to perform

classification on the agricultural dataset before it was subjected to 10 fold cross-validation. For the purpose of determining which classifiers produce the most accurate results, a wide variety of performance indicators are considered. It is necessary to establish the accuracy of classification, precision, and recall in order to confirm the findings obtained from the proposed different deep learning classifier as well as those obtained from other classifiers. These measurements are determined by applying the following formula:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1Score = \frac{2 * Precision * Recall}{Precision + Recall}$$

The terms "true positive," "true negative," "false positive," and "false negative" refer, respectively, to "true positive," "true negative," "false positive," and "false negative" The accuracy, precision, and recall scores of each of the classifiers are shown in Figure 7 and continue through Figure 10.

The classification algorithms were used to a multi-modal data set, which includes input data from data collected by Internet of Things sensors. The results of the performance evaluation of several categorization techniques are shown in Table 5. Naïve bayes had the lowest performance when compared to the others making it inappropriate for learning complicated structures for the subject data. All other classification models were surpassed by the proposed system (CNN + LSTM), which had the best accuracy, precision, recall, and F1 Score.

Table 2: Performance parameters comparison of algorithms

	Precision	Recall	F-Measure	Accuracy
NB	69	65	56	65
RF	85	85	84	85
SVM	91	91	90	91
CNN +LSTM	95	96	95	95
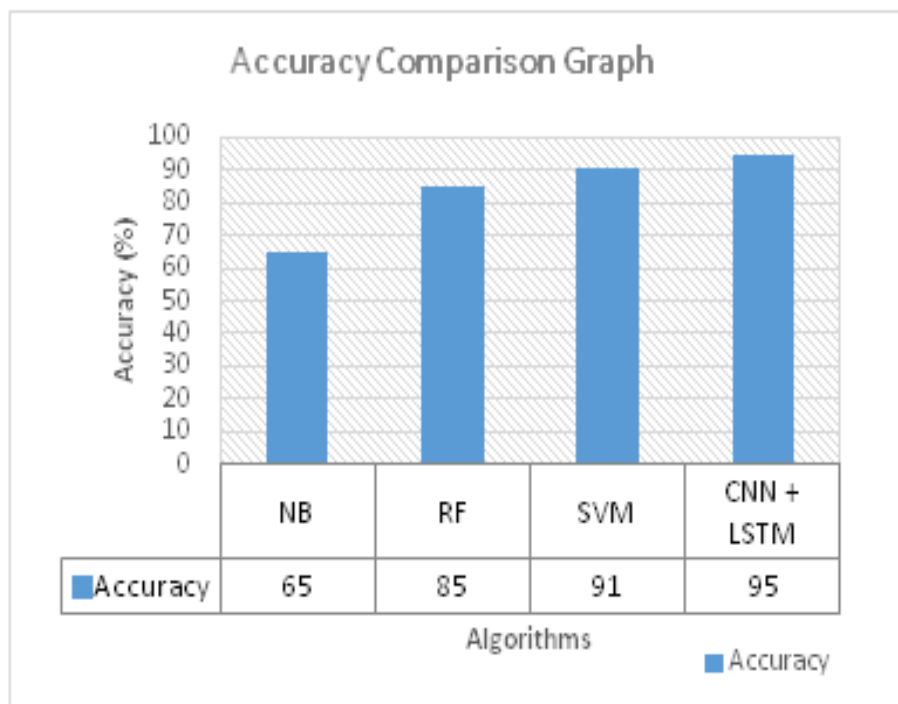
Fig 7: Accuracy comparison graph of ML and Hybrid DL algorithms

Figure 8 shows the training and validation accuracy comparison of CNN + LSTM model for 10 epochs. The validation accuracy after 10 epochs is 95.20 %. With increase in number of epoch the accuracy remains nearly same as shown in figure 8.
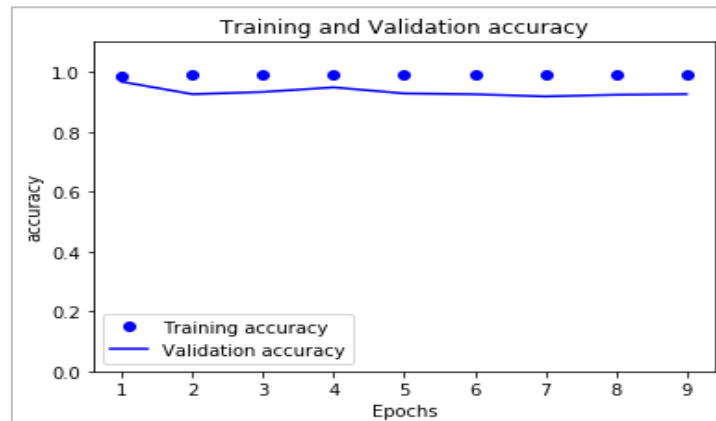
Fig 8: Training and validation accuracy comparison of CNN + LSTM

Figure 9 shows the training and validation loss comparison of CNN + LSTM model for 10 epochs. The validation loss after 10 epochs is 0.08. With increase in number of epoch the loss is reduced which can be seen in figure 9.
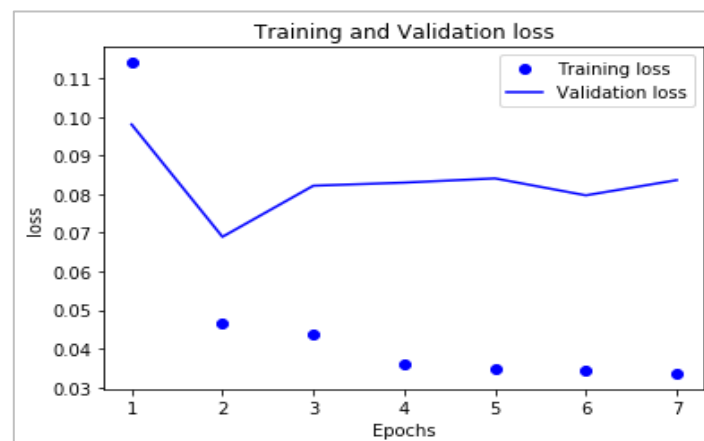
Fig 9: Training and validation loss comparison of CNN + LSTM

V. CONCLUSION

Machine learning is a scientific field that has applications in crop prediction research. Farmers are keen to find out how much they can expect to produce, therefore crop cultivation forecasting is critical in agriculture. Previously crop yield prediction is used to be done by taking into consideration farmers' fundamental knowledge of specific areas of land and the crops that will be cultivated there. Several machine learning and deep learning technologies are utilised and analysed in agriculture to anticipate future crop production or which crop to be take in that soil. Our study focused on use of IOT sensors to collect real-time data from the farm, as well as employing feature selection methods to extract relevant features for prediction models. Propose system uses traditional machine learning algorithms and proposed hybrid classification model (CNN + LSTM) to forecast the crop perdition. Our findings reveal that Hybrid CNN + LSTM classifier beats other approaches with 10 fold and 80%–20% data splitting range and gives maximum accuracy of 95.20 %.

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COLLEGE CONNECT: CONNECTING BOND BEYOND

SWARUP PHATANGARE, ABHISHEK CHILEKAR, NIKHIL MAHAJAN, AKSHAY GIDWANI AND PROF. POONAM RAILKAR

ABSTRACT

The College Connect app will benefit the students a lot in many ways. Students will also get notified of any new activity taking place in the campus. They can bookmark the resources and use them later. Also, the app provides a student the ability to directly message other students or a teacher or an alumnus by sending a request and communicating with them once the request is accepted. This also ensures that no one can message anybody without the receiver's permission thus maintaining good user experience. This paper consists of the basic and advanced functionalities of college connect including its system architecture and many more.

Keywords: Web Development, UI UX, Alumni System, Bookmarking, One - many and many-many communications, publishing events

1. INTRODUCTION

In the Big Institutes, messages generally take a lot of time to reach the students and sometimes they are not conveyed as well which might result in a loss of opportunities for the student. Students just admitted do not have a central platform to connect and communicate with their seniors and teachers. Students face a lot of trouble collecting all the resources they need for their studies. Some students might not get the proper guidance just because they don't know the proper authority. These are some problems which motivated us to build this application. [3-4]

This system has a unique capability of connecting Alumni to the Students and Teachers. Alumni is a very powerful source which colleges have and can help students to better prepare themselves to grab the future opportunities , Students can increase their contacts , Can learn from their real life experiences and Alumni can also provide some opportunities to the students but sadly there is no direct way for alumni to connect to the students, which can limit the college from giving student what they really can , so this system provides a way to connect and communicate with the alumni.

Other features that this system provides are to Chat with the other users, create groups, share resources with others and publish the events. Chatting and creating groups are the most common and most useful functionalities, System allows users to search for the users, request them to initiate chats, which saves users from getting flooded with unnecessary messages, and if the user accepts, they can communicate. System also allows creating groups thus supporting one-to-many and many-to-many communication. [1-2].

Many times, we miss the opportunities just because we were not informed about them, this can happen in competitions, cultural events or even with placements. So, System has a separate event publishing window where organizers can publish their events and select the students who should be notified about it. This makes event publicity easy and also solves the above-mentioned problem.

Many students face issues while collecting the resources they need to study for their exam or prepare for the interviews and thus wastes their valuable time so System provides a central platform to share the resources and help others with the capability of bookmarking which allows user to link their needed resources to their profile and download and refer it whenever they want. [5]

2. LITERATURE SURVEY

The Author of [1] describes the structure of creating a secure Chat System with a proposed architecture of a Client-Server model with email login functionality followed by the architecture of Firebase cloud messaging service bound with the session key setup where data is stored in Local Storage and exchange of messages in JSON format.

Paper [2] points out the advantages of the discord-based Education system. They created an educational community where students can communicate with their classmates and teachers to resolve their queries. They also provided a facility to share the required resources which will be helpful for the students while preparing for the exam.

The author of [3] explains the concept of discord to help Students improve communication with Teachers in an engaging way and helping Students at any time Teacher wants benefiting the student and encouraging Instructors more to adopt this practice.

The author of [4] describes the way to use the slack application to communicate and coordinate all the team members in the agile team. As we all know the communication and coordination of the team is a major factor of the agile model so the author describes a way to communicate and coordinate all the members and all the barriers encountered in the process

The paper [5] points out the significance of efficient resource allocation done through the cloud. Resource allocation for applications revolving around file sharing, messaging etc is a crucial part of their performance. Various different resource allocation strategies are also discussed in the paper.

The author [6] proposes a method to build a trusted computing environment for a cloud computing system by providing a method that encrypts the data using a secret key before sending it to cloud storage and decrypts the data using the same secret key with user authentication.

The author [7] gives the idea of a virtual community where a group of people are drawn together by an opportunity to share a sense of community with like-minded students from a common branch.

The author [8] gives an idea and algorithm on instant messaging services with the help of firebase with a way to authenticate users and interact with each other with the help of chat rooms.

The author [9] proposes the idea to develop an environment where users could share the same copies for teaching and co-operation purposes over Internet connections in a GUI format.

The author [10] gives the firebase services for cloud messaging services, firebase authentication, real-time database, firebase storage and shows comparison of JSON and SQL DBMS and how we can implement firebase features for our purpose.

The author [11] gives the use of firebase as a Backend as a Service (BaaS) for building better applications and improving application quality and handling large authentication services and storage buckets.

The author [12] explains the history of the AES algorithm and evaluation criteria for algorithms like security and cost to evaluate the algorithm and describes the basic structure of the AES algorithm and the process of encryption and decryption.

The author [13] describes the architecture of a secure chat application with a symmetric key encryption communication system; it describes the encryption and decryption of user messages.

The author [14] gives some background about some chat applications like WhatsApp, messenger, Viber, etc and explains the security service required for a secure chat application with a proposed architecture for backend connection and encryption and decryption.

The author [15] explains the symmetric key and asymmetric key encryption along with some encryption decryption algorithms like AES, MD5, DES, RSA with a proposed scheme of architecture of cloud technologies with experience-based trust management systems.

3. PROPOSED SYSTEM

Proposed Algorithm
Let, choice be the user's action which he wants to perform on this system Login (Username,password) allows user to login into the system Signup (UserDetails) allow user to sign up into the system send(message) allow you to send a message to the receiver or group request(permission) allows you to send the request to the user group_request(permission) allows you to send joining request to the admin start_poll(poll data) allow you start the poll in the group vote(data) allow user to vote in the poll print ("") prints the message on the screen add_resource(data) uploads the resource on the system download_resource(data) downloads the resource from the system delete_resource() delete the resource from the system add_event(data) publishes the event on the system view(data) transfer the control to the event's website delete_event() delete the event from the system add_member() add the member to the group remove_member() remove the member from the group leave_group() leave the group choose_new_admin() allows admin to transfer their rights to the other member before leaving the   group logout () logout from the system

Step 1: if the 'User' is present in the local storage then goto step 4

Step 2: else if user has an account then Login (Username,password) and goto step 4

Step 3: else Signup (UserDetails) and goto Step 2

END IF

Step 4: if choice is equal to "private chat" then

Step 5: if user is equal to "student" then

Step 6: if user has a permission to chat with the receiver, then

Step 7: request (permission)

Step 8: else send (message)

END IF

Step 9: else send (message)

END IF

Step 10: else if the choice is equal to "group chat" then

Step 11: if user is a part of the group, then

Step 12: send (message)

Step 13: else group_request (permission)

END IF

Step 14: else if the choice is equal to "Start poll" then

Step 15: if user is a part of the group, then

Step 16: start poll (poll data)

Step 17: else group_request(permission)

END IF

Step 18: else if the choice is equal to "vote in the poll" then

Step 19: if the user is a part of the group, then

Step 20: vote(data)

Step 21: else group_request(permission)

END IF

Step 22: else if choice is equal to "Add member" then

Step 23: if user is the admin of the group, then

Step 24: add_member(member)

Step 25: else print ("permission denied")

END IF

Step 26: else if choice is equal to "Remove member" then

Step 27: if user is the admin of the group, then

Step 28: remove_member(member)

Step 29: else print ("permission denied")

END IF

Step 30: else if choice is equal to "Leave a group" then

Step 31: if user is the admin of the group, then

Step 32: choose_new_admin(member)

Step 33: leave_group()

Step 34: else leave_group()

END IF

Step 35: else if choice is equal to "Adding the resource" then

Step 36: if resource name exists then

Step 37: print ("Duplicate name not allowed")

Step 38: else add_resource(resource_details)

END IF

Step 39: else if choice is equal to "download the resource" then

Step 40: if resource exist then

Step 41: download_resource()

Step 42: else print ("resource does not exist")

END IF

Step 43: else if choice is equal to "delete resource" then

Step 44: if user is the owner of the resource, then

Step 45: delete_resource()

Step 46: else print ("permission denied")

END IF

Step 47: else if choice is equal to "Add event" then

Step 48: if event name already presents then

Step 47: print ("resource already exist")

Step 48: else add_event(event_details)

END IF

Step 49: else if choice is equal to "view event website" then

Step 50: if event exist then

Step 51: view(event)

Step 52: else print ("event already deleted")

END IF

Step 53: else if choice is equal to "delete event" then

Step 54: if user is the owner of the event, then

Step 55: delete_event()

Step 56: else print ("permission denied")

END IF

Step 57: else if choice equal to "Logout" then

Step 58: logout ()

END IF

Step 59: End

PROJECT SCOPE

In the current situation there is no platform for college students to connect, communicate, share resources. And so, this platform is providing a platform/portal where students can communicate and share resources to each other and also can contact their seniors and college Alumni for their guidance. Coming to the scope of this

project , this project will be limited to college premises only and will have limited space regarding storage and other workflows .In the starting phase it will have limited participants for the well-functioning of this project.

User Classes and Characteristics
There will be four main users with significant characteristics (Admin, Students, Staff members, Alumni)

Admin
Admin will be the main person to handle all the processing of the projects any issues occurred will be reported to admin.

Students
The students will be able to communicate with staff members, alumni of the college and also, they will be able to upload resources with each other, they will be able to know about events and many more.

Staff Members
The staff members will be the main bridge between students and alumni there will be to verify the resources shared and also notices and events. They can also help students to solve their issues.

Alumni: the alumni will be able to share their company experience and how students can prepare for interview for particular company. Even share resources and solve students doubts

System Architecture
The System Architecture of College Connect is divided into three components: these components consist of the Frontend, the Middleware and the Database. The Frontend consists of the view layer, the actual view for the user, this component consists of all necessary Views for the user. The Frontend is made-up of React JS. The Middleware consists of the APIs to which the Frontend communicates. The Middleware is made-up of Node JS. The Database component handles the storage purpose, The Database is made-up of Firebase.

Referring the Fig 1 of System Architecture below are the following Modules in brief

Frontend: - The Frontend part in System Architecture handles the view for the user, the user interacts with this layer.

Home Screen: - One of the Sub-components of Frontend is the Home Screen which is the default screen when user is not login, Home Screen displays the features of the Application.

Login Screen: - When the user clicks Register button on Home Screen, Login Screen is opened where users can login themselves. In Login Screen Users Can Login them with Username and password, In case the User is not registered they can register themselves. In the register screen User has three options: Student, Teacher and Alumni. While registering User has to fill necessary details according to the User role selected.

Private Chats: - In the Private Chat screen users can chat with another user. They can send Messages, Images, Videos. They can view another user's profile also. The chatting functionality helps Users to exchange messages with each other, they can also share images or videos with them. If a student user has to communicate with any Teacher or Alumni user, they have to take permission from them by requesting them.
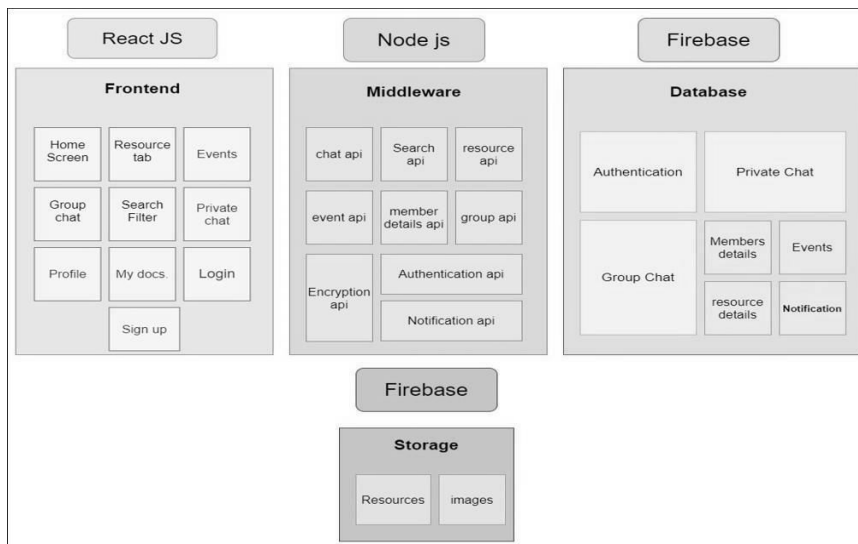
Fig -1: System Architecture

Profile: - Users can view their Profile details they can also update their profile and add skills to their profile.

Search Filter: - Users can search for other Users, Resources and Events. They can also apply search filters through which they can search for the result relevant to them.

Group Chat: - In Group Chat Users can join the group, chat with other Users in a Group. Users can also take part in polling where users can select any option in the poll, polling helps users to take the opinion of other users or use it as a survey too. Users can share Uploaded Resources in Group Chat if they want to share Users can also report a message if they find it inappropriate. Any user who has created a group is also Admin of the group, also Admin role can be assigned to user by another Admin.

Resources: - Resources are the files uploaded by other users in the community this can be any study material that can be viewed by other users. Users can also add a Resource with respect to a particular branch. Whenever the user opens the resource tab the resource list is shown depending which branch the user Student has selected, Users can also Search or resources they can also apply search filters relevant to their search. Users can share uploaded resources on any Group chat or on personal chat too.

My Docs: - Users who have bookmarked resources can view their bookmarked resources. In this screen users can remove the bookmarked resources also.

Events: - Users can participate in Events that are being held in the community. Users can view the Events or Event details They can Participate in the Events, Events can be of any type like Karandak, Sports, Competition, Placement, etc. Users can also create their own Event, during creation of any Event User has to give the Event Registration link where the actual Event registration takes place. Whenever the User opens Events tab, the Events list is shown depending on the branch the Student User has chosen during Registration. Every Event has a start date and end date, the start date indicates the date the event begins and end date indicates the date the Event ends, so the user has to register themselves before the end date if they wish to participate in that particular Event. Users can also search for Events and can also apply search filters relevant to their search.

Middleware: - The Middleware consists of APIs which the Frontend communicates to, the data transfer takes place between Database and Frontend with the help of Middleware.

Chat API: - The chat API handles the private chatting between users. Chat API handles all the data which is to be shown or transported to private chats. [8-14]

Search API: - The search API handles the searching part, this API handles the searching for users, resources and events. This API also handles the filtering part for searches and shows relevant results to users.

Resource API: - This API handles revealing the resources for the branch the student user has selected. This also handles the uploading of the resource as well as displaying bookmarked resources.

Event API: - Event API handles the displaying the ongoing events for the branch the student user has selected. This also handles the creating event part and managing events like removing events after the end date.

Member Details API: - The Member Details API handles displaying the user profile and showing another user's profile. This API also handles updating the user profile details.

Group API: - The Group API handles all the messages in the group chat and the group info supports polling and handling members of the group.

Encryption API: - Encryption API handles the Encrypting and Decrypting of the data. This API also handles the resource encryption also. Every time the data transfer happens between Frontend and any APIs of Middleware it moves through this API. [13-15]

Authentication API: - This API handles the user authentication, With the help of Firebase Each user can be authenticated, this API also handles the Login or Signup portion.

Notification API: - This API handles the segment of notifying the users about any new Resource being uploaded or any new Event being held or created, the notification goes to the user and the Student user who had selected that particular branch. This API also notify users about the Group creation depending on the Admin whether to notify everyone or not, the notification thus goes to the users and Student user who is in that particular branch. This API also handles the deletion of the Notification.

Database: - The Database stores all the incoming data into the database. It is divided into two subcomponents: Firebase Database and Firebase Storage, where Firebase Database stores all the textual data and Firebase Storage stores all the Resources and data like Images.

Authentication: - Firebase handles and stores user data like username, password, etc.

Private Chat: - This database stores all the chats between users in textual JSON format.

Group Chat: - This database stores all the chats involved in group chats. Also, it stores group members' details in textual JSON format.

Member Details: - This database stores each user's details. This database also stores the bookmarked resources of the user.

Events: - This database stores all the event details, adding new events, destroying outdated events.

Resource: - This database stores all the Resource details including the path where the Resource is actually stored. This database only stored the details of the resources in Textual format.

Notification: - This database stores the notification to be sent to the users about either the group creation or event creation or resource uploading.

Storage: - This database actually stores the data like Resources and Images, User Profile Image, Event Image, etc.[10-11-14]

Resources: - This storage stores the resources uploaded by the user which can be later retrieved by the user.

Images: - This storage stores the Image files uploaded by user let that be shared Images by users or user profile images or event profile image.

FUNCTIONAL REQUIREMENTS

Private Messaging: - The Private Message feature helps users to have a private chat with another user. Users can send messages without other interference. The messages are secured with encryption so that no other person can observe the messages. Group Chat: - Users can also have a chat with multiple other users via group chat. This feature helps to send information to multiple people and share ideas with several people. The messages are secured with encryption so that no other person not in the group or not a member can see the messages.

Resource Sharing: - Users can view the resources uploaded by other users in the community. Resources can be of numerous types like pdf, docx, ppt file etc. Users can also upload any resource if they think will help other users so that will help the community. Users can also bookmark a resource so that they don't have to search for a resource every time.

Events: - Users can view what are the current Events going on and they can also participate in those events. Users will get a glimpse about the event and they will also get notified about the ongoing events. Users can also create their own event if they want to.

Alumni Support: - Student users can contact other users who were once a part of the college. Student users can contact alumni of the colleges to get help or guidance from them. Alumni can help students who are confused or don't know what to do next.

DATABASE REQUIREMENTS

Firebase
Software Requirements (Platform Choice)
Microsoft Windows 7/8/10 (32 or 64 bit), Mac OS X 10.8, GNOME or KDE or Unity desktop on Ubuntu or Fedora or GNU/Linux Debian,2GB RAM,4GB RAM recommended,500 MB disk space.

4. LIMITATIONS
Success of the application totally depends on the member's willingness to help others. Maximum Resource Upload size 1 GB.

5. RESULT & DISCUSSION
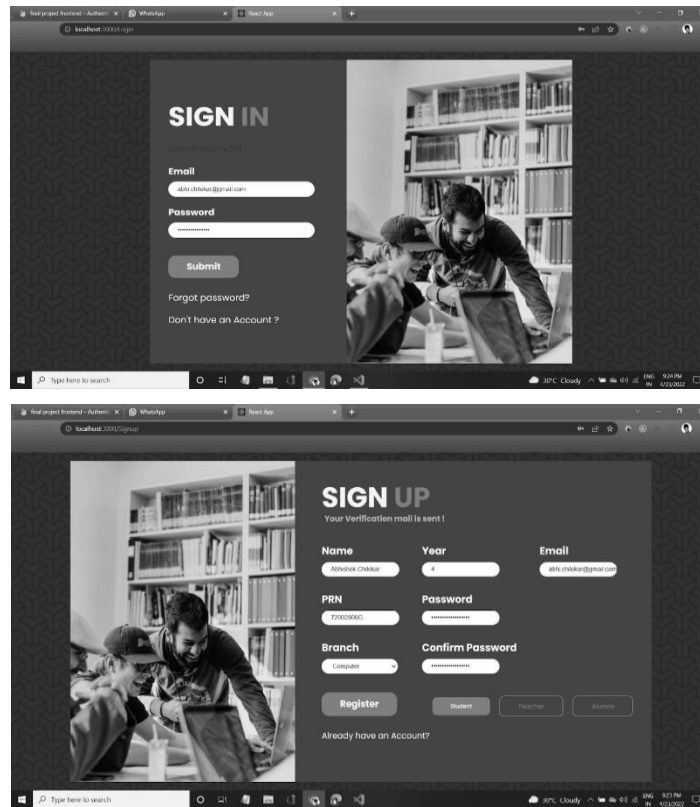
Fig 2: Sign up & Sign In

Fig 2: This is the Interface for Signing in and Up for College Connect Which Helps the User for Getting Started.
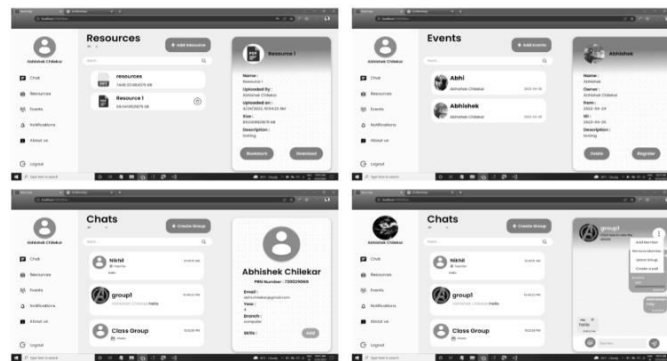
Fig 3: Main profile and chat section

Fig 3: Is the Main Profile Interface Where User will be Landed After Sign in From College Connect
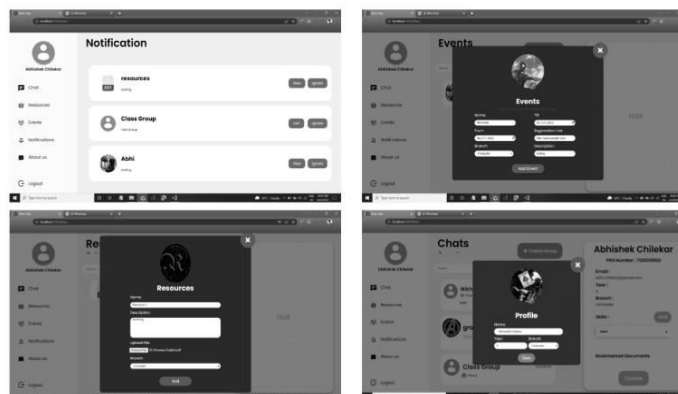
Fig 4: Events Groups & Notification

Fig 4 is about the creating events, chats and Notification interface

6. CONCLUSION AND FUTURE WORKS

In the end the conclusion is that this app can not only be used for a college premises but for other colleges also. It can be used to bridge the gap between students, teachers and Alumni.

This app can be further extended for multiple colleges so students from multiple colleges can help each other and share information among them.

This app can also include some additional features to support the official college administration functions.

Even add a feature to create a virtual locker for each student in which he can store all his documents, certificates, assignments.

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CUBE DIFFERENCE MEAN LABELING OF DISCONNECTED GRAPHS

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ABSTRACT

In this paper, we contribute some new results for cube difference mean Labeling of disconnected graphs. We prove that cube difference mean labeling of disconnected graphs are cube difference mean graphs. We use some standard graphs to derive the results for disconnected graph.

Keywords: Cube difference mean graph, path, cycle, comb, Y-tree and ladder graph.

1. INTRODUCTION

All graphs in this paper are simple finite undirected and nontrivial graph G = (V,E) with vertex set V and the edge set E. For graph theoretic terminology, we refer to Harary [1]. A dynamic survey on graph labeling is regularly updated by Gallian [2] and it is published by Electronic Journal of combinatorics.

Graph labeling was first introduced in the late 1960 's, many studies in graph labeling refer to Rosa's research in 1967 [3]. Rosa introduced a function f from a set of vertices in a graph G to the set of integers. $\{0,1,2,3,\dots\}$, so that each edge xy is assigned the label $|f(x) - f(y)|$, with all labels distinct, Rosa called this labeling $\beta - valuation$. Independently, Golomb studied the same type of labeling and called this labeling as graceful labeling.

The concept of mean labeling was introduced and studied by Somasundaram and ponraj [3]. Further some more results on mean graphs are discussed in [4]. V. Swaminathan and C. Sekar introduced the concept of one modulo three graceful labeling in [6]. As an Analogue, Jeyanthi and Maheswari [7-8] introduced the concept of one modulo three mean labeling and proved some standard graphs are one modulo three mean graphs.

The concept of Cube Difference Labeling was first introduced by J. Shiama and it was proved in [9] that many standard graphs, and also we introduced Cube difference mean labeling of graphs [14]. Further some more references of [10-13].

Motivated by the work of these authors, we investigate Cube Difference Mean Labeling of disconnected graphs using Path, Comb, Y-Tree and ladder graph.

1.1 Definition

A graph G = (V,E) with p vertices and q edges is said to be Cube difference mean labeling, if their exist a bijection $f: V(G) \to \{1,2,3,\dots,n+m\}$ such that the induced function $f^*(uv) = E(G) \to \{a/1 \le a \le N \text{ and } a \equiv 1(mod 3)\}$ given by

$f^*(uv) = \left\lceil \frac{[f(u)]^3 - [f(v)]^3}{2} \right\rceil$ for every $uv \in E(G)$ are all distinct. A graph which admits Cube difference mean labeling is called Cube difference mean graph.

1.2 Definition

A walk in which vertices are distinct is called a path. A path on 'n' vertices is denoted by P_n.

1.3 Definition

The graph obtained by joining a single pendant edge to each vertex of a path is called a comb graph

1.4 Definition

A graph that contains no cycles is called an acyclic graph. A connected acyclic graph is called a tree

1.5 Definition

A Y-tree is a graph obtained from a path by appending an edge to a vertex of a path adjacent to an end point and it is denoted by Y_n , where 'n' is the number of vertices in the tree.

1.6 Definition

The ladder graph L_n is a planner undirected with 2n vertices and 3n-2 edges. The ladder graph can be obtained as the Cartesian product of two path graphs, one of which has only one edge $L_n = P_n X P_2$

1.7 Definition

A graph G is disconnected if it does not contain at least two connected vertices.

Theorem 1

$P_n \cup P_m$ is a Cube difference mean labeling Graph.

Proof:

Let P_n be a path with vertices $v_1, v_2, \ldots, v_n$ and P_m be an another path with vertices $u_1, u_2, \ldots, u_m$ respectively and let the edges are $\{e_1, e_2, \ldots, e_{n-1} \ ; \ a_1, a_2, \ldots, a_{m-1}\}$. Which are denoted in Fig(1.1)
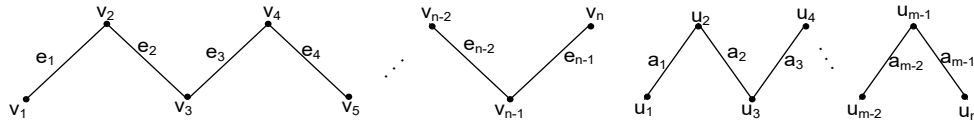
Fig (1.1) - $P_n \cup P_m$

Define the function, $f: V(P_n \cup P_m) \to \{1, 2, 3, \ldots, n+m\}$ as follows

$f(v_i) = i$ for $1 \le i \le n$

$f(u_i) = n + i$ for $1 \le i \le m$

Induced edge labeling function $f^*(uv) = E(G) \to \{a/1 \le a \le N \text{ and } a \equiv 1 (mod3)\}$ is defined by $f^*(uv) = \left\lceil \frac{[f(u)]^3 - [f(v)]^3}{2} \right\rceil$

Now, $f^*(v_{i+1}v_i) = \left\lceil \frac{3i^2 + 3i + 1}{2} \right\rceil$ for $1 \le i \le n$

$f^*(u_{i+1}u_i) = \left\lceil \frac{3(n+i)^2 + 3(n+i) + 1}{2} \right\rceil$ for $1 \le i \le m$

Clearly $f^*(v_{n+1}v_n) = \left\lceil \frac{3n^2 + 3n + 1}{2} \right\rceil$

Hence all edge labels are distinct.

Thus $P_n \cup P_m$ is Cube difference mean labeling Graph.

Example 1.1

The following example shows that $P_6 \cup P_5$ is Cube difference mean labeling graph.
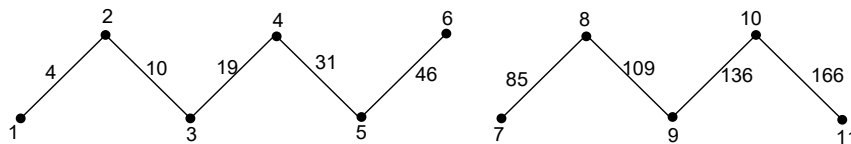
Fig (1.2)

Hence the edge labeling of $P_6 \cup P_5$ are distinct.

Thus the path $P_6 \cup P_5$ is Cube difference mean labeling Graph.

Theorem 2

$Y_n \cup P_m$ is a Cube difference mean labeling Graph.

Proof:

Let $\{u_1, u_2, \ldots, u_n\}$ be the vertices of Y_n- Tree and P_m be a path with vertices $\{v_1, v_2, \ldots, v_m\}$. and $\{a_1, a_2, \ldots, a_{n-1}\}$ be the edges of Y_n - Tree and $\{e_1, e_2, \ldots, e_{m-1}\}$ be the edges of P_m. Which are denoted in Fig(1.3)
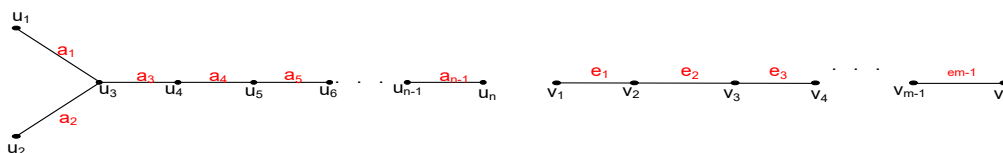
Fig (1.3)

Define the function, $f: V(G) \to \{1,2,3, \dots, n+m\}$ as follows

$f(u_i) = i$ for $1 \le i \le n$

$f(v_i) = n + i$ for $1 \le i \le m$

And the induced edge labeling function $f^*(uv) = E(G) \to \{a/1 \le a \le N \text{ and } a \equiv 1(mod3)\}$ is defined by
$f^*(uv) = \left\lceil \frac{[f(u)]^3 - [f(v)]^3}{2} \right\rceil$

Now,

$f^*(u_{i+2} \, u_i) = \left\lceil \frac{[i+2]^3 - [i]^3}{2} \right\rceil = \lceil 3i^2 + 6i + 4 \rceil$ for i=1

$f^*(u_{i+1} u_i) = \left\lceil \frac{3i^2 + 3i + 1}{2} \right\rceil$ for $2 \le i \le n$

$f^*(v_{i+1} v_i) = \left\lceil \frac{3(n+i)^2 + 3(n+i) + 1}{2} \right\rceil$ for $1 \le i \le m$

Clearly $f^*(u_{n+1} u_n) = \left\lceil \frac{3n^2 + 3n + 1}{2} \right\rceil$, n= 2,3,4,…

And $\quad f^*(u_{n+2} \, u_n) = \lceil 3n^2 + 6n + 4 \rceil$ for n=1

Hence all edge labels are distinct.

Thus $Y_n \cup P_m$ is Cube difference mean labeling Graph.

Example 2.1
Cube difference mean labeling of $Y_6 \cup P_4$ is given below.
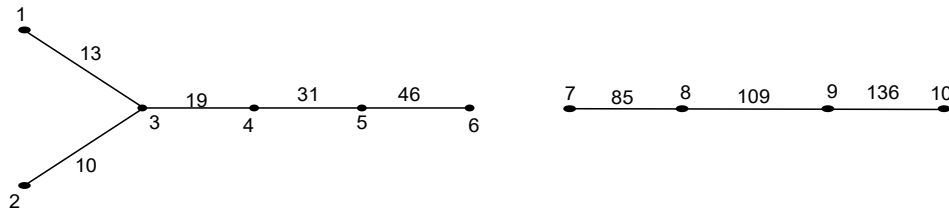
Fig (1.4)

Hence the edges are distinct.

Theorem 3
$P_n \cup (P_m \Theta K_1)$ is a Cube difference mean labeling Graph.

Proof:
Let $\{v_1, v_2, \dots, v_n\}$ be the vertices of path P_n and let $P_m \Theta K_1 \, \forall \, n$ be a comb graph with 2m vertices and 2m-1 edges.

i.e., V(G) = $\{u_1, u_2, \dots, u_{2m}\}$. Here we take P_m as odd vertices and join vertex even vertices to odd vertices.

Let $\{e_1, e_2, \dots, e_{m-1}; e_1', e_2', \dots, e_m'\}$ be the edges of comb graph and $\{a_1, a_2, \dots, a_{n-1}\}$ be the edges of path graph. Which are denoted in Fig(1.5)
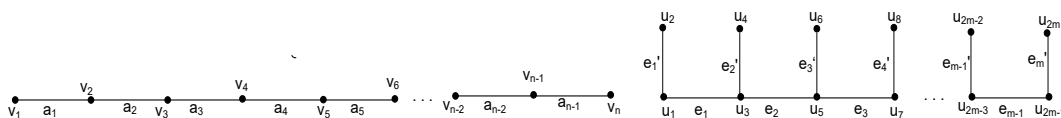
Fig (1.5)

Define the function, $f: V(G) \to \{1,2,3, \dots, n+m\}$ as follows

$f(v_i) = i$ for $1 \le i \le n$

$f(u_i) = n + i$ for $1 \le i \le 2m$

And the induced edge labeling function $f^*(uv) = E(G) \to \{a/1 \le a \le N \text{ and } a \equiv 1(mod3)\}$ is defined by $f^*(uv) = \left\lceil \frac{[f(u)]^3 - [f(v)]^3}{2} \right\rceil$

Now,

$f^*(v_{i+1} v_i) = \left\lceil \frac{[i+1]^3 - [i]^3}{2} \right\rceil = \left\lceil \frac{3i^2 + 3i + 1}{2} \right\rceil$ for $1 \le i \le n$

$f^*(u_{2i} u_{2i-1}) = \left\lceil \frac{3(n+2i)^2 - 3(n+2i) + 1}{2} \right\rceil$ for $1 \le i \le m$

$$f^*(u_{2i+1} u_{2i-1}) = \left\lceil \frac{[n + 2i + 1]^3 - [n + 2i - 1]^3}{2} \right\rceil$$

$= \lceil 3(n + 2i)^2 + 1 \rceil$ for $1 \le i \le m - 1$

Hence all edge labels are distinct.

Thus $P_n \cup (P_m \Theta K_1)$ is Cube difference mean labeling Graph.

Example 3.1

$P_5 \cup (P_6 \Theta K_1)$ is Cube difference mean labeling Graph given below:
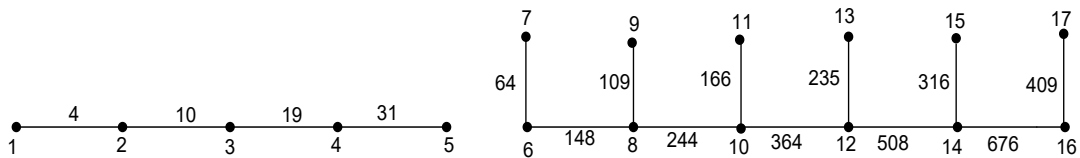
Fig (1.6)

Hence the edges are distinct.

Theorem 4

$Y_n \cup (P_m \Theta K_1)$ is a Cube difference mean labeling Graph.

Proof:

Let $\{u_1, u_2, \dots, u_n\}$ be the vertices of Y_n - Tree and $P_m \Theta K_1 \forall n$ be a comb graph with 2m vertices and 2m-1 edges.

i.e., $\{e_1, e_2, \dots, e_{m-1}; e_1', e_2', \dots, e_m'\}$ be the edges of comb graph and $\{a_1, a_2, \dots, a_{n-1}\}$ be the edges of Y_n – Tree graph. Which are denoted in Fig(1.7)
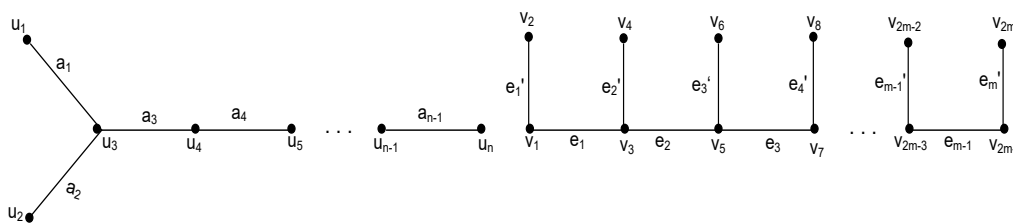
Fig (1.7)

Define the function, $f: V(G) \to \{1,2,3, \dots, n + m\}$ as follows

$f(u_i) = i$ for $1 \le i \le n$

$f(v_i) = n + i$ for $1 \le i \le 2m$

And the induced edge labeling function $f^*(uv) = E(G) \to \{a/1 \le a \le N \text{ and } a \equiv 1(mod3)\}$ is defined by $f^*(uv) = \left\lceil \frac{[f(u)]^3 - [f(v)]^3}{2} \right\rceil$

Now,

$f^*(u_{i+2} u_i) = \lceil 3i^2 + 6i + 4 \rceil$ when i=1

$f^*(u_{i+1}u_i) = \left\lceil \frac{3i^2+3i+1}{2} \right\rceil$ for $2 \le i \le n$

$f^*(v_{2i}v_{2i-1}) = \left\lceil \frac{3(n+2i)^2-3(n+2i)+1}{2} \right\rceil$ for $1 \le i \le m$

$f^*(v_{2i+1}v_{2i-1}) = \lceil 3(n+2i)^2 + 1 \rceil$ for $1 \le i \le m-1$

Hence all edge labels are distinct.

Thus $Y_n \cup (P_m \Theta K_1)$ is Cube difference mean labeling Graph.

Example 4.1
$Y_6 \cup (P_6 \Theta K_1)$ is a Cube difference mean labeling Graph.
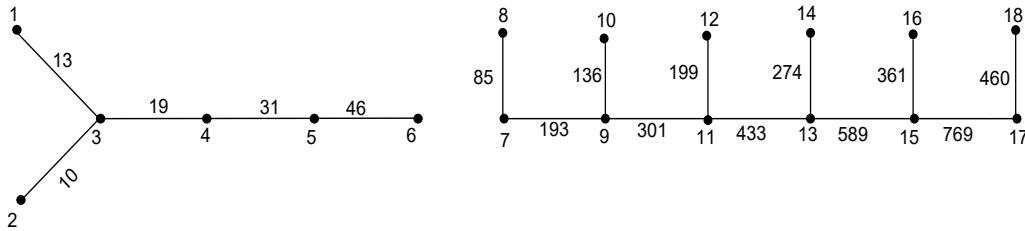
Fig (1.8)

Hence the edges are distinct.

Theorem 5:
$L_n \cup P_m$ is a Cube difference mean labeling Graph.

Proof:
Let $L_n = P_n X P_2$ be a Ladder Graph.

Let $V(L_n) = \{u_i, v_i ; 1 \le i \le n\}$ and

$E(L_n) = \{u_i u_{i+1}, v_i v_{i+1} ; 1 \le i \le n-1 \& u_i v_i ; 1 \le i \le n\}$

$\{w_1, w_2, \ldots, w_m\}$ be the vertices of P_m path graph and $\{b_1, b_2, \ldots, b_{m-1}\}$ be the edges of corresponding path graph. Which are denoted in Fig(1.9)
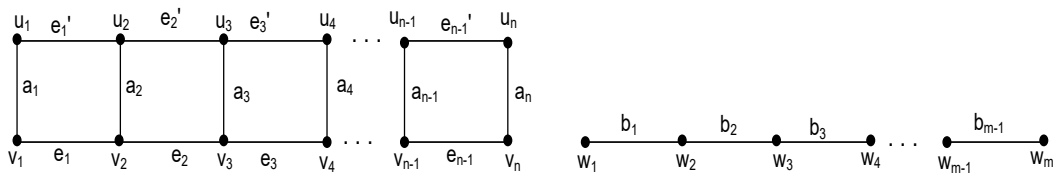
Fig (1.9)

Define the function, $f : V(L_n \cup P_m) \to \{1,2,3,\ldots,n+m\}$ as follows

$f(u_i) = 2i - 1$ for $1 \le i \le n$

$f(v_i) = 2i$ for $1 \le i \le n$

$f(w_i) = 2n + i$ for $1 \le i \le m$

And the induced edge labeling function $f^*(uv) = E(G) \to \{a/1 \le a \le N \text{ and } a \equiv 1(mod3)\}$ is defined by
$f^*(uv) = \left\lceil \frac{[f(u)]^3-[f(v)]^3}{2} \right\rceil$

Now,

For $1 \le i \le n-1$;

$$f^*(u_{i+1}u_i) = \lceil 12i^2 + 1 \rceil$$

$f^*(v_{i+1}v_i) = \lceil 12i^2 + 12i + 4 \rceil$

For $1 \leq i \leq n$;

$$f^*(v_i u_i) = [12i^2 - 6i + 1]$$

For $1 \leq i \leq m$;

$$f^*(w_{i+1}w_i) = \left\lceil \frac{((2n+i)+1)^3 - (2n+i)^3}{2} \right\rceil$$

$$= \left\lceil \frac{3(2n+i)^2 + 3(2n+i) + 1}{2} \right\rceil$$

Hence all edge labels are distinct.

Thus $L_n \cup P_m$ is Cube difference mean labeling Graph.

Example 5.1

The following example for $L_9 \cup P_6$ is Cube difference mean labeling graph.
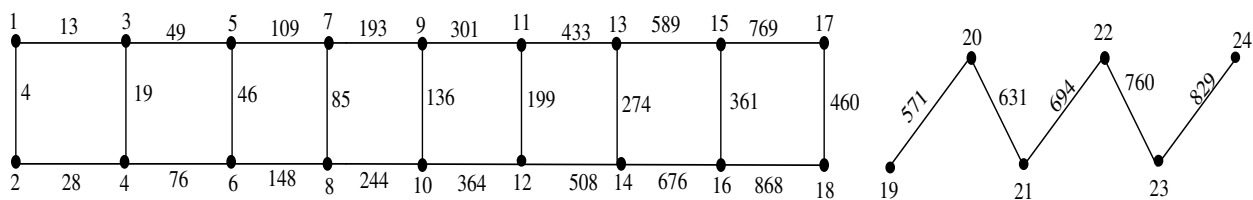
Fig (1.10)

Hence the edge labeling of $L_9 \cup P_6$ are distinct.

Thus the above graph is Cube difference mean labeling Graph.

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ENHANCEMENT IN SEMI-CONDUCTOR GAS SENSOR PERFORMANCE USING CONVENTIONAL METAL-OXIDE-SEMICONDUCTOR FIELD EFFECT TRANSISTORS INTEGRATED WITH DATA CLASSIFICATION USING BACK PROPAGATION BASED ADAPTIVE TRANSFER LEARNING

ARULANANTHAN P *, SARAVANAN R AND BHARATHI RAJA B

ABSTRACT

Innovative engineering solutions that are cost-effective, faster, and easier to adopt are becoming increasingly important due to rapid industrialization and technology breakthroughs. Electrodes of semiconductor gas sensors are critical in determining the sensitivity, reversibility, response time and long-term stability of sensors. Therefore, electrode types, as well as materials utilised in semiconductor gas sensors, are investigated. This research proposes novel technique in enhancing gas sensing performance of semi-conductor using a transistor-based circuit and classifying the sensed data using machine learning architectures. The semiconductor gas sensor circuit is designed with CMOSFET (conventional metal-oxide-semiconductor field effect transistors). Sensed data of gas has been collected and processed for classification. After data processing, the classification is carried out using backpropagation based adaptive transfer learning (BP_Adap_TransL). Equations derived theoretically utilizing physical specifications on semiconductor side as well as chemical specifications on gases side appear to reproduce sensing behaviour to gases above satisfactorily as well as influence of changes in physical specifications such as grain size as well as donor density. Proposed technique obtained sensor response of 49%, accuracy of 97%, average sensing time of 79%, computational time of 50% for sensed gas dataset.

Keywords: semiconductor gas sensors, transistor, machine learning, sensor circuit, classification

1. INTRODUCTION

A porous assemblage of small crystals of an n-type metal oxide semiconductor, often SnO_2, In_2O_3, or WO_3, forms the electrical resistance of a semiconductor gas sensor. In addition, a small amount of foreign substance called a sensitizer is frequently added to the crystals. Resistor changes its resistance sharply when it comes into contact with a small concentration of less gas or oxidising gas when it is operated at the proper temperature in air, allowing us to determine concentration from resistance change. This group of sensors are subjected to a significant amount of R&D efforts worldwide since its inception with a report and a patent by Taguchi [1] to improve sensing performances as well as extend to new applications. Due to this research, the group has expanded to give vital tools to detect as well as control gases in modern society and has also pioneered the formation of a new technology field known as chemical sensors. Specifically, semiconductor gas sensors are divided into surface-sensitive sensors that operate at temperatures below 500°C and bulk-sensitive sensors that operate at high temperatures [2]. This is largely due to the numerous complicated elements that influence sensory properties [3].

Furthermore, the sensing properties are frequently altered by including exogenous compounds such as sensitizers. Understanding these processes has necessitated a combination of semiconductor physics, surface chemistry, solid-state chemistry, and other disciplines. Propose that 3 primary factors find sensing properties: receptor function, transducer function, and utility factor, to make comprehension easier. Researchers have developed several sorts of sensors for various physical qualities such as speed, temperature, pressure, humidity, infrared, gas, and so on [4] for energy savings as well as protection from various types of risks. Gas sensing technology, in particular, has gotten a lot of attention and has grown in importance as a result of its ubiquitous uses for detecting and monitoring flammable, poisonous, and exhaust gases in both household and industrial environments. Indoor air quality monitoring, in addition to commercial usage of gas sensors, is critical. Due to their toxicity as well as accompanying damage to ecosystem, gas molecules such as triethylamine, CO, formaldehyde, NOx, and H2 gas must be detected. Gas sensors with improved selectivity and sensitivity are in high demand, and researchers are putting forth a lot of effort to find better gas detecting materials. Various sensing materials such as MOSs, polymers, carbon nanotubes, and graphene materials are studied to attain remarkable performance in gas sensing applications. MOSs, which have a size range of 1-100 nm, are the most checked gas sensors among various sensing materials. These semiconducting materials' mechanical, optical, electrical, magnetic, and catalytic properties distinguish them [5]. A larger surface area enhances material's surface to volume ratio, allowing for increased adsorption of target gas at reaction sites, resulting in a

substantial resistance change and improved sensitivity [6]. Aside from surface area, the shape of material and electron (e-)/hole (h+) transit in MOSs are the two most essential aspects for sensing. The manufacturing of MOS-based gas sensors has increased due to their good crystalline structure, noble metal doping capabilities, and high production rate [7].

Research Contribution is as Follows

1. To design novel techniques in improving the gas sensing performance of semi-conductor using transistor-based circuit and classifying the sensed data using machine learning architectures

2. To develop semi-conductor gas sensor circuit is designed with conventional metal-oxide-semiconductor field effect transistors (CMOSFET)

3. To processing of data, the classification is carried out using backpropagation based adaptive transfer learning (BP_Adap_TransL)

The experimental results show sensor response vs sensed features of gas, accuracy, average sensing time, computational time.

2. RELATED WORKS

Surface, as well as interface science for semiconductor gas sensors, have recently received a lot of attention. Some researchers have also looked at gas detecting methods, gas sensor technologies, semiconductor junctions, practical hydrogen sensors and gas sensor models [8]. The semiconductor gas sensor is an energy control rather than an energy conversion sensor. When a sensing material is exposed to gas molecules, its physical properties change, and the change is sent as a sensor signal by external electric energy. As a result, in traditional electronic devices, electrode solely serves as a link between device as well as external circuit. As a result, strong mechanical adhesion, as well as low contact resistance, are most important characteristics to consider, along with durability, chemical resistance, reliability, and affordability [9]. Author [10] suggested DAELM drift compensation approach. This strategy yielded a greater classification accuracy, but it also necessitated using more labelled drift samples in the model formation. Researchers [11] employed stacked auto-encoders and limited Boltzmann machines to add deep learning into sensor drift compensation. The author [12] showed how to pre-process gas sensor data using a deep belief network (DBN). This strategy improved the connection between each character of the sensor data. In addition, it aided in successfully extracting and expressing the data's depth features.

Furthermore, numerical testing showed that combining this technique with a support vector machine (SVM) was beneficial. Drift correction was achieved in [13] by determining invariance between original sample domain as well as drift sample domain. Through feature, enhancement pre-processing, this technique incorporated background data of the 2 sample domains to sample's original features. Based on BLS, work [14] established a DTBLS. DTBLS methodology learns a strong target classifier using labelled source data as well as unlabeled target data to adjust for sensor response drift adaptively. Author [15] developed a domain-based subspace learning method that is adaptive. To solve drift problem based on gas sensor arrays, our strategy evaluated both maximising DMDMR. Most related research is carried out from the perspective of software compensation. Work [16] contributed the famous gas sensor array drifted dataset and proposed an integrated learning method based on support vector machines, which provided a machine learning solution for drift compensation research. For more convenient and practicable procedures, [17] presented a calibration method for classification based on a single category of drift correction samples. Work [18] developed an online drift compensation model by adapting two domain adaptation-based strategies for online learning. Author [19] developed a novel active learning methodology that intelligently selects sample labels for drift correction to tackle the issues of only a few drifted samples being usable for label querying. Work [20] proposed a unique drift compensation approach based on balanced distribution adaptation, which uses the weight balance factor to adjust conditional and marginal distributions between the two different domains. In recent years, scholars have started to focus on deep learning techniques and introduced them into the study of drift compensation. Author [21] tried to use long short-term memory (LSTM) NNs to improve the drift compensation effect, and [22] proposed a very innovative method called augmented convolutional neural network (ACNN), which converts sensor signals into matrices and hands them over to convolutional neural network (CNN) for processing like pictures.

3. SYSTEM MODEL

This section discussed proposed semi-conductor based gas sensing and sensed data classification using electrode circuit and machine learning techniques. First, the semi-conductor gas is sensed using conventional

metal-oxide-semiconductor field effect transistors (CMOSFET) with sensor circuits. This sensed data had been classified using backpropagation based adaptive transfer learning (BP_Adap_TransL). The overall proposed architecture is shown in figure-1.
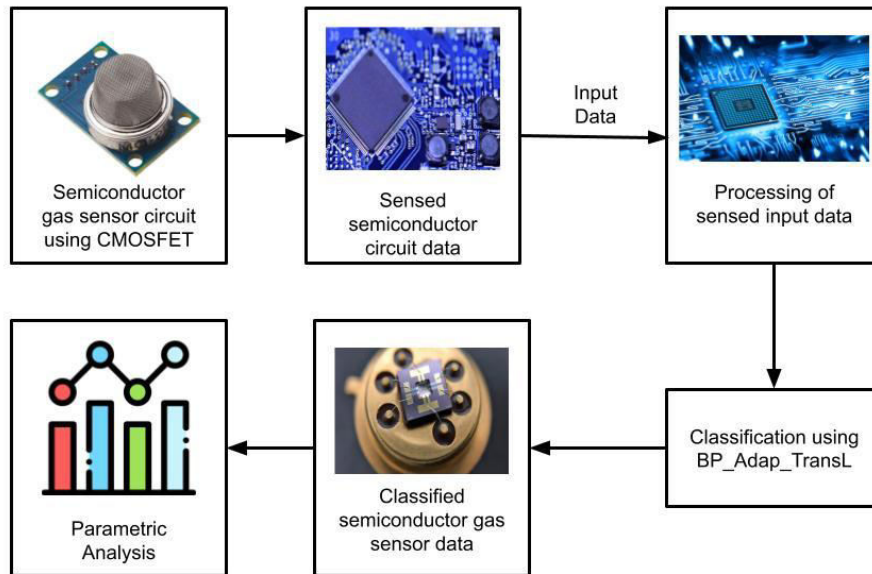
Figure-1: Overall Proposed architecture

Conventional Metal-Oxide-Semiconductor field Effect Transistors (CMOSFET)

CMOSFETs are one of the most dependable and versatile transducers available for gas sensor applications. The CMOSFET structure in electronics are continuously developed as well as enhanced throughout time, and it forms the foundation of both analogue and digital electronics. Because the MOSFET structure is basis for development of various sensors as well as biosensors for a variety of applications, it was changed into chemical sensors more than four decades ago, replacing gate with either an electrolyte or a catalytic metal. Because MOSFET is an extension of MOS capacitor, the sensitivity can be engaged at any time. An additive gate voltage is generated by this layer of charges or dipoles, followed by a fluctuation in the drain-source current. Architecture of a CMOSFET is shown in Figure 2. The gate was originally a hydrogen-sensitive palladium sheet used as a gas sensor.
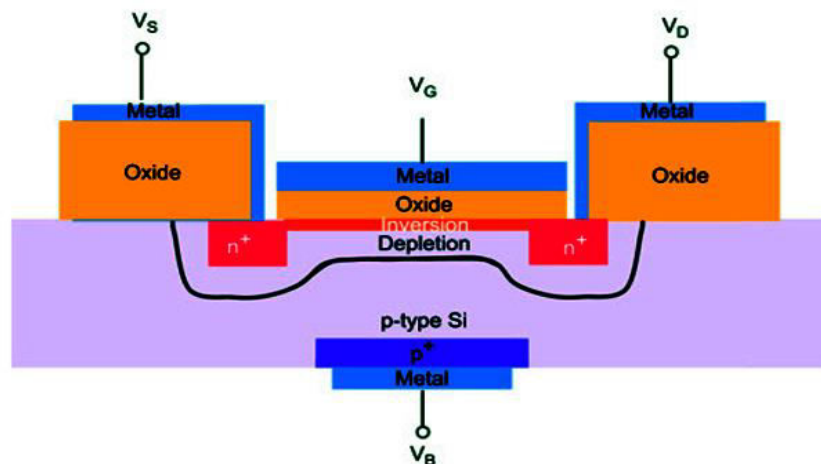
Figure-2: A metal-oxide semiconductor field-effect transistor device

In quasi-linear zone, the charge management equation of the MOSFET is roughly in eq (1)

$$I_{DS} = \mu_n \cdot C_{ox} \cdot \frac{w}{L} \left[(V_{GS} - V_T) \cdot V_{DS} - \frac{V_{DS}^2}{2} \right] \qquad (1)$$

The current becomes substantially independent of VDS in eq. in the saturation area (2)

$$I_{DS} = \mu_n \cdot C_{ox} \cdot \frac{w}{2L} (V_{GS} - V_T)^2 \qquad (2)$$

The above connection holds beyond the pinch-off threshold, but it ignores the influence of VDS on effective channel length.

VGS and VDs are voltages applied between gate, source and drain, while IDS is current from the drain to the source in above calculations. This is because the effective electron mobility in channel is μ_n, oxide capacitance is C_{ox}, the channel width and length are w and L, and the threshold voltage is V_T. This is a critical device parameter because, in first approximation, the channel is established and current can flow only when VGS > VT, as shown in figure 3.
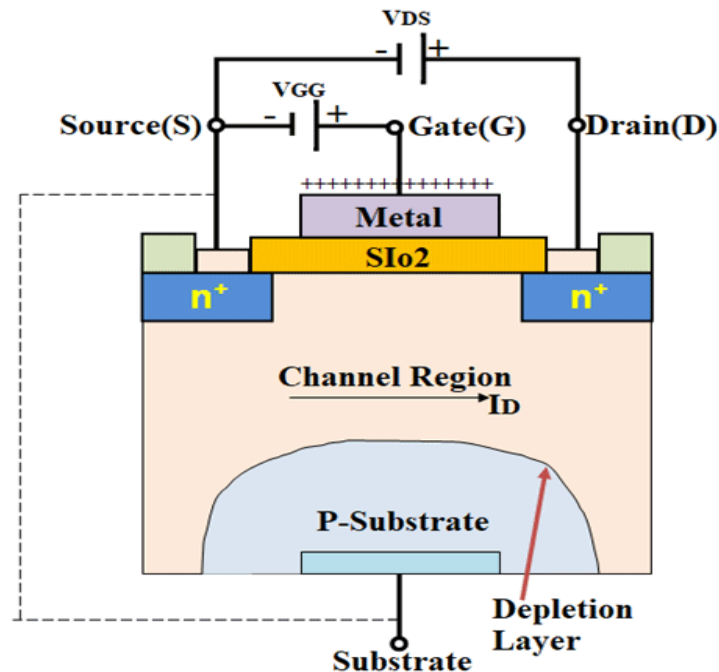
Figure-3: CMOSFET electrode circuit operation

The threshold voltage is determined by all essential MOS structural parameters such as flat band voltage as well as oxide capacitance. Saturation condition is derived by assuming that the current IDS is independent of VDS, i.e. dIDS/dVDS = 0. When VDS =VGS VT, this condition is met. Figure 4 depicts the block diagram of the Pd-FET sensing mechanism. It is similar to the MOS capacitor as well as LAPS block system, except that in this case, changes in flat band voltage affect threshold voltage. When CMOSFET's biassing specifications are held constant, the IDS changes.
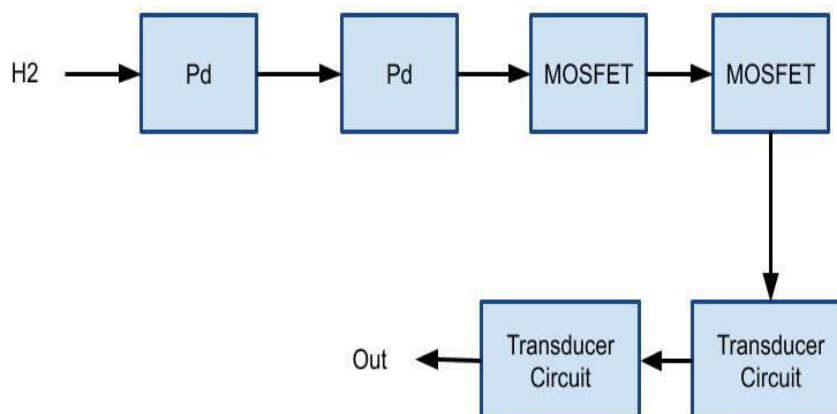
Figure-4: Block diagram of Pd field-effect transistor (FET).

Adsorption of hydrogen gas alters MOS structure's flat band voltage, which influences threshold voltage as well as the device's current-voltage properties. CMOSFET drain-to-source breakdown voltage for short gate devices differs significantly from avalanche breakdown voltage VB of drain–bulk junction. A substantial carrier multiplication occurs as source current passes into avalanching drain zone. The produced electrons go to positively biased drain electrodes, whereas holes flow to substrate, ground and source directly. For small gate lengths as well as long diffusion lengths, it is lower than VB. Operation of CMOSFET is shown in figure-5.
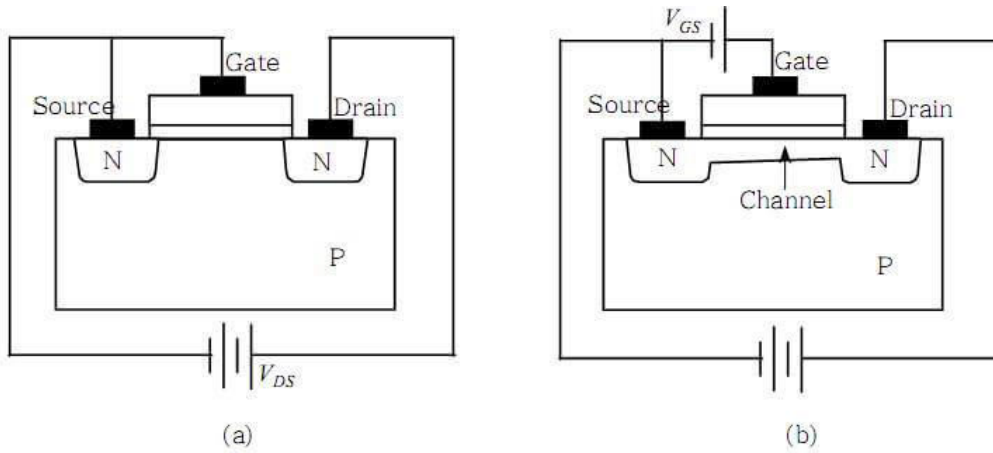
Figure-5: operation of CMOSFET

In eq. (3), electric field is continuous near oxide as well as gate interface front-end.

$$\frac{\partial \varphi_1(x,y)}{\partial y}\bigg|_{y=0} = \frac{\varepsilon_{ox}}{\varepsilon_{si}} \frac{\varphi_{sp1}(x) - V_{GSS1}}{t_{ox}}; \text{ under ME}_1$$

$$\frac{\partial \varphi_2(x,y)}{\partial y}\bigg|_{y=0} = \frac{\varepsilon_{ox}}{\varepsilon_{si}} \frac{\varphi_{sp2}(x) - V_{GSS2}}{t_{ax}}; \text{ under ME}_2 \qquad (3)$$

$$\frac{\partial \varphi_3(x,y)}{\partial y}\bigg|_{y=0} = \frac{\varepsilon_{ox}}{\varepsilon_{si}} \frac{\varphi_{sp3}(x) - V_{GSS3}}{t_{ox}}; \text{ under ME}_3$$

Where $V_{GSS1} = V_{GS} {}^{-V_{FBV,Lg1}}$, $V_{GSS2} = V_{GS} - V_{FB,L2}$ and $V_{GSS3} = V_{GS} {}^{-V_{FBV,Lg3}}$ is gate-to-source applied voltage and ε_{ox} is gate-oxide permittivity.

In eq. (4), electric field at back-gate oxide as well as channel interface is continuous for all gate metals

$$\frac{\partial \varphi_1(x,y)}{\partial y}\bigg|_{y=t_{si}} = \frac{\varepsilon_{ox}}{\varepsilon_{si}} \frac{V''_{GSS,bd1} - \varphi_{BB1}(x)}{t_{oxbb}}; \text{ under ME}_1$$

$$\frac{\partial \varphi_2(x,y)}{\partial y}\bigg|_{y=t_{si}} = \frac{\varepsilon_{ox}}{\varepsilon_{si}} \frac{V''_{GSS,bd2} - \varphi_{BB2}(x)}{t_{oxbb}}; \text{ under ME}_2 \qquad (4)$$

$$\frac{\partial \varphi_3(x,y)}{\partial y}\bigg|_{y=t_{si}} = \frac{\varepsilon_{ox}}{\varepsilon_{si}} \frac{V''_{GSS,bd3} - \varphi_{BB3}(x)}{t_{oxbb}}; \text{ under ME}_3$$

Where

$$V_{GSS,bd1} = V_{GS} - V_{FBV,Lg_1}, V''_{GSS,bd2} = V_{GS} - V_{FBV,Lg2}, \text{ and } V''_{GSS,bd3} = V_{GS} - V_{FBV,Lg3}$$

$$\varphi_{BB}(x,y) = \varphi(x,y)|_{y=t}$$

$$\varphi_{Bn}(x) = \varphi_{sn}(x) + Q_{n1}(x)t_{si} + Q_{n2}(x)t_{si}^2 \qquad (5)$$

Where $\varphi_{Bn}(x)$ is rear surface potential under control gate, first screen gate and second screen gate.

The surface potential at contact of two divergent metals is constant eq. (6)

$$\varphi_1(L_{g1}, 0) = \varphi_1(L_{g1}, 0)$$

$$\varphi_2(L_{g1}, 0) = \varphi_2(L_{g2}, 0) \qquad (6)$$

Electric flow is continuous at interface of two different metals eq. (7),(8)

$$\frac{\partial \varphi_1(x,y)}{\partial x}\bigg|_{x=L_{g1}} = \frac{\partial \varphi_2(x,y)}{\partial x}\bigg|_{x=L_{g1}} \qquad (7)$$

$$\frac{\partial \varphi_1(x,y)}{\partial x}\bigg|_{x=Lg2} = \frac{\partial \varphi_2(x,y)}{\partial x}\bigg|_{x=L_{g2}} \qquad (8)$$

On the source side, the potential is expressed as eq (9)

$$\varphi_1(0,0) = V_{bipot} = 0 \qquad (9)$$

value of constants A, B, C, D, E and F were given as eq. (10), (11) (12),

$$A = V_{bipot} - B + \frac{\beta_1}{\lambda} \mathrm{B} = \frac{\left(V_{bipot} + V_{DS}\right)\exp\left[-\sqrt{\lambda}(L_{g1} - L_{g3})\right](1-G)}{H} + \frac{G[-\beta_3 + \beta_2]}{H\lambda} + \frac{V_{bipot}\exp\left(\sqrt{\lambda}L_{g2}(1-G)\right)}{H}$$

$$(10) - \frac{\beta_3 \exp\left[-\sqrt{\lambda}(L_{g1} + L_{g3})\right]}{H\lambda} - \frac{\sinh\left(\sqrt{\lambda}(L_{g2} - L_{g1})\right)}{H} C = A\exp\left(\sqrt{\lambda}L_{g_1}\right) + \frac{(-\beta_1 + \beta_2)}{2\lambda} D = B\exp\left(-\sqrt{\lambda}L_{g_1}\right) +$$

$$\frac{(-\beta_1 + \beta_2)}{2\lambda} E = \left[V_{bipot} + V_{DS}\right) + \frac{\beta_3}{\lambda} - F\exp\left(-\sqrt{\lambda}L_{g3}\right)\right]\exp\left(-\sqrt{\lambda}L_{g3}\right) \qquad (11)$$

$$F = \frac{1}{\exp\left(-\sqrt{\lambda}(L_{g1} + 2L_{g3}) + \exp\left(\sqrt{\lambda}L_{g1}\right)\right)}\left[2B\sinh\left((\sqrt{\lambda}L_{g2}) - \frac{\beta_1}{\lambda}\exp\left((\sqrt{\lambda}L_{g2}) + (V_{bipot} + V_{DS})\exp\left(-(\sqrt{\lambda}L_{g1} + \right.\right.\right.\right.$$

$$\left. L_{g3}) + \frac{(-\beta_2 + \beta_3)}{\lambda}\right] + \left[V_{bipot}\exp\left(\sqrt{\lambda}L_2\right) - \left[\frac{(-\beta_1 + \beta_2)}{\lambda}\cosh\left[\sqrt{\lambda}(L_{g2} - L_{g1})\right]\right] + \left[\frac{\beta_3}{\lambda}\exp\left(-(\sqrt{\lambda}(L_{g1} + L_{g3}))\right]\right]$$

$$(12)$$

$$F = \frac{1}{\exp\left(-\sqrt{\lambda}(L_{g1} + 2L_{g3}) + \exp\left(\sqrt{\lambda}L_{g1}\right)\right)} \frac{(-\beta_2 + \beta_3)}{\lambda} + \left[V_{bipot}\exp\left(\sqrt{\lambda}L_2\right) - \left[\frac{(-\beta_1 + \beta_2)}{\lambda}\cosh\left[\sqrt{2}\text{sen}\right.\right.$$ as Where $\lambda, \beta_1, \beta_2$

and β_3 can be expressed $\lambda = \frac{4\varepsilon_{ox}\varepsilon_{si}t_{ox} + 2\varepsilon_{ax}^2 t_{si}}{t_{ax}\varepsilon_{si}[t_{si}^2\varepsilon_{ax} + 2\varepsilon_{si}t_{ox}t_{si}]}$ eq. (13)

$$\beta_1 = \frac{-qN_D}{\varepsilon_{si}} - \frac{\varepsilon_{ox}}{t_{si}^2\varepsilon_{ox} + 2\varepsilon_{si}t_{ax}t_{si}}\left[2V_{GSS,bd1} + 2V_{GSS1}\left(1 + \frac{\varepsilon_{ox}t_{si}}{t_{ox}\varepsilon_{si}}\right)\right] \beta_2 = \frac{-qN_D}{\varepsilon_{si}} - \frac{\varepsilon_{ax}}{t_{si}^2\varepsilon_{ax} + 2\varepsilon_{si}t_{ox}t_{si}}\left[2V_{GSS,bd2} + \right.$$

$$2V_{GSS_2}\left(1 + \frac{\varepsilon_{ox}t_{si}}{t_{ax}\varepsilon_{si}}\right)\right] \qquad (13)$$

$$\beta_3 = \frac{-qN_D}{\varepsilon_{si}} - \frac{\varepsilon_{ox}}{t_{si}^2\varepsilon_{ox} + 2\varepsilon_{si}t_{ox}t_{si}}\left[2V_{GSS,bd3} + 2V_{GSS3}\left(1 + \frac{\varepsilon_{ax}t_{si}}{t_{ax}\varepsilon_{si}}\right)\right]$$

Surface Potential under different metals is shown in eq. (14)

$$\varphi_{s1}(x) = A\exp(\sqrt{\lambda}x) + B\exp(-\sqrt{\lambda}x) - \frac{\beta_1}{\lambda}; \quad \text{for } 0 \le x \le L_{g1} \text{ under ME 1}$$

$$\varphi_{s2}(x) = C\exp\left(\sqrt{\lambda}(x - L_1) + D\exp\left(-\sqrt{\lambda}(x - L_1) - \frac{\beta_2}{\lambda}\right); \quad \text{for } Lg_1 \le x \le \left(L_{g1} + L_{g2}\right) \text{ under ME 2}$$

$$\varphi_{s3}(x) = E\exp\left(\sqrt{\lambda}(x - L_1 - L_2) + F\exp\left(-\sqrt{\lambda}(x - L_1 - L_2) - \frac{\beta_3}{\lambda}\right); \quad \text{for } \left(L_{g1} + L_{g2}\right) \le x \le L \text{ under ME3}$$

$$(14)$$

Electric field of metal 1 is given by eq (15),

$$ELE_{1x}(x) = -\frac{d\phi_1(x,y)}{dx}\bigg|_{y=0} = -A\sqrt{\lambda}\exp(\sqrt{\lambda}x) + B\sqrt{\lambda}\exp(-\sqrt{\lambda}x) \text{ for } 0 \le x \le L_{g1} \text{ under Mel} \quad (15)$$

Metal 2 electric field is given as eq. (16),

$$ELE_{2x}(x) = -\frac{d\phi_2(x,y)}{dx}\bigg|_{y=0} = -C\sqrt{\lambda}\exp(\sqrt{\lambda}(x - L_{g1}) + D\sqrt{\lambda}\exp(-\sqrt{\lambda}(x - Lg_1)$$

$$forLg_1 \le x \le \left(L_{g1} + L_{g2}\right) \text{ underME2} \qquad (16)$$

When the S/D doping concentration reaches critical value of Nde in eq. (17), effective S/D ends are evaluated:

$$S_{eff}\sqrt{\ln(N_{dc}/N_{sD}(P)) \times (-2\sigma_L^2)} \rightarrow$$

$$L_{eff} = L_g - 2 \times S_{eff} \rightarrow$$

$$D_{eff} = L_g - S_{erf} = S_{eff} + L_{eff} \rightarrow \qquad (17)$$

$$C_1 = \left(\frac{V_{bi} - C_2 e^{S}eff/A - PI}{e^{-seff/2}}\right) \rightarrow$$

This yields expression for V_t as shown in eq. (18):

$$V_{hi}: V_t \ln\left(\frac{N_{dc}N_S}{n_{ieft}^2}\right) \rightarrow V_1 = K^T/q \text{ - Thermal voltage} \qquad (18)$$

When channel densities at min potential point exceed channel doping density in eq. (19), the threshold voltage is determined as:

$$n_i(T) = 5.29 \times 10^{19} (\,T/300)^2$$

$$\phi = V_t \ln(N_a/n_i) \tag{19}$$

$$n_i = 8.3e^9 \text{ cm}^{-3}$$

$$T = 298.15 \text{ K}$$

Back Propagation Based Adaptive Transfer Learning (BP_Adap_Transl)

D-dimensional parameter vector comprising all d parameters of target method is therefore denoted by $\omega \in R\ d$. Furthermore, using transfer learning paradigms, one may evaluate specifications ωs of target network given a pretrained network with parameters based on an exceptionally large dataset as source. Goal of based DLL optimization is to find $L(\omega)$ minimizer, as indicated in eq (20)

$$\min_w \mathcal{L}(\omega) = \left\{ \frac{1}{n} \sum_{i=1}^n L(z(\mathbf{x}_i, \omega), y_i) + \lambda \cdot \Omega(\omega, \omega_s) \right\} \tag{20}$$

where I first term $\sum_{i=1}^n L(z(\mathbf{x}_i, \omega), y_i)$ is the empirical loss of data fitting and (ii) second term $\Omega(\omega,\ \omega s)$ denotes differences in target as well as source network parameters. Tuning parameter $\lambda > 0$ balances empirical loss vs regularisation term trade-off.

MMD to reduce distance of marginal distribution P(xs), P(xt) and conditional distribution P(ys|xs), P(yt|xt) between source domain and target domain as in eq. (21):

$$D(D_s, D_t) \approx (1 - \mu) \left\| \frac{1}{n} \sum_{i=1}^n x_{si} - \frac{1}{m} \sum_{j=1}^m x_{tj} \right\|^2 + \mu \sum_{c=1}^c \left\| \frac{1}{n_c} \sum_{x_{s_i} \subset D_s}^n x_{si} - \frac{1}{m_c} \sum_{x_{t_j} \subset D_t}^m x_{tj} \right\|_j^2 \tag{21}$$

where H is for reproducing RKHS, c1,2,...,C stands for different class labels; n and m stand for number of samples in source and target domains and Ds and Dt stand for samples belonging to class c in source and target domains. The number of samples in Ds and Dt is given by nc = |Ds| and mc = |Dt|. When you apply further matrix tricks and regularisation to Equation (22) you get:

$$\text{mintr}\left(\mathbf{A}^T \mathbf{X}((1 - \mu)\mathbf{M}_0 + \mu \sum_{c=1}^L \mathbf{M}_c) \mathbf{X}^T \mathbf{A}\right) + \lambda \parallel \mathbf{A} \parallel_F^2$$

s.t. $\mathbf{A}^T \mathbf{X} \mathbf{H} \mathbf{X}^T \mathbf{A} = \mathbf{I}, 0 \leq \mu \leq 1 \tag{22}$

The first requirement is to keep the modified data's inner properties (ATX) compatible with original data. Second constraint restricts balancing factor μ to range, where X is input data matrix and xs and xt are the input data elements. I represents identity matrix, $\in \mathbf{R}^{(n+m) \times (n+m)}$. H stands for the centred matrix, which is defined as $\mathbf{H} = \mathbf{I} - (1/n)\mathbf{1}$. $\mathbf{M}_0$ and $\mathbf{M}_c$ c are matrices that make up the MMD matrix, which may be built using subsequent equations (23, 24):

$$(\mathbf{M}_0)_{ij} = \begin{cases} \frac{1}{n^2}, & x_i, x_j \in D_s \\ \frac{1}{m_2^2}, & x_i, x_j \in D_t \\ \frac{-1}{mn}, & \text{otherwise} \end{cases} \tag{23}$$

$$(\mathbf{M}_c)_{ij} = \begin{cases} \frac{1}{n_c^2}, & x_i, x_j \in D_s^{(c)} \\ \frac{1}{m_c^2}, & x_i, x_j \in D_t^{(c)} \\ \frac{-1}{m_c n_c}, & \begin{cases} x_i \in D_s^{(c)}, x_j \in D_t \\ x_i \in D_t^{(c)}, x_j \in D_s \end{cases} \\ 0, & \text{otherwise} \end{cases} \tag{24}$$

If the Lagrange multiplier is denoted as $\Phi = (\varphi1, \varphi2, \ldots, \varphi d)$, then Lagrange function for Equation (4) is written as eq. (25):

$$\begin{aligned} L = \ & \text{tr}\left(\mathbf{A}^T \mathbf{X}\left((1 - \mu)\mathbf{M}_0 + \mu \sum_{c=1}^C \mathbf{M}_c\right)\mathbf{X}^T \mathbf{A}\right) \\ & + \lambda \parallel \mathbf{A} \parallel_F^2 + \text{tr}\left(\left(\mathbf{I} - \mathbf{A}^T \mathbf{X} \mathbf{H} \mathbf{X}^T \mathbf{A}\right)\Phi\right) \end{aligned} \tag{25}$$

Then, by converting the optimization of Equation (26) into a generalised eigen decomposition problem, we may derive:

$$\left(\mathbf{X}\big((1-\mu)\mathbf{M}_0 + \mu\sum_{c=1}^{C}\mathbf{M}_c\big)\mathbf{X}^{\mathrm{T}}\right) + \lambda\mathbf{I} = \mathbf{X}\mathbf{H}\mathbf{X}^{\mathrm{T}}\mathbf{A}\Phi \qquad (26)$$

Finally, we may find the best transformation matrix A as well as its d smallest eigenvectors by solving Equation (27). The degree of similarity between tasks is a good predictor of task consistency. The weighting model is denoted by the letters (sim):

$$\text{sim}_i = \cos\left(\nabla_\theta\mathcal{L}_{\text{sup}}(\theta), \nabla_\theta\mathcal{L}_{\text{aux},i}(\theta)\right) \qquad (27)$$

where $\nabla\theta$ Lsup (θ) is gradient vector calculated at θ by loss of target task and $\nabla\theta$ L$aux,i(\theta)$ is gradient vector calculated by loss of auxiliary task i. Utilizing (sim ;) to produce weight for each task, joint loss is given as eq. (28):

$$\mathcal{L}(\theta; w) = g(\text{sim}_0; w)\mathcal{L}_{\text{sup}}(\theta) + \sum_{i=1}^{K}g(\text{sim}_i; w)\mathcal{L}_{aux,i}(\theta) \qquad (28)$$

We exploit loss of target task on updated BP_Adap TransL to optimise weighting model after one update of BP_Adap TransL by above total loss. As a result, weighting model is revised as follows: eq. (29):

$$\underset{w}{\text{argmin}}\, \mathcal{L}_{\text{sup}}(\dot{\theta}(w))\Big). \qquad (29)$$

After one gradient update utilizing joint loss L (;), $\dot{\theta}(w)$ reflects the modified parameters of the BP_Adap_TransL.

Given that weights of various tasks are specified by weighting method, describe multi-task objective of BP_Adap_TransL as eq. (30).

$$\underset{\theta}{\text{argmin}}\, g(\text{sim}_0; w)\mathcal{L}_{sup}(\theta) + \sum_{i=1}^{K}g(\text{sim}_i; w)\mathcal{L}_{aux,i}(\theta) \qquad (30)$$

We iteratively train both networks until they converge. Finally, our proposed solution is demonstrated in Algorithm 1, which utilises gradient descent to update both networks.

Algorithm of BP_Adap_TransL:

Input: training data for target task/auxiliary tasks D^{sup}, D^{aux}; learning rate: α, β, max iterations N; number of auxiliary tasks K;

1: Start $\theta_0, w_0, \text{sim}_0 = 1$

2. for $t = 0$ to N do

3: fetch one batch of training data: D^{sup}, D^{aux}

4: # step 1: enhance weighting method via meta-learning

5: $D^{\text{sup (train)}}, D^{\text{sup (meta)}} \leftarrow \text{Split}\left(D^{\text{sup}}\right)$

6: for $i = 1$ to K do

7: # Evaluate gradient similarity

8: $\text{sim}_i \leftarrow \cos\left(\nabla_{\theta_t}\mathcal{L}_{\text{sup}}(\theta_t), \nabla_{\theta_2}\mathcal{L}_{aux}\right.$

9: end for

10: $\mathcal{L}(\theta_1; w_2) \quad -g(\text{sim } 0; w_1)\mathcal{L}_{sup}(\theta_1) + \sum_{i=1}^{K}g(\text{sim}_i; w_t)\mathcal{L}_{auc,i}(\theta_t)$

10: $\mathcal{L}(\theta_t; w_t) \leftarrow g(\text{sim } 0; w_t)\mathcal{L}_{\text{sup}}(\theta_t) +$

11: compute: $\dot{\theta}_t(w_t) \leftarrow \theta_t - \alpha\nabla_\theta\mathcal{L}(\theta_t; w_t)$ with $D^{\text{sup (train)}} \cup D^{aux}$

12: Update $w_{t+1} \leftarrow w_t - \beta\nabla_w\mathcal{L}_{\text{sup}}\left(\dot{\theta}_l(w_l)\right)$ with D^{sup}(meta)

13: # step 2: enhance GNN via joint loss

14: for $i = 1$ to K do

15: # Evaluate gradient similarity

16: $\text{sim}_i \leftarrow$

18: $\mathcal{L}(\theta_t) \leftarrow g(\text{sim}_0; w_{t+1})\mathcal{L}_{sup}(\theta_t) +$

$\sum_{i=1}^{K}g(\text{sim}_i; w_{t+1})\mathcal{L}_{aux,i}(\theta_t)$ 19: Update $\theta_{t+1} \leftarrow \theta_t - \alpha\nabla_{\theta_t}\mathcal{L}(\theta_t)$ with $D^{\text{sup}} \cup D^{aux}$

20: end for

The domain classifier D attempts to distinguish between features from source and target domains, but domain feature representation network T attempts to confound them, resulting in an adversarial training method. β During domain classifier D training, the source feature distribution is re-weighted with to improve the domain confusion effect. We utilised the following minimax objective function when gaming between T and D.

$$\min_{\mathcal{T}}\max_{\mathcal{D},\beta}\mathcal{L}_{adv}^{R_{\varepsilon}} \qquad (31)$$

where the weight β is multiplied by D, and both β and D were cooperatively trained. Minimising the cross-entropy loss was simple to learn the source classifier C.

4. Performance Analysis

This study utilized Anaconda (Python 3.8, individual edition) as development environment. Experimental environment utilized Intel i5-6200U 2.40 GHz CPU, 8 GB RAM. This project required third-party libraries including NumPy 1.20.1, Pandas 1.2.4, SciPy 1.6.2, Scikit-learn 0.24.1, and Matplotlib 3.3.4.

DATASET DESCRIPTION

The gas sensor array drift dataset (GSAD), one of the famous data sets of gas sensor drift problems, was adopted as the research object in this study. The dataset, created and donated by Alexander Vergara [15] in 2012, contains 13,910 chemical gas sensor data collected by 16 chemical gas sensors (including four TGS2600, four TGS2602, four TGS2610, and four TGS2620) for six different concentrations of different gases. Data were collected during 36 months from January 2008 to February 2011 at the Gas Delivery Platform facility of Chemical Signals Laboratory at BioCircuits Institute at University of California, San Diego. Dataset is divided into 10 batches by time, as represented in Table 1.

Table 1: Data distribution of each batch in GSAD dataset

Batch Id	Month Ids	Quantity and Proportion of Each Gas in the Batch										
		Ethanol		Ethylene		Ammonia		Acetaldehyde		Acetone		Toluene	
Batch1	1,2	90	20.2	98	22.0	83	18.7	30	6.7	70	15.7	74	16.6
Batch 2	3,4,8,9,10	164	13.2	334	26.8	100	8.0	109	8.8	532	42.8	5	0.4
Batch 3	11,12,13	365	23.0	490	30.9	216	13.6	240	15.1	275	17.3	0	0.0
Batch 4	14,15	64	39.8	43	26.7	12	7.5	30	18.6	12	7.5	0	0.0
Batch 5	16	28	14.2	40	20.3	20	10.2	46	23.4	63	32.0	0	0.0
Batch 6	17,18,19, 20	514	22.3	574	25.0	110	4.8	29	1.3	606	26.3	467	20.3
Batch 7	21	649	18.0	662	18.3	360	10.0	744	20.6	630	17.4	568	15.7
Batch 8	22,23	30	10.2	30	10.2	40	13.6	33	11.2	143	48.6	18	6.1
Batch 9	24,30	61	13.0	55	11.7	100	21.3	75	16.0	78	16.6	101	21.5
Batch 10	36	600	16.7	600	16.7	600	16.7	600	16.7	600	16.7	600	16.7

Table-2: comparative analysis of various semi-conductor gas sensor datasets

Datasets	Techniques	Sensor response vs Sensed features of gas	Accuracy	Sensing time	Computational time
TGS2600	**DTBLS**	33	60	59	55
	DMDMR	39	63	61	42
	ACNN	50	69	65	20
	CMOSFET_ BP_Adap_TransL	55	91	71	18
TGS2602	**DTBLS**	42	65	45	55
	DMDMR	49	73	55	53
	ACNN	55	80	62	51
	CMOSFET_ BP_Adap_TransL	59	95	63	43
TGS2610	**DTBLS**	40	49	59	71
	DMDMR	42	61	70	63
	ACNN	45	82	72	60
	CMOSFET_ BP_Adap_TransL	48	93	79	55
TGS2620	**DTBLS**	31	69	65	61
	DMDMR	35	79	69	55

ACNN	40	85	72	53
CMOSFET_ BP_Adap_TransL	49	97	79	50

The above tables-2 shows comparative analysis of various semi-conductor gas sensor datasets. Here is the dataset is taken from chemical gas sensor data for six different concentrations of gases and the sensed data classification metrics. The comparison is carried between existing DTBLS, DMDMR, ACNN and proposed technique CMOSFET_ BP_Adap_TransL.

(a) Sensor Response

(b) Accuracy

(c) Average Sensing Time

(d) Computational Time
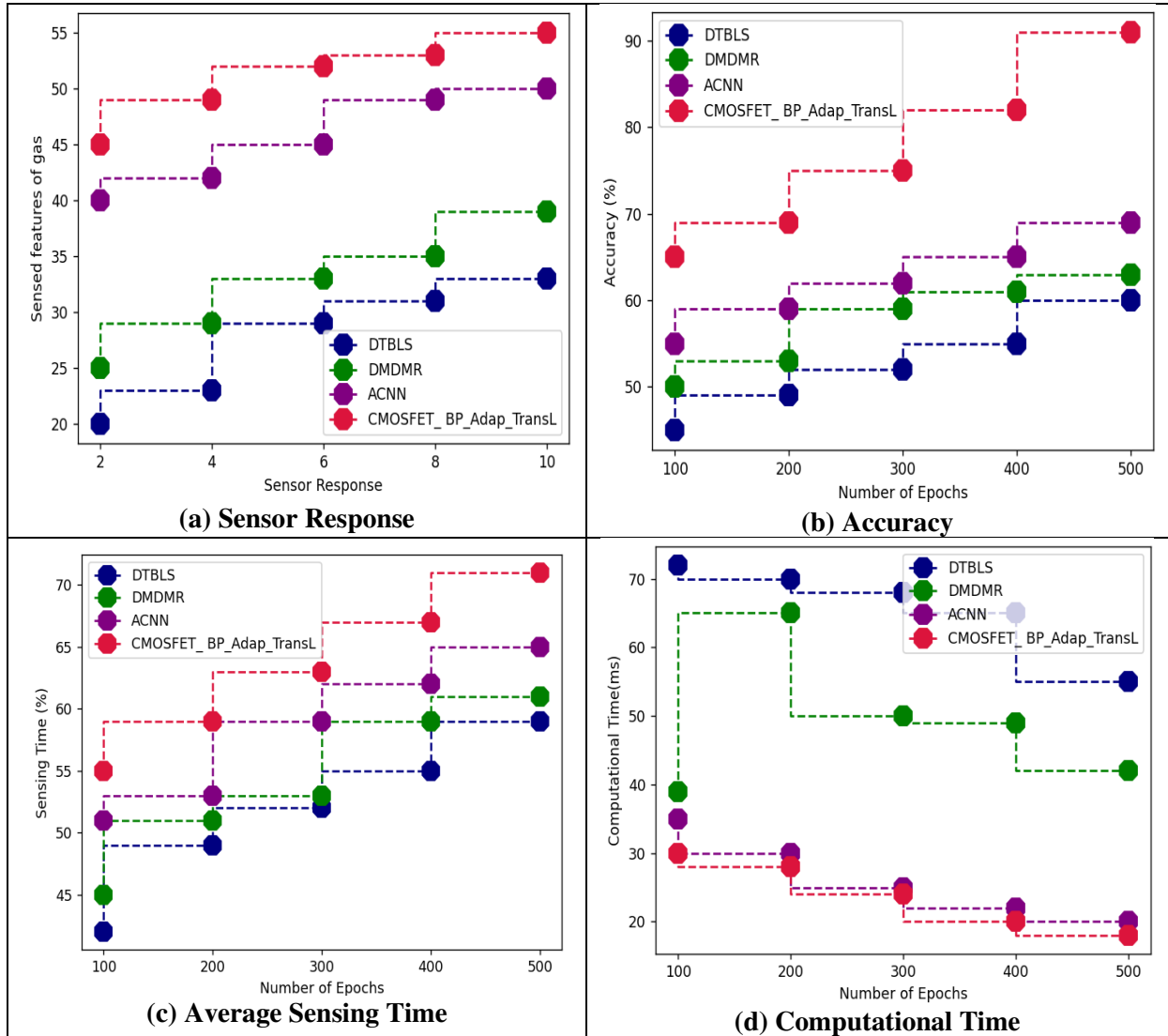
Figure- 6: comparative analysis for TGS2600 dataset in terms of (a) sensor response, (b) accuracy, (c) average sensing time, (d) computational time

(a) Sensor Response

(b) Accuracy

(c) Average Sensing Time

(d) Computational Time
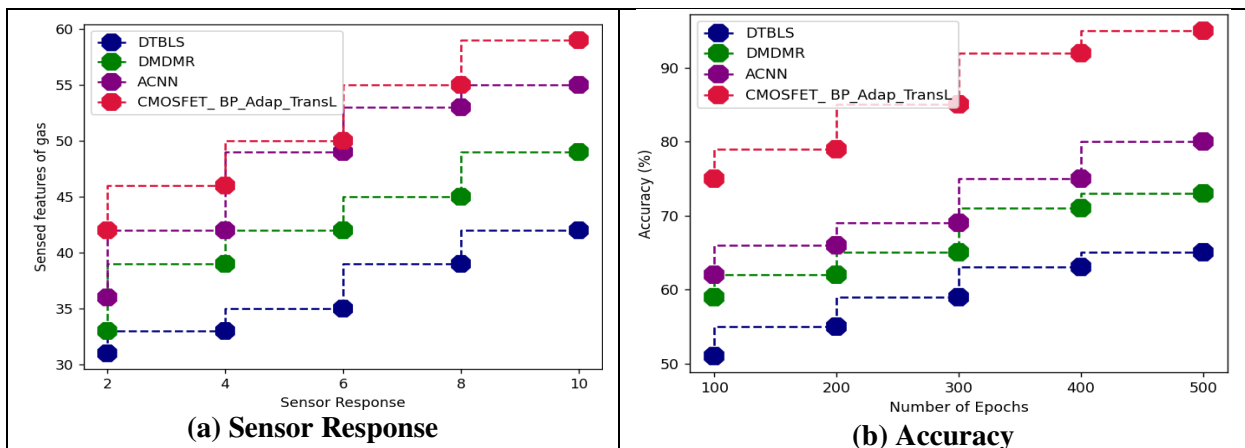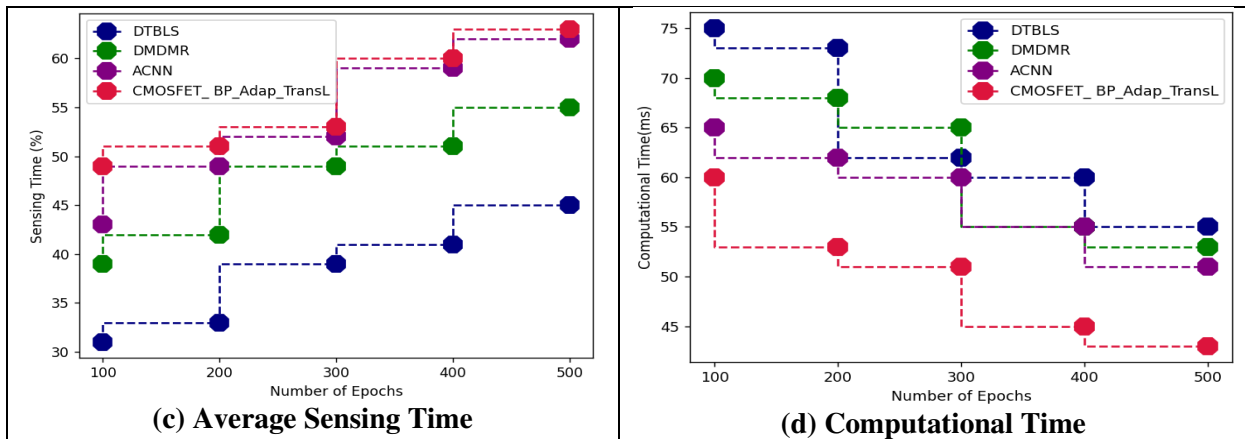
Figure- 7: comparative analysis for TGS2602dataset in terms of (a) sensor response, (b) accuracy, (c) average sensing time, (d) computational time

(a) Sensor Response

(b) Accuracy

(c) Average Sensing Time

(d) Computational Time
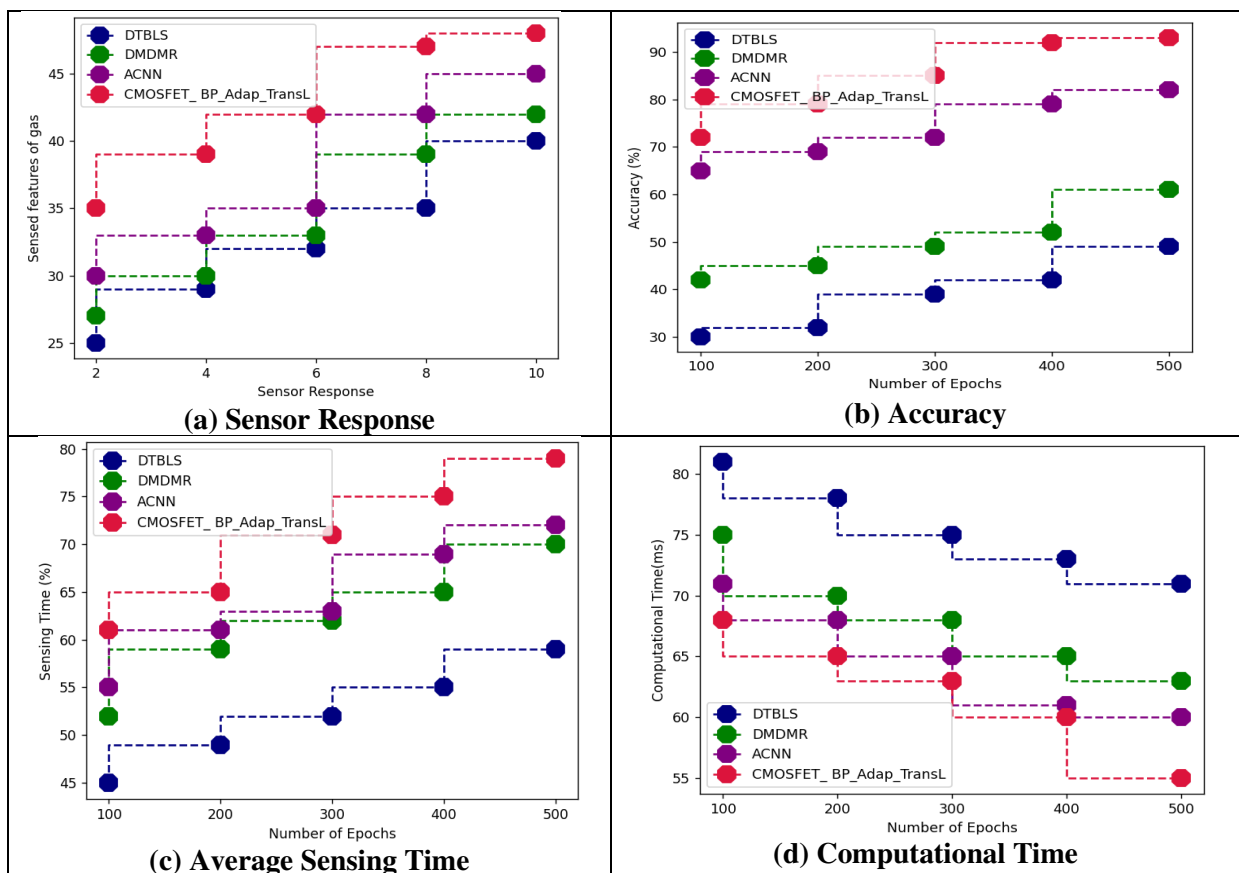
Figure- 8: comparative analysis for TGS2610 dataset in terms of (a) sensor response, (b) accuracy, (c) average sensing time, (d) computational time

(a) Sensor Response

(b) Accuracy

(c) Average Sensing Time **(d) Computational Time**
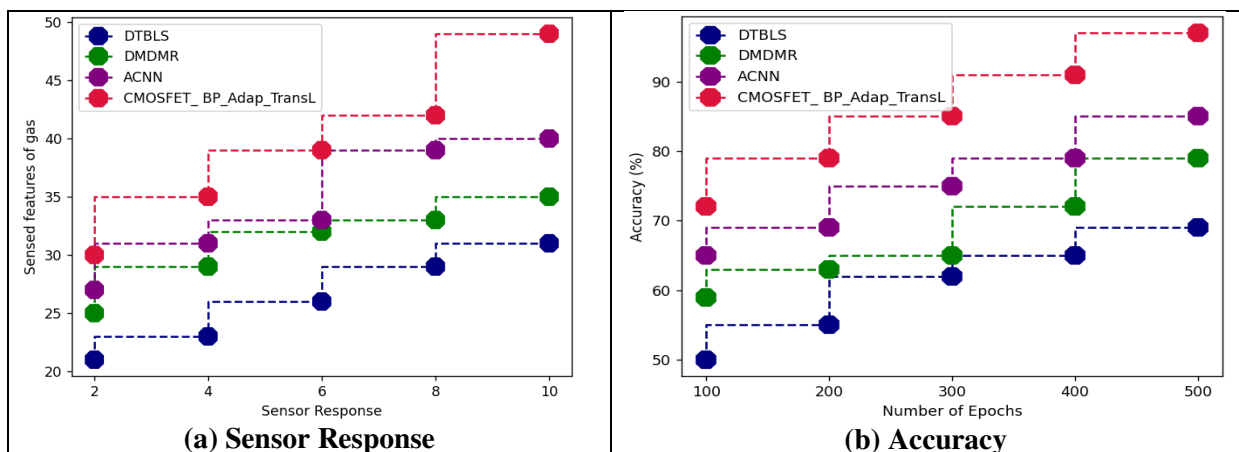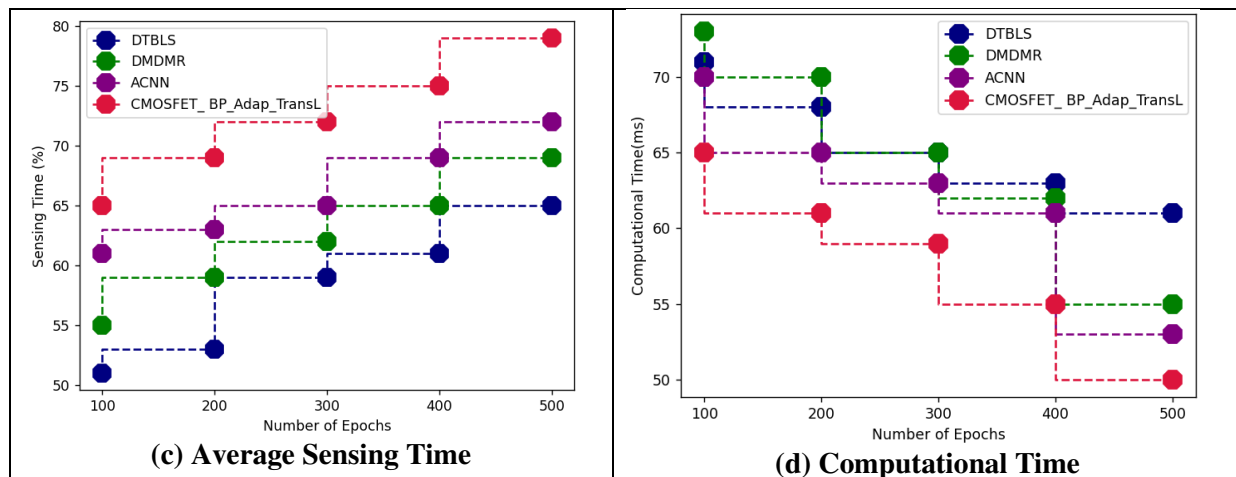
Figure- 9: comparative analysis for TGS2620 dataset in terms of (a) sensor response, (b) accuracy, (c) average sensing time, (d) computational time

The above figure 6-9 shows comparative analysis in terms of sensor response, accuracy, average sensing time, computational time for TGS2600, TGS2602, TGS2610, and TGS2620 datasets. Here the proposed technique obtained sensor response of 55%, accuracy of 91%, average sensing time of 71%, computational time of 18% for TGS2600 sensed gas dataset. For the TGS2602 dataset, the proposed technique obtained a sensor response of 59%, accuracy of 95%, average sensing time of 63%, and computational time of 43%. TGS2610 dataset received sensor response of 48%, accuracy of 93%, average sensing time of 79%, computational time of 55% using proposed technique. Finally, the proposed method obtained sensor response of 49%, accuracy of 97%, average sensing time of 79%, computational time of 50% for TGS2620 sensed gas dataset.

5. CONCLUSION

This research proposed a novel semi-conductor-based gas sensing and sensed data classification using electrode circuits and machine learning techniques. The semi-conductor gas is sensed using conventional metal-oxide-semiconductor field effect transistors (CMOSFET) with sensor circuits. This sensed data had been classified using back propagation based adaptive transfer learning (BP_Adap_TransL). The experimental analysis shows comparative analysis in terms of sensor response, accuracy, average sensing time, computational time for TGS2600, TGS2602, TGS2610, and TGS2620 datasets. Equations derived theoretically utilizing physical specifications on semiconductor side as well as chemical on gases side seems to reproduce sensing behaviour to gases mentioned above as well as influence of variations in physical specifications such as grain size as well as donor density satisfactorily. Proposed technique obtained sensor response of 49%, accuracy of 97%, average sensing time of 79%, computational time of 50% for sensed gas dataset.

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FUZZY INVENTORY MODEL FOR DETERIORATING ITEMS WITH POWER PATTERN DEMAND WITH SHORTAGES AND BACKLOGGING

SANJU KUMAR[*] AND RAVISH KUMAR YADAV

ABSTRACT
In this paper, we derive a fuzzy inventory model for deteriorating items with power demand patterns allowing shortages and partially backlogging. Time-dependent deterioration rate as well as holding cost have been taken. The total cost depends on two variables, one of those is the time at which the inventory level becomes zero, and the second one is the time length of the planning period. Triangular fuzzy number is assigned to the cost parameter and defuzzified by the signed distance method. Finally, numerical examples are presented to illustrate to calculate optimised results.

Keywords: fuzzy inventory, power pattern demand, shortages, Weibull backlogging, deteriorating item.

1. INTRODUCTION

It is important to understand the demand pattern for management of inventories in business, trade and industry. Harris developed the first inventory model to define the Economic Order Quantity in 1915. Wilson gave generalized economic order quantity model. Generally, the nature of goods is deteriorating in many inventory systems. Initially, the study on inventory management including deteriorating items conducted for fashionable items that deteriorated at the end of the storage period. Ghare and Schrader [1] gave a model for an exponentially decaying inventory with constant demand. Naddor [2] in 1966 introduced a special class of time varying demand known by the power demand pattern which considers the demand rate is constant during the inventory cycle and also allows the situation where primarily withdrawn at the beginning of the period or situation where a larger portion of demand occurs at the end of the inventory cycle. Many research articles based on power demand pattern have been published. Goel and Aggarwal [3] introduced an order level inventory system with power demand pattern for deteriorating items. Saxena and Yadav [6] introduced an ordering policy for non-instantaneous decaying items with stock dependent demand and shortages. Hill [4] gave an inventory model for increasing demand followed by level demand. Sicilia et al. [8] provides a deterministic inventory system with power demand pattern for deteriorating items. Yadav et al. [11] developed an inventory model with volume flexibility, random deterioration and increasing demand rate exponentially. Yadav and Yadav [12] introduced a production model in volume flexibility with cubic demand rate. Sicilia et al. [13] provide an inventory model for deteriorating items with shortages and time varying demand i.e. power demand. Keshavarzfard et al. [17] gave a multi-product pricing and inventory model with production rate proportional to power demand rate. Olalekan and Osertin [20] gave a deteriorating inventory policy for items with power demand and variable holding cost considering shortages.

The real business world is full of uncertainties and thereby imprecision in defining the important parameters of the inventory problem. The fuzzy set theory is a most suitable way to deal with uncertainties. The fuzzy set theory was given by L. A. Zadeh [5]. Bartman and Bach [7] gave in inventory control models and methods. Yadav et al. [9] studied the effect of demand boosting policy on optimal inventory policy for imperfect lot size with backorder in fuzzy environment. Mandal and Islam [14] introduced a fuzzy inventory model for power demand pattern with inflation, shortages under partially backlogging condition. Yadav et al. [15] gave a retailer optimal policy under inflation in fuzzy environment with trade credit. Rajeswari et al. [16] introduced an optimization in fuzzy inventory model for linearly deteriorating items, with power demand, partially backlogging and linear holding cost. A joint pricing, supplier selection, and inventory replenishment model using the logit demand function was introduced by Duan and Ventura [18]. Ban [19] provided an inventory model for non-instantaneous deteriorating items with power demand and partially backlogged shortages in fuzzy environment.

The objective of this paper is to determine optimum inventory cost as well as optimum cycle length for an inventory system with power demand and time dependent holding cost in fuzzy environment. Cost components like products cost, deterioration cost, cost of lost sale, backordering cost are fuzzified by taking triangular fuzzy numbers and defuzzification completed by the signed distance method. Findings are verified by numerical examples.

2. ASSUMPTIONS AND NOTATIONS

2.1 Assumptions

➤ Only single item has been considered in the inventory model.

➤ Holding cost, deterioration cost are depends on time.

➤ **Power demand:-** The demand up to time t is assumed to be $dT\left(\frac{t}{T}\right)^m$, where d the average demand during the fixed cycle time T, and m $(0 < m < \infty)$ is the pattern index of demand. The demand rate at time t is given by $\left(\frac{t}{T}\right)^{m-1}$, which is known by power demand pattern.

i.e demand at any time t, $D(t) = md\left(\frac{t}{T}\right)^{m-1}$, due to the value of m, three case arises

1 *$0 < m < 1$.*

2 *$m=1$.*

3 *$m>1$*

➤ **Generalised Triangular Fuzzy Number:-** A fuzzy number $\tilde{A}$= (a, b, c), where a < b < c and defined on $\mathbb{R}$, is called a triangular fuzzy number if its membership function is

$$\mu_A(x) = \begin{cases} \dfrac{x-a}{b-a}, & a \le x \le b \\ \dfrac{c-x}{c-b}, & b \le x \le c \\ 0 & otherwise \end{cases}$$

When $a = b = c$, we have fuzzy point $(c, c, c) = \tilde{c}$. The family of all triangular fuzzy number on $\mathbb{R}$ is denoted as $F_N = \{(a,b,c): a < b < c, \forall\ a,b,c \in \mathbb{R}\}$.

The α-cut of $\tilde{A} = (a, b, c) \in F_N$, $0 \le \alpha \le 1$ *is $A(\alpha) = [A_L(\alpha), A_R(\alpha)]$*,

Where $A_L(\alpha) = a + (b-a)\alpha$ and $A_R(\alpha) = c - (c-b)\alpha$ are the left and right end points of $A(\alpha)$.
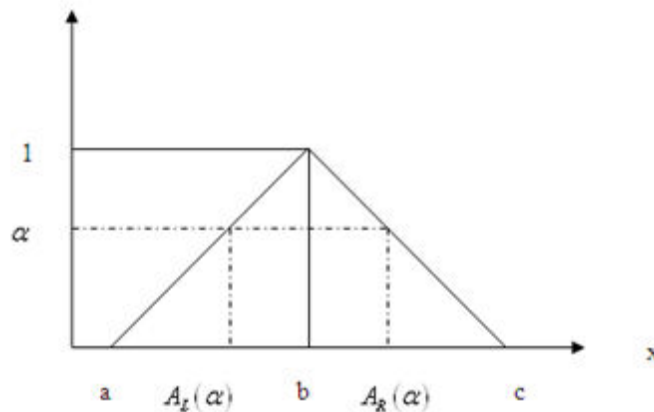
Figure 1: Triangular fuzzy number

➤ **Defuzzification:-** The process of conversion of a fuzzy set into a crisp set is known as defuzzification. There are several methods are available for defuzzification. But in this research work, we have used signed distance method.

The signed distance of $\tilde{A}$ is defined by the given integration

$$d(\tilde{A}, 0) = \frac{1}{2}\int_0^1 [\tilde{A}_L(\alpha) + \tilde{A}_R(\alpha)]\, d\alpha$$

$=\dfrac{a+2b+c}{4}$

If triangular fuzzy number is the triplet $\tilde{A} = (a, b, c)$ where b,$a = b - \Delta_1$ and $c = b + \Delta_2$ are crisp numbers satisfying the condition $a \le b \le c$ then

$$d(\tilde{A},0) = \frac{a+2b+c}{4} = \frac{\Delta_2 - \Delta_1}{4} + b$$

2.1 NOTATIONS
Following notations will be used throughout the paper

A - Ordering cost per cycle.

C – Per unit cost.

θt. - Time dependent Deterioration rate.

$h(t)$ - Holding cost per unit per unit time, $h(t) = a + bt$ where a > 0, and b > 0.

C_b- Backordering cost per unit short per unit time.

C_l - Cost of lost sale per unit.

C_d - Deterioration cost per unit.

T - Time length of cycle, and $T = (t_1 + t_2)$

t_1 - Time at which the the inventory level becomes zero.

$\tilde{h}(t)$– Fuzzy holding cost per unit per unit time, $\tilde{h}(t) = \tilde{a} + bt$ where a > 0, and b > 0.

$\tilde{C}$ – Fuzzy cost per unit.

$\tilde{C}_b$ – Fuzzy backordering cost per unit short per unit time.

$\tilde{C}_l$ – Fuzzy cost of lost sale per unit.

$\tilde{C}_d$ - Fuzzy Deterioration cost per unit.

Q – The ordered quantity during the cycle of length time T, and $Q = (q_1 + q_2)$, where q_1 is maximum inventory level during the time period [0, T], and q_2 is maximum backordered units during stock out period.

B – Backlogging rate, where backordered item follows the backlog function $B(t) = e^{-\alpha t}$, where $B(0) = 1$ and $B(T) \geq 0, 0 < \alpha < 1, t > 1$.

3. MATHEMATICAL MODELS

3.1 Crisp model
Inventory level during the period [*0, t₁*] controlled by the following differential equation,

$$\frac{d}{dt} I_1(t) + \theta t I_1(t) = -md\left(\frac{t}{T}\right)^{m-1}, \qquad 0 \leq t \leq t_1 \tag{1}$$

With the condition $I_1(t) = 0$ when $t = t_1$. So we have, inventory level at any time *t*,

$$I_1(t) = \frac{md}{T^{m-1}}\left\{\left(1 - \frac{1}{2}\theta t^2\right)\left(\frac{t_1^m}{m} - \frac{t^m}{m}\right) + \frac{\theta}{2(m+2)}\left(t_1^{m+2} - t^{m+2}\right)\right\}, \quad 0 \leq t \leq t_1 \tag{2}$$

Inventory level during shortage period controlled by the following equation,

$$\frac{d}{dt} I_2(t) = -e^{-\alpha(T-t)}.md\left(\frac{t}{T}\right)^{m-1}, t_1 \leq t \leq T \tag{3}$$

With boundary condition $I_2(t) = 0$ when $t = t_1$, the solution of equation (3), we get

$$I_2(t) = -\frac{md}{T^{m-1}}\left\{\frac{1}{m}\left(t^m - t_1^m\right) - \frac{\alpha T}{m}\left(t^m - t_1^m\right) + \frac{\alpha}{m+1}\left(t^{m+1} - t_1^{m+1}\right)\right\} \tag{4}$$

The maximum positive inventory q_1, obtained by putting *t = 0* in equation (2),

$$q_1 = I_1(0) = \frac{md}{T^{m-1}} \left\{ \frac{t_1^m}{m} + \frac{\theta}{2(m+2)} t_1^{m+2} \right\} \tag{5}$$

The maximum backordered unit's q_2 is obtained by using equation (4)

$$q_2 = -I_2(T) = \frac{md}{T^{m-1}} \left\{ \frac{(1-\alpha T)}{m}(T^m - t^m) + \frac{\alpha}{m+1}(T^{m+1} - t_1^{m+1}) \right\} \tag{6}$$

Hence the order size Q during the planning period [0, T], from equation (5) and (6), we have

$$Q = q_1 + q_2$$

$$Q = \frac{md}{T^{m-1}} \left[\left\{ \frac{t_1^m}{m} + \frac{\theta}{2(m+2)} t_1^{m+2} \right\} + \left\{ \frac{(1-\alpha T)}{m}(T^m - t^m) + \frac{\alpha}{m+1}(T^{m+1} - t_1^{m+1}) \right\} \right] \tag{7}$$

Since the inventory level during the period $(0, t_1)$ is positive so the holding cost is calculated for the time period $(0, t_1)$ only.

Holding cost

$$HC = \int_0^{t_1} h(t) I_1(t) dt$$

$$HC = \int_0^{t_1} (a+bt) \frac{md}{T^{m-1}} \left\{ \left(1 - \frac{1}{2}\theta t^2\right) \left(\frac{t_1^m}{m} - \frac{t^m}{m}\right) + \frac{\theta}{2(m+2)}(t_1^{m+2} - t^{m+2}) \right\} dt$$

$$HC = \frac{md}{T^{m-1}} \left[\frac{at_1^{m+1}}{m+1} + \frac{a\theta t_1^{m+3}}{3(m+3)} + \frac{bt_1^{m+2}}{2(m+2)} + \frac{b\theta t_1^{m+4}}{8(m+4)} \right] \tag{8}$$

Backordering cost

$$BC = C_b \int_{t_1}^{T} -I_2(t) dt$$

$$BC = \frac{C_b md}{T^{m-1}} \left[\begin{array}{l} \dfrac{(1-\alpha T)}{m(m+1)}(T^{m+1} - t_1^{m+1}) - \dfrac{(1-\alpha T)}{m} t_1(T - t_1) \\[3mm] + \dfrac{\alpha}{(m+1)(m+2)}(T^{m+2} - t_1^{m+2}) - \dfrac{\alpha}{(m+1)} t_1^{m+1}(T - t_1) \end{array} \right] \tag{9}$$

Cost of lost sale

$$LS = C_i \int_{t_1}^{T} \left(1 - e^{-\alpha(T-t)}\right) \frac{md}{T^{m-1}} t^{m-1} dt$$

$$LS = \frac{C_l \alpha md}{T^{m-1}} \left[\frac{T^{m+1}}{m(m+1)} - t_1^m \left(\frac{T}{m} - \frac{t_1}{m+1}\right) \right] \tag{10}$$

Deterioration cost

$$DC = C_d \left[Q - \int_0^{t_1} \frac{md}{T^{m-1}} t^{m-1} dt - \int_{t_1}^{T} e^{-\alpha(T-t)} \cdot \frac{md}{T^{m-1}} t^{m-1} dt \right]$$

$$DC = \frac{C_d md}{T^{m-1}} \frac{\theta t_1^{m+2}}{2(m+2)} \tag{11}$$

Purchase cost

$$PC = C \times Q$$

$$PC = \frac{Cmd}{T^{m-1}} \left[\left\{ \frac{t_1^m}{m} + \frac{\theta}{2(m+2)} t_1^{m+2} \right\} + \left\{ \frac{(1-\alpha T)}{m} \left(T^m - t^m \right) + \frac{\alpha}{m+1} \left(T^{m+1} - t_1^{m+1} \right) \right\} \right] \qquad (12)$$

Hence, the average total cost per unit time given by,

$$K(T, t_1) = \frac{1}{T} \left[OC + HC + BC + LS + DC + PC \right]$$

$$K(T, t_1) = \frac{md}{T^m} \begin{bmatrix} A + \dfrac{at_1^{m+1}}{m+1} + \dfrac{a\theta t_1^{m+3}}{3(m+3)} + \dfrac{bt_1^{m+2}}{2(m+2)} + \dfrac{b\theta t_1^{m+4}}{8(m+4)} \\[2mm] +C_b \left\{ \begin{array}{l} \dfrac{(1-\alpha T)}{m(m+1)}(T^{m+1} - t_1^{m+1}) - \dfrac{(1-\alpha T)}{m} t_1 (T - t_1) \\[2mm] + \dfrac{\alpha}{(m+1)(m+2)}(T^{m+2} - t_1^{m+2}) - \dfrac{\alpha}{(m+1)} t_1^{m+1}(T - t_1) \end{array} \right\} \\[2mm] +C_l \alpha \left\{ \dfrac{T^{m+1}}{m(m+1)} - t_1^m \left(\dfrac{T}{m} - \dfrac{t_1}{m+1} \right) \right\} + \dfrac{C_d \theta t_1^{m+2}}{2(m+2)} + \\[2mm] C \left\{ \dfrac{t_1^m}{m} + \dfrac{\theta}{2(m+2)} t_1^{m+2} + \dfrac{(1-\alpha T)}{m} \left(T^m - t^m \right) + \dfrac{\alpha}{m+1} \left(T^{m+1} - t_1^{m+1} \right) \right\} \end{bmatrix} \qquad (13)$$

3.2 FUZZY MODEL

In the real world, any kind of cost could not be precise. So we are dealing with impreciseness by assigning triangular fuzzy numbers to the different cost parameters C, C_b C_d, C_l and a such that

$$\tilde{C} = (C - \delta_1, C, C + \delta_2) \ where \ \delta_1, \delta_2 > 0 \ and \ C > \delta_1 > 0$$

$$\tilde{C}_b = (C_b - \delta_3, C_b, C_b + \delta_4) \ where \ \delta_3, \delta_4 > 0 \ and \ C_b > \delta_3 > 0$$

$$\tilde{C}_d = (C_d - \delta_5, C_d, C_b + \delta_6) \ where \ \delta_5, \delta_6 > 0 \ and \ C_d > \delta_5 > 0$$

$$\tilde{C}_l = (C_l - \delta_7, C_l, C_l + \delta_8) \ where \ \delta_7, \delta_8 > 0 \ and \ C_l > \delta_7 > 0$$

$$\tilde{a} = (a - \delta_9, a, a + \delta_{10}) \ where \ \delta_9, \delta_{10} > 0 \ and \ a > \delta_9 > 0$$

Total average cost of the inventory per unit time in fuzzy sense is given by

$$K(T, t_1) = \frac{md}{T^m} \begin{bmatrix} A + a \left(\dfrac{t_1^{m+1}}{m+1} + \dfrac{\theta t_1^{m+3}}{3(m+3)} \right) + \dfrac{bt_1^{m+2}}{2(m+2)} + \dfrac{b\theta t_1^{m+4}}{8(m+4)} \\[2mm] +C_b \left\{ \begin{array}{l} \dfrac{(1-\alpha T)}{m(m+1)}(T^{m+1} - t_1^{m+1}) - \dfrac{(1-\alpha T)}{m} t_1 (T - t_1) \\[2mm] + \dfrac{\alpha}{(m+1)(m+2)}(T^{m+2} - t_1^{m+2}) - \dfrac{\alpha}{(m+1)} t_1^{m+1}(T - t_1) \end{array} \right\} \\[2mm] +C_l \alpha \left\{ \dfrac{T^{m+1}}{m(m+1)} - t_1^m \left(\dfrac{T}{m} - \dfrac{t_1}{m+1} \right) \right\} + \dfrac{C_d \theta t_1^{m+2}}{2(m+2)} + \\[2mm] C \left\{ \dfrac{t_1^m}{m} + \dfrac{\theta}{2(m+2)} t_1^{m+2} + \dfrac{(1-\alpha T)}{m} \left(T^m - t^m \right) + \dfrac{\alpha}{m+1} \left(T^{m+1} - t_1^{m+1} \right) \right\} \end{bmatrix} \qquad (14)$$

Now we defuzzify (10) by applying signed distance method, we have

$$d(K,0) = \frac{md}{T^m} \left[\begin{array}{l} A + d(a,0)\left(\dfrac{t_1^{m+1}}{m+1} + \dfrac{\theta t_1^{m+3}}{3(m+3)} \right) + \dfrac{bt_1^{m+2}}{2(m+2)} + \dfrac{b\theta t_1^{m+4}}{8(m+4)} \\[4mm] + d(C_b,0)\left\{ \begin{array}{l} \dfrac{(1-\alpha T)}{m(m+1)}(T^{m+1} - t_1^{m+1}) - \dfrac{(1-\alpha T)}{m}t_1(T - t_1) \\[3mm] + \dfrac{\alpha}{(m+1)(m+2)}(T^{m+2} - t_1^{m+2}) - \dfrac{\alpha}{(m+1)}t_1^{m+1}(T - t_1) \end{array} \right\} \\[6mm] + d(C_l,0)\alpha\left\{ \dfrac{T^{m+1}}{m(m+1)} - t_1^m(\dfrac{T}{m} - \dfrac{t_1}{m+1}) \right\} + \dfrac{d(C_d,0)\theta t_1^{m+2}}{2(m+2)} + \\[4mm] d(C,0)\left\{ \dfrac{t_1^m}{m} + \dfrac{\theta}{2(m+2)}t_1^{m+2} + \dfrac{(1-\alpha T)}{m}\left(T^m - t^m\right) + \dfrac{\alpha}{m+1}\left(T^{m+1} - t_1^{m+1}\right) \right\} \end{array} \right] \quad (15)$$

Where

$$d(C,0) = \frac{\delta_2 - \delta_1}{4} + C, \quad and \quad d(C_b,0) = \frac{\delta_4 - \delta_3}{4} + C_b$$

$$d(C_d,0) = \frac{\delta_6 - \delta_5}{4} + C_d, \quad and \quad d(C_l,0) = \frac{\delta_8 - \delta_7}{4} + C_l$$

$$d(a,0) = \frac{\delta_{10} - \delta_9}{4} + a$$

Let
$$d(K,0) \cong K(T,t_1)$$

Hence,

$$K(T,t_1) = \frac{md}{T^m} \left[\begin{array}{l} A + \left(\dfrac{\delta_{10} - \delta_9}{4} + a \right)\left(\dfrac{t_1^{m+1}}{m+1} + \dfrac{\theta t_1^{m+3}}{3(m+3)} \right) + \dfrac{bt_1^{m+2}}{2(m+2)} + \dfrac{b\theta t_1^{m+4}}{8(m+4)} \\[4mm] + \left(\dfrac{\delta_4 - \delta_3}{4} + C_b \right)\left\{ \begin{array}{l} \dfrac{(1-\alpha T)}{m(m+1)}(T^{m+1} - t_1^{m+1}) - \dfrac{(1-\alpha T)}{m}t_1(T - t_1) \\[3mm] + \dfrac{\alpha}{(m+1)(m+2)}(T^{m+2} - t_1^{m+2}) - \dfrac{\alpha}{(m+1)}t_1^{m+1}(T - t_1) \end{array} \right\} \\[6mm] + \left(\dfrac{\delta_8 - \delta_7}{4} + C_l \right)\alpha\left\{ \dfrac{T^{m+1}}{m(m+1)} - t_1^m(\dfrac{T}{m} - \dfrac{t_1}{m+1}) \right\} + \left(\dfrac{\delta_6 - \delta_5}{4} + C_d \right)\dfrac{\theta t_1^{m+2}}{2(m+2)} \\[4mm] + \left(\dfrac{\delta_2 - \delta_1}{4} + C \right)\left\{ \dfrac{t_1^m}{m} + \dfrac{\theta}{2(m+2)}t_1^{m+2} + \dfrac{(1-\alpha T)}{m}\left(T^m - t^m\right) + \dfrac{\alpha}{m+1}\left(T^{m+1} - t_1^{m+1}\right) \right\} \end{array} \right] \quad (16)$$

4 ALGORITHM

To optimize total average cost per unit time, the value of T and t_1 can be obtained by solving the following equations for both crisp and fuzzy model.

$$\frac{\partial K(T,t_1)}{\partial t_1} = 0 \quad and \quad \frac{\partial K(T,t_1)}{\partial T} = 0$$

Provided that the following conditions must be satisfied,

$$\frac{\partial^2 K(T,t_1)}{\partial t_1^2} > 0, \qquad \frac{\partial^2 K(T,t_1)}{\partial T^2} > 0$$

and

$$\left(\frac{\partial^2 K(T,t_1)}{\partial t_1^2}\right)\left(\frac{\partial^2 K(T,t_1)}{\partial T^2}\right) - \left(\frac{\partial^2 K(T,t_1)}{\partial t_1 \partial T}\right)^2 > 0$$

5. NUMERICAL EXAMPLES

5.1 Crisp Model

$d = 100\, units / week, A = \$40\, per\, order, a = 0.3, b = 0.05, C = \$8\, per\, unit, C_b = \$12 / unit / week,$
$C_l = \$15 / unit, C_d = \$10 / unit, \alpha = 0.7, \theta = 0.05, m = 1$

The solution of crisp model is

$t_1^* = 2.4967\, weeks, \quad T^* = 3.7334\, weeks, \quad K^*(T,t_1) = \$1700.7$

And

$$\frac{\partial^2\, K^*(T,t_1)}{\partial t_1^2} = 206.4273 > 0, \quad \frac{\partial^2\, K^*(T,t_1)}{\partial T^2} = 103.5606 > 0$$

$$\left(\frac{\partial^2\, K^*(T,t_1)}{\partial t_1^2}\right)\left(\frac{\partial^2\, K^*(T,t_1)}{\partial T^2}\right) - \left(\frac{\partial^2\, K^*(T,t_1)}{\partial t_1 \partial T}\right)^2 = 20187.7541217 > 0$$
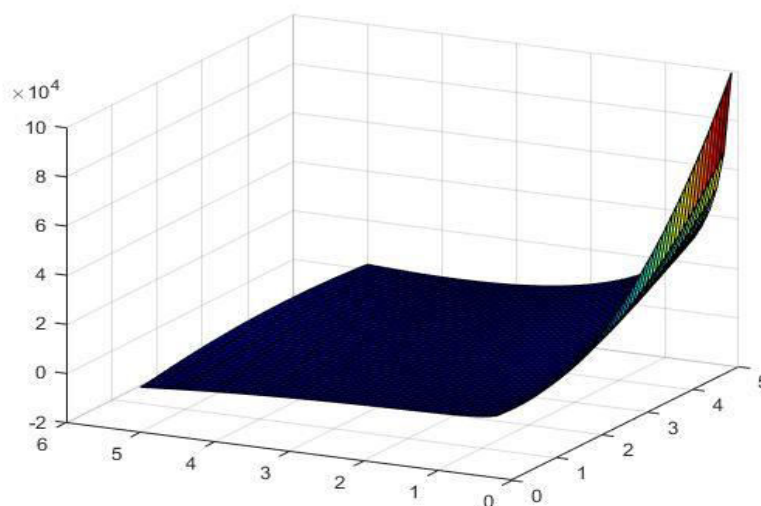
Figure 1:

5.2 FUZZY MODEL

$d = 100\, units / week, A = \$40\, per\, order, a = 0.5, b = 0.05, C = \$8\, per\, unit, C_b = \$12 / unit / week,$
$C_l = \$15 / unit, C_d = \$10 / unit, \alpha = 0.7, \theta = 0.05, m = 1, \delta_1 = 3, \delta_2 = 1, \delta_3 = 5, \delta_4 = 2, \delta_5 = 4, \delta_6 = 2,$
$\delta_7 = 5, \delta_8 = 3, \delta_9 = 0.04, \delta_{10} = 0.02,$

The solution of fuzzy model

$t_1^* = 2..5600\, weeks, \quad T^* = 3.8213\, weeks, \quad K^*(T,t_1) = \$1639.7$

And

$$\frac{\partial^2\, K^*(T,t_1)}{\partial t_1^2} = 118.2408 > 0, \quad \frac{\partial^2\, K^*(T,t_1)}{\partial T^2} = 18.6521 > 0$$

$$\left(\frac{\partial^2\, K^*(T,t_1)}{\partial t_1^2}\right)\left(\frac{\partial^2\, K^*(T,t_1)}{\partial T^2}\right) - \left(\frac{\partial^2\, K^*(T,t_1)}{\partial t_1 \partial T}\right)^2 = 1.50292047 > 0$$
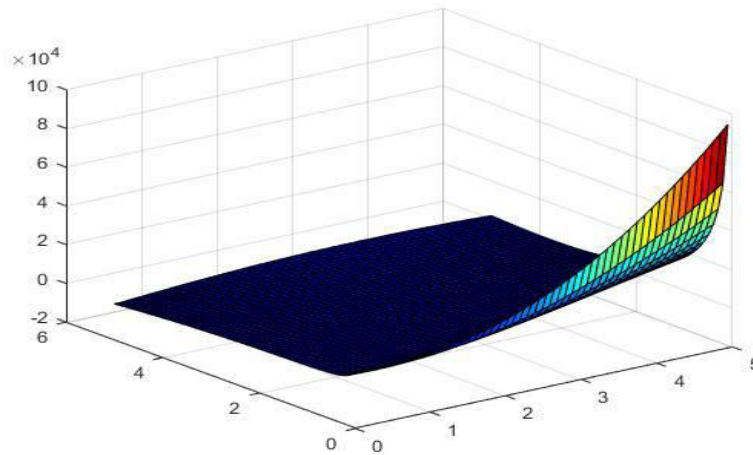
Figure 2:

6. SENSITIVITY ANALYSIS

In this section we study the effects of change in parameters θ, A, α, and d. Three values are considered for the index of the power demand pattern m, that is $m = 0.5$, 1 and 1.5.

6.1 Crisp Model

We choose the values for the deterioration fraction θ = 0.01, 0.03, 0.05, and 0.08. Computed results are reported in table 1. These results indicate that optimal cost K increases as the deterioration fraction increases, but optimal cost decreases as index of power demand pattern m increases. The minimum cost per unit time is attained when θ = 0.01 and m = 1.5.

Table. 1

$d = 100\,units\,/\,week,\,\theta = 0.05,\,A = 40,\,a = 0.5,\,b = 0.05,\,C = \$8\,per\,unit,\,C_b = \$12\,/\,unit\,/\,week,$ $C_l = \$15\,/\,unit,\,C_d = \$10\,/\,unit,\,\alpha = 0.5,$			
Deterioration	**$m = 0.5$**	**$m = 1$**	**$m = 1.5$**
θ=0.01	$t_1 = 1.5921,\,T = 2.7095$ $K(t_1,T) = 2116.8$	$t_1 = 3.2177,\,T = 4.6586$ $K(t_1,T) = 1534.2$	$t_1 = 2.1908,\,T = 3.7669$ $K(t_1,T) = 1274.5$
θ=0.03	$t_1 = 1.6552,\,T = 2.6699$ $K(t_1,T) = 2124.3$	$t_1 = 2.9101,\,T = 4.3753$ $K(t_1,T) = 1635.7$	$t_1 = 2.1436,\,T = 3.7573$ $K(t_1,T) = 1304.7$
θ=0.05	$t_1 = 1.8166,\,T = 2.6313$ $K(t_1,T) = 2133.5$	$t_1 = 2.6929,\,T = 4.1792$ $K(t_1,T) = 1712.2$	$t_1 = 2.0985,\,T = 3.7475$ $K(t_1,T) = 1332.8$
θ=0.08	$t_1 = 1.7514,\,T = 2.6354$ $K(t_1,T) = 2146.9$	$t_1 = 2.4562,\,T = 3.9701$ $K(t_1,T) = 1800.3$	$t_1 = 2.0348,\,T = 3.7328$ $K(t_1,T) = 1371.6$

In table 2, we analyse the optimal policy when the ordering cost A and the power demand pattern index m vary at different values. The optimal cost is obtained at m = 1.5 and A = 20. Results of this table indicate that inventory cost decreases as ordering cost decreases and the inventory cost decreases when m increases.

Table 2

$d = 100\,units\,/\,week,\,\theta = 0.05,\,a = 0.5,\,b = 0.05,\,C = \$8\,per\,unit,\,C_b = \$12\,/\,unit\,/\,week,$ $C_l = \$15\,/\,unit,\,C_d = \$10\,/\,unit,\,\alpha = 0.5,$			
Deterioration	$m = 0.5$	$m = 1$	$m = 1.5$
$A = 20$	$t_1 = 1.6589,\,T = 2.3252$ $K(t_1,T) = 1498.9$	$t_1 = 2.1966,\,T = 3.5134$ $K(t_1,T) = 1352.3$	$t_1 = 1.9124,\,T = 3.1605$ $K(t_1,T) = 1204.5$
$A = 30$	$t_1 = 1.7194,\,T = 2.4928$ $K(t_1,T) = 1820.9$	$t_1 = 2.4343,\,T = 3.8515$ $K(t_1,T) = 1546.1$	$t_1 = 2.0126,\,T = 3.4884$ $K(t_1,T) = 1278.7$
$A = 50$	$t_1 = 2.0386,\,T = 2.7434$ $K(t_1,T) = 2439.5$	$t_1 = 2.9504,\,T = 4.4892$ $K(t_1,T) = 1861.7$	$t_1 = 2.1764,\,T = 3.9655$ $K(t_1,T) = 1374.2$
$A = 60$	$t_1 = 2.0430,\,T = 2.8390$ $K(t_1,T) = 2738.7$	$t_1 = 3.1984,\,T = 4.7795$ $K(t_1,T) = 2000.5$	$t_1 = 2.2480,\,T = 4.1556$ $K(t_1,T) = 1407.0$

The sensitivity of the inventory policy with respect to the backlogging parameter is shown in table 3. The best result is obtained at $m = 0.5$ and $\alpha = 0.1$. For m = 0.5 cost increases as the value of backlogging parameter increases but cost decreases as backlogging parameter increases for m greater or equal to one.

Table 3

$d = 100\,units\,/\,week$, $A = \$40\,per\,order$, $a = 0.5$, $b = 0.05$, $C = \$8\,per\,unit$, $C_b = \$12\,/\,unit\,/\,week$, $C_l = \$15\,/\,unit$, $C_d = \$10\,/\,unit$, $\theta = 0.05$,			
Deterioration	m = 0.5	m = 1	m = 1.5
$\alpha = 0.1$	$t_1 = 4.2425$, T =6.5075 $K(t_1,T) = 1143.3$	$t_1 = 4.4349$, T=5.8485 $K(t_1,T) = 1927.7$	$t_1 = 4.2130$, T=4.9026 $K(t_1,T) = 1951.9$
$\alpha = 0.3$	$t_1 = 2.4205$, T = 3.2662 $K(t_1,T) = 1970.2$	$t_1 = 3.3209$, T =5.3104 $K(t_1,T) = 1724.0$	$t_1 = 2.7543$, T =4.4378 $K(t_1,T) = 1478.4$
$\alpha = 0.7$	$t_1 = 1.9501$, T = 2.3754 $K(t_1,T) = 2215.6$	$t_1 = 2.4967$, T =3.7334 $K(t_1,T) = 1700.7$	$t_1 = 1.8376$, T =3.3710 $K(t_1,T) = 1244.5$
$\alpha = 0.9$	$t_1 = 1.8438$, T = 2.2060 $K(t_1,T) = 2265.4$	$t_1 = 2.3695$, T =3.4565 $K(t_1,T) = 1693.5$	$t_1 = 1.6932$, T =3.1211 $K(t_1,T) = 1186.9$

Now, we have observed variation of optimal cost with respect to the holding cost, for this purpose changes in the value of *b* is considered in table 4. The minimum cost is obtained when *b*= 0.03 and *m* = 1.5. The inventory cost increases as the value of *b* increases and cost of inventory decreases as *m* increases.

Table 4

$d = 100\,units\,/\,week$, $A = \$40\,per\,order$, $a = 0.5$, $\alpha = 0.5$, $C = \$8\,per\,unit$, $C_b = \$12\,/\,unit\,/\,week$, $C_l = \$15\,/\,unit$, $C_d = \$10\,/\,unit$, $\theta = 0.05$,			
Deterioration	m = 0.5	m = 1	m = 1.5
$b = 0.01$	$t_1 = 1.8234$, T =2.6307 $K(t_1,T) = 2132.4$	$t_1 = 2.7153$, T=4.1992 $K(t_1,T) = 1704.3$	$t_1 = 2.1034$, T=3.7486 $K(t_1,T) = 1329.8$
$b = 0.03$	$t_1 = 1.8200$, T = 2.6310 $K(t_1,T) = 2132.9$	$t_1 = 2.7040$, T =4.1891 $K(t_1,T) = 1708.2$	$t_1 = 2.1009$, T =3.7481 $K(t_1,T) = 1331.3$
$b = 0.05$	$t_1 = 1.8166$, T = 2.6313 $K(t_1,T) = 2133.5$	$t_1 = 2.6929$, T =4.1792 $K(t_1,T) = 1712.2$	$t_1 = 2.0985$, T =3.7475 $K(t_1,T) = 1332.8$
$b = 0.08$	$t_1 = 1.8119$, T = 2.6317 $K(t_1,T) = 2134.3$	$t_1 = 2.6766$, T =4.1646 $K(t_1,T) = 1718.0$	$t_1 = 2.0948$, T =3.7467 $K(t_1,T) = 1335.1$

6.2 FUZZY MODEL

Here we observe the variation of θ, A, α, and *d.* As above three values are considered for the index of the power demand pattern *m*, that is *m* = 0.5, 1 and 1.5.

In table 5 results indicate that fuzzy optimal cost increases as the deterioration fraction increases, but optimal cost decreases as index of power demand pattern *m* increases. The minimum cost per unit time is attained when $\theta = 0.01$ and *m* = 1.5.

Table 5

$d = 100\,units\,/\,week$, $A = 40$, $a = 0.5$, $b = 0.05$, $C = \$8\,per\,unit$, $C_b = \$12\,/\,unit\,/\,week$, $C_l = \$15\,/\,unit$, $C_d = \$10\,/\,unit$, $\alpha = 0.5$, $\delta_1 = 3$, $\delta_2 = 1$, $\delta_3 = 5$, $\delta_4 = 2$, $\delta_5 = 4$, $\delta_6 = 2$, $\delta_7 = 5$, $\delta_8 = 3$, $\delta_9 = 0.04$, $\delta_{10} = 0.02$,			
Deterioration	m = 0.5	m = 1	m = 1.5
θ=0.01 θ=0.03	$t_1 = 1.6065$, T = 2.7364 $\widetilde{K}(t_1,T) = 2064.4$	$t_1 = 3.3013$, T =4.7673 $\widetilde{K}(t_1,T) = 1475.4$	$t_1 = 2.2242$, T =3.8339 $\widetilde{K}(t_1,T) = 1211.5$
θ=0.05	$t_1 = 1.6667$, T = 2.6986 $\widetilde{K}(t_1,T) = 2071.6$	$t_1 = 2.9784$, T =4.4701 $\widetilde{K}(t_1,T) = 1575.9$	$t_1 = 2.1761$, T = 3.8243 $\widetilde{K}(t_1,T) = 1240.8$
θ=0.08	$t_1 = 2.1460$, T = 2.6887 $\widetilde{K}(t_1,T) = 2081.1$	$t_1 = 2.7521$, T =4.2659 $\widetilde{K}(t_1,T) = 1651.2$	$t_1 = 2.1303$, T = 3.8146 $\widetilde{K}(t_1,T) = 1268.1$
	$t_1 = 1.7979$, T =2.6608 $\widetilde{K}(t_1,T) = 2094$	$t_1 = 2.5067$, T =4.0494 $\widetilde{K}(t_1,T) = 1737.7$	$t_1 = 2.0656$, T = 3.7999 $\widetilde{K}(t_1,T) = 1309.6$

The analysis of the fuzzy optimal policy is discussed in table 6 when the ordering cost *A* and the power demand pattern index *m* vary at different values. The fuzzy optimal cost is obtained at *m* = 1.5 and *A* = 20. Results of this table indicate that inventory cost decreases as ordering cost decreases and the inventory cost decreases when *m* increases.

Table 6

$d = 100\,units/week, \theta = 0.05, a = 0.5, b = 0.05, C = \$8\,per\,unit, C_b = \$12/unit/week,$ $C_l = \$15/unit, C_d = \$10/unit, \alpha = 0.5, \delta_1 = 3, \delta_2 = 1, \delta_3 = 5, \delta_4 = 2, \delta_5 = 4, \delta_6 = 2,$ $\delta_7 = 5, \delta_8 = 3, \delta_9 = 0.04, \delta_{10} = 0.02,$			
Deterioration	*m = 0.5*	*m = 1*	*m = 1.5*
A = 20	*t₁ = 1.6805, T = 2.3450* $\widetilde{K}(t_1,T)$ *= 1448.8*	*t₁ = 2.3450, T =3.5808* $\widetilde{K}(t_1,T)$ *= 1297.4*	*t₁ = 1.9417, T =3.2157* $\widetilde{K}(t_1,T)$ *= 1144.5*
A = 30	*t₁ = 1.7545, T = 2.5159* $\widetilde{K}(t_1,T)$ *= 1448.8*	*t₁ = 2.4852, T =3.9291* $\widetilde{K}(t_1,T)$ *= 1517.3*	*t₁ = 2.0434, T = 3.5503* $\widetilde{K}(t_1,T)$ *= 1216.1*
A = 50	*t₁ = 2.0036, T = 2.7704* $\widetilde{K}(t_1,T)$ *= 2384.2*	*t₁ = 3.0165, T =4.5835* $\widetilde{K}(t_1,T)$ *= 1798.6*	*t₁ = 2.2091, T = 4.0369* $\widetilde{K}(t_1,T)$ *= 1307.9*
A = 60	*t₁ = 2.0376, T =2.8720* $\widetilde{K}(t_1,T)$ *= 2681.8*	*t₁ = 3.2703, T =4.8803* $\widetilde{K}(t_1,T)$ *= 1935.6*	*t₁ = 2.2815, T = 4.2307* $\widetilde{K}(t_1,T)$ *= 1339.3*

The sensitivity of the fuzzy inventory policy with respect to the backlogging parameter is shown in table 7. The best result is obtained at *m* = 0.5 and $\alpha = 0.1$. For m = 0.5 cost increases as the value of backlogging parameter increases but cost decreases as backlogging parameter increases for *m* greater or equal to one

Table 7

$d = 100\,units/week, A = 40, \theta = 0.05, a = 0.5, b = 0.05, C = \$8\,per\,unit, C_b = \$12/unit/week,$ $C_l = \$15/unit, C_d = \$10/unit, \delta_1 = 3, \delta_2 = 1, \delta_3 = 5, \delta_4 = 2, \delta_5 = 4, \delta_6 = 2,$ $\delta_7 = 5, \delta_8 = 3, \delta_9 = 0.04, \delta_{10} = 0.02,$			
Deterioration	*m = 0.5*	*m = 1*	*m = 1.5*
$\alpha = 0.1$	*t₁ = 4.2507, T = 6.5284* $\widetilde{K}(t_1,T)$ *= 1126.6*	*t₁ = 4.4921, T =5.9674* $\widetilde{K}(t_1,T)$ *= 1858.0*	*t₁ = 4.2648, T =5.0313* $\widetilde{K}(t_1,T)$ *= 1873.4*
$\alpha = 0.3$	*t₁ = 2.4490, T = 3.2996* $\widetilde{K}(t_1,T)$ *= 1919.3*	*t₁ = 3.3543, T =5.3783* $\widetilde{K}(t_1,T)$ *= 1663.8*	*t₁ = 2.7829, T =4.5116* $\widetilde{K}(t_1,T)$ *= 1409.1*
$\alpha = 0.7$	*t₁ = 1.9418, T = 2.3946* $\widetilde{K}(t_1,T)$ *= 2160.6*	*t₁ = 2.5600, T =3.8213* $\widetilde{K}(t_1,T)$ *= 1639.7*	*t₁ = 1.8676, T =3.4334* $\widetilde{K}(t_1,T)$ *= 1183.3*
$\alpha = 0.9$	*t₁ = 1.8422, T =2..2248* $\widetilde{K}(t_1,T)$ *= 2210.3*	*t₁ = 2.4321, T =3.5423* $\widetilde{K}(t_1,T)$ *= 1632.4*	*t₁ = 1.7213, T =3.1800* $\widetilde{K}(t_1,T)$ *= 1128.2*

Finally, we have observed variation of fuzzy optimal cost with respect to the holding cost, for this purpose changes in the value of *b* is considered in table 8. The minimum cost is obtained when *b*= 0.01 and *m* = 1.5. The inventory cost increases as the value of *b* increases and cost of inventory decreases as *m* increases.

Table 8

$d = 100\,units/week, A = 40, \theta = 0.05, a = 0.5, C = \$8\,per\,unit, C_b = \$12/unit/week,$ $C_l = \$15/unit, C_d = \$10/unit, \alpha = 0.5, \delta_1 = 3, \delta_2 = 1, \delta_3 = 5, \delta_4 = 2, \delta_5 = 4, \delta_6 = 2,$ $\delta_7 = 5, \delta_8 = 3, \delta_9 = 0.04, \delta_{10} = 0.02,$			
Deterioration	*m = 0.5*	*m = 1*	*m = 1.5*
$b = 0.01$	*t₁ = 2.824, T = 2.6756* $\widetilde{K}(t_1,T)$ *= 2079.5*	*t₁ = 2.7767, T =4.2879* $\widetilde{K}(t_1,T)$ *= 1643.0*	*t₁ = 2.1356, T =3.8157* $\widetilde{K}(t_1,T)$ *= 1265.0*
$b = 0.03$	*t₁ = 2.1173, T = 2.6825* $\widetilde{K}(t_1,T)$ *= 2080.3*	*t₁ =2.7643, T =4.2768* $\widetilde{K}(t_1,T)$ *= 1647.1*	*t₁ = 2.1329, T =3.8152* $\widetilde{K}(t_1,T)$ *= 1266.6*
$b = 0.05$	*t₁ = 2.1460, T = 2.6887* $\widetilde{K}(t_1,T)$ *= 2081.7*	*t₁ = 2.7521, T =4.2659* $\widetilde{K}(t_1,T)$ *= 1651.2*	*t₁ = 2.1303, T =3.8146* $\widetilde{K}(t_1,T)$ *= 1268.1*
$b = 0.08$	*t₁ = 2.1824, T =2..6973* $\widetilde{K}(t_1,T)$ *= 2082.4*	*t₁ = 2.7343, T =4.2499* $\widetilde{K}(t_1,T)$ *= 1657.3*	*t₁ = 2.1264, T =3.8137* $\widetilde{K}(t_1,T)$ *= 1270.5*

7. CONCLUSION

In this paper, an inventory model has been developed to determine the optimal inventory cycle, backordering point, optimal inventory cycle and the average total cost per unit time for deteriorating items. The above-proposed model is fuzzified by a triangular fuzzy number to improve results. Defuzzification has been done by the signed distance method. The demand depends on time and follows a power pattern. Convexity of the average total cost function is also proved. The applicability of the proposed models is demonstrated by examples. Sensitivity analysis was also carried out concerning different parameters and different power pattern indexes.

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ELECTROMAGNETIC EXPOSURE ON THE SEEDS OF ABELMOSCHUS ESCULENTS AND ITS IMPACT ON GROWTH AND BIOCHEMICAL PARAMETERS OF PLANT

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ABSTRACT

Abelmoschus esculents are widely used for medicinal and edible purposes. It is a rich source of pectin, iron, calcium, and fiber. Due to good nutritional value and health benefits, it snatches the attention of the researchers to improve techniques for its productivity. Paper deals with the impact of stimulation on the seeds of Abelmoschus esculents in the pre-sowing stage. The uniform seeds were sorted and exposed to electromagnetic fields of 200 G, 400 G, 600 G, and 800 G. Exposure time was selected 40, 60, and 80 minutes for each field of stimulation. Non exposed seeds were marked as control. All ranges of treated and control seeds were sown in a separate pot under the same laboratory conditions. The impacts of electromagnetic exposure on seeds were investigated on basis of germination percentage, plant height, root length, stem diameter, leaf area, biochemical parameters, and chlorophyll contents. It is distinguished that the stimulation of seeds with 800 G for 40 minutes of exposure favors the growth of plants and gives a better result than others. The result suggested that pre-sowing electromagnetic treatment may have the potential to improve the productivity of plants by enhancing germination and seedling growth in a chemical-free, damage-free, and supportable procedure for the farmer level.

Keywords: Abelmoschus esculents, germination, electromagnetic exposure, chlorophyll.

1. INTRODUCTION

Abelmoschus esculents belong to the family of hibiscus and commonly known as lady's finger, is an edible plant medium-sized, spiny herb, unripe fruits are harvested and used as a vegetable in many Asian cuisines (Singh et. al, 2021). The study of the biological effects of both magnetic and electromagnetic fields is a very popular area of research. Recently, new techniques based on the application of electromagnetic field stimulation have been developed particularly in agricultural science (Singh and Agrawal, 2019). The seed's electromagnetic field treatment increases plant growth. The shoot length, root length, biomass, chlorophyll content on leaves increased Radhakrishnan and Kumari, 2013). On the other hand, when the seed is treated with an electromagnetic field, it is obtained a more quickly seed germination and higher emergence rate; plants grow more vigorous, the root system develops better, and occasionally it reaches as much twice its length (Ramirez et. al, 2014). Chemical pre-sowing seed treatments have been used for better seed germination and these treatments have been used improved seed germination and these treatments are considered cost-effective and also harmful to the environment (Adesola et. al, 2016) and environment safety is also an important issue worldwide, which previously has been polluted and adulterated with contaminated agents due to frequent use of the chemical in farming (Abbas et. al, 2015). therefore, it is essential to adopt sustainable agriculture methods i.e. environment friendly, affordable, and safe method (Kowalyszyn and Konyk, 2015). The modern technique of agricultural efforts is now in search of a competent ecological tool based on physical treatment of seeds to enhance the germination, seedling strength, and crop yield, and recently, pre-sowing magnetic field seed treatment has attracted the attention of the agricultural community (Vashisth & Nagarajan, 2010). Electromagnetic pre-sowing treatment of seeds encouraged physiological and biochemical changes in biological entities (Iqbal et. al, 2016). Electromagnetic radiation is a low-cost technique that contributes to the improvement of seed physiological quality, resulting in a better emergence rate and field establishment (Majkowska-Gadomska et. al, 2015). Electromagnetic induced physiological and biochemical changes in biological objects. Water assimilation and intensified photosynthesis collectively enhance seed germination and growth (Podleoeny et. al, 2004).In the interpretation of the importance of *Abelmoschus esculent,* still, attention has been paid to evaluate the effect of the electromagnetic field of germination, growth, and yield since it is a common vegetable in India. Therefore, the main objective of the present study was to appraise the electromagnetic pre-sowing seed treatment effect on germination, seedling growth, chlorophyll contents in leaves, and characteristics of *Abelmoschus esculent* native to Indian soil in laboratory condition.
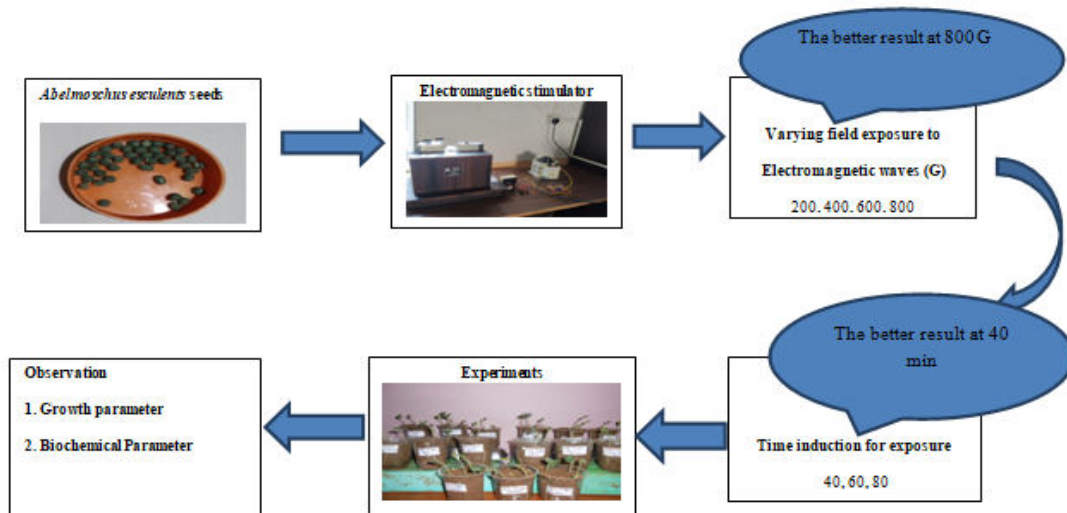
2. METHODS AND MATERIALS

2.1 Collection of Seed

Abelmoschus esculents **seeds were obtained from the government authorized shop. Mature and uniform size** seeds without visible defects, insect damage, and malformation were selected and stored in sealed paper bags after drying in shade. Seed moisture content was 7.8% on a fresh weight basis before electromagnetic field exposure and the final germination percentage was 100%.

2.2 Electromagnetic Stimulation

Electromagnetic shocks provided to the seeds by the electromagnetic stimulator as shown in Fig: 1 it is assembled for the present study. A count of 50 seeds was subjected to the planned quantity of exposure. To optimize the experimental conditions exposure on the seeds was done in two steps. The optimization steps are -

Magnetic treatment	Time Induction		
Control	-		
200 G	40 min	60 min	80 min
400 G	40 min	60 min	80 min
600 G	40 min	60 min	80 min
800 G	40 min	60 min	80 min

a) **Under varying electromagnetic Induction -** In the range of 200, 400, 600, and 800 G of electromagnetic Induction given in each seed lot for different time induction.

b) **Under varying time induction –** In this condition duration of 40, 60, and 80 minutes were selected to expose seeds on a different electromagnetic induction.

2.3 Electromagnetic field generator
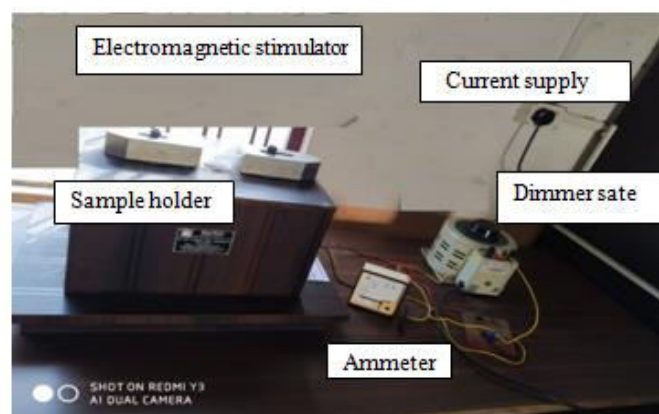
Fig. 1: Electromagnetic Simulator assembled to set up

An electromagnetic stimulator "Mug Tech association" with variable electromagnetic strength (1 kilo Gauss to 10 kilos Gauss) with a space of 5 cm between magnet bars was fabricated (Fig: 1). The magnet bars were rectangular, in between the magnet bars the sample was kept for treatment. A digital gauss meter is used for monitoring the field strength produced in between the magnet bars gap. All treatments in the experiments were run along under similar conditions. Seeds were exposed to electromagnetic fields of 200 G, 400 G, 600 G, and 800 G. Exposure time was selected 40, 60, and 80 minutes for each field of stimulation in a sample holder. Cylindrical in shape and made of non-magnetic thin transparent plastic sheet. The temperature during treatment was 25 ± 1°C. The control seeds were kept away from the magnetic field generator.

2.4 Seed Propagation and Culture Practices

The seed material was divided into five groups: the control group and the experimental group, whereas the seeds in the experimental group were exposed to 200 G, 400 G, 600 G, and 800 G for 40, 60, and 80 minutes respectively. The size of the soil container used for the experiment was disposable glasses which long, 20 cm in width, and 8 cm in depth. Pots were filled with a 1:1 ratio of black soil and sand mixed properly and fill up to 5 inches. Seeds were seeded in the depth of soil 1.5 - 2.5 cm and water irrigated two times in a day. Experimental setup under laboratory conditions is shown in Fig 2.

Fig. 2: Experimental set up of Abelmoschus esculents plants, under the laboratory conditions.

2.5 Estimation of Parameters

Germination Test

Seeds were allowed to germinate on the pot at laboratory temperature ranges 28- 30°C and average humidity level 82%. Each complete block design with the experiment had a randomized complete block design with three replicates and with 10 seeds per pot. Germination counts were made every 12 hrs. A seed was considered germinated when the tip of the radical 2 mm had grown free out of the soil. Each experiment was carried out twice and the germination percentage was calculated as described by the Association of official seed Analysis (1990) by the following formula.

$$\text{Germination percentage} = \frac{\text{Seeds germinated}}{\text{Total seeds}} \times 100$$

Chlorophyll a and b

The chlorophyll a, chlorophyll b, and total chlorophyll was measured following before now reported the method (Kousar Makeen et. al, 2007). Fresh leaves of *Abelmoschus esculents* were ground and extracted with 80% acetone at 0-4 °C. The extract was centrifuged at 12,000 rpm for 5 min. The absorbance of the supernatant was measured at 663 and 645 nm with a UV spectrophotometer. Chlorophyll a, chlorophyll b, and total chlorophyll were calculated by the Arnon method.

Leaf Area

Leaf area is measured by the graphical method (cm^2/plant), with the help of a millimeter graph paper and magnifying glass. This method can estimate accurately the leaf area of plants without the use of any expensive instruments.

3. RESULTS AND DISCUSSION

Effects of pre-sowing electromagnetic treatments on seed germination, plant growth, and biochemical changes on *Abelmoschus esculents* seeds are plotted, at various frequencies on different time induction. Increase in the rate of germination as compared to the untreated seeds (control). Seeds are observed in fig. 3. The germination percentage of *Abelmoschus esculents* seeds is gradually increasing due to the induction of pre-sowing

electromagnetic treatments from 200 G, 400 G, 600 G, and 800 G, during the experimental time slot of 40, 60, and 80 minutes. Previous studies also revealed that pre-sowing electromagnetic exposure helps enhance germination and a similar trend was observed in the present investigation (Iqbal et. al, 2016). The speed of germination of cucumber seeds has been reported higher in seed treated at various magnetic exposure doses (Anand et. al, 2011).
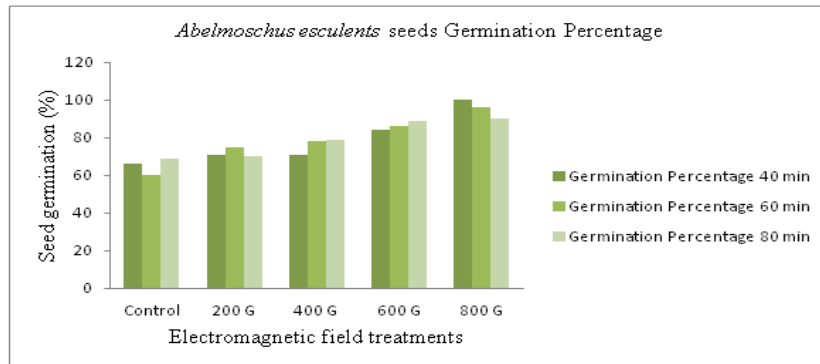
Fig.3: Effect of pre-sowing electromagnetic treatments on germination percentage in Abelmoschus esculents seeds.

Chlorophyll plays a significant role in plant growth and adaptation to different environmental conditions, which depends upon the photosynthetic efficiency of leaves. The effect of electromagnetic field pre-sowing seed treatment on *Abelmoschus esculents* content was also studied meanwhile this pigment is highly sensitive to external factors affecting the synthesis of chlorophyll and the leaf chlorophyll varies significantly under different environmental condition. Chlorophyll content in plants was higher in some of the treatment of pre-sowing electromagnetic treated plants in comparison with control. The *Abelmoschus esculents* chlorophyll contents under the effect of electromagnetic field treatments are shown in fig. 4 (ABCD) for chlorophyll a, chlorophyll b, and total chlorophyll, respectively. Electromagnetic field treatments enhanced the chlorophyll contents significantly and 800 G 40 min. electromagnetic field effect was considerably higher than 200 G, 400 G, and 600 G treatments.
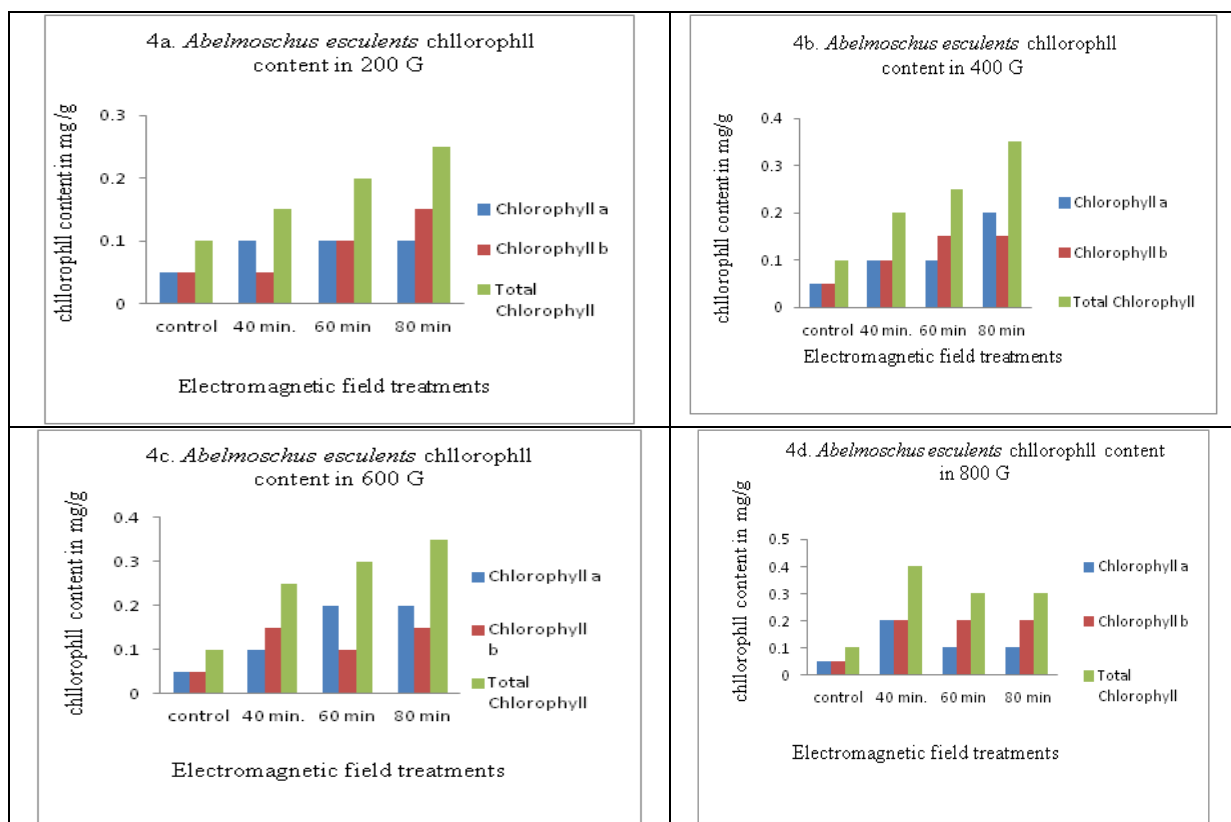
Fig. 4: Effect of pre-sowing electromagnetic treatments on chlorophyll a, chlorophyll b, and total chlorophyll content in Abelmoschus esculents seeds 4a. 200 G treatments, 4b. 400 G treatments, 4c. 600 G treatments, 4d. 800 G treatments.

Table 1 Effect of pre-sowing electromagnetic treatments on morphological variation, average plant height, average root length, leaf area, stem diameter, steam radius

S. no	Parameter	Seed sample	Abelmoschus esculents after 1-week germination plant height			
			control	40 min	60 min	80 min
1	Average Plant Height cm	200 G	6.5	6.5	7.9	6.5
2		400 G	6.5	6	10	7.5
3		600 G	6.5	8.5	9.5	11.9
4		800 G	6.5	13.5	8.4	9.5
1	Average root length cm	200 G	5	6	7.5	6
2		400 G	5	6	7.5	6
3		600 G	5	7	8.5	8.8
4		800 G	5	11	7.5	7.8
1	Leaf area cm²	200 G	3.5	3	3.5	2
2		400 G	3.5	3.5	4.5	3
3		600 G	3.5	4	3.5	4
4		800 G	3.5	5	4.5	4.5
1	Steam diameter mm	200 G	0.033	0.027	0.016	0.017
2		400 G	0.033	0.027	0.033	0.026
3		600 G	0.033	0.025	0.025	0.026
4		800 G	0.033	0.037	0.028	0.03
1	Steam radius mm	200 G	0.016	0.013	0.008	0.008
2		400 G	0.016	0.013	0.016	0.013
3		600 G	0.016	0.012	0.012	0.013
4		800 G	0.016	0.018	0.014	0.015

S. no	Sample	Abelmoschus esculents after 1-week germination image			
		Control	40 min	60 min	80 min
5a	200 G				
5b	400 G				
5c	600 G				
5d	800 G				
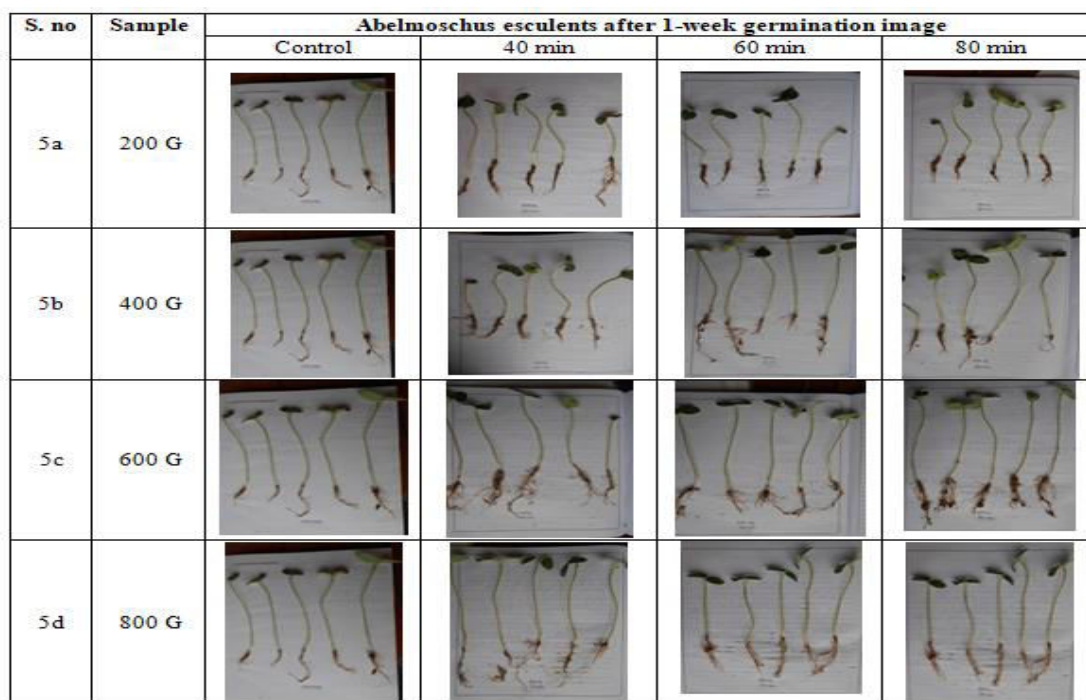
Fig.5 *Abelmoschus esculents* seedling growth image before and after treatments under the different frequencies of electromagnetic treatment [5a. 200 G Control, 40, 60, and 80 min treatment plant, 5b. 400 G Control, 40, 60, and 80 min treatment plant, 5c. 600 G Control, 40, 60, and 80 min treatment plant, 5d. 800 G Control, 40, 60, and 80 min treatment plant after one week.

The growth rate is considered one of the important parameter to enhance productivity and in the present investigation, all electromagnetic exposure treatment enhanced significantly as compared to control, as it can be seen in fig. 5, the plant growth was significantly different after one week of germination and this difference was clearer at the lateral stage of growth and development. A maximum increase in plant growth was recorded in 800 G for 40 minutes of exposure in comparison to control. These findings were comparable with earlier studies that electromagnetic exposure influenced and plant growth and development at lateral stages (Denise, 2013). Similarly treated maize seed to the magnetic doses of 125mT and 250mT and resultantly, faster germination and early growth were observed versus non-treated seeds (Carbonell and Martinez, 2007).

4. CONCLUSION

Pre-sowing electromagnetic field treatment of seeds stimuli nodding pathways and gene expression in plant cells can alter the electromagnetic properties of biological molecules and membrane. This might be a reason for enhancing plant growth. The present study showed that stimulation of seeds with an 800 G for 40 minutes of exposure favors the growth of plants. The use of pre-sowing electromagnetic field treatment of seeds for crop improvement is a promising technology because it is a non-chemical method for agriculture and it is environmentally friendly.

ACKNOWLEDGMENT

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DEVELOPMENT AND VALIDATION OF A DISSOLUTION METHOD FOR TRAMADOL TABLETS

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ABSTRACT

A simple, rapid, selective, and reproducible reversed-phase high performance liquid chromatographic (RP-HPLC) method has been developed and validated for the estimation of Tramadol in dissolution samples of Tramadol tablet. The drugs were estimated using Thermo C18 (250 mm x 4.6 mm, 5 µm particle size) column. A mobile phase composed of water, Acetonitrile and Trifluoroacetic acid in the ratio of 690:300:10, v/v/v at a flow rate of 1.0 ml/min was used for the separation. Detection was carried out at 271 nm. The linearity range used was 5-15µg/ml and (Rt) was 6.858 min. The correlation coefficient values were found to be 0.99999. Precession studies showed % RSD values less than 5 % for all the selected concentrations. The percentage recovery of Tramadol was found to be 99.50. The assay results of Tramadol was within the limits of 98-102 %. The method was validated as per the International Conference on Harmonization (ICH) guidelines. The developed method was successfully used for the quantitative analysis of commercially available dosage form.

Keyword: RP-HPLC, UV detector, Dissolution, Tramadol, Tablet.

1. INTRODUCTION

Tramadol is chemically 2-[(Dimethylamino) methyl]-1-(3-methoxyphenyl)cyclohexanol. Tramadol is a centrally acting synthetic opioid analgesic and SNRI (serotonin/norepinephrine reuptake-inhibitor) that is structurally related to codeine and morphine. Due to its good tolerability profile and multimodal mechanism of action, tramadol is generally considered a lower-risk opioid option for the treatment of moderate to severe pain. As is typical of opioids, common side effects include constipation, itchiness, and nausea. Serious side effects may include seizures, increased risk of serotonin syndrome, decreased alertness, and drug addiction.
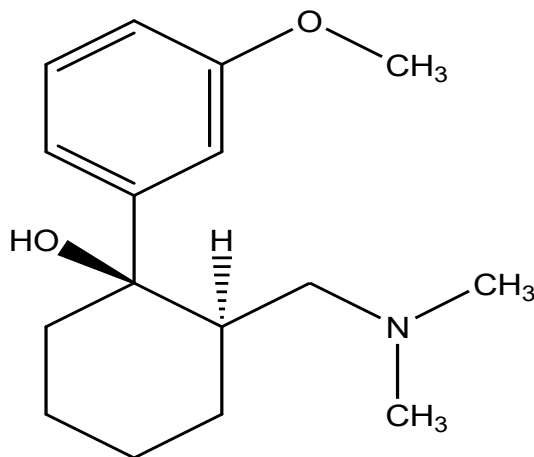
Figure.1: Structure of Tramadol

2. MATERIAL AND METHOD

2.1. Instruments

Shimadzu LC-2030 HPLC, The Zorbax Eclipse XDB C_{18} (mm, 5 μm) analytical column was used as a stationary phase, Chromatographic data was acquired using LabSolutions software, Double beam UV-VIS spectrophotometer (UV-1800, Shimadzu, Japan), Labindia Tablet Dissolution Test Apparatus DS 14000, pH Meter (Lab India), Balance (Mettler Toledo), Sonicator (Rolex).

2.2. REAGENTS AND MATERIALS

Tramadol API, Tramagen 50mg tablets

Chemicals- Acetonitrile (HPLC Grade), Methanol (HPLC Grade), Potassium Dihydrogen Phosphate, Sodium Hydroxide, Distilled Water.

2.3. METHODS

2.3.1. Dissolution Medium: Water

2.3.2. Preparation of Mobile Phase: Mixed 10 ml of Trifluoroacetic acid, 300 ml of acetonitrile and 690 ml of Water. Filtered through 0.45-micron membrane filter paper and degased.

2.3.3. Preparation of Standard solution: Weight accurately and transfered about 55mg of Tramadol Hydrochloride Standard into 100ml volumetric flask. Add about 70ml of water, sonicate with intermediate shaking to dissolved and diluted up to the volume with water.

Further diluted 10 ml of this solution to 100 ml with water. Mixed well and inject.

(Concentration- Tramadol HCl: 0.055 mg/ml).

2.3.4. Preparation of Sample Solution:

Placed the stated volume of dissolution medium of each vessel of the dissolution apparatus. Warm the dissolution medium at 37°C ± 0.5°C. Transfer 1 tablet into each vessel. Immediately operate the apparatus at specified speed. At the end of specified time interval, withdraw sufficient quantity of aliquot from each specimen. (Aliquot withdrawal position: - from the midway zone between the top surface of dissolution medium and top)

2.3.5. Preparation of Blank solution: Used water as such.

3. RESULT AND DISCUSSION

3.1 Linearity and Range

Weigh accurately and transferred about 55mg of Tramadol Hydrochloride standard into 100 ml volumetric flask. Added about 50 ml of water, sonicate with intermediate shaking to dissolved and dilute up to the volume with water. Mixed well and injected. (Concentration is 0.55 mg / ml) Preparation of linearity level solution: Prepare the linearity level as per the table below table.1, Figure 2. Shows Calibration Curve of Tramadol Hydrochloride where we found r2 value is 0.99999. Figure 3-8 represent a typical chromatograph of Tramadol at 50%, 80%, 100%, 120% and 150%.

Table.1: Preparation of Linearity Level Solution

Linearity Level	Volume of Linearity stock solution to be taken in ml	Dilution in ml	Concentration in mg/ml
Level 1 (50 %)	5	100	0.0275
Level 2 (80 %)	8	100	0.0440
Level 3 (100 %)	10	100	0.0550
Level 4 (120 %)	12	100	0.0660
Level 5 (150 %)	15	100	0.0825
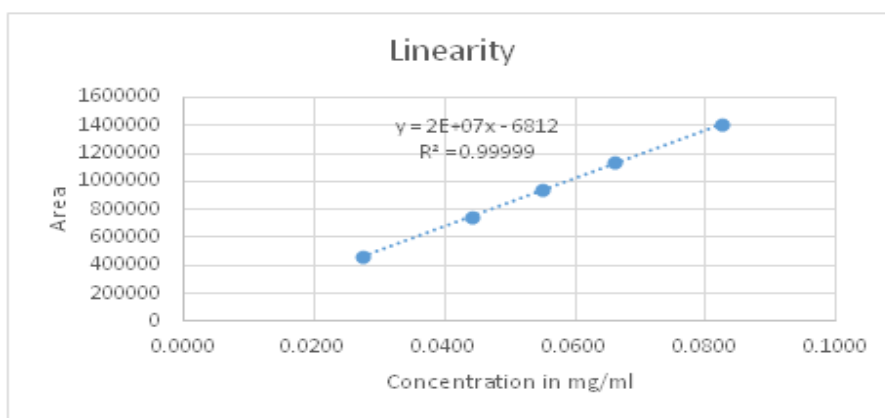
Figure 2: Calibration Curve of Tramadol Hydrochloride

Table 2: Linearity for Tramadol Hydrochloride

Linearity Level	Level 1	Level 2	Level 3	Level 4	Level 5	Regression coefficient	% Y intercept
Peak area of injection 1	475533	756177	944764	1132605	1426946	0.99999	-6812

Peak area of injection 2	466793	748024	939329	1120278	1421708		
Peak area of injection 3	467801	747733	946076	1139399	1415583		
Peak area of injection 4	461369	747956	942205	1135164	1403970		
Peak area of injection 5	473652	747282	920328	1141256	1406415		
Average peak area	469029.6	749434.4	938540.4	1133740.4	1414924.4		
Concentration in mg/ml	0.0275	0.044	0.055	0.066	0.0825		
Response factor	17055636	17060114	17064364	17132742	17150594		
Relative response factor	0.9995	0.9998	1.0000	1.0040	1.0051		
Average	1.0017						
% RSD	0.27						
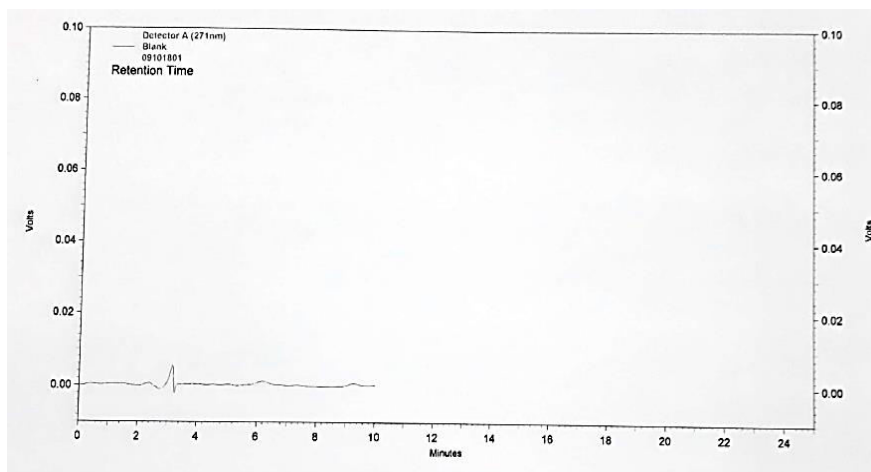
Figure 3: A typical chromatogram of Tramadol Hydrochloride Blank
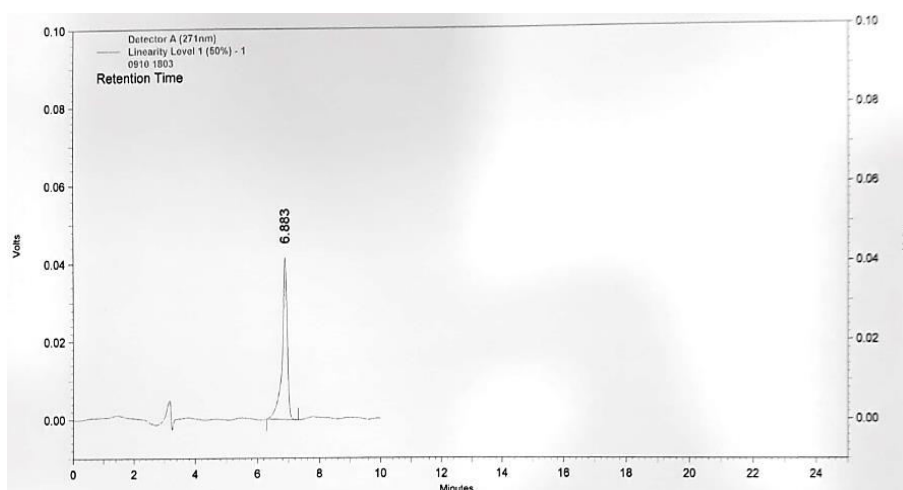
Figure 4: A typical chromatogram of Tramadol Hydrochloride at 50%
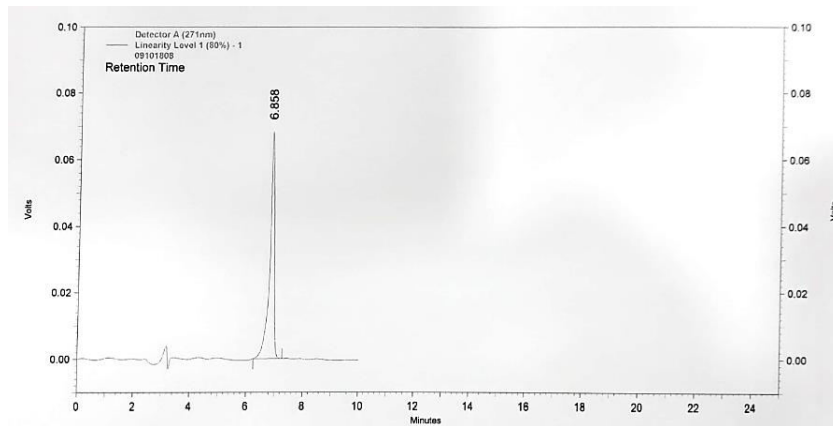
Figure 5: A typical chromatogram of Tramadol Hydrochloride at 80 %
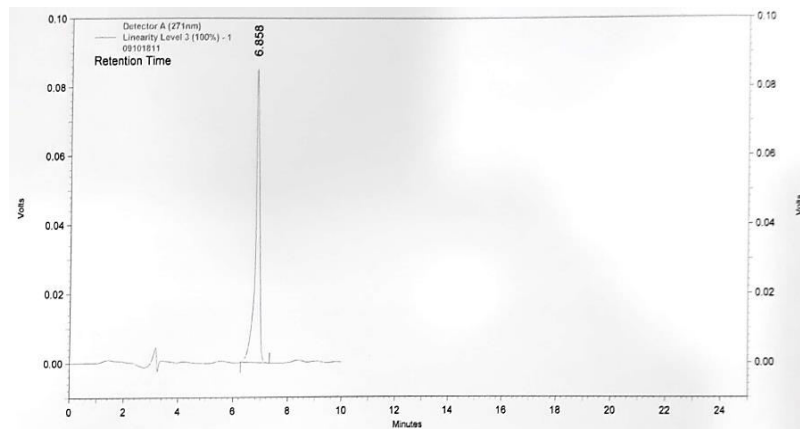
Figure 6: A typical chromatogram of Tramadol Hydrochloride at 100%
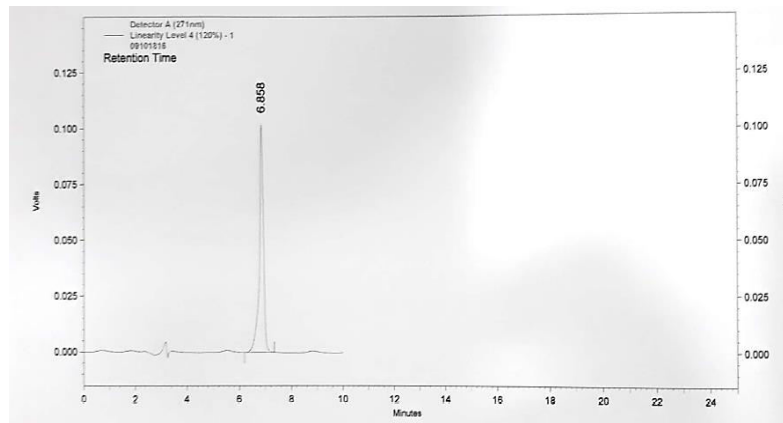
Figure 7: A typical chromatogram of Tramadol Hydrochloride at 120%
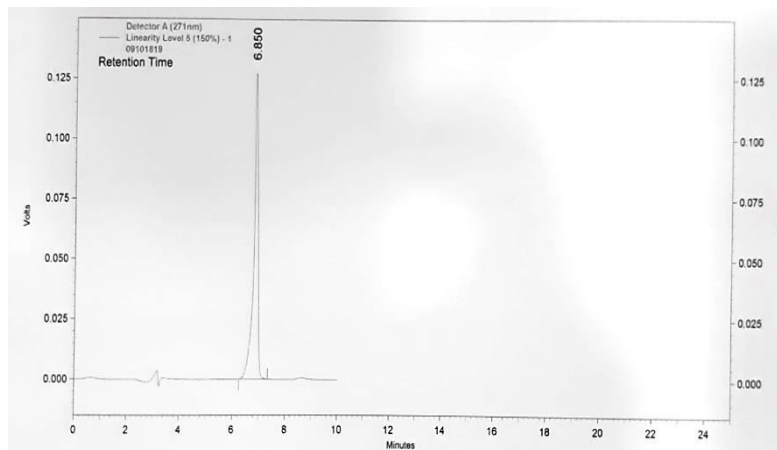
Figure 8: A typical chromatogram of Tramadol Hydrochloride at 150%

3.2 PRECISION

The precision of an analytical procedure expresses the closeness of agreement (degree of scatter) between a series of measurements obtained from multiple sampling of the same homogeneous sample under the prescribed conditions. The Precision test, Intermediate Precision and Cumulative % RSD between both are shown in table 3, 4 & 5 respectively and % RSD is within limit i.e. below 5 %.

Table 3: Precision test

Sr.No.	Peak Area	% Content
Tablet 1	906090	95.1
Tablet 2	913527	95.9
Tablet 3	857733	90.0
Tablet 4	928446	97.5
Tablet 5	928446	92.1
Tablet 6	877927	91.2
Average		93.6
%RSD		3.20

Table 4: Intermediate Precision

Sr.No.	Peak Area	% Content
Tablet 1	874787	91.9
Tablet 2	915255	96.1
Tablet 3	843437	88.6
Tablet 4	918492	96.4
Tablet 5	883882	92.8
Tablet 6	866355	91.0
Average		92.8
%RSD		3.30

Table 5: Cumulative % RSD between Precision Test and Intermediate Test

Sr. No	Content in % Tramadol
Sample 1 (P)	95.1
Sample 2 (P)	95.9
Sample 3 (P)	90.0
Sample 4 (P)	97.5
Sample 5 (P)	92.1
Sample 6 (P)	91.2
Sample 1 (IP)	91.9
Sample 2 (IP)	96.1
Sample 3 (IP)	88.6
Sample 4 (IP)	96.4
Sample 5 (IP)	92.8
Sample 6 (IP)	91.0
Average	93.2
SD	2.88
% RSD	2.69

3.3 Accuracy (Recovery)

The accuracy of an analytical procedure expresses the closeness of agreement between the value which is accepted either as a conventional true value or an accepted reference value and the value found. Accuracy of the dissolution method was calculated by recovery studies at three concentrations of 50%, 100%, and 150% levels by standard addition method. The mean percentage recoveries (accuracy) obtained were found between 95% and 105%. The results of recovery study are summarized in Table 6 and 7.

Table 6: Percentage Recovery Study

Sr.No.	Peak Area of accuracy level 50 %	Content in %	Peak Area of accuracy level 100 %	Content in %	Peak Area of accuracy level 150 %	Content in %
Tablet 1	465959	49.6	936040	99.0	1411917	150.7

Tablet 2	462555	49.2	936467	99.1	1407670	150.3
Tablet 3	453808	48.3	942338	99.7	1407842	150.3
Tablet 4	476992	50.7	941084	99.6	1407572	150.3
Tablet 5	463581	49.3	939084	99.4	1428173	152.5
Average		49.4	Average	99.4	Average	150.8
% RSD		1.75	% RSD	0.31	% RSD	0.63

Table 7: Mean of % recovery

Level	% Recovery
1 (50%)	98.8
2 (100%)	99.3
3 (150%)	100.5
Average	99.5
% RSD	0.9

3.4 ROBUSTNESS

Robustness is a measure of capacity of a method to remain unaffected by small, but deliberate variations in the method conditions, and is indications of the reliability of the method. A method is robust, if it is unaffected by small changes in operating conditions. To determine the robustness of this method, the experimental conditions were deliberately altered at three different levels and retention time and chromatographic response were evaluated. One factor at a time was changed to study the effect. Variation of column oven Temperature (38^0C and 42^0C) and mobile phase flow rate by 1.0 ml/min (0.9 and 1.1 ml/min) had no significant effect on the retention time and chromatographic response of the 50 μg/ml solution, indicating that the method was robust. The results are shown in Table 8 and 9.

Table 8: Robustness of Flow Rate

Sr.No.	Flow rate from 1.0 to 0.9 ml/min		Flow rate from 1.0 to 1.1 ml/min	
	Peak Area	% Content	Peak Area	% Content
Tablet 1	943975	90.0	725403	84.5
Tablet 2	1030176	98.2	832783	97.0
Tablet 3	972500	92.7	770790	89.8
Tablet 4	1019428	97.2	840790	98.0
Tablet 5	966317	92.1	804050	93.7
Tablet 6	974854	92.9	779061	90.8
Average		93.9		92.3
% RSD		3.40		5.40

Table 9: Robustness of Column Oven Temperature

Sr.No.	Column oven temp change from 40□C to 38°C		Column oven temp change from 40□C to 42°C	
	Peak Area	% Content	Peak Area	% Content
Tablet 1	863617	90.6	880589	91.7
Tablet 2	914518	96.0	913740	95.2
Tablet 3	846190	88.8	871162	90.8
Tablet 4	969557	101.7	933795	97.3
Tablet 5	883898	92.8	874429	91.1
Tablet 6	847923	89.0	867560	90.4
Average		93.2		92.8
% RSD		5.30		3.00

ACKNOWLEDGMENTS

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METHOD DEVELOPMENT AND VALIDATION FOR THE ESTIMATION OF RAMIPRIL IN BULK AND PHARMACEUTICAL FORMULATION

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ABSTRACT

A rapid, sensitive and accurate Reverse Phase High Performance Liquid Chromatographic Analytical Method Development and Validation for estimation of Ramipril and its pharmaceutical formulation. The all experimental work was carried out on Shimadzu HPLC (LC2030), C18 (25cm×4.6 mm i.d, 5µm) particle column was used for analysis at ambient temperature moreover a mobile phase composed of Organic Phase: Buffer (76: 24 v/v) pH was adjusted at 6.5 at a flow rate of 1.0 ml/min was used for the separation. Detection was carried out at 215 nm. As per optimized chromatographic condition performed and validate various parameter like Linearity, Specificity, Precision, LOD and LOQ, Accuracy and Robustness. The linearity range was 10-60 µg/ml and (Rt) was 3.101 minutes. The correlation coefficient values were found to be 0.9999. Precession studies showed % RSD values less than 2 % for all the selected concentrations and at intraday and interday condition. The percentage recovery of Ramipril was found to be 100.02 additionally mentioned method found satisfactory and robust at different level of mobile phase, change in pH and wavelength and flowrate. The assay results of Ramipril was within the limits of 98-102 %. All parameters were evaluated for the method according to the International Conference on Harmonization (ICH) Q2 R1 guidelines. The developed method was successfully used for the quantitative analysis of commercially pharmaceutical dosage form.

Keywords: Ramipril, Assay, Method Development, Validation, ICH Guidelines.

3. INTRODUCTION

Ramipril (RAM) is chemically (2S,3aS,6aS)-1- [(2S)-2- [[(2S)-1- Ethoxy- 1-oxo-4- phenylbutan-2-yl]amino]propanoyl] -3,3a,4,5,6,6a- hexahydro- 2H- cyclopenta[b] pyrrole-2- carboxylic acid and having molecular formula $C_{23}H_{32}N_2O_5$. Ramipril is a drug belonging to the angiotensin-converting enzyme (ACE) inhibitor class of medications. Angiotensin-converting enzyme (ACE) inhibitors are medications that help relax the veins and arteries to lower blood pressure. Ramipril is mostly used in treatment of hypertension, congestive heart failure, nephropathy, and reduce the rate of death, myocardial infarction, and stroke in individuals at high risk of cardiovascular events. Ramipril is break down to ramiprilat in the liver and, to a lesser extent, kidneys.

RAM is authorised in United State Pharmacopeia (USP) and British Pharmacopeia (BP) where HPLC and potentiometric titration is the official method of analysis. There are several methods reported for estimation of Ramipril drugs alone along with in combination with other drugs in pharmaceutical dosage forms. In the present experimental work, a new reversed-phase high performance liquid chromatographic (RP-HPLC) method development and validation for assessment of Ramipril in standard and in single drug formulation.
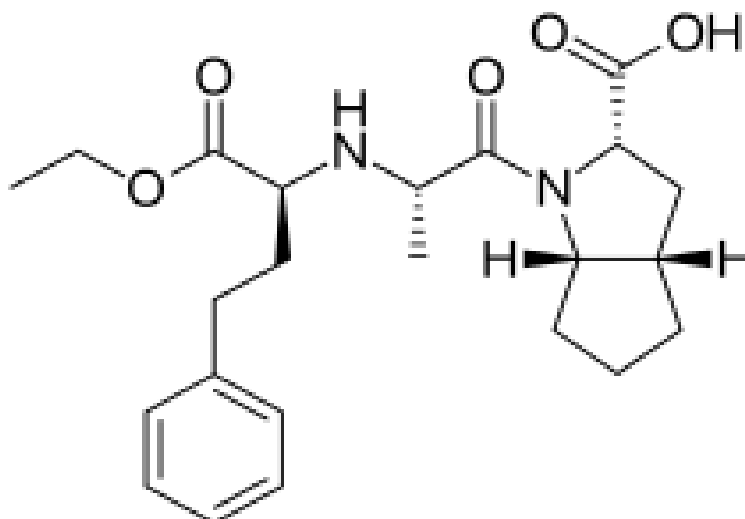
Figure.1: Structure of Ramipril

4. MATERIAL AND METHOD

2.1 Chemicals and Reagents

Table 2: Active Pharmaceutical Drug

Sr. No.	Name	Description
1.	Ramipril	White powder, use as an Antihypertensive
2.	Rami-2.5	2.5 mg drug contain each tablet

Table 3: List of Chemicals use in Research work

Sr. No.	Name of Chemical	Molecular Formula	Manufacturer
1.	Acetonitrile	C_2H_3N	Merck Life Science
2.	Methanol	CH_3OH	Merck Life Science
3.	Phosphate Buffer	KH_2PO_4	S D Fine Chem. Ltd, Mumbai
4.	Distilled Water	H_2O	Inhouse

2.2 Instrumentation

Table 4: List of Instruments

Sr. No.	Name of Equipment's/ Instruments	Model / Specification	Manufacturer
1	HPLC	Series 2000	Shimadzu
	Pump	PU2080	
	Sample Injection Port	Automatic	
	UV/Vis Detector	UV 2075 plus	
	Software	LabSolution	
2	pH Meter	101	Chemiline
3	Balance	AY-120	Shimadzu
4	Sonicator	UCB-40	Rolex
5	Deep Freezer	-	Blue Star
6	Refrigerator	-	Godrej

2.3. Preliminary Analysis of Drug

a) Description
Color and texture of Ramipril was compared with reported characters mentioned in drug bank.

b) Solubility
Solubility of Ramipril was determined in various solvents like water, methanol, ethanol and Acetonitrile.

c) UV Analysis
UV analysis was carried out by scanning the solution of Ramipril at 200-400 nm.

2.4. Preparation of Solution

i. Preparation of standard stock solution:
Standard stock solution of drug was prepared by dissolving 10 mg of drug in 10 ml of methanol to get concentration of 1000 µg/ml. From this solution 1 ml was taken in 10 ml volumetric flask and volume was made up with methanol to get solution 100 µg/ml. Further 4 ml of this solution was diluted to 10 ml with mobile phase to get concentration of solution 40 µg/ml.
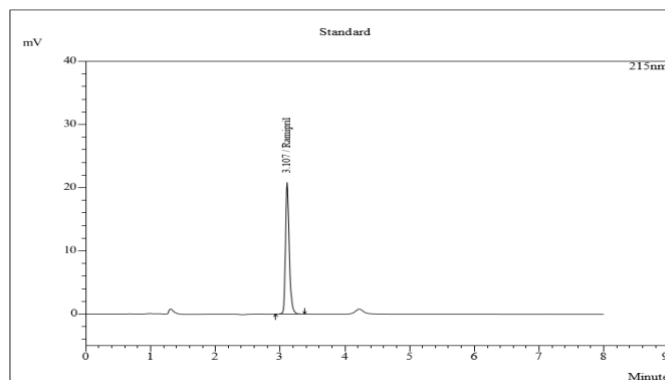
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.107	Ramipril	5010742	1.319	72845
Total			5010742		

Figure 2: A Typical Chromatogram of Standard

Selection of Detection Wavelength

From the standard stock solution (20 μg/ml) further dilutions was made using methanol and scanned over the range of 200-400 nm and the spectra was obtained. It was observed that the drug showed linear, stable and considerable absorbance at 215 nm.

Ii. Preparation of Sample Solution

20 tablets were weighed and triturated to powder. A quantity of powder equivalent to 10 mg of Ramipril was transferred to a 10 ml volumetric flask containing 10 ml of Methanol. Furthermore, resulting sample stock solution was filtered with Whatman filter paper 41 and the volume was made up with methanol the to get concentration of 1000 μg/ml. Further dilution were made to get concentration 40 μg/ml.
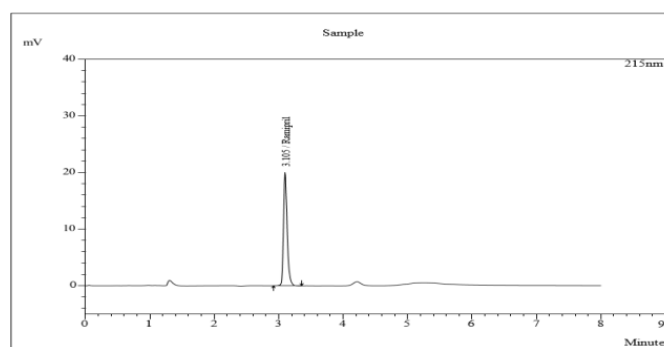
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.105	Ramipril	5012803	1.319	78788
Total			5012803		

Figure 3: A Typical Chromatogram of Sample

2.5. Chromatographic Conditions

Table 5: Optimized Chromatographic Condition

Mobile Phase (V/V)	Organic	Buffer
	76	24
Acetonitrile: Methanol : Ammonium Format Buffer		
pH of Aqueous Phase	6.5	
Flow Rate (mL/min)	1.0	
Detection Wavelength (nm)	215	

2.6 Assay Procedure: A solution of 20 μL standard, sample seperately were injected into the chromatographic system and areas for the Ramipril peaks were measured and the percentage assay calculated by using the formulae. Recorded the chromatogram and measured the peak responses. Calculated the mean and persentage RSD for the same.

$$\text{Assay Percentage} = \frac{AT}{AS} \; X \; \frac{WS}{DS} \; X \; \frac{DT}{WT} \; X \; \frac{P}{100} \; X \; \frac{Avg.Wt}{Label\ Claim} \; X \; 100$$

Where

AT = average area counts of sample preparation.

AS = average area counts of standard preparation.

WS = Weight of working standard taken in mg.

P = Percentage purity of working standard

LC = label claim of drug mg/ml.

3.0 RESULT AND DISCUSSION

3.1 Method Validation
As per ICH guidelines the method validation was carried out on the basis of following parameters [38-39]:

Linearity
A calibration curves were plotted over a concentration range 10-50 ppm for Ramipril. These solutions were injected into the HPLC under the optimized conditions. Recorded the chromatograms and measured the peak responses. The spectrum and area of drug standards were analysed and drawn a plot between the concentration (µg/ml) Vs area and reported the slope, intercept Figure 7.4 represents calibration curve.

Table 6: Linearity Parameter

Linearity		
Sr. No	**Concentration (µg/mL)**	**Peak Area**
1	10	1252654
2	20	2505308
3	30	3707962
4	40	5010616
5	50	6263270
6	60	7515924
Slope		125408.26
Standard Error		22625.31
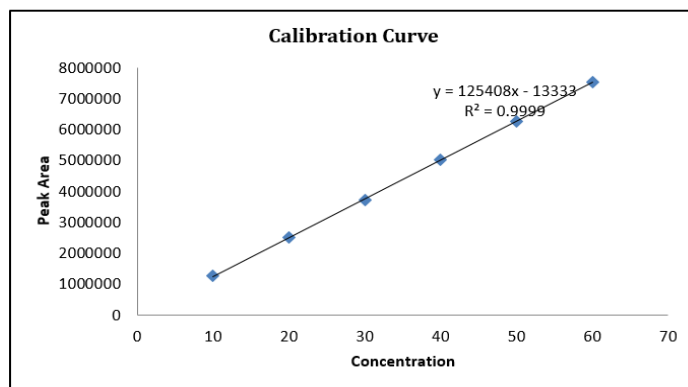
Figure 5: Linearity of Ramipril
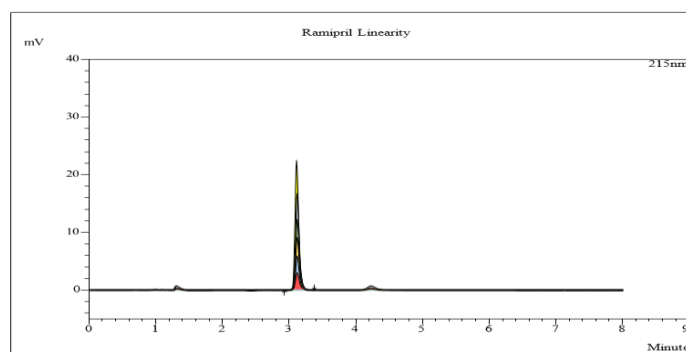
Peak No.	Ret. Time	Name	Area	Tailing Factor	Theoretical Plates
1	3.102	Ramipril	1252654	1.315	77134
2	3.101	Ramipril	2505308	1.312	78757
3	3.102	Ramipril	3707962	1.312	78695
4	3.104	Ramipril	5010616	1.316	79956
5	3.102	Ramipril	6263270	1.315	81246
6	3.103	Ramipril	7515924	1.317	82005
Total			26255734		

Figure 6: Overlay of Ramipril (API)

Specificity: The specificity of the RP-HPLC method was determined by comparison of the chromatogram of mixed standards and sample solutions. The parameters like retention time (t R), resolution (RS) and tailing factor (Tf) were calculated. Good correlation was found between the results of mixed standards and sample solutions and no interference of any other peak.

Table 7: Specificity Parameter

Specificity			
Sample	Label Claim (mg)	Amount Found	Recovery	Retention Time
Tablet	2.5	2.41	96.4	3.101
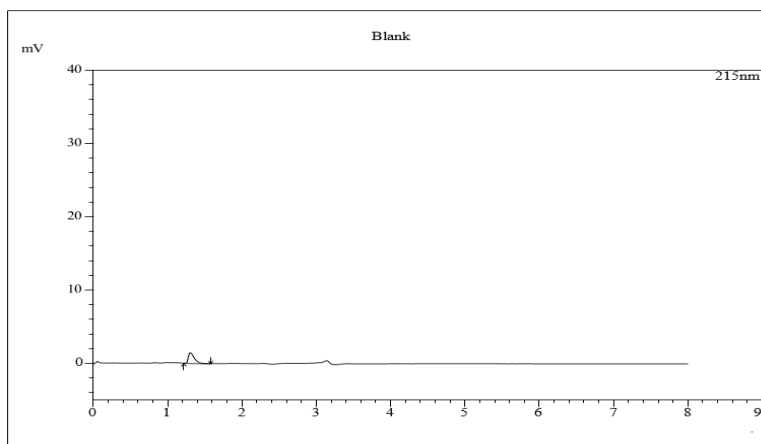
Figure 7: Specificity chromatogram of blank
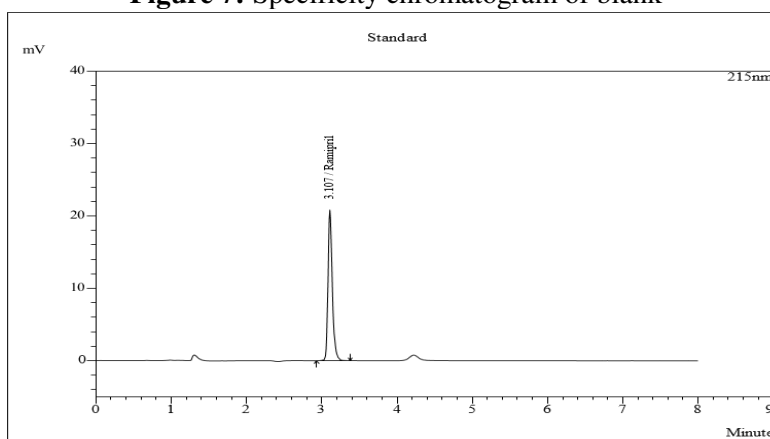
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.107	Ramipril	5010616	1.312	78534
Total			5010616		

Figure 8: Specificity chromatogram of standard
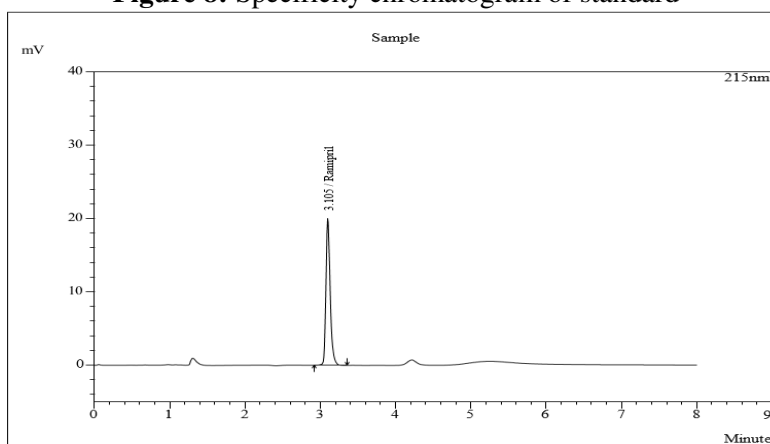
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.105	Ramipril	5012456	1.313	78992
Total			5012456		

Figure 9: Specificity chromatogram of sample

Accuracy (% Recovery)

It is defined as closeness of agreement between the actual (true) value and analytical value and obtained by applying test method for a number of times. Accuracy may often be expressed as % Recovery by the assay of known, added amount of analyte. It is measure of the exactness of the analytical method. These solutions were filtered through 0.45μ membrane and then each concentration three replicate injections were made under the optimized conditions. Recorded the chromatograms and measured the peak responses. The chromatograms of these solutions are analysed and the amount recovery and percent recovery and mean recovery for the same was calculated.

Table 8: Accuracy

		Accuracy		
Sr. No	Concentration (μg/mL)	Peak area	Found Concentration (μg/mL)	% Recovery
1	32	4034096	31.99	99.96
2	40	5042621	39.99	99.98
3	48	6025572	48.09	100.18
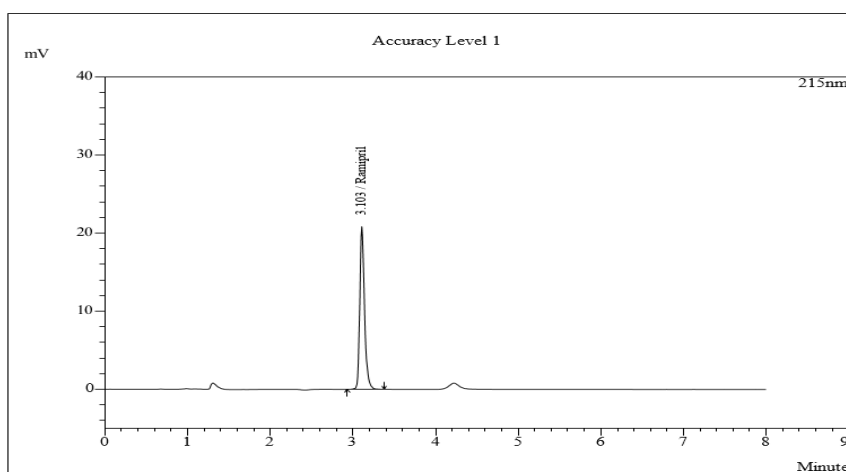
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.103	Ramipril	4034096	1.310	78900
Total			4034096		

Figure 8: Accuracy Level 1 (32 μg /mL)
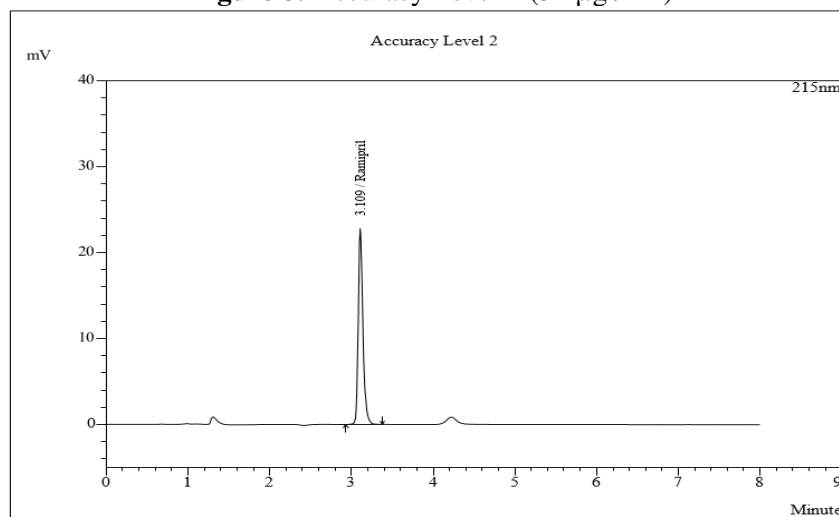
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.109	Ramipril	5042621	1.318	799810
Total			5042621		

Figure 9: Accuracy Level 2 (40μg/mL)
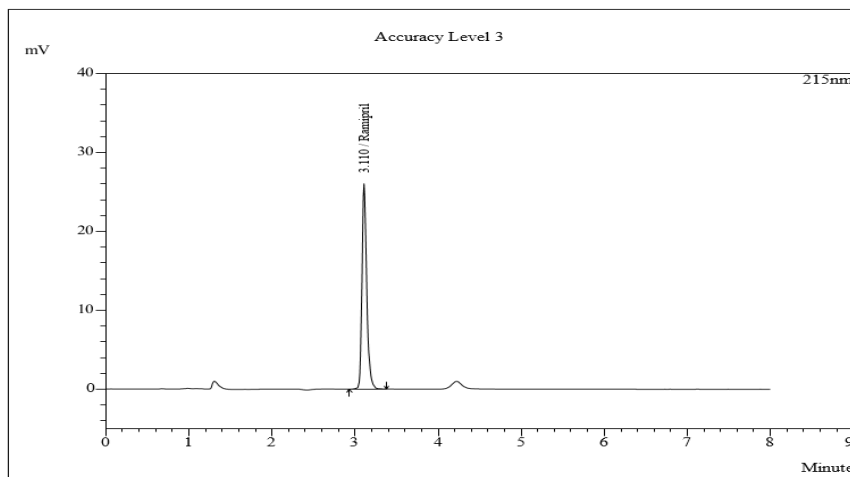
Peak No.	Ret. Time (min.)	Name	Area	Tailing Factor	Theoretical Plates
1	3.110	Ramipril	6025572	1.314	794212
Total			6025572		

Figure 10: Accuracy Level 3 (48μg/mL)

PRECISION

The standard solution was injected for six times and measured the area for all six injections in HPLC. The %RSD for the area of five replicate injections was calculated as mean and percentage RSD.

Table 10: Precision of Ramipril

Precision			
Sr. No	Concentration (μg/mL)	Intraday	Interday
1	40	5035092	5023455
2	40	5060117	5064365
3	40	4886730	5149778
4	40	5042097	4929408
5	40	5073852	5010318
6	40	5047303	4976039
Average		5024198.6	5025560.6
Standard Deviation		62750.91	69366.48
RSD%		1.2490	1.380

Limit of Detection & Limit of Quantification: The Limit of Detection & Limit of Quantification of ramipril are shown in table 11.

Table 11: LOD & LOQ

LOD & LOQ		
1	LOD (μg/mL)	0.5954
2	LOQ (μg/mL)	1.8041

ROBUSTNESS

The robustness is measure of its capacity to remain unaffected by small and deliberate variations in method parameters and provides an indication of its reliability during normal usage hence the following are performed by slight variations in parameters.

Variation of flow the assay content of the sample was measured by change in the flow rate 0.4ml/min to 0.6ml/min.

Table 12: Robustness Parameter

Robustness					
Sr. No	**Parameter**		**Response**	**Parameter**	**Response**
Acetonitrile: Methanol : Ammonium Format Buffer			**Retention Time (min)**	**Detection Wavelength**	**Peak Area**
(V/V)				(nm)	
1	75	25	3.504	213	4952489
2	76	24	3.601	215	5010804
3	77	23	3.7	217	5044068
Average			3.602	Average	5002454
Standard Deviation			0.080	Standard Deviation	37850.36
RSD%			2.222	**RSD%**	0.757
Flow Rate			**Retention Time (min)**	**pH of Buffer**	**Peak Area**
(mL/min)				(mmol/L)	
1	1.1		3.732	6.3	5038876
2	1.2		3.601	6.5	5010977
3	1.3		3.487	6.7	4935356
Average			3.607	Average	4995070
Standard Deviation			0.1001	Standard Deviation	43733.13
RSD%			2.775	**RSD%**	0.8755

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FLOWER PREDICTION AND CLASSIFICATION USING MACHINE LEARNING ALGORITHMS

RUPINDER KAUR AND DR. ANUBHA JAIN

ABSTRACT
Our paper presents Artificial intelligence techniques and algorithms by which the prediction of flower species and category is possible. In the world there are millions of species of flower. From these species some flower species look similar but belong to different categories. Smart devices and scanners themselves are not capable of differentiation of flowers that look alike; hence we have proposed a combination of algorithms which are capable of prediction of accurate species of flower despite of similar looks and features. We have collected dataset of Indian flower species and with data pre-processing steps implementation we have analysed prepared dataset using various algorithms i.e. J48, MLP and Bayes Net. After implementation we have analysed that all algorithm performance was similar but j48 produces fastest results as compare to other algorithm also in other performance factor the algorithm shows the victory over other algorithms

Keyword: MLP, j48, Bays net, Dimension reduction, Primrose, Marigold, Geranium, Calendula, Flowering Kale

INTRODUCTION
Reportedly 391,000 species of plants are recognised in science out of which it is assumed that 36900 are flowers species and every year the reorganisation of flower specie increase in wide range of numbers. Flowers are the regenerative structure found in blossoming (plants of the division Magnoliophyta, likewise called angiosperms. There were much kind of flowers, we take a region India then flower can be categorised into annual and seasonal flowers. As India has four seasons' summer, winter, Rainy and autumn, seasonal flower blooms in particular season

Summer Annual Flowers
Marigold: This flower is most widely available flower in India, in occasion like festivals marriage and hadli function these flowers are mostly used in decoration. This flower don't need special care it just need sun and it can easily grow up. The type of these flowers available with beautiful colour of yellow golden combination and variety of sizes are available

Geranium: This is a beautiful bunch of flower which need well drained soil full sun and it comes in variety of colours like pink blue yellow red and in light shade of each previously mentioned colour

Petunia: Petnuia plant is 0.66 to 1 foot tall plant, this flower need not much care. Also it comes in variety of colours like pink blue and red

Calendula: This flower comes in edible category as it is added into soup and salads as well also with this flower some essential oils are also made which is beneficial for skin.

Winter Annual Flowers
Hoary stock: For gardening this flower is very popular as it forms a beautiful line up or shape if you arrange in an order. For additional flowers in bouquet this flower is popularly used. It may grow is moist soil or in well-drained soil.

Primrose: In flower of bright colour primrose is most popular in its kind. In winter season you can easily grow and decorate your home, garden area or balcony area. It do not need full sun, grow in partial light.

Flowering Kale: This is plant with combination of flower and leaves flower is in colour of pink to purple and leaves are green. This flower is beautiful of its kind but not edible.

LITERATURE SURVEY
Andrew Ng et al. undertook a critical investigation into CNNs in order to enhance CNN algorithm performance and design optimization [12]. According to Yann LeCun et al. [20], Deep CNN is used for feature finding in images, audio, voice, and speech processing. There has been no comprehensive study of deep CNN for flower categorization up to this date. The goal of this research is to demonstrate how CNN can effectively characterise flower classes. CNN is well suited to provide solutions to complicated problems involving massive amounts of data [22]. For example, in the ImageNet dataset, which has 1.2 million images and approximately 1000

classifications, the ranking of precision has increased. In certain instances, we must consider how to make CNN work for us. We must consider how and where to design and construct a structure that adapts to varied elements while using convolutional neural networks. The value and scale of the images are severe issues that must be addressed. The asymmetrical ranking is caused by the dataset's lopsided measurements of poor and good photographs.

METHODOLOGY

The motivation for using the deep CNN architecture for flower pattern recognition is that the component training in CNNs is profoundly automatic from data images, which avoids the unpredictability of concentrating the various characteristics for conventional classifications. Academic scholars emphasise the higher level intellectual representation of low - level floral imagery using deep engineering. As a result, in this research, we developed a deep CNN model for floral image layout. To achieve greater acknowledgement rates, a unique CNN-based floral order is presented in this study. To extract the optimal technology for characterization, different CNN architectures are tested on our floral data. For evaluation, three different pooling strategies were used, namely mean pooling, max pooling, and stochastic pooling, with stochastic pooling proving to be the best result in our situation .As illustrated in CNN's capabilities in recognition, the results are compared to the Adaboost, ANN, and Deep ANN techniques, which are all commonly used cutting edge methods. The Flower Prediction Algorithm is as follows:

Multi-Layer Perceptron (MLP)

As such, MLP differs from strategic relapse in that there might be at least one non-straight layer between the data and the yield layer, known as the hidden layer. MLP learning is a non-direct pattern and is one of its main advantages. Despite this, there seem to be a number of drawbacks, such as having a non-arched misfortune capacity and adjusting for the number of veiled layers and neurons (N. Coskun and T. Yildirim, 2003).

J48

J48 computation is unique within Data frameworks in that it analyses data entirely and continuously. Used for instance, it takes additional amount of memory and depletes the display and precision in sorting clinical evidence. Weka's use default J48 decision tree uses trimming based on subtree elevating, a 0.25 certainty factor, an insignificant amount of components of 2, and hubs with diverse components.

Bayes Net

A Bayesian belief network, also known as a "Bayesian network," is a simple way to apply Bayes' Theorem to complicated problems. By definition, the structures really aren't Bayesian, but because both the probability dispersions for arbitrary variables and the linkages among random components for edges are expressed, the model may be used to capture the complicated space. In contrast to the frequentist method, where chances are completely dependent on the previous event of the occurrence, Bayesian likelihood investigates emotional probabilities or confidence in a finding. A Bayesian network captures the combined probability of the events addressed by the model.

EXPERIMENTAL EVALUATION

Data splitting

Splitting the data was done in two stages. To begin with, defined splitting with rearranging for all highlights and marks with rates 60 for preparing and 40 for approving and testing. Second, splitting the 40% using a similar route into 20% for approval and 20% for testing as appeared on the outline beneath; the data split dispersion for the picked 7 classes.

	J48	**MLP**	**BayesNet**
Time taken (second)	0.03V	0.25	0.25
Kappa Statistic	0.4639	0.4582	0.4649
MAE	0.1662	0.1671	0.1511
RMSE	0.2966	0.2893	0.293
RAE	69.7929	70.1857	63.4658
RRSE	85.4342	83.339	84.3797

Table 1: Comparative analysis of all Algorithms (J48, MLP, and Bayes Net)

Implementation Using J48
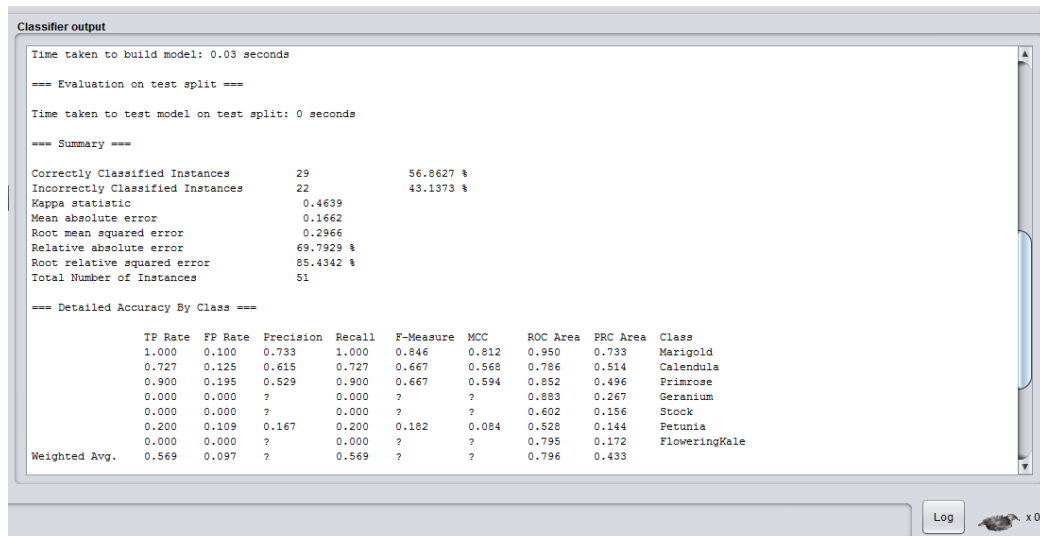
Figure 1: Analysis of dataset using j48 algorithm

Implementation Using MLP
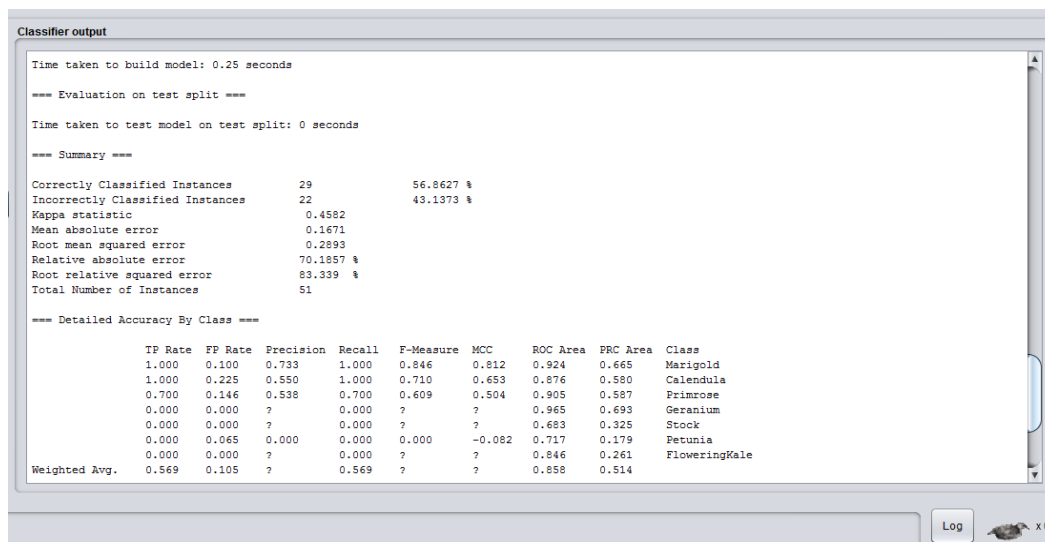
Figure 2: Analysis of dataset using MLP algorithm

Implementation using Bayes Net
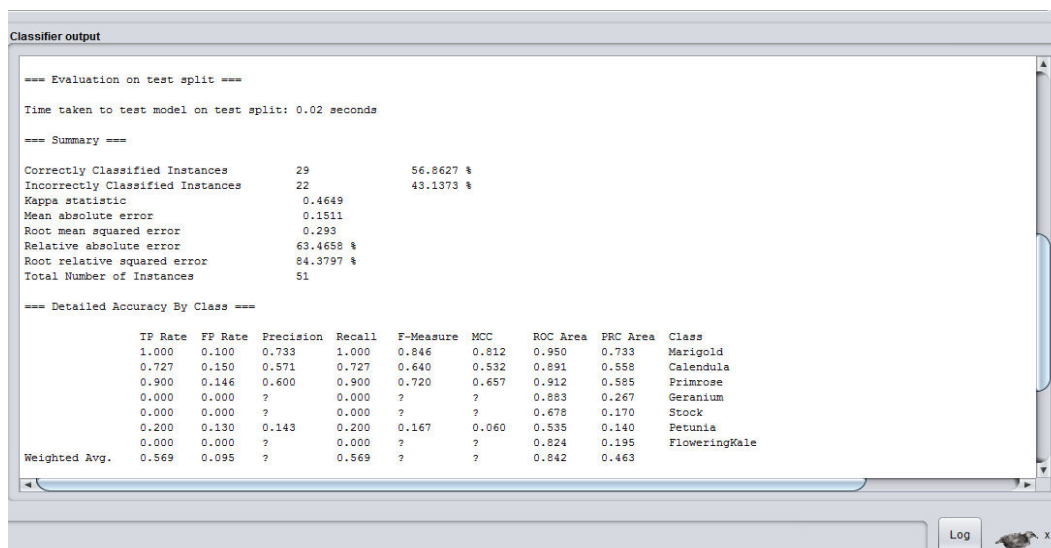
Figure 3: Analysis of dataset using Bayes Net algorithm
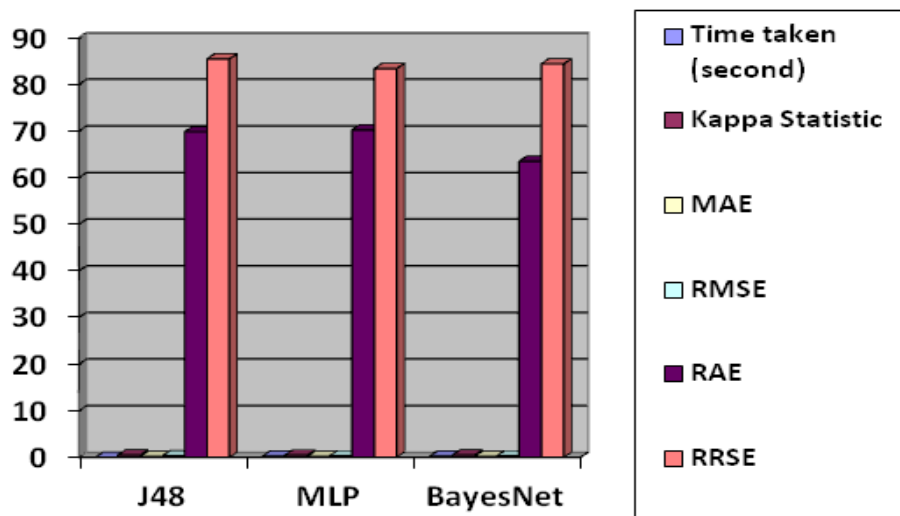
Figure 4: Graphical Representation of comparative analysis

CONCLUSION AND FUTURE WORK

The paper focuses on collection of some species which are growing in Indian atmosphere widely, we have developed a dataset for various seasonal flower species and collected their feature according to that a dataset has been prepared. The prepared Indian Flower dataset is been analysed weka tool in which we have used some classification algorithm to correctly classify flower species or type. With j48 the results are comparatively better than Bays net and MLP. However this algorithm doesn't give the worst result. After implementation we have analysed that all algorithm performance was similar but j48 produces fastest results. In future we can include more species and develop a more instance containing dataset and we will try to analyse and predict the accuracy of model. We can also include the image files of flower for feature extraction; in that case we will shift our implementation of algorithm from Weka to Matlab.

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CONTRACT LABOR IN INDIA: BUSINESS ADVANTAGES, RISKS AND MITIGATION STRATEGIES

KANCHAN KHATANA

INTRODUCTION

A large number of Indian businesses rely heavily on contract labour. Manpower and staffing services firms, for example, are among India's top private employers, providing or deploying contract workers to industries and commercial enterprises.

Workers hired in or in conjunction with the work of an enterprise "by or via a contractor, with or without the knowledge of the principal employer" are referred to as contract labour. When the Contract Labour (Regulation and Eradication Act) of India (CLRA) was enacted in 1970, it was intended "to govern the employment of contract labour in particular businesses and to provide for its abolition in specific circumstances."

The employee and the employer have traditionally had a direct employment connection. But, as a result of the challenges of modern business, this tradition has been shattered, clearing the door for alternative staffing practises. While some businesses want to outsource their work, others turn to contract labour to solve staffing issues.

Contract labour and outsourcing are not the same thing. The work is assigned to an external organisation, and it is up to that organisation to organise everything in order to complete the work, from setting up the plant and machinery to managing the human resources.

In contact labour, the external organisation appoints and deploys the individuals in its position to your organisation. These contract workers will work under your supervision on your premises.

The number of contract workers has risen dramatically in both the organised and unorganised sectors in India. The usage of contract workers employed by a third-party contractor has grown in the organised industrial sector, according to statistics from the Annual Survey of Industries (ASI). Given India's labor-intensive workforce, the percentage of contract employees in total employment jumped from 15.5 percent in 2000-01 to 27.9 percent in 2015-16. Staffing firms have reported a significant increase in hiring from IT firms in banking and financial services, among other industries, in the last year.

OVERVIEW

The Contract Labour (Regulation and Abolition) Act of 1970 governs the practise of contract labour. Despite the fact that this regulation solely applies to workers and supervisors, the practise of contract employment has spread to managerial positions.

The organisation that uses manpower is known as the Principal Employer, whereas the organisation that instals individuals in their roles and deploys them to the workplaces of its clients is known as the Labour Contractor. The Act applies to any organisation (principal employer) that employs twenty or more contract workers in the previous twelve months, as well as any labour contractor that employs twenty or more contract workers. To engage contract labour, the major employer must get a certificate of registration, and the contractor must obtain a licence from the government's labour department.

On a monthly basis, the principal employer pays the contractor the total amount of salary, allowances, and benefits due to contract workers, and the contractor in turn pays the contract workers. The major employer also pays the contractor's service charges, which are roughly 10% of the wage bill. While contract labourers work at the premises of the principal employer under his supervision, they have no employment relationship with him. For all intents and purposes, the labour contractor is their employer. Because the contractor cannot guarantee regular work on behalf of the principle employer, the nature of employment is always temporary for no more than one year at a time. Even if contract labourers have a complaint or a conflict, they must address it alone with the contractor, who is also their employer for all intents and purposes.

Advantages of Deploying Contract Labour

Contract labour is now used in a variety of sectors and industries, ranging from government agencies to software companies. It is no longer limited to low-level jobs; scientists, doctors, corporate managers, and

chartered accountants are all employed as labour contractors. While hiring temporary staff directly can lead to an industrial dispute over service regularisation at a later date, this problem can be easily avoided by using a labour contractor.

Regular workers in multinational manufacturing companies are heavily unionised, their salaries are high, they are tough to encourage for higher productivity, and they are easily irritated even over little concerns. Under the rules of the Industrial Disputes Act 1947, taking disciplinary action for misconduct or terminating their services to properly size the workforce is a lengthy process. As a result, more than half of the workers in these organisations are hired through a labour contractor.

In the software development organisations (IT companies), brand image of the employer by ensuring higher salaries and continuous employment is very important to attract and retain talented people. But all the work they do is not necessarily either of high paying or of continuous nature. As a result, they engage software engineers through the contractor for shorter periods of time and at lesser rates, and they are treated as contractor employees for all practical purposes. Many IT organisations have a higher percentage of contract employees and a lower percentage of permanent staff. Research projects in research and development organisations are tenure-based, which means that the organisation may not acquire another project or may get a project that requires a completely different skill set. As a result, contract labour is preferred in this industry. Many companies prefer to hire contract employees, observe them on the job for roughly six months to a year for high performance and good behaviour, and then consider hiring them on corporate responsibilities after paying the contractor one month's salary as recruitment fees.

Contract labour is a short-term alternative that does not require an annual salary. In most cases, you won't need to save money for paid learning and development for them because they'll only be useful to your company for a short time.

Traditionally, the process of employing contract personnel has been much faster - and it should be! This is because, rather than long-term cultural fit, you can hire for technical talents to produce something particular.

Contract and temp workers typically have a specific skill set and are used to working on specialised projects. Having a highly specialised person on your team can be quite beneficial to moving your company ahead.

Perhaps the most well-known advantage is that they are adaptable. Temps give you the flexibility to respond to market needs and demands as they arise. They're used to working in a variety of settings, for a variety of personalities, and for varying lengths of time. Additionally, hiring a contractor allows you to assess whether you have a long-term work requirement in a certain role.

Risk Associated with Contract Labor

I. Incorrect Classification

Contract workers may be incorrectly classified as direct employees of the Principal employer as a result of a claim by the workers or a determination by an independent labour authority. Despite not being on the company's payroll, the workers would be entitled to the same benefits and privileges as Full time employees.

II. Statutory Non-Compliances by the Contractor

Any non-compliances by the labor contractor can impose risks to principal employer. If a contractor fails to meet its legal obligations, the principal employer is required by law to step into the shoes of the contractor. Payment of wages and social security contributions is taken over by the principal employer, as are labour registrations and the provision of specified facilities such as canteens, creches, first-aid facilities, bathrooms, and so on. The principal employer is entitled to collect these amounts from the contractor under the law, but the contractor's financial wherewithal to satisfy its obligations will determine how effective the recovery is.

Mitigation Measures for Employers

The risks identified above can be limited to an extent via the following measures:

I. Robust Services Agreement

Engage contract labour by entering into a services agreement with the contractor that spells out the contractor's role and obligations (including timely payments and renewal of statutory registrations, with proof to be submitted to the company). Include warranty and indemnity terms that require adherence to Indian laws, as well as additional methods to quickly recover expenses, such as performance bonds, LDs, and speedy dispute settlement, as needed. Use the services agreement as a conduit to find the suitable contract labour, but don't get involved in the selection or management of the workers.

I.   Contractor Due Diligence

When onboarding contractors, perform due diligence to ensure they are in compliance with applicable laws and have the necessary permits. Previous non-compliances and sanctions may also be discovered through antecedents checks. Consider pre-contract site visits to examine the contractor's provision of essential facilities, as well as regular "spot checks" for high-risk and sensitive industries like food, if possible.

II.   Control Restrictions

The contract labor's work terms should not be controlled (directly or indirectly) by the principal employer. For example, you should not: - pay wages to contract workers directly. The contractor should be responsible for all wage/benefit payments; - authorise days of leave or salary decisions for contract workers; or participate in recruiting and firing decisions.

Where contract labour is not exclusively employed by the principal employer, the risk of misclassification is also reduced.

III.   Good Governance of Compliance

Use your rights under the services agreement to keep an eye on the contractor's adherence to applicable labour regulations, such as wage payment, statutory dues, and the establishment of anti-sexual harassment measures, among other things.

CONCLUSIONS

This is still the most talked about topic in the business world today. Employers in a variety of industries, from micro to large, rely on the Contract labour to sustain. As Principal Employers, they must exercise extreme caution when hiring a contractor. They must not only be compliant, but also verify that the contractors they hire are compliant.All necessary mitigation steps have to be taken in order to avoid the risk in a contractual.

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VALUE INVESTING USING RESIDUAL INCOME VALUATION MODEL

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ABSTRACT
Using cross-sectional projections, the study aims to analyse the role of fundamental research approach known as intrinsic value, based on the V/P ratio measure from (Frankel & Lee, 1998), in explaining future returns. Based on the 1526 stocks listed on the BSE for the year 2017 in Indian stock market, the results found that the high V/P quintile portfolios are able to generate more excess return than the low V/P quintile portfolios in one year holding period. Moreover, we discover positive and significant four factor alpha for these portfolios. The stocks are seen to be more volatile though able to produce higher Sharpe ratios. This witness that the strategy of selecting value stocks based on high V/P ratio can outperform. The findings have relevance for both academic research in fundamental analysis and practitioners seeking alpha-generating strategies.

INTRODUCTION

Fundamental analysis aims to determine which firms will be the most successful in long run and which will be the most unsuccessful. To put simply, it is basically concerned with identifying possible winners and losers in relation to future returns across a wide range of cross-sectional firms. Prior research in finance and accounting has pursued two strategies to fundamental analysis. The first technique determines a company's "intrinsic worth." by combining analysts' earnings estimates with a valuation model. The second method, known as financial statement analysis, uses numerous pieces of information from a company's financial statements. Frankel and Lee (1998) were among the first to assess intrinsic value using the RIV approach. Frankel and Lee (1998) provide a reasonable argument that enterprises' anomalous performance will dissipate across time and that stock prices will likely coincide with their underlying value. However, this strategy is confined to organisations whose future earnings predictions are known. Recent study, on the other hand, has studied the effectiveness of cross-sectional earnings projections. Hou et al. (2012) build a cross-sectional model for forecasting future earnings estimates without requiring a large time set of information. Further, Li and Mohanram (2014) augment these models by embedding them in existing accounting theory, resulting in cross-sectional projections, particularly for the enterprises without analyst's estimates. Researchers may use cross-sectional models to forecast future profitability for a diverse range of equities, even for companies whose analyst forecasts are not available.

The majority of practitioners and academic scholars agree that a stock's intrinsic value is the present worth of its projected future dividends or cash flows to common stockholders. Nevertheless, a handful of academic research have concentrated about the fundamental issue of intrinsic value estimation. Arguably minimal attention accorded to this critical subject mirrors the widely held academic belief that a stock's price is the best estimate of its intrinsic worth (Lee et al., 1999). A company's tendency to create value relies on its ability to produce a return on investment that exceeds its cost of capital over time (Forsyth, 2019). According to Koller et al. (2010), firms earn more return than their cost of capital for a duration of time, and afterwards the return falls toward the cost of capital as the relative advantage dwindles. The purpose of this article is to determine if residual income models, as asserted by Frankel and Lee (1998), can accurately anticipate future securities return.

Hence, our article draws on three previous important studies: intrinsic value basic analytical technique, cross-sectional forecasting, and merging the two approaches (Frankel & Lee, 1998; Li & Mohanram, 2014; Li & Mohanram, 2019). The assumption of a clean surplus in these models enables researchers to convert analysts' earnings expectations into projected book values and residual income estimates. This paper's key contribution is the construction of a rather conducive approach to compute intrinsic value estimates for a large set of companies.

Residual Income Valuation Model

Frankel and Lee (1998) demonstrate implicit corporate values using the residual income model developed by Ohlson (1995), which establishes a relationship between accounting variables and company values. The approach is based on the discounted dividend framework, which defines the implicit worth of an organisation as the current value of its anticipated future dividends. Assuming that the book values and earnings fulfil the clean surplus relationship, corporate values could be characterised as the combination of book values plus discounted

anticipated residual income, while residual income could be recognised as current year's profits less required return on capital invested. As a consequence, the following equation (1) is expressed in the manner:

Equity Value = book value of firm's equity + PV of anticipated future anomalous profits   (1)

$$V_e = Equity_0 + \frac{NI_1 - r_e * Equity_0}{(1+r_e)} + \frac{NI_2 - r_e * Equity_1}{(1+r_e)^2} + \cdots + \frac{NI_t - r_e * Equity_{t-1}}{(1+r_e)^t} + \frac{TV_t}{(1+r_e)^t} \qquad (2)$$

Given,

$$NI_t - r_e * Equity_{t-1} = (ROE_t - r_e) * Equity_{t-1}$$

Residual income model may alternatively be expressed as:

$$V_e = Equity_0 + \frac{(ROE_1 - r_e)*Equity_0}{(1+r_e)} + \frac{(ROE_2 - r_e)*Equity_1}{(1+r_e)^2} + \cdots + \frac{(ROE_t - r_e)*Equity_{t-1}}{(1+r_e)^t} + \frac{TV_t}{(1+r_e)^t} \quad (3)$$

Additionally, Frankel and Lee (1998) assert that the model of residual income has predictive ability to explain the positive association between firm's implicit business values and future stock returns.

LITERATURE REVIEW

The intrinsic value approach is founded on the use of a precise valuation techniques like the residual income model. Additionally, it tends to ignore the intricacy of substantial financial statement data. In comparison, the financial statement analysis may be attributed to a broader spectrum of businesses. On the other hand, it overlooks the likelihood that the market may have already priced the financial statement insights in its valuation. Previous work has attempted a variety of methods to ICC measurement (Gebhardt et al., 2001).In a study by Claus and Thomas (2001), discount rate serves as a proxy that corresponds price as the sum of book value and the present value of future anomalous profits using the residual income model. These ways to calculate ICC require analyst EPS projections. This strategy has a number of drawbacks. To begin, expert projections are accessible for a select group of businesses. Second, a substantial body of evidence demonstrates that ICC proxies produced from analyst projections are inaccurate, with low correlations to future returns (Easton & Monahan, 2005). Elgers et al. (2001) seek to explain why, despite the fact that analysts' earnings predictions are increasingly trustworthy and exact proxies for potential earnings, market predictions of future earnings do not improve consistently. Their argument is that the market is unable to absorb all relative valuation information included in expert estimates. Moreover, when the dataset is divided into two categories based on analyst coverage, the returns to hedge portfolio for the FY1/P strategy are much higher for businesses that do not have analyst coverage than for firms with have high analyst coverage. In a work by Hou et al. (2012), henceforth referred to as HVZ, published an article that takes an intriguing approach to overcome these issues. Cross sectional regressions based on lagged data are used by HVZ to anticipate profits over a period of one year to five years.

A key feature of their model is the regression of future profits on total assets as well as dividends, earnings, and accruals, which builds on previous work by Fama and French (2000, 2006). They use the model's profit predictions to develop ICC estimations. HVZ demonstrate that their methodology overcomes the limitations associated with depending on analyst projections by generating credible ICC forecasts for a diverse sample of enterprises. The study showed that the ICC produced from models consistently outperformed the ICC derived from expert estimates. Moreover, the HVZ model has been used in recent studies based on company valuation (e.g., Lee et al. 2011; Patatoukas, 2011; Jones & Tuzel, 2013;). Using a naive random walk (RW) model, Gerakos and Gramacy (2013) showed that the HVZ model underperforms the RW model. There are several inferred costs of capital indicators based on short-term growth estimates that are unreasonable in a RW model. Moreover, Li and Mohanram (2014) conducted a comparison using four cross-sectional forecasting models: EP, RI, HVZ, and RW. Results found that the two models namely the RI and EP models outperformed the HVZ model in the context of prediction accuracy and bias. Frankel and Lee (1998) found that the V/P measure is highly associated with future stock returns across the investment horizons of one, two and three years respectively. On the other hand, it has been argued that the relationship between future stock returns and V/P is attributable to its component variables. As a result, it is indeed reasonable to think that V/P only serves as a proxy for the relationship between these component variables and anomalous returns.

Prior research sought to provide alternatives to analyst estimates for firms that were not tracked by analysts. Invariably, time series projections were created using firm-specific estimation techniques for this purpose. On the other side, these models need an extensive time series of data, which results in a significant level of survivorship bias. This seems to be particularly hard for firms without analyst coverage, since they are often

small and lacking in data. Hence, against this background, the present study uses cross-sectional projections from Li and Mohanram (2014) to analyse the profitability of fundamental analysis approach based on intrinsic value, in particular the V/P ratio from (Frankel & Lee, 1998).

DATA COLLECTION AND METHODOLOGY

Data Collection

The estimate sample comprises of all stocks listed on Bombay Stock Exchange as of March 31, 2017. It consists of around more than 5000 companies on the list. We further extracted data for the required variables over the preceding 15 years. The list of variables and their description in given in appendix. The number of stocks for which the data relating to specified variables is available turns out to be 1526 in number. The current study makes use of the ACE equity database.

Earnings Predictions for Year T+1 to T+5

The research employs Li and Mohanram (2014) methodology, namely the RI model, to estimate cross-sectional earnings predictions for years t+1 through t+5. For 2017, we utilised data from 2007 to 2016 to anticipate profits for year t+1. Similarly, profit forecasts for years t+2 were calculated using data from 2006 through 2015 and so on. This assures that the earnings projection is completely out of sample. To eliminate any look ahead bias, the portfolio creation date is set to 30th September. Predictions of profits for years t+1 to t+5 are generated for each business by scaling the independent variables in year t with the pooled regression coefficients estimated from preceding 10-year data. Only a non-missing independent variable in year t is required to predict the company's profitability in year t.

Implementation of V/P approach

We perform the V/P intrinsic value strategy using the methodology described in Frankel and Lee (1998). To be more precise, we evaluate a firm's intrinsic value using the residual income valuation model:

$$V_t = B_t + \sum_{i=1}^{\infty} \frac{E_t[NI_{t+i} - (r_e * B_{t+i-1})]}{(1 + r_e)^i}$$

$$V_t = B_t + \sum_{i=1}^{\infty} \frac{E_t[ROE_{t+i} - r_e) B_{t+i-1}]}{(1 + r_e)^i}$$

Where B_t denotes the per share book value of equity at time t, and Et denotes the expectation as regards to known facts at time t. NI_{t+i} represents per share profits before exceptional and extraordinary items for the period t+i; re represents the cost of equity for the period t+i; and ROE_{t+i} represents the after-tax return on book value for the period t+i.

To put the model into practice, firstly. the firm's future earnings per share from t+1 to t+5 are estimated. We compute the book value of equity and return on equity assuming clean surplus relationship: $B_{t+i}=B_{t+i-1}+(1-k)*NI_{t+I}$ and $ROE_{t+i}=NI_{t+i}/B_{t+i-1}$, where k is the estimated payout ratio.

The dividend pay-out ratio k is made up of three components: dividends, earnings, and assets. Then k=dividend per share/earnings per share =(dividend per share/market price) * (market price/earnings per share). With negative earnings, k=dividend per share/ (6% *total assets per share) = (dividend per share/market price) * (market price/ (6% *total assets per share)).

Terminal Value and Discount Rate

Since the residual income model holds indefinite time period, it is necessary to set finite prediction boundaries to calculate the terminal values. Frankel and Lee (1998) used the short run earnings predictions of three years to establish the terminal value. To calculate terminal value, we assume that abnormal earnings stay constant after the projection horizon. Moreover, we utilise the risk-free interest rate (91-day Treasury Bills rate) + 5% equity premium (r_e).

RESULTS AND DISCUSSION

Table 1 shows the regression coefficients and time series t-statistics from the RI model predicted for the year 2017. Ten years of lagged data are required to calculate the future earnings estimates for t+1, t+2, t+3, t+4 and t+5 respectively. Each coefficient has a sign consistent with the model's theoretical prediction. Along with the positive earnings and negative loss interaction coefficients, the regression features a positive book value coefficient and a negative accruals coefficient. The model produced the 1-, 2-, 3-, 4- and 5-year ahead earnings forecasts based on the regression coefficients.

$$E_{i,t+\omega} = x_0 + x_1 * NegE_{i,t} + x_2 * E_{i,t} + x_3 * NegE * E_{i,t} + x_4 * B_{i,t} + x_5 * TACC_{i,t} + \varepsilon_{i,t+\omega}$$

Where, $\omega = 1$ to 5; $E_{i,t}$ is earnings per share before special and extraordinary items, $NegE_{i,t}$ is an indicator variable for loss firms; $B_{i,t}$ is the book value of equity per share; $TACC_{i,t}$ is the total accrual per share calculated as: $\frac{\Delta WC + \Delta NCO + \Delta FIN}{No. \text{ of outstanding shares}}$ as per Richardson et al. (2005).

Table 1: Coefficients Estimates from the RI Cross Sectional Earnings Prediction Model

	Intercept	NegE$_t$	E$_t$	NegE$_t$* E$_t$	B$_t$	TACC$_t$	Adj. R^2 (%age)
E$_{t+1}$	5.9804	-7.9402	0.7576	-0.5204	0.0011	-0.0111	59.9
	(2.80)	(2.71)	(12.45)	(3.97)	(0.03)	(0.55)	
E$_{t+2}$	6.3921	-7.7650	0.7876	-0.6111	0.0054	-0.0150	60.6
	(2.88)	(2.58)	(10.75)	(5.09)	(0.30)	(0.92)	
E$_{t+3}$	9.3381	-4.5886	0.4596	-0.4375	0.0373	-0.0200	43.7
	(3.27)	(0.99)	(1.97)	(0.74)	(0.24)	(0.14)	
E$_{t+4}$	10.0631	-12.4624	0.3014	-0.2206	0.0406	-0.0045	59.6
	(3.47)	(5.09)	(4.10)	(1.71)	(1.58)	(0.23)	
E$_{t+5}$	23.0435	-20.5729	0.3383	-0.3384	0.0004	-0.0469	68.1
	(4.20)	(4.67)	(7.74)	(1.81)	(0.01)	(0.03)	

Note: The figures of t test statistics are reported in parenthesis.

Using the coefficients from the model, the future earnings forecasts are calculated by multiplying the independent variables year t with the coefficients obtained. Further, the intrinsic values are calculated as per the methodology described and the V/P measure is obtained by dividing the intrinsic value with the market price of a stock. The stocks are ranked into five quintiles to form five portfolios. We apply a hedging strategy by taking long positions in companies in the top quintile and short positions in companies in the lowest quintile.

Table 2 shows the results of excess return, beta, Sharpe ratio, CAPM (alpha), 3 factor alpha and 4 factor alphas respectively for the V/P ratio portfolios. The stocks were sorted into five quintiles based on their V/P ratio. The stocks are held for one year and the log monthly returns are computed. Results discover that the excess return to high V/P ratio stocks rise monotonically from quintile 1 to quintile 5. Moreover, the excess returns to long short portfolio, which goes for long in high V/P stocks and short in low V/P stocks is also greater. On the other hand, high V/P ratio stocks seems to be more volatile as compared to low V/P stocks in terms of high beta. In addition, the Sharpe ratio indicates the extra return that a portfolio generates in exchange of additional volatility by keeping a riskier asset. The high V/P ratio portfolios are able to produce higher Sharpe ratios. Hence, the results showed that although the high V/P stocks are more volatile but they are able to produce greater excess returns for the investors. CAPM alpha here measures the investment's performance relative to the market index or benchmark. It can be noted that the low V/P stocks which are basically the growth stocks have resulted in negative excess returns and this return reduced gradually as we move to the higher quintile. In the third quintile portfolio, the return becomes positive but not significant. For the fourth and fifth quintile portfolios, the excess return is highly positive and significant. Moreover, the long short portfolio, provided 1.95 basis point monthly return. Moreover, the results of 3 factor alpha and 4 factor alphas also suggests the same picture. Moreover, the 4-factor alpha rises significantly after controlling the impact of market, size, book to market and momentum factor.

Table 2: Results of Quintile Portfolios Sorted on V/P Measure

Quintile	1(Low)	2	3	4	5(High)	H-L
Excess Return	-0.5085	-0.0186	0.3589	0.6412	0.8889	1.3974
Beta	0.8569	0.9952	1.1523	1.0253	1.0356	1.1245
Sharpe ratio	-0.5289	0.2563	0.5823	0.8756	1.5235	1.6589
CAPM (alpha)	-1.4523	-1.1278	0.15620	0.3698	0.4985	1.9508
	(-3.94)	(-1.75)	(1.99)	(2.85)	(3.85)	(4.85)
3-factor alpha	-1.2569	-0.5215	0.6689	0.1541	0.2569	1.5138
	(-4.43)	(-1.59)	(2.11)	(2.58)	(4.58)	(5.89)
4-factor alpha	-1.2356	-0.5874	-0.0456	0.2578	0.3045	1.5401
	(-3.94)	(-2.29)	(1.45)	(1.22)	(2.56)	(6.45)
Adj. R^2	0.8565	0.6696	0.9004	0.8982	0.8845	0.7856

Note: Coefficients of t test statistics are reported in parenthesis.

CONCLUDING REMARKS

We compute the profitability of V/P measure for BSE listed stocks in Indian stock market. Results found that the value strategy outperforms the growth strategy based on V/P measure. Stocks in the highest quintile, with the high intrinsic value as compared to market price, provided more return than the stocks that are trading at high price in comparison to their intrinsic value. Hence, the strategy can be safely employed to compute intrinsic value estimates for the stock purchasing. Although the calculation of intrinsic value is a rigorous task but the policy makers and intuitional investors can use this cross-sectional model to compute the earnings forecasts for even those firms for which the analyst forecast are not available, basically the small and new or ignored firms. Thus, it builds a broader perspective to bring large number of stocks in the screening process.

APPENDIX

Variables	Description
EPS	Profit before special and extraordinary items/No. of equity shares outstanding
Book Value per share	Shareholder's funds/No. of equity shares outstanding
Total accrual per share	ΔWC+ΔNCO+ΔFIN/No. of equity shares outstanding
ΔWC	COA-COL
ΔNCO	NCOA-NCOC
ΔFIN	FA-FL
COA	Total current assets - (Current investments + Cash & Bank balance)
COL	Total current liabilities – short term borrowings
NCOA	Total assets- total current assets- (noncurrent investments +long term loans & advances + current investments)
NCOC	Total liabilities – total current liabilities – long term borrowings
FA	Current investments + Noncurrent investments
FL	Long term borrowing + Short term borrowing+ Preference share capital paid up

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FUTURE OF MANAGEMENT PROFESSORS – A VISIONARY STUDY

PROF. (DR.) DHANANJAY AWASARIKAR

ABSTRACT

The future of Professors working in Management Institutions was really very bright as well as promising around twenty five to thirty (1992- 1997) years ago. It had changed in different phases namely; Pre-Recession Period (1995-2007); Post-Recession Period (2008-2019) and Post-COVID Period (2020 onwards).

In this Research Paper; the present Position of the Professors is studied under different heads namely; Professors' Recruitment and Selection; Security; Working Conditions; Increments; Incentives and Fringe Benefits; Privileges; Benefits; Welfare; Inability and Percolation of Malpractices; Post Retirement Benefits.

As a matter of fact; no Individual in the world ever likes to live with injustice just like a slave. But when the situation compels; he has to endure something when nothing can; in fact; be cured. In general; very often it is said that when nothing can be cured; something has to be endured.

The Research Paper explains current helpless and inevitable position; of the Professors; in brief. As the job opportunities are scarce; both in the Educational Institutions and elsewhere; say; Public Sector; Private Sector; Government Sector; etc; the Professors cannot switch over to the other job; at present.

Keywords: (a) Pre-quantification, (b) Holiday Farce, (c) Percolation of Malpractices, (d) Corona Warriors

INTRODUCTION

The future of Professors working in Management Institutions was really very bright as well as promising around twenty five to thirty (1992- 1997) years ago. There was a young generation highly interested in joining the Management Fraternity especially out of passion. Moreover; joining the Management field was regarded as one of the best Career Options. Also; the Social Status of the Management Institutions was altogether different in the sense that it was relatively higher as compared to the status as on today. The salaries of the Professors were paid as per the scale prescribed by the appropriate authority whether U. G. C. or A. I. C. T. E.; of course barring a few exceptions.

Unfortunately; the situation of the Management Professors is not; at all; as sound as it was. Moreover; it had not changed all of a sudden; however; it had changed gradually from Very Good to Worse. Really; it had changed in different phases namely; ***Pre-Recession Period (1995-2007); Post-Recession Period (2008-2019) and Post-COVID Period (2020 onwards).***

RESEARCH PAPER OBJECTIVES –
The Following are the Objectives of the Research Paper.

1. To Study the prevailing Position of the Professors working in Unaided Educational Institutions with special reference to the Management Institutions

2. To predict the future of the Professors working in Unaided Educational Institutions with special reference to the Management Institutions

RESEARCH PAPER SCOPE –
The Scope of the Research Paper extends to the Professors working in adverse circumstances in any part of the Globe.

RESEARCH PAPER METHODOLOGY –
Primary Data for the Research Paper is collected through ***informal or unofficial (Personal or Mobile) interactions*** with the Professors; with ***unstructured disguised questionnaire***.

Sampling Plan for the Mobile Survey –

(I) Population –
(a) Professors working in Management Institutions in and around Pune

(II) Sample Unit –
(a) A Professor working in Management Institute in and around Pune

(III) Total Sample Size – **100**

Sampling Methodology for the Mobile Survey -

The Sampling Methodology adopted for the Opinion Survey was ***Non Probability – Stratified (Demographic) resulting into Purposive and Convenience Sampling.***

SAMPLE CATEGORY –

The Sample Consisted of the Following four Different Categories.

Sr. No	Category	Population	The Sample Unit	Sample Size
1	Professor	Professors working in Management Institutions in Pune	Select Professor working in Management Institution in Pune	75
2	Professor	Professors working in Management Institutions around Pune	Select Professor working in Management Institution around Pune	25
			Total Sample Size	**100**

A. Professors Present Position

(I) Recruitment and Selection -
At the time of selection of the Professors; the Managements apply all the rules regarding their eligibility; quite rigorously and meticulously. ***The Managements do not relax even a minor rule; particularly when they do not want to select a candidate; not falling within their Political Selection Criteria devoid of Merit.*** At the same time; it may not out of place to point out that ***the Major Qualifying Rules too; forget the minor ones; are comfortably modified in order to accommodate a candidate particularly fitting within the criteria in the light of Poor Pay Package.*** In sixty percent cases; the Professor's exploitation is to the tune of such an extent that he finds it too difficult to make both the ends meet.

(II) Security -
The ninety percent Professors are insecure; basically because they are not confirmed as a Pitiable Political Policy even after the completion of the prescribed (by the University Statutes) Probation Period. The general reason put forward for this consequence is that the Professor's Performance during the Probation period was not satisfactory.

The word 'Satisfactory' is a word having ***Subjective (not Objective); thus Relative (not Absolute) Characteristics*** denoting inherent existence of the quality; in the performance. The Quality; referred to; over here indeed needs to be well quantified as well as defined beforehand. In eighty per cent cases; ***Pre-definition and Pre-quantification of the Qualitative factors associated with the Professor's Performance is deliberately not done.*** Under such precarious position; the innocent professor; ignorant of the Evaluating Standards; assumes them on the basis of his level of intelligence; Maturity and Wisdom. In seventy percent cases; such Evaluation does not turn out to be realistic and practical. Even if a Professor realizes this reality; he cannot raise his voice against the Giant Management for want of Secured Position and Continuation in the service.

(III) Working Conditions -
The Working Conditions prevalent at present in sixty percent Management Institutions are worse in the sense that the Managements hardly care for the Faculty Health; Security as well as Welfare. Eighty percent Faculties; especially the lady faculties; had shoddier experience during recent Pandemic when they were forced to come to the Institute for completion of work which was neither urgent nor important. It was quite difficult for the lady faculties at that time to maintain work life balance when the crèches were closed; maid servants were not allowed to work at home and there was nobody to take care of the senior citizens staying at home. The working Conditions maintained then were not at all hygienic in nature and at times those were not noticed as per the restrictions prescribed by the law from time to time depending upon the condition of the Pandemic. ***In the opinion of the Researcher; these Faculty Members were also the real Corona Warriors who continued their duty out of fear and tension of losing the job created by their superiors when over three thousand patients were found every day.***

(IV) Increments and Facilities -
The theoretical concept of Annual Notional Increment is almost nonexistent in the Management Institutions.
As a general rule; an increment is not given even to a deserving Professor as it is given to a Professor; if he is indispensable; that too; if he simultaneously makes an alternative arrangement. Broadly speaking; both these

factors do not coincide; as a result the Management is saved from giving the Increment. ***The Privileges; Incentives; Fringe Benefits and other Official Facilities are given to the Professors on the basis of relation.*** The ***Post Retirement Benefits*** are almost so ordinary that they fail to attract the Professors to retain the job over a long period.

(V) Status of Holidays -

The Managements of twenty percent Management Institutions do not prepare a ***List of Holidays for an Academic Year.*** When such list is not prepared well in advance; the professors cannot plan their personal work properly. Furthermore; when the holiday is declared all of a sudden; a day in advance; the professors find it impossible to manage their work; especially if it is required to be scheduled outstation.

The Managements of the ten percent Management Institutions; no doubt; prepare a List of Holidays at the start of the Academic Year; they also disclose the same in the Academic Calendar for the Year. However; on the threshold of the holiday; one day or two days before; they cancel the same for reasons; genuine thus convincing just on one   percent occasions; and in-genuine thus unconvincing on the other ninety nine percent occasions. In one of the Management Institutions; to the utter surprise of the Teaching Staff; out of fifteen holidays; eight holidays were cancelled in an Academic Year; all for in-genuine reasons in an aforesaid manner. In other words; ***the Managements of the Management Institutions merely make a farce of holidays*** and no more.

(VI) Welfare -

All the rules; regulations; byelaws and statutes designed for the welfare or wellbeing of the Professors are interpreted by the Managements quite discretely and selectively; not uniformly and equitably; thus; conveniently for the Professors. There are a number of Judicial or Quasi-Judicial Bodies established under different Statutes to combat with the unfortunate incidences of injustice if any; with the Professor; but their processes of Administration and Execution of Justice are so cumbersome; complicated and lengthy in character that instead of giving justice to an aggrieved Professor and causing his convenience at an early date; they give injustice and cause inconvenience in the process.

(VII) Exploitation -

In-spite of the fact that today ninety five percent newly joined professors are well aware about the exact position of the professors as narrated above; they are not only accepting the jobs but also continuing them; quite surprisingly. Moreover; ***if a Professor leaves a job say out of agitation; there are observed several other well qualified and experienced senior professors eagerly awaiting to grab the opportunity and join the resultant vacancy; that too; on the half salary which the leaving Professor is drawing.*** When the Researcher initiated an inquiry on this point; he came across a reality that these Professors are totally helpless and they are behaving likewise and living with injustice naturally ***not out of liking but simply out of compulsion.*** One will not wonder for this situation when he will consider the number; of educated and unemployed citizens in India; rising at an alarming rate. ***Instead to die out of starvation; they find it quite normal to survive on half bread when full bread cannot be bought.***

(VIII) Percolation of Malpractices -

The persons in charge for running the Management Institutions in and around Pune; may be designated as the Chairman or the Director; meet informally and unofficially once or twice a month. The Agenda of this meeting shows its purpose as transfer of vital information regarding some good Events conducted in the light of promotion of Culture and Tradition; other ancillary Activities and good deeds; incidental or occasional; if any; like Charity or Social Service undertaken as a part and parcel of discharge of Corporate Social Responsibility; etc. resulted since the last meeting within the Institutions. But this purpose really remains on the paper in the meeting and what get exchanged are the malpractices taking place within the Institutes. Thereafter; it does not need too long time to percolate the same malpractices in almost all the Management Institutions. Thus; just one bad practice taking place in one Institute turns out to be a Regular Practice in the Management field over a period. As a Dramatic irony of the situation; today it is good to note that a Malpractice has yet to get the status of the Best Practice from the contemplation of NAAC or NBA. In this connection; the following is an eye opening example as it proves this point beyond a shadow of reasonable doubt.

In one of the reputed Management Institutions; the salaries of the Professors were not paid months over months. The funds received in the form of Students' Fees were invested in another business; as a special kind of Diversification. Whether the Management would have given the idea of this adventure to its staff well in advance or not; is indeed an Ethical topic of doubt and dispute; therefore of debate; however; it is not to be narrated here. This Institute may be the first Institute where the Professors' salaries were not paid almost for eighteen months.

The aggrieved Professors of the Institute approached the:

(a) Appropriate Authorities in the University to whom the Institute was affiliated;

(b) All India Council of Technical Education (A. I. C. T. E.) by whom the Institute was Approved;

(c) Director of Technical Education (D. T. E.) whose rules were claimed to be followed by the Institute;

(d) Grievance Committee constituted by the concerned University for Redressal of the Professors' Grievances;

(e) University Tribunal which is a Quasi-Judicial Body having the powers almost similar to those of the Hon. Civil Court;

(f) Educational Minister of the State Government; and

(g) Several other local influential Bodies like Corporaters and Ward Officers

The Orders passed by the Statutory Bodies were not followed fully by the Management Institute in the sense that they were complied partially and flouted partially. In essence; there was only a show carried out of following the Orders to reduce Professors' agitation temporarily.

While the above matter was the topic of the town; in one of the Management Institutions; when the Professors' salary was not paid for a month; one of the needy Professors *dared* to inquire with the Management Representative and responsible member of the top Management about the same; the reply given was as follows. *"When the salary in the other Institute is not paid over a year; is it something wrong if it is not paid over here for a month?"* The word 'Dared' is used deliberately because raising one's voice against the Giant Management really requires so called *Courage.*

Moreover; *that marked the beginning of the Bad Era in the field of the Management when the bad Precedents were put forward as a defense in order to overcome very poor Financial Management on the part of the Institute.* Subsequently; *the Management Policy 'No Payment of Salary on Time' became a regular practice in the Management Institutions and of late; all the Professors are well accustomed with the Phenomenon as it is a common and standard practice right now.*

B. Professors' Future -
If the same position as regards different dominating and decisive factors like *Recruitment and Selection; Salary Structure; Working Conditions; Increments and Privileges; Incentives and Fringe Benefits; Incidental or Ancillary Facilities; Promotional Policies; Post Retirement Benefits* continues; the number of good Professors in the teaching field in general and the Management sphere in particular; would definitely erode over a period.

A person highly aspirant and passionate to teach would definitely search an alternate opportunity of career as *Monetary Orientation with Official and Social Status is an ultimate objective of the ninety five percent of the youngsters today.*

After evaluating the overall Official and Social Position of the Professors as on today; several senior Professors are advising the Junior Professors not to continue with the same profession. It may be an appropriate place to put on the record over here that many senior Professors are not recommending or encouraging the new comers to join the profession of teaching. In simple words; instead of motivating more youngsters to join the same profession; the youngsters are discouraged by highlighting different disadvantages of the profession. The history had revealed time and again that the young follow the old only when the young get good guidance and support from the old. Otherwise; they tend to change the field or the path. *The researcher finds the approach and attitude of the Senior Professors as fully considered; well balanced and sound because it is no wise to suggest an earning line; not lucrative in nature even in the long future.*

Moreover; the Professors presently doing well will; no doubt; advise the other way. At the same time; as an interesting observation; the proportionate percentage of such Professors is relatively very low. Besides; the 'Activities' they had indulged in; in order to reach at the existing position may be beyond the purview of the new comers. (Such activities may include malpractices of many kinds like giving bribe to the members of the Selection Committee and Approval Committee of the University; Lobbying; Pressurizing; Partiality; Favoritism; Red Tapism; etc.)

RESEARCH PAPER LIMITATIONS

Full intellectual concurrence with all the Views as well as Opinions; of the Researcher; expressed in the Research Paper and also of the other Respondents; interviewed for the purpose of the Research; is certainly not possible; thus; not expected also.

The Researcher has mentioned the figures of percentage wherever possible. However; in case of some parameters; the same was quite difficult; thus; it is not mentioned.

SCOPE FOR FUTURE RESEARCH

During the Course of the Study of this Research Paper, the Researcher found out that there is an ample Scope and Potential for Research in future for the following topic.

(a) Management's Role during Diversification

REFERENCE

1. Chakraborty S. K. Education in India: A Tree without Roots; Shastra Dharma Prachar Sabha; India; Kolkata; edn1; 2010.

Foot Note -

The detail description of different phases of Management Education is already done by the Researcher in another Research Paper titled; **'Recent Trends in Management Education – A Study'** Thus; here the same description is not repeated.

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OVERCONFIDENCE BIAS, FINANCE RISK TAKING ATTITUDE AND MUTUAL FUND INVESTMENT DECISION

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ABSTRACT
The mutual fund market is developing at an incredible pace. The main benefit of the mutual funds is expansion, professional administration and liquidity. The current study primarily intends to explore the impact of overconfidence bias and finance risk taking attitude on mutual fund investment decision. It also examines if the city in which a person resides moderates this relationship. Data has been collected from 223 respondents from the Indian state of Karnataka. Standard instruments have been used for quantitative primary data collection. Two cities namely Bengaluru and Mysuru have been targeted in this study. This research emphasized the strong relationship between overconfidence bias, financial risk taking attitude and mutual fund investment decision. The decision making patterns also varies depending upon the city in which the respondents are put up.

Keywords: investment, overconfidence bias, attitude, risk taking

1. INTRODUCTION

Mutual fund companies across the country launch new categories of schemes in a serious attempt to attract investors and increase assets or resources under management. The determination to launch a new category of fund or scheme is influenced by various factors, such as, investors' particular demand for the fund's qualities. Investors agree with and prefer mutual funds for some reasons. Primarily, changes in prospects of mutual fund functioning might encourage investors to transfer capital amongst their savings. Next, as it is possible in mutual funds to be traded on a daily basis (Bollen, 2007) investors might transfer investment in and out of them to tackle their liquidity demands. As emphasized by (Bollen 2007) female depositors are less inclined to an overconfidence bias in investment of mutual funds.

Investment in mutual fund schemes is usually influenced by the investors' attitude. The mutual fund is nothing but a professionally-handled and established cooperative investment scheme that collects money from a large number of investors. The profit expanded from investments is given to depositors corresponding to the total number of units literally hold by them. As a result, a mutual fund investment is the most right and proper investment tool for any individual investor since it provides a prospect to invest in a diversified, proficiently handled security measures at a relatively minimal cost. Desigan, et al (2006) carried out a out a research on investor's viewpoint with respect to women towards mutual fund investment and emphasized that women investor's fundamentally are faltering in investing as a result of different reasons such as poor knowledge regarding the investment security and their different procedures regarding investment processes, various risks etc. To the extent that the socio-economic factors are considered, age, gender, income and job (Subramanya and Murthy 2013) have been promoting the investors' attitude towards Mutual fund.

A mutual fund is a kind of investment tool which accumulates money from depositors who have a common goal in terms of financial source, and invest income in various resources such as, shares, bonds and so on. By and large, mutual fund is a financial mediator, start with a goal to proficiently handle the money collected from the vast number of investors. Investors could as well benefit from economies of scale and could buy stocks and bonds comparatively at extremely lower trading costs than that of direct investment in capital markets. Economies of scale from mutual funds are highly organized and deliver natural advantage. It is considered comparatively cheaper than investing directly in the large capital markets that entail high-level cost of charges. This as well increases retail investors' access to complex level markets, and as well there is a better control and management over costs. Research by Karnam and Nandan (2019) has shown that the majority of the family men will earn and largely approaches mutual funds; and the regions like India wherein females are subjugated by male are not allowed to choose mutual funds even if they have a common knowledge regarding the investment schemes.

Financial goals are generally based on number of factors, such as the age, financial independence, lifestyle, income, etc (Mishra and Kumar 2011). Mutual funds are considered a low-risk ways of investment in the complex capital market, but as well entailed a market risk. Risk orientation amongst depositors is extremely significant for choosing mutual fund schemes and their investment behavior. The risks related with finance are generally referred to as the volatility or instability of the proceeds created by the fund. The higher the variation

in the fund's profits over a certain period of time, the more the risks linked with the fund's income. Safety and risk diverseness are major concerns for investing in mutual fund schemes. Khurana and Panjwani (2010) emphasized that it is important for investors to understand the risks involved before investing in mutual fund. Research by Supriya (2019) specified that working class people in Bangalore are more attracted towards investments and the author also reported that safety and risk diversification are major concerns for investing in mutual funds.

The financial system gives the investors numerous investment alternative tools with unstable amounts of risks and return. Investment selection method entails finding various investments with some classified benefit characteristics and taking amongst them the one which goes well with the investment goal of the investors' return target and risk tolerance. Risk tolerance is more complicated since it integrates characteristics of risk-taking capability and readiness. Study by (Jain and Rawal 2012; Jain and Mandot 2012) found no relationship between gender and investors' investment decision and on the other hand Murugan (2012) exhibited that there is considerable relationship gender and investors' attitude towards mutual fund. An investor's capability to take on risk is reliant on different factors such as age, income, financial requirements etc (Kumar, 2016). Though, an investor's readiness to take risk is more psychological process, in which the investor's insight regarding the investment will define his/her investment preference.

An effective economic system must provide its shareholders various investment alternatives to go well with their investment goals. This integrates alternative tools with unstable maturities and risk, i.e. return characteristics. Mutual fund and its related schemes proffer diversification of risks. Das (2011) studied about perception of small investors on mutual funds and reported that various demographic factors of investor, particularly age, gender, and as well level of income have a strong effect on the preference of investment schemes. Kaur, et al (2013) carried out an investigation on investor's perception towards choosing mutual fund schemes and found that investors prefer mutual fund as stock market is considered complicated and risky. Prabhu and Vechalekar (2014) exhibited that age, income and return or profit etc. has effect on the mutual fund selection. Kaur and Arora (2018) reported that awareness and non-awareness level towards mutual fund schemes has greater effect on the investors' decision and as well perception.

The main reason for any individual to invest is to change his consumption design so as to accomplish greater levels of consumption in the near future. Investors' age factor is considered to be the fundamental factor in satisfaction in terms of the self-development relating to return from the investment (Ravi and Mathivanan 2015). The perception of people towards investment differs with their age, academic qualification, income, etc. As stated by Ravi and Mathivanan (2015) the solution to a profitable financial plan is to protect a considerable amount of funds and ultimately invest it effectively, by considering a long duration.

As the future is ambiguous, every investment entails the aspect of risk. This risk is probability of variation in predictable and actual returns. It has the chances of losing some or whole amounts of investment. The motivating force for selecting mutual fund is the security of invested amount, in addition to the added benefit provided by various schemes. However, perception differs according to the demands and demographic variables of investors (Deo and Jagtap 2017). Geethaa and Vimala (2014) found a positive relationship between demographic variables and investment preference with different risk-taking capability. Dhiraj et.al (2012) reported no relationship among variables such as marital status, gender, age, and career of the investors' and also strong relationship found between place of living, income level and awareness level of the investors in various schemes. Akbar et.al (2013) expressed that the investor's perception is completely based on the demographic profiles and variables such as age factor, marital position and level of education has direct influence on the investors' preference towards investment. Deo and Jagtap (2017) opined that the perception might significantly influence behavioral bias of depositors.

2. LITERATURE REVIEW

2.1 Introduction
In India Behavioral Finance is a new field and various factors that literally impact the decision of investors are explored by researchers for creating awareness among the individuals through research articles. Investors take decisions while investing in mutual funds. If the decision is appropriate the returns will be good, but if the investors take decisions by overlooking the risks associated the investment due to overconfidence or lack of financial knowledge it might result in loss or unpleasant situation. Hence in this study a conceptual model has been developed to find the overall effect of overconfidence bias, financial risk-taking attitude and financial literacy on the mutual fund investment decisions. The demographic variables of the investors like age, gender,

income level and city are also chosen to check whether they are influencing the decisions related to mutual fund.

2.2 Meaning and Definition of Opportunity Bias

Overconfidence bias is one of the most explored factors by the existing studies in the aspect of financial investment decision-making. Basically, the term overconfidence is used to represent deviations from rational behavior. Psychologists had demonstrated that overconfidence bias can influence the decision making of the investors. Pompian (2012) has defined overconfidence as a belief of the individuals that they have the ability, rational reasoning and intellectuality to predict the results accurately.

Taylor and Brown (1988) developed three tools that are commonly associated with positive illusions namely Better than average effect, Illusion of control and unrealistic optimism.

(i) Better than average effect: The inclination of the individuals to recognize their knowledge and abilities to more superior when compared to others (Guenther, and Alicke, 2010).

(ii) Illusion of control: The overestimation of the people that they can handle undesirable outcomes (Yarritu et al, 2014).

(iii) Unrealistic optimism: It refers to the underestimating the occurrence of negative events and overestimating the occurrence of positive events (Weinstein and Klein, 1996) by the individuals during the process of decision making.

2.3 Meaning and Definition of Financial Risk Taking Attitude

The attitude of investors towards risk taking is considered to be one of the most important factors contributes positively or negatively to financial decision making process. In behavioral finance risk is component of subjective nature, which is determined by evaluating the beliefs, attitudes and feelings towards a particular event (Ricciardi, 2007).

According to Lampenius and Zickar (2005) the following are the two dimensions of financial risk-taking behavior: That is, Risk Control and Speculative Risk. These two dimensions are used as a part of this study to measure the risk-taking attitude of investors.

Risk Control: It refers to the degree to which the individual is inclined towards aversion of risk. The individual weighs the pros and cons before taking risk. They tend to think that higher the risk higher will be its consequences hence this influences their decision making. These individuals are generally termed as risk averse individuals due to their aversion towards risk taking. Due to their risk control behavior they plan well ahead to accomplish their investment goals in a successful way (Zaleskiewicz, 2001).

Speculative Risk – The term speculative risk denotes the tendency of the individual investors to take more risks during investment decisions. They tend to take risk even if there is no proper information about loss or gain. Basically, it describes the gambling behavior of the individual that is the temptation of the individual to take more risk in order to get more returns. The characteristic of speculative risk is the existence of uncertainty in the event which can either result is profit or loss (Ferrer et al, 2011)

2.4 Review on the Impact of Opportunity Bias on Investment Decision Making

Lambert et al (2012) has measured and compared the impact of overconfidence on decision making among students and bankers. Overconfidence is measured based on first two dimensions. Their result showed when compared with students, bankers are influenced by overconfidence and their decision making is as well get influenced and their decision making is also influenced by overconfidence.

Bakar and Yi (2016) explored the role of various biases such as overconfidence, conservatism and their overall effect on the decision-making process of investors. They findings reported that all the mentioned biases in this study have an effect on investor's decision-making process except one factor, i.e. herding bias. The authors had also stated that gender difference also have impacts on the investment decision making.

A study conducted by Pikulina et al (2017) explored how the level of confidence of individuals impacts the decision to invest. The authors have mentioned that there is a direct relationship between overconfidence and decision making of investors. Their results show that strong overconfidence will possibly result in excessive level of investment while low self-confidence results in underinvestment. Hence both overconfidence and under-confidence may cause the investor to make suboptimal investment decisions. One of the notable findings of this paper is that moderate level of overconfidence is considered to be an advantage since it results in appropriate investment decision.

Mahalakshmi and Anuradha (2018) analysed the impact of behavioral factors like overconfidence, familiarity level and as well anchoring bias on the investor's decision making. The conceptual model shows that overconfidence has influence over the investor's decisions. The authors suggested that better investment decisions can be achieved by financial advisors by framing strategies by considering the factors that influence the decision of investors.

Table 2.1: Review on the Impact of Opportunity Bias on Investment Decision Making

S.No	Author and Year	Description
1	Lambert et al (2012)	Measured and compared the impact of overconfidence on decision making among students and bankers and found that overconfidence of bankers has an impact on decision making.
2	Bakar and Yi (2016)	Examined the impact of various biases and found that all the mentioned biases including overconfidence bias have an effect on investor's decision making.
3	Pikulina et al (2017)	Explored how the level of confidence of individuals impacts the decision to invest. The authors have mentioned that there is a direct relationship between overconfidence and decision making of investors
4	Mahalakshmi, and Anuradha (2018)	Analysed the impact of behavioral factors like overconfidence, and anchoring bias on the investor's decision-making. The conceptual model shows that overconfidence has influence over the investor's decisions.

2.5 Review on the Impact of Financial Risk Taking Attitude on Investment Decision Making

A study conducted by Chavali and Mohanraj (2016) investigated the investment pattern and individuals' decision-making and their risk tolerance. The authors had also examined the overall impact of demographic characteristics on investment pattern and investment decisions of individuals. The results showed that both risk tolerance and demographic variables influence the investment pattern and investment decision making of individuals.

Nguyen et al (2017) explored the impact of risk can be assessed by measuring both risk tolerance and as well risk perception. From the analysis it is found that risk tolerance is found to influence decision making and this relationship is intervened by risk perception. Risk seekers perceive investment as less risky; they overestimate positive outcomes and allocate more funds when compared to risk avoiders who estimate the risks, they overestimate negative outcomes and allocate lesser funds.

Table 2.2: Review on the impact of financial risk taking attitude on investment decision making

S.No	Author and Year	Description
1	Hyll and Irrek, (2015)	Examined whether decisions are influenced by risk attitudes of the investors and showed that individuals with high risk-taking attitude tend to invest more.
2	Chavali and Mohanraj (2016)	Investigated the impact of risk tolerance level and as well demographic characteristics on investment pattern and financial decision making of individuals and this relationship is confirmed through empirical analysis.
3	Nguyen et al, (2017)	Explored the impact of risk aspects on the decision-making process in terms of investment. From the analysis it is found that risk tolerance is found to influence decision making and this relationship is intervened by risk perception.

2.6 RESEARCH GAP

Investment decision making is obviously a complex and complicated process due to availability of various investment choices and ease of access of information from several sources. Hardly studies can be found that dealt with city of residence and mutual fund investment decision. Hence, this study bridges the gap and carried out in order to explore investors' decision making with special reference to Bangalore and Mysuru city. The study fill the gap, i.e. to identify the reasons about why the investors behave in a certain way with respect to the investment decisions and what influences them do so. Hence in this study after exploring the previous researchers models three variables namely overconfidence bias, risk taking attitude and financial literacy is selected and a conceptual model was created and analysis is being performed to verify the model empirically. The impact of demographical variables is also tested in this study.

2.7 Conceptual Framework and Hypothesis

The following figure Fig 1 shows the conceptual model formulated for this study. The conceptual model is created after going through previous studies in which the variables under the study are analysed. The definition and the relationship among the chosen variables have been discussed in the previous sections.
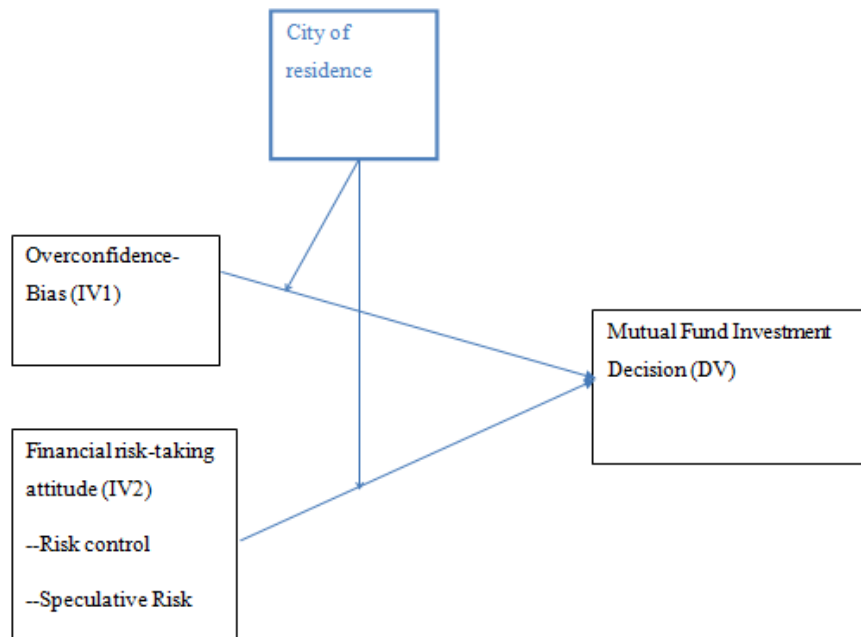
Fig 2.1: Conceptual Model
Source: Author

Hypothesis

The following are the hypotheses are to be tested in this study.

1. **H1:** The overconfidence bias of the investors has an impact on the decisions made by them in mutual fund investments.

2. **H2:** The financial risk-taking attitude of the investors has an impact on the decisions made by them in mutual fund investments.

3. **H3:** The mutual fund investor's behavior of the two groups in Bengaluru and Mysuru City are significantly different.

3. RESEARCH METHODOLOGY

This research adapts quantitative approach and descriptive research design. The sample population are the local public who have invested in mutual funds. 223 people from Bengaluru and Mysuru city of the Indian state of Karnataka have been surveyed using standard instruments. Cluster sampling has been adapted in this research. Overconfidence bias is measured using a 7 item scale proposed by Gill et al (2018). Financial risk taking is measured using two tools, i.e. Speculative risk and Risk control. Risk control is measured using 6 items and speculative risk is measured using 6 items. The research instrument is a modified version of the scale proposed by Lampenius and Zickar (2005). The version modified by Sahi et al (year) in order to suit the Indian context has been adapted in this research. Investment decision making in mutual funds is measured by a 14 item scale proposed by Pacewark and Relay (2009). All the instruments used a Five Point Likert scale with options varying from strongly agree to strongly disagree for the respondents to answer. The city was measured using two options Bengaluru and Mysuru which were the target places of study in the Karnataka region of the Indian nation. SPSS has been used to analyse the quantitative data statistically. Multiple Linear Regression and T Test have been applied in this research. The research has been done adhering to ethical guidelines.

4. RESULTS OF THE ANALYSIS

Total of 223 respondents have been included in the study. The test of hypothesis results is presented as follows.

Hypothesis 1

H1: The overconfidence bias of the investors has an impact on the decisions made by them in mutual fund investments

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.998[a]	.997	.997	.43859	.997	14106.910	5	217	.000
a. Predictors: (Constant), FBTOT, FLTOT, SRTOT, RRTOT									
b. Dependent Variable: MFTOT									

The model summary table gives the R Value, R square value and the adjusted R Square value, in this model the R value is found to be .998 and adjusted R square value is .997 and R Square value is found to be. 997. This gives the best fit to the model.

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	13568.248	5	2713.650	14106.910	.000[b]
	Residual	41.743	217	.192		
	Total	13609.991	222			
a. Dependent Variable: MFTOT						
b. Predictors: (Constant), FBTOT, FLTOT, SRTOT, RRTOT						

Anova is found to be Significant.

Hypothesis 2
H2: The financial risk-taking attitude of the investors has an impact on the decisions made by them in mutual fund investments

Model Summary[b]

Model	R	R Square	Adjs. R Square	Std. Error of the Estimate Value	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.988[a]	.987	.987	.43859	.987	14106.910	5	217	.000
a. Predictors: (Constant), FBTOT, FLTOT, SRTOT, RRTOT									
b. Dependent Variable: MFTOT									

The model summary table gives the R Value R square value and the adjusted R Square value, in this model the obtained R value is .998 and adjusted R square value is .997 respectively and R Square value is found to be. 987.This gives the best fit to the model

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13568.248	5	2713.650	14106.910	.000[b]
	Residual	41.743	217	.192		
	Total	13609.991	222			
a. Dependent Variable: MFTOT						
b. Predictors: (Constant), FBTOT, FLTOT, SRTOT, RRTOT						

Anova is found to be Significant

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.025	.220		.113	.000
	RRTOT	.025	.018	.014	1.335	.003
	SRTOT	1.002	.009	.590	117.371	.000
	FLTOT	-.069	.035	-.021	-1.976	.004
	FBTOT	.998	.015	.466	68.098	.000
a. Dependent Variable: MFTOT						

H3: The mutual fund investor's behavior of the two groups in Bengaluru and Mysuru City are significantly different.

T-Test

Group Statistical Values					
	City	N	Mean	Std. Deviation	Std. Error Mean
MFTOT	Bangalore	92	52.2500	8.73621	.91081
	Mysuru	131	51.9389	7.15730	.62534

Independent Sample Test									
		Levene's Test for Equal Variances		t-test value for Equality of Variances					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MFTOT	Equal variances assumed	1.362	.245	.291	221	.771	.31107	1.06726	-1.79225	2.41439
	Equal variances not assumed			.282	170.493	.779	.31107	1.10482	-1.86982	2.49196

The findings of Levene's Test for Equality of Variances (Homogenisity) reports that significant value, i.e. 0.245 which essentially denotes that both groups are homogeneous group. Here, the mean value obtained for Bangalore is 52.50 and Mysuru is 51.938 respectively. The difference between the two obtained value is .562 which is insignificant. The result of SPSS shows that the significant value is .245, which is is greater than 0.05 hence accept alternate hypothesis. Hence the findings reported that there is significant difference between the two means mutual fund investor's behavior of the two groups in Bengaluru and Mysuru City. The statistical values of the study accepted the hypothesis, i.e. the relationship found between overconfidence and mutual fund investment decision making and the mutual fund investor's behavior of the two groups in Bengaluru and Mysuru City are significantly different.

S.No	Hypothesis	Accepted/Rejected
1	H1: The overconfidence bias of the investors has an impact on the decisions made by them in mutual fund investments.	Accepted
2	H2: The financial risk-taking attitude of the investors has an impact on the decisions made by them in mutual fund investments.	Accepted
3	H3: The mutual fund investor's behaviour of the two groups in Bengaluru and Mysuru City are significantly different.	Accepted

5. DISCUSSION AND CONCLUSION

The mutual fund industry is found to be one of the fastest growing investment markets. Investors are highly preferring mutual fund industry as comparatively the risk is low than that of other sources of investment. It is more accessible to the individual investors as the funds never get capitalized in one division but gets expanded to many divisions. This financial expansion takes place in a professional way. This research paper paid attention to financial risk taking attitude that highlights investor's risk control behavior towards mutual fund. The study of the research is on overconfidence bias towards mutual funds. These days, how an individual handles his finance has become a matter of great concern. It is no longer about overseeing their temporary financial affairs such as how much to save and spend on a holiday, but, it's about long-standing prospects for example: how to retain the same level of affluence even after their retirement days, how much their investment must return to nullify the impact of inflation, how the eventualities in their life, such as medical emergencies, will be handled, and many more. It was reported that investment decisions of an investor are largely impacted by number of factors such as overconfidence bias, risk-taking and risk control and as well on demographic variables amongst many others (Baruah, et al 2018). 223 respondents have been chosen from the two cities, i.e. Bengaluru and Mysuru City. Investors' behavior of the two groups has been examined in detail. The extent to which risk control and overconfidence bias and interrelated behavioral qualities for example excessive pride might have any effect on financial performance is examined. A mutual fund business is to finance the funds therefore collected in line with the desires of the investors who formed the pool. Investing in financial sector in recent

period has become widespread not only amongst organizational but as well individual investors. But what makes them retain in the market is their risk-taking or risk-control behavior and overconfidence bias. Overconfidence individuals overvalue their abilities, their knowledge towards information which leads them to wrong decision-making. They might become more confident about the optimistic effect of their decision and as well make narrow range future estimations. Overconfidence bias might emerge from optimism, affirmation and delusion of control biases. Many researches have been carried out to investigate the influence of increased pride or overconfidence bias in investment market. Kufepaksi (2007) carried out the research and reported that overconfidence bias results in wrong decision wherein investors make wrong prediction. Eshraghi and Taffler (2012) carried out the research to explore the effect of mutual fund investors' overconfidence bias on their overall investment performance. They emphasized that the previous good performance results in overconfidence and this overconfidence might lead to unnecessary trading together with the lessened future returns. In terms of risk-taking behavior, it was emphasized that women show less risk taking than their opposite counterparts in their most risky investment decisions. The current study reported a positive relationship between financial risk taking attitude and mutual fund investment decision, which is similar to the study done by Baruah, et al (2018) and Sudarmathi, et al (2017). The general assumption is that female investors prefer less risky portfolios compared to male investors which imply that women have a stronger aversion on taking financial risks (Singh and Yadav 2016). Risk is an essential trait of all kinds of financial investments as a result of the difference occur in the real and expected returns from the investment they made. There is a probability for any investor to experience the less return on an investment than the predicted amount in real case. Mutual fund market has been exposed to speculations and ineffectiveness, which are literally bleached to the consistencies of the investors. The study reported that there is a significant difference between the two means mutual fund investor's behavior of the two groups in Bengaluru and Mysuru City.

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SEISMIC GROUND MOTION ASSESSMENT AROUND DURG REGION OF CHHATTISGARH (INDIA)

ASHISH KUMAR PARASHAR

ABSTRACT

These instructions give you guidelines for preparing papers for In this study, the past tectonic earthquake records were observed for the study area and peak ground acceleration was calculated using DSHA method. This study quantifies seismic hazard, using a deterministic framework for Durg district headquarter and Tandula dam of Chhattisgarh. The seismic investigation is performed in the seismic control region over a radius of 300 kms. Then the seismotectonic map was prepared by compiling the earthquake data from 1846 – 2015. The present study then applied completeness test over the above collected earthquake data. The seismic parameters a and b values are calculated and regional recurrence relationship has been developed. The well known attenuation model for peninsular India is considered for estimating the ground motion uniqueness at the bedrock level. The maximum PGA (g) values for Durg district headquarter and Tandula dam is obtained for 84 percentile as 0.09757g, and 0.07973 g. The results obtained in the present study will be useful for preparing hazard index maps of the study area and designing seismic resistant structures.

Keywords: Dam, Deterministic Seismic Hazard Analysis, Seismic Sources, Seismic Parameters Seismicity, Peak Ground Acceleration.

1. INTRODUCTION

The present study area is Durg region, which is an important district headquarter of Chhattisgarh, as it is a business center of the state. Tandula Dam is located at about 61 km from Durg district headquarter as shown in Figure 1.

Figure 1: Location of Study Area

Dam is constructed over the Tandula River which stores water from a catchment area of 827.2 square kilometres. The gross storage capacity of a reservoir is 302.31 million cubic metres and the highest flood level is found to be 333.415 metres. The Dam provides drinking water to Durg & Bhilai (twin city) Nagar Nigam area and caters to the entire industrial requirement of the existing Bhilai Steel Plant. As Durg district is a business hub of the state, so major Government and private construction projects are continuously at boom there. It is noteworthy that, earthquake occurrence and its frequency is increasing day by day throughout the world. In past scenario the earthquake occurrence is also seen to be augmented in India. Thus the Present study is focused on, seismic hazard analysis around Durg region. For seismic hazard analysis, it is essential to understand the processes by which earthquake occurs and their effects on ground motion. Earthquake is an incident of ground shaking, usually caused by the rupturing of a fault within the earth. In other way the earthquake is defined as unpredictable natural phenomenon of vibration of the ground. It becomes one of the most devastating natural hazard when it is considered in relation with structures [1]. The earthquake has begun to become a problem for humans and built structures since they have started. The deaths and the damage to the buildings are cause due to earthquake. Most earthquakes occur at plate margins due to tension, compression or shearing forces. Rocks at plate margins are in constant motion and are being pushed, pulled, bent, twisted and folded. Inevitably at some point they must break or crack to produce FAULTS!! Locally, the movement between two portions of the crust will occur on new or pre-existing offsets in the geologic structure of the crust known as faults [Figure 2].
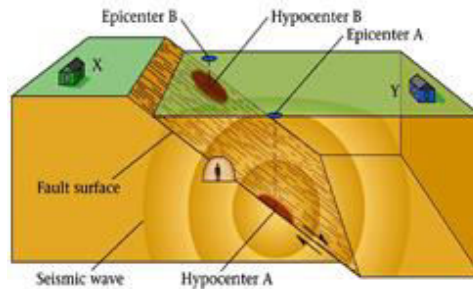
Figure 2: Normal Fault

The lack of observable surficial faulting, on the other hand, does not imply that earthquakes cannot occur; in fact, fault rupture does not reach the earth's surface in most earthquakes.

For seismic hazard analysis few words and its meaning needs to be understood accurately. Essential and important words used in analysis are defined as below:

Active Fault: A fault that may produce an earthquake within a specified exposure time, given the assumptions adopted for a specific seismic-risk analysis.

Design Earthquake: A specification of the seismic ground motion at a site; used for the earthquake resistant design of a structure [2].

Epicenter– The point on Earth's surface that is directly above where an earthquake starts underground.

Focus or Hypocenter: Actual location of the earthquake at depth.

Focal Depth: Distance of focus from Earth's surface

Fault Plane: The plane along which the rock or crustal material has fractured.

Return Period: For ground shaking, return period denotes the average period of time or recurrence interval between events causing ground shaking that exceeds a particular level at a site; the reciprocal of annual probability of exceedence.

2. LITERATURE REVIEW

For precise seismic hazard analysis of a study area, the knowledge of plate-tectonic and location of seismic sources and characteristics is required. To enhance the knowledge and acquire the innovative techniques in the present research, the past literature and pioneer contribution of various seismologist and researchers play a vital role.

Gutenberg and Richter (1944), tried to revise the frequency of destructive shocks in California as it was based on the imperfect historical records. He made a comparison of earthquake frequency of California with that of the whole world [3]. He was the one who stated that, the difference between the larger and the smaller shocks should be based on the instrumental records and not based on the destructive effects. To compute this, he used instrumental magnitude scale which, originally was set up for California and then was extended, to shocks in all parts of the world. In 1954 Gutenberg and Richter presented a Logarithmic relationship for seismic hazard analysis.

$$Log\ N = a - b \times M --------(1)$$

Where; N=number of earthquakes, M=magnitude, and a and b are constants.

Parvez et al. (2003) were the first ones to use a deterministic approach, based on the computation of synthetic seismograms, used for preparing seismic hazard maps for the territory of India and the adjacent areas. The seismic hazard, expressed in terms of maximum displacement (D_{max}), maximum velocity (V_{max}), and Design Ground Acceleration (DGA), had been extracted from the synthetic signals and mapped on a regular grid over the studied territory [4].

Sitharam et al. (2010), performed seismic hazard analysis of India (6°–38°N and 68°–98°E) with deterministic approach, using logic tree method with different source models and attenuation relations thus developing the seismotectonic maps of the study area. They divided the study area into small grids, size 0.1° × 0.1° and the hazard parameters were calculated at the centre of each grid by considering all the sources within the radius of 300 kms. The Peak Ground Acceleration (PGA), at surface level was calculated for entire India, for four different site classes [5].

Puri and Jain (2016), have identified 12 seismogenic sources in the seismic study area Haryana and used deterministic seismic hazard analysis approach. The maximum magnitude has been assigned to each seismogenic source considering regional rupture character. Ground motion prediction equation developed for Indo- Gangetic region by National Disaster Management Authority of India has been used [6]. The peak ground acceleration along with response spectrum for the sites have been estimated using DSHA method. The estimated strong ground motion parameters and also have been compared with the values given in Indian Standard for criteria for earthquake resistant design of structures to validate them for further practical use.

Seal et al. (2017), have used the Deterministic Seismic Hazard Analysis of Mawphu Dam Project located at Meghalaya, India. The data of earthquake occurrences in the region for the time period from the year 1822 to the year 2016 were used during the analysis [7]. Total 18 tremor sources were acknowledged within a radius of 300 Kms from the site. The peak horizontal accelerations from different tremor sources surrounding the study region are evaluated using an attenuation model designed for this region. It is observed that the study region is vulnerable of encountering a maximum acceleration 1.07 g from the Dauki fault, a 305 Km long fault line which is at a minimum distance of 15 Km from the project site for a maximum magnitude of 7.1 Mw.

Somerville et al. (2017), have drafted ANCOLD Guidelines for Design of Dams and Appurtenant Structures for Earthquake identify that active faults (with movement in the last 11,000 to 35,000 years) and neotectonic faults (with movement in the current crustal stress regime, in the past 5 to 10 million years) which could significantly contribute to the ground motion for the dam and be accounted for in the seismic hazard assessment [8]. The purpose of this study was to give guidance on the conditions under which these contributions could be significant in a deterministic seismic hazard analysis (DSHA). They have consider five primary conditions under which identified faults can contribute significantly to the hazard

Anbazhagan and Abraham (2020), have carried out Region-specific seismic hazard analysis for Krishna Raja Sagara Dam site in Karnataka, India. Seismic event data and seismic source data within a 500 km radius were collected. Deterministic seismic hazard analysis was conducted for different methods of earthquake magnitude and location estimation [9]. Based on this study, the greatest median ground motion at the dam site is estimated as 0.43 g and the ground motion required to be tolerated without catastrophic failure was considered as 0.11 g.

Sinha and Sarkar (**2020)** have been developed seismic hazard map of Dhanbad City for the bedrock level following the deterministic approach. In view of the absence of the region-specific Ground Motion Prediction Equations, the concept of logic tree comprising four different attenuation models is adopted [10]. It was observed that the Peak Ground Acceleration in the range of 0.10–0.26 g could be expected in the city. Specifically, southern blocks of the city such as Baghmara, Jharia and Baliapur are found to be most vulnerable to the seismic hazard.

Tosun (2020), has applied the seismic hazard for the dam site and it is based on the peak ground acceleration. The total risk analysis is depending on the seismic hazard rating of dam site and risk rating of the structure has concluded that most of these large dams have high-risk class for the metropolitan area. This study summarizes the methods considered for earthquake safety evaluation and introduces the results of a study, which was performed for the large dams, namely Berdan, Catalan, Seyhan, Sanibey and Nergizlik dams in Lower Seyhan basin [11].

Mehta and Thaker (2020) have considered the seismic scenario of the peninsular India which has been changed due to many devastating earthquakes in the past few decades [12]. The present study discusses the hazard analysis with deterministic and probabilistic approaches for Vadodara region. Homogeneous seismic catalogue had been prepared covering the longitude 68° E to 77° E and latitude 18° N to 26° N for the study region and seismotectonic model had been developed for the different moment magnitude range of the earthquake events. Four ground motion prediction relationships have been used to evaluate the peak ground acceleration value at rock level for the Vadodara region.

Rao and Choudhury (2021) have used a deterministic framework for the northwestern part of India, where a new nuclear power plant (NPP) is going to be built in the near future. The region of interest is situated about 200 km from the Himalayan thrust, home of many great earthquakes including the 1897 Shillong, 1905 Kangra, 1934 Bihar–Nepal, 1950 Arunachal Pradesh, and 2011 Sikkim events [13]. This region has also witnessed six intraplate earthquakes of magnitude greater than 6 in the past two centuries. The captured earthquake hazard for three earthquake situations reveals different seismicity levels of sources from low to high using the logic tree approach. The maximum PGA for the three respective scenarios is obtained as 0.088 g, 0.110 g, and 0.151 g.

3. METHODOLOGY

The seismic hazard analysis has been done deterministically and probabilistically. The present study is confined over deterministic approach and selecting area around Durg district headquarter, which includes major dam site of Tandula. Deterministic approach includes following steps as illustrated in Figure 3.
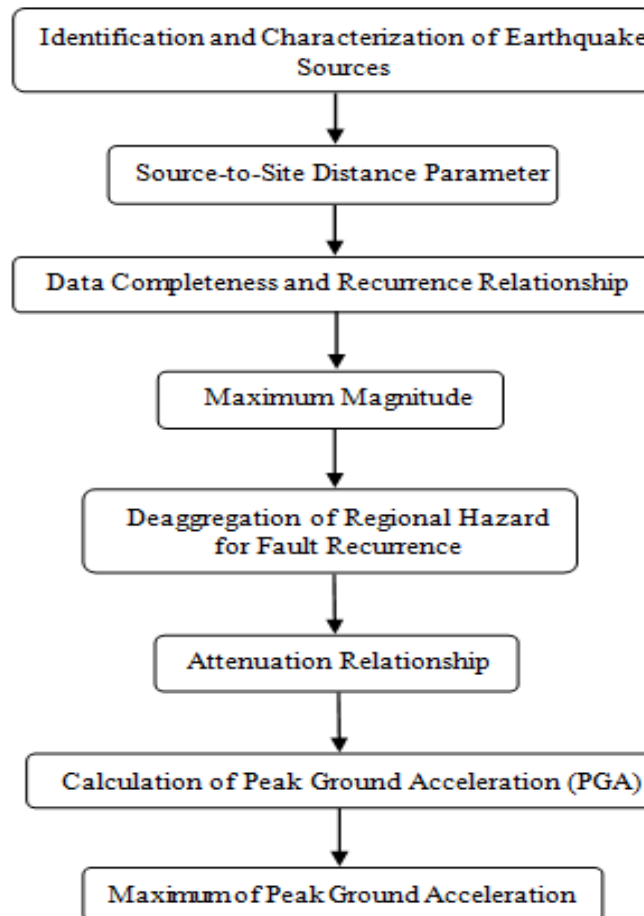
Figure 3: Flow Chart of Deterministic Approach

3.1 Identification and Characterization of Earthquake Sources

Seismotectonic Atlas, developed by Survey of India (SEISAT 2000) [14] was taken as the base, to identify the faults for district headquarter Durg and Tandula Dam.
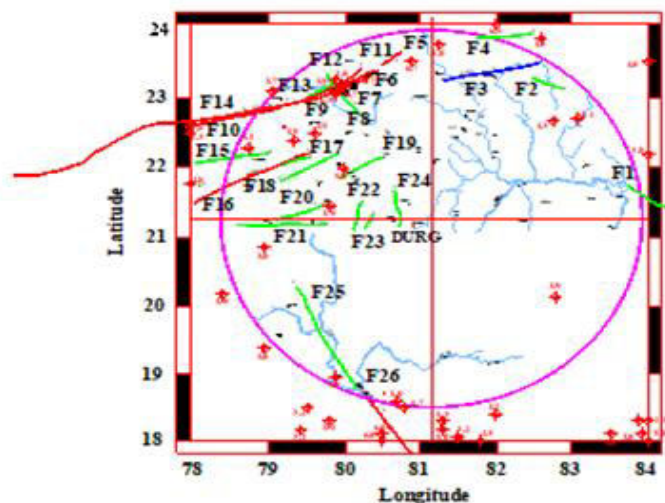
(a) Durg
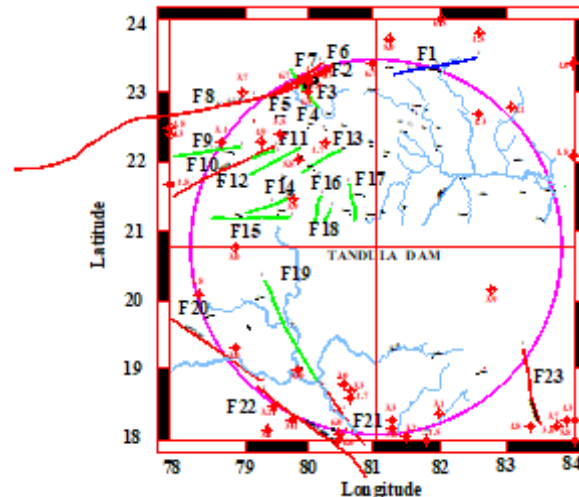
(b) Tandula Dam
Figure 4: Seismotectonic Map of Durg District and Tandula Dam of Chhattisgarh

Keeping the headquarter and dam at the center of the circle, having a radius of 300 kms, all probable faults having fault length (Li) ≥ 25 km were identified and numbered. Then the Seismotectonic Maps [15], prepared for district headquarter and dam are shown in Figure 4 (a) & (b). Around 26 numbers of faults for Durg district and 23 numbers of faults for Tandula dam were marked. A list of key faults is given in Table 3, describing the length of the faults and minimum map distances of the key faults. The de-clustered, earthquake catalogue data spanning a time period of 1846–2015 for earthquake magnitude M ≥ 3.0 were used for study.

3.2 Data Completeness and Recurrence Relationship

The seismic parameters are the essential part of hazard analysis. Using seismic parameters a regional recurrence relationship has been developed for the region. The seismic parameter "b" value, assess the frequency of the occurrence of earthquakes of different sizes. For estimation of seismic parameter b value the first method, Linear Least-Square Fit method developed by Stepp (1972)[16] has been applied over the past earthquake data collected for district headquarter Durg and Tandula Dam, from various catalogue and research agencies (USGS).
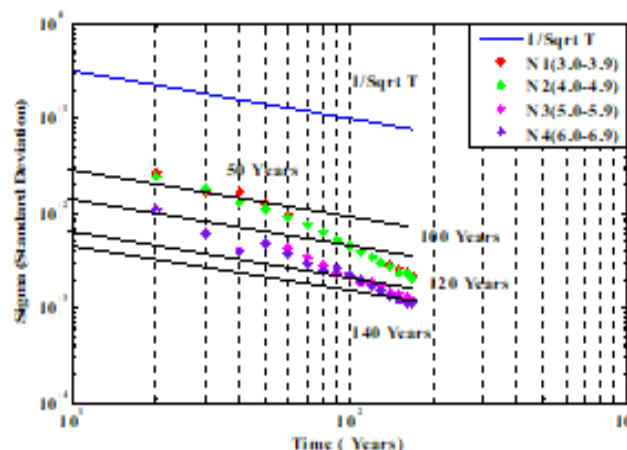
Figure 5: Completeness Analysis of Earthquake Data for

Durg District and Tandula Dam of Chhattisgarh

Table 1: Activity Rate and Interval of Completeness for Durg District and Tandula Dam of Chhattisgarh

Study Area	Magnitude Mw	No of Events ≥ Mw Mw	Complete in interval (year)	No. of Events per year ≥ Mw
Durg District and Tandula Dam	3	58	50	1.1600
	4	34	100	0.3400
	5	13	120	0.1084
	6	6	140	0.0429

After checking the completeness of the data, the values in the Table 1 were used to plot the graphs for study area which is based on distribution of past earthquake in Time intervals for four magnitude classes (N1 to N4) as shown from Figure 5.
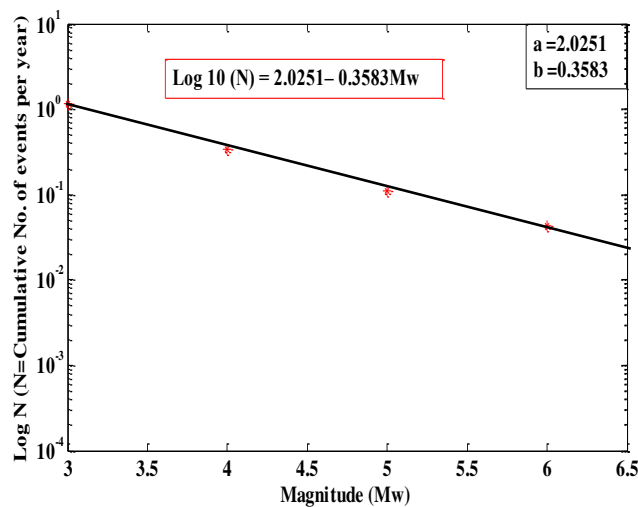
Figure 6: Recurrence Relationship for Durg District and Tandula Dam of Chhattisgarh

The outcome of Stepp (1972), gives a recurrence relationship for the study area and as given below:

Log $_{10}$(N) = 2.0251-0.3583Mw--------(2)

Where; N=number of earthquakes, Mw = Moment magnitude, and seismic parameters as, a= 2.0251 and b = 0.3583[From Figure 6]

3.3 Maximum Magnitude
In hazard analysis, the acquaintance of estimating the maximum magnitude is essential and used as one of the key input parameters in the seismic design. The maximum magnitude (M_{ma}) is an upper limit or the largest possible earthquake that may produce the highest seismic hazard scenarios of the region. For estimation of M_{max} two methods were used (1) Method of Wells and Coppersmith (1994) [17] and (2) Method of Gupta (2002) [18]. In Wells and Coppersmith (1994) method a relation between M_w and surface rupture length (SRL) is used.

Log (SRL) = 0.57Mw − 2.33---------(3)

Gupta's method (2002) was applied to estimate M_{max} by equation given as below:

$M_{max}= M_{obs}+0.5$ ------------------(4)

Mmax(M)= Maximum Magnitude

M_{obs} = Moment Magnitude

After comparing the outcome of the two methods, maximum magnitude (M_{max}) values have been tabulated in **Appendix -A Table 1**(a) & (b).

3.5 Deaggregation of Regional Hazard for Fault Recurrence
The truncated exponential recurrence relationship is commonly used in practice. For calculation of PGA values it is essential to estimate the most likely earthquake magnitude and the most likely source-site-distance [19]. This process of Deaggregation requires, the mean annual rate of exceedance (λ_m), expressed as a function of magnitude. A MATLAB computer program has been developed to solve the equation 5 and the graphs were plotted as shown in Figure 7 (a) & (b). The estimated M_{100} values were further used for calculation of PGA values.

$$\lambda_m = w_i * \upsilon * \frac{\exp[-\beta(m-m_0) - \exp[-\beta(m_{max}-m_0)]}{1-\exp[-\beta(m_{max}-m_0)]}$$

------------(5)

Where $\upsilon = \exp(\alpha - \beta * m_0)$ α=2.303*a, β=2.303*b and wi, is weight factor for a particular source.
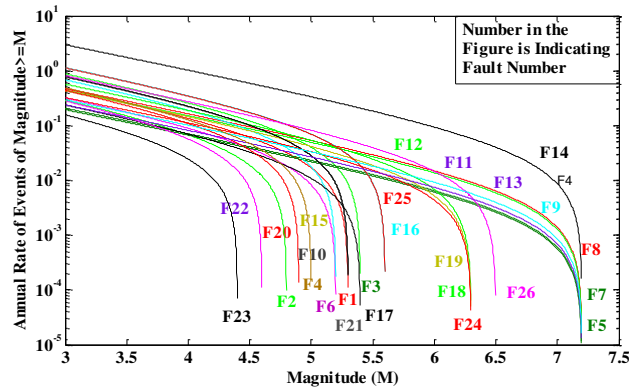
(a) Durg
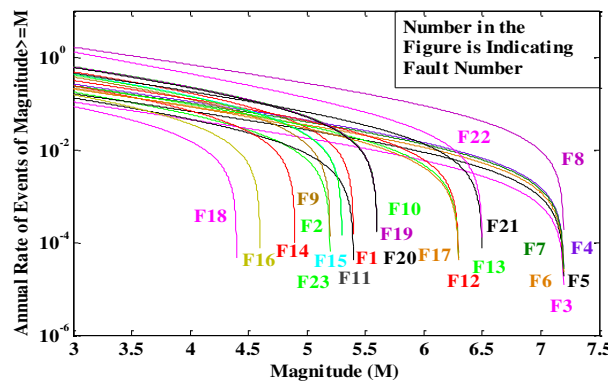
(b) Tandula Dam

Figure 7: Deaggregation of Seismic Sources near Durg District and Tandula Dam of Chhattisgarh

3.4 Attenuation Relationship

Earthquakes in India occur in the plate-boundary region of the Himalayas as well as in the intraplate region of peninsular India (PI). Devastating events have occurred in PI in the recent past, which is a warning about the possibility of such earthquakes in the future. But very limited recorded data are available about ground motion in PI for engineers to rely upon. Thus in the present study, after reviewing the available data, an attenuation relationship proposed for Peninsular India by Iyengar and Raghu Kanth (2004)[20], was used to estimate PGA, under bed rock condition.

$$\ln Y = C1 + C2\,(M\text{-}6) + C3(M\text{-}6)^2 - \ln(R) - C4(R) + \ln(\varepsilon)$$

---------(6)

where Y, M, and R refer to PGA(g), moment magnitude, and hypocentral distance, respectively

Peninsular India: C1= 1.6858;   C2= 0.9241; C3= -0.0760;

C4= 0.0057;

σ (ln ε) = Standard Deviation of Error =0

[50 Percentile, for DSHA ε = 0]

σ (ln ε) = Standard Deviation of Error =0.4648

[84 Percentile]

M100 = Magnitude of Earthquake

[100 years Reccurance - Period]

R = Hypo-central Distance = $\sqrt{(d2+F2)}$ [21]

d= Shortest distance from the site to the fault, F= Focal Depth

3.6 Calculation of Peak Ground Acceleration (PGA)

Further a computer programme has been developed in excel for finding out attenuation relationship, by Iyengar and Raghu Kanth (2004), and this is again used for estimation of peak ground acceleration for study area. For estimation of PGA (g), Twenty six & Twenty three number of linear seismic sources are used for Durg district headquarter and Tandula dam respectively. Estimated PGA (g) values for study are tabulated in **Appendix-B**, **Table 2** (a) & (b).

Study Area	Fault No.	Fault Length (Li) in km	Hypo Central Distance (R) in km	PGA (g) 50 Percentile	PGA (g) 84 Percentile
g District	F24	58	49.122	0.06130	0.09757
Tandula Dam	F17	58	57.736	0.05009	0.07973

3.7 Maximum of Peak Ground Acceleration

For the design of seismic resistant Civil Engineering vital structures, it is indispensable to know the maximum peak ground acceleration. In Twenty six & Twenty three numbers of linear seismic sources the fault no F24 and fault no F17 were found to produce maximum peak ground acceleration for 50 & 64 percentile respectively for district headquarter Durg and Tandula dam. The maximum PGA (g) values are tabulated in the Table 2.

Table 2: PGA Values for Seismic Sources for Durg District and Tandula Dam of Chhattisgarh

Fault No.	Fault Length (Li) in km	Minimum Map Distance (D)in km	Weight Factor $w_i = L_i/\Sigma L_i$	Observed Magnitude (M_{obs})	Maximum Magnitude (M_{max})
F1	75	285.99	0.0304	4.8	5.3
F2	46	267.067	0.0187	4.3	4.8
F3	140	221.31	0.0568	4.5	5.4
F4	78	295.772	0.0316	4.5	5.0
F5	33	252.488	0.0134	6.7	7.2
F6	51	241.44	0.0207	4.7	5.2
F7	31	243.873	0.0126	6.7	7.2
F8	76	198.403	0.0308	6.7	7.2
F9	47	244.973	0.0191	6.7	7.2
F10	124	279.579	0.0503	4.8	5.3
F11	60	249.789	0.0244	6.7	7.2
F12	70	258.657	0.0284	6.7	7.2
F13	38	257.176	0.0154	6.7	7.2
F14	477	250.916	0.1932	6.7	7.2
F15	109	253.578	0.0442	3.4	5.2
F16	182	204.694	0.0738	4.9	5.6
F17	38	169.96	0.0154	4.9	5.4
F18	91	169.96	0.0369	5.8	6.3
F19	70	119.711	0.0284	5.8	6.3
F20	70	156.866	0.0284	3.9	4.9
F21	125	151.696	0.0507	3.9	5.3
F22	45	103.314	0.0183	3.9	4.6
F23	25	84.157	0.0102	3.9	4.4
F24	58	48.093	0.0235	5.8	6.3
F25	180	221.63	0.0730	5.0	5.6
F26	130	289.362	0.0527	6.0	6.5

4. CONCLUSION

The deterministic framework is effective to quantify the seismic hazard for the study area which includes district headquarter Durg and Tandula dam in the Chhattisgarh state. This analysis considers the latest earthquake database and a renowned and accepted attenuation model, for Peninsular India of, Iyengar and Raghu Kanth (2004), to evaluate the ground motion characteristics. The results are presented in terms of hazard of PGA (50th and 84th percentile) for Twenty six and Twenty three scenarios. The variation in the PGA (g)

Value is observed as 0.00102-0.06130g, 0.00162-0.09757g and 0.00119-0.05009g, 0.00189-0.07973for the Durg district headquarter and Tndula dam respectively. Fault having fault length 58 kM governs the seismicity in and around the district headquarter Durg region. The result of the study highlighted the fact that the maximum PGA (g) value for study area is less than the recommended value. As per IS: 1893-2016 [22], sixth revision, the Zone factor is 0.1g. So the vital Civil Engineering structures, high rise buildings and Dams in and around district headquarter Durg region are found to be safe.

Appendix –A

Table 1 (a): Estimated Maximum Potential Magnitude for Seismic   Sources of Durg District

F15	**125**	**149.402**	**5.151**	**0.00666**	**0.01060**
F16	45	108.748	4.402	0.00502	0.00799
F17	58	57.736	5.689	0.05009	0.07973
F18	25	94.281	4.300	0.00558	0.00888
F19	180	190.187	5.462	0.00571	0.00909
F20	174	284.464	5.457	0.00222	0.00353
F21	139	233.953	6.112	0.00674	0.01072
F22	228	225.774	6.266	0.00839	0.01336
F23	121	290.986	5.146	0.00152	0.00242

Table 1(b): Estimated Maximum Potential Magnitude for Source of Tandula Dam

Fault No.	Fault Length (Li) in km	Minimum Map Distance (D)in km	Weight Factor $w_i = L_i/\Sigma L_i$	Observed Magnitude (Mobs)	Maximum Magnitude (M_{max})
F1	140	277.988	0.0539	4.5	5.4
F2	51	288.123	0.0197	4.7	5.2
F3	31	288.103	0.0120	6.7	7.2
F4	76	243.533	0.0293	6.7	7.2
F5	47	288.372	0.0181	6.7	7.2
F6	60	293.945	0.0231	6.7	7.2
F7	70	299.464	0.0270	6.7	7.2
F8	477	294.27	0.1837	6.7	7.2
F9	109	272.903	0.042	3.4	5.2
F10	182	230.574	0.0701	4.9	5.6
F11	38	225.292	0.0147	4.9	5.4
F12	91	202.258	0.0351	5.8	6.3
F13	70	164.806	0.0270	5.8	6.3
F14	70	164.605	0.0270	3.9	4.9
F15	125	149.066	0.0482	3.9	5.3
F16	45	108.287	0.0174	3.9	4.6
F17	58	56.863	0.0224	5.8	6.3
F18	25	93.749	0.0097	3.9	4.4
F19	180	189.923	0.0693	5.0	5.6
F20	174	284.288	0.0670	3.0	5.6
F21	130	233.739	0.0501	6.0	6.5
F22	228	225.552	0.0878	6.0	6.5
F23	121	290.814	0.0466	4.8	5.3

APPENDIX –B

Table 2 (a): PGA Values for Seismic Sources for Durg District

Fault No.	Fault Length (Li) in km	Hypo Central Distance (R) in km	Magnitude M100 [Recurrence Period -100 years]	PGA (g)	
				50 Percentile	**84 Percentile**
F1	75	286.165	5.072	0.00147	0.00233
F2	46	267.255	4.580	0.00102	0.00162
F3	140	221.536	5.258	0.00333	0.00530

F4	78	295.942	4.830	0.00103	0.00164
F5	33	252.686	5.675	0.00372	0.00592
F6	51	241.648	4.910	0.00188	0.00299
F7	31	244.078	5.600	0.00375	0.00598
F8	76	198.655	6.293	0.01140	0.01815
F9	47	245.178	5.982	0.00535	0.00852
F10	124	279.758	5.157	0.00170	0.00271
F11	60	249.990	6.142	0.00591	0.00941
F12	70	258.851	6.234	0.00589	0.00938
F13	38	257.371	5.870	0.00428	0.00682
F14	477	251.116	6.998	0.01198	0.01906
F15	109	253.776	5.055	0.00195	0.00311
F16	182	204.939	5.470	0.00491	0.00782
F17	38	170.254	4.949	0.00418	0.00666
F18	91	170.254	5.871	0.01065	0.01695
F19	70	120.128	5.762	0.01810	0.02881
F20	70	157.185	4.729	0.00383	0.00610
F21	125	152.026	5.153	0.00646	0.01028
F22	45	103.797	4.414	0.00549	0.00874
F23	25	84.75	4.138	0.00540	0.00860
F24	58	49.122	5.680	0.06130	0.09757
F25	180	221.856	5.467	0.00411	0.00654
F26	130	289.535	6.125	0.00401	0.00022

Table 2 (b): PGA Values for Seismic Sources for Tandula Dam

Fault No.	Fault Length (Li) in km	Hypo Central Distance (R) in km	Magnitude M100 [Recurrence Period -100 years]	PGA (g)	
				50 Percentile	84 Percentile
F1	140	278.168	5.251	0.00191	0.00303
F2	51	288.297	4.894	0.00119	0.00189
F3	31	288.277	5.554	0.00236	0.00376
F4	76	243.739	6.263	0.00700	0.01114
F5	47	288.546	5.902	0.00330	0.00525
F6	60	294.116	6.095	0.00374	0.00596
F7	70	299.631	6.192	0.00389	0.00619
F8	477	294.440	6.994	0.00795	0.01266
F9	109	273.087	5.039	0.00160	0.00254
F10	182	230.791	5.460	0.00373	0.00593
F11	38	225.514	4.942	0.00229	0.00364
F12	91	202.506	5.851	0.00731	0.01163
F13	70	165.110	5.739	0.00997	0.01587
F14	70	164.909	4.721	0.00346	0.00551

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DESIGN OF AN EFFICIENT AMBIENTLY SECURE KNOWLEDGE-BASED DATASET FOR INTRUSION DETECTION SYSTEMS

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ABSTRACT
An effort is made to integrate various tools and techniques to generate inside and outside attacks for a Network. Various proactive and reactive attacks were generated from source host to destination host for internal Networks, websites, and databases to create probing, DOS, U2R, R2L, and cyber threats. This paper presents the proposed Signature-Based(knowledge) dataset for intrusion detection systems. The raw data was collected from a controlled environment and then processed to have 41 features with full labels. Various paradigms and platforms have been employed, resulting in 41 attributes(parameters) for the traffic. DDoS attacks have also been launched against the server for a collection of sufficient traffic of DOS. Analysis of logs of these attacks at the victim end was accomplished, resulting in a collection of traffic at the host. Further, four classification algorithms were used for analysis, and it is found that Random Forest was the best among all with the highest accuracy.

Keywords: Dataset, Attacks, Attack Tools, Sampling, Random Forest, KNN, SVM, Logistic Regression.

1. INTRODUCTION

Intrusion detection has drawn the attention of many researchers towards accelerating intrusions in networks. As indicated by the insight revealed for cybersecurity, the loss due to cyber-attacks will reach 3 trillion [1]. By 2022, the demand for the information used by the public and private sectors will also increase by 100 times [2].

Anomaly detection is a possible choice due to its perspective of exposing novel attacks [3]. However, before implementing IDS, there is a need for significant testing, evaluation, and tuning. Therefore, researchers often seek an optimal dataset. The datasets used to date are obsolete, difficult to modify, unadaptable to changes in the network behavior. Researchers realize that there is a need to move from a static dataset to a dynamically generated dataset. These dynamically generated datasets are flexible, expandable, reproducible, and most importantly, they mirror the traffic composition and intrusion [4]. Nowadays, it is challenging to find such a suitable dataset because of some security issues. Therefore, the system has to be evaluated with available datasets that have some statistical characteristics. These datasets do not mirror the real world and are heavily anonymized like CAIDA and Lawrence Berkeley National Laboratory, and ICSI. Many researchers like Tavallaee et al. (2010) and Sommer and Paxson (2010) have pointed out these issues [4]. Because of the unavailability of such datasets and due to the lack of some statistical characteristics, there is a need to build a reliable dataset.

DARPA (Lincoln Laboratory) and KDDCup99 have given their significant contribution in evaluating the IDS. However, these are primarily criticized by McHugh (2000) and Brown et al. (2009) because of inaccuracy and the inability to reflect the real world. This creates a problem in estimating intrusion detection systems against current intrusion and traffic behavior in a network. This leads to the demand for a new and dynamically generated dataset that can reflect the system's intrusion and abnormal behavior. To beat the problems of these existing datasets, a methodical approach has been designed for generating the dataset which can evaluate and test network-based intrusion detection systems. To design a dataset, sufficient infrastructure is required to represent the physical implementation of actual traffic in an environment of different devices and workstations. To determine the performance in the fluctuating network environment, it is necessary to evaluate intrusion detection systems [5] correctively. Therefore, this evaluation in different network conditions requires the user to add both normal and abnormal traffic in designing the dataset.

The remaining part of the paper is arranged as: Section 2 discusses the available datasets. Section 3 briefly states that the proposed signature-based dataset is taking regular and intrusive data. Section 4 explains various classification algorithms. Section 5 compiles the outcome of the application of machine learning algorithms to evaluate the NIDS. Section 6 concludes the paper and mentions some future scope of the work.

2. AVAILABLE DATASETS

2.1 DARPA

The Defense Advanced Research Projects Agency (DARPA) 1998 created the first dataset designed to estimate the achievements of intrusion detection systems. DARPA and The Air Force collectively worked with Lincoln Laboratory at MIT to evaluate IDS from 1998-2001. During this period, DARPA designed an architecture for the evaluation of IDS [6,7]. Analogous to The Air Force network, the simulated network was created to generate both normal and abnormal traffic. Training and test data were collected for nine weeks in tcpdump format. DARPA was greatly criticized in the immersion case for injecting an artificial attack. It also does not show real-world network traffic and has some inconsistencies like false positives. According to the modern attack type, this dataset has become obsolete.

2.2 KDD Cup99

KDDCup99 dataset is built on the tcpdump files of DARPA 98. It also has the same problem as in DARPA. It has more than 20 attack types. Regular and attack records were put together in a simulated environment, and the result was a lot of redundant records, which affected the accuracy of the result. To come up with these drawbacks, the NSL-KDD dataset was designed [9,10].

2.3 DEFCON-8

This dataset was produced in 2000 and consists of port scanning and buffer overflow attack. DEFCON10 was built in 2002 that had the administrative privilege, sweeps, port scans, etc. The traffic that was taken in it was completely different from the real world. Instead of taking regular traffic, it focused mainly on intrusive traffic. It was used to check the alert technology [11,12].

2.4 Kyoto 2006

This dataset had been made using honeypots so that there is no need to manually label and anonymize it. It has a very narrow aspect as it observed only those attacks that were directed towards honeypots. This dataset has eliminated redundant features and is insignificant in the KDDCup99 dataset [8]. It has taken 14 statistical features from KDDCup99 along with ten extra features. It does not reveal any clue about specific attack types.

2.5 ISCX2012

This dataset was designed using a systematic approach based on the notion of Alpha and Beta profile. This profile consists of a detailed explanation of the intrusion, protocol, application, and network entity. Actual footprints were analysed to build the profile to produce real traffic for SMTP, FTP, SSH, POP3, IMAP, and HTTP protocol [13]. It does not trace HTTPS network traffic [14]. The guidelines for generating the dataset are the basis for measuring the dataset in terms of completeness, naturalness, total capture, assessment, and abnormal behaviour. This dataset intends to help the investigators obtain such datasets for examining, assessing, and comparative objectives through sharing of designed datasets and profiles.

2.6 CIDDS-001

Coburg NIDS is designed to evaluate anomaly-based intrusion detection. This is a labelled and flow-based dataset [14] that takes the data from OpenStack like mail, web, file, etc., and external servers like a web server and file synchronization. This dataset has a total of 14 attributes. This dataset has many instances from which 153026 instances are taken from an external server and 172839 instances taken from an OpenStack server.

2.7 ADFA

This dataset has been created at Australia Defence Force Academy. The researchers created two datasets named ADFA-LD and ADFA-WD publicly available datasets, which illustrate the structure and functioning of present-day attacks. These datasets cover the records from windows and Linux operating systems. These datasets are constructed against the analysis of system call-based HIDS and incorporated with different types of attacks. ADFA-LD dataset is good enough to differentiate between signature-based IDS and anomaly-based IDS to detect intrusion. ADFA-WD came up with the recent windows dataset for the analysis of host-based IDS [15].

2.8 CICIDS 2017

This dataset consists of modern malicious attacks like DoS, DDoS, web attack, brute force, FTP, and SSH. Labelling is done based on some features like timestamp, source and destination IPs and ports, protocols used, and attacks. It has a total of 80 features that are captured from the network traffic [15].

3. PROPOSED WORK

3.1 Architecture of Proposed Test Bed

We attempted to create an appropriate infrastructure through installation, deployment, and evaluation to produce a reliable dataset that could be used to analyze various methods for detecting security breaches and track and archive network flows to be used later. Two subnets were created for the network infrastructure. Attacker networks and victim networks are major differences in security. Attacker networks rely on target servers, while victim networks rely on legitimate users who act as bots. Computers and servers are part of network infrastructure along with a variety of switches, routers, firewalls, and computers.

Table 3.1, describes the detailed information regarding servers and workstations along with the operating systems installed and the IP addresses associated with them. In the Attack-Network, there is one router, one switch, two PCs with Ubuntu (16.04 and 14.04) and Windows (7, 8 &10) installed. In Victim-Network, there are two servers, five PCs, and a domain controller (DC). As well, a mirror port has been set up on the main Victim-Network switch and it can capture both sending and receiving traffic.

Table 3.1. Detail of Victim and Attack Network PC's

Machine	Operating System	IP Address
Servers	Window Server 10	192.168.0.7
	Ubuntu 16.04	192.168.0.4
PC	Window 8	192.168.0.6
	Window 10	192.168.0.10
	Window 10	192.168.0.8
	Ubuntu 14.04	192.168.0.12
	Ubuntu 16.04	192.168.0.5
Attacker Machine	Window 7	192.168.0.8
	Ubuntu 16.04	192.168.0.9

The dataset has been prepared using inside and outside the traffic of the network separated by a router. The Apache Web server generates the outside traffic. Inside traffic (attack + normal) is generated using the tools shown in Table 3.2.

Table 3.2. List of Attack Generated on Victim

Attack Type	Tool Used	Victim
Apache2	Tor's Hammer	Website
HTTP Tunnel	LOIC/HOIC	Website
Imap	Net Tool 5	Mails
IPSweep	Net Tool 5	IP
Mailbomb	Zip bomb	Email
Nmap	Nmap	Server
Neptune	Neptune	Server
SYN Flood	Neptune	Server
Smurf	Smurf	Server
Rootkit	DDoSIM	Linux Box
Port sweep	Net Tool 5	Server/Linux Box
HTTP	Pyloris	Website
Back	Nmap	Server
Buffer Overflow	Tor's Hammer	Server
FTP	Net Tool 5	Server
Guess Password	R-u-dead yet	Server
Finalonee	Hyenae	Website/server
Land	LOIC	Website
loadmodule	Pyloris	Server
Merge	Neptune	Server
Mscan	Hyenae	Server
Multihop	Tor's Hammer	Server
Perl	DDoSIM	Linux OS
Phf	DDoSIM	Server

Rootkit	DDoSIM	Linux OS
Spy	R-u-dead-yet	Server
Sqli	R-u-dead-yet	Server
Udpstorm	Net Tool 5	Server
Xterm	Hyenae	Server
Warezmaster	Pyloris	Server

The Network architecture used is shown in Figure 3.1. The clients are connected to a server. Various traffic generation tools are run at clients. All the tools mentioned in Table 3.2 are installed at the server machine, and the server is used to generate traffic consisting of regular and attack data for various client machines. The client machines are prevented from going to crash state, and the logs of traffic received are viewed at the client machines to be collected as per the 42 attributes of the proposed signature-based dataset.

The attacks are launched to client machines from the server, and the client is prevented from being crashed. The log files are observed at the client machines for traces of attacks and normal traffic. The network traffic is captured using Wireshark for windows and then convert into CSV format and tcpdump on the Linux operating system and save in the captured packets in the PCAP file for further analysis. The text files are converted to CSV files and are labeled manually for the type of attack. Some attacks have been applied to the websites using an Apache web server—the proposed dataset named Research Database in Knowledge System (RDKS19) dataset.
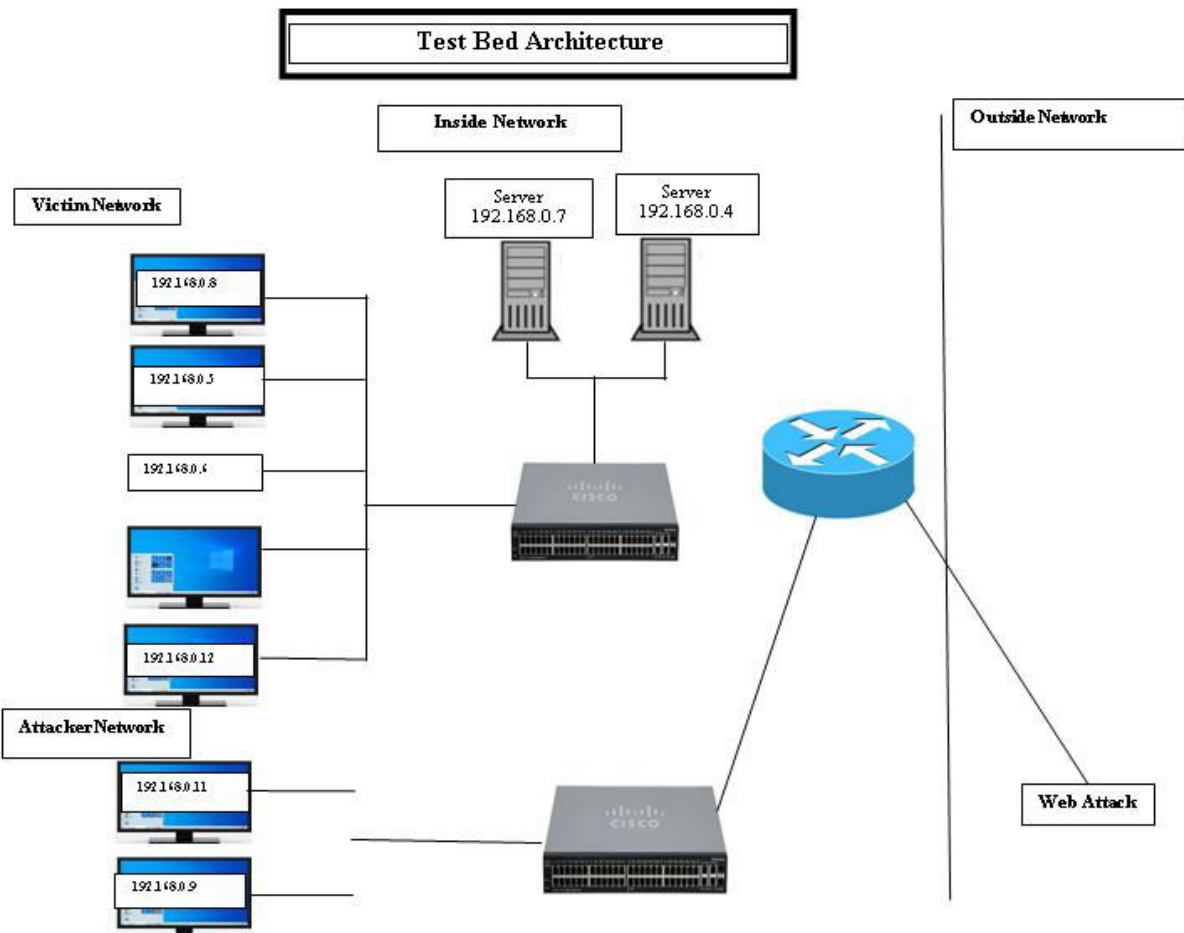
Figure 3.1: Test Bed Architecture

3.2 Extraction of Attributes for Proposed Dataset

Figure 3.2 summarizes the procedure for collecting the RDKS19 dataset. As part of the process, real-time data is generated, features are extracted, and the data is then combined with labels into connection records. To capture raw traffic, Packet Sniffer based on WINcap and Tcpdump captures simulated attacks and real-time traffic data. A connection is created or a session is created by combining the protocol and payload characteristics derived from traffic dumps. In addition to current connections, feature vectors are also created based on connections from the last two seconds as well as the previous 100 connections.
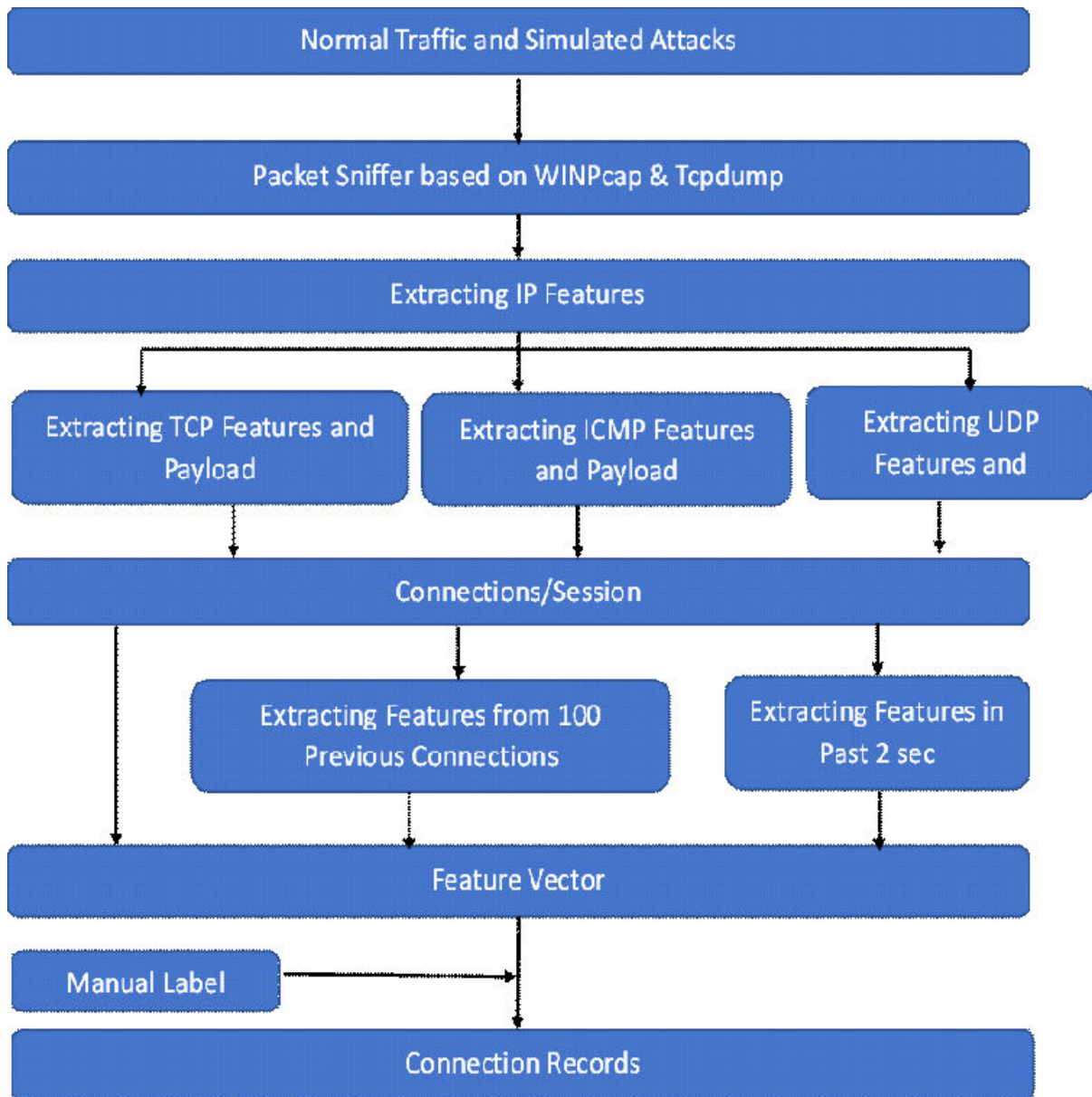
Figure 3.2. The Flow of Dataset Creation

Lastly, labels must be manually inserted into connection records. We obtain 42 features as a result of this process. Throughout these sections, each step is described in detail.

3.3 Pre-processing of Proposed Dataset

The learning algorithms in machine learning have a deep relationship with the data types and structures that affects their performance with existing data. Most machine learning is based on certain assumptions, such as the structures of the proposed data and its types. The methods of machine learning that we use require the preparation of data to meet the necessary criteria. Using improper data in machine learning will result in inferior models that will not give the correct prediction.

The information acquired during the data collection period is first prepared to produce the elementary features, for example, the ones in KDD Cup 99 dataset [20]. This stage contains three principal stages that appeared as follows.

3.3.1 Data transferring

A trained classifier acquires each record from the input data set in vector form. Hence, there is a need for conversion from symbolic to numerical—for instance, KDD CUP 99 supports both symbolic and numerical features. Symbolic features contain three parts, i.e., type of protocols, service type, and TCP status flags like ICMP, TCP, and HTTP. Categorical attribute values are substituted into numerical values by the methods.

3.3.2   Data normalization

Normalization is the subsequent significant step in data pre-processing. The normalization of data is a method of scaling the value of each feature into the range that is well proportioned to eliminate the biasing in case of the features with enormous value in the dataset. Each feature is normalized by each record's respective most enormous value and falls within the same range of 0-1.

3.3.3   Feature selection

To achieve greater efficiency accuracy, it is therefore essential to recognize the most insightful features of traffic data. In our proposed dataset we use Feature Importance for feature reduction. The figure 3.3 shows the selected features after applying feature importance. In our research work, we have chosen 10 features.
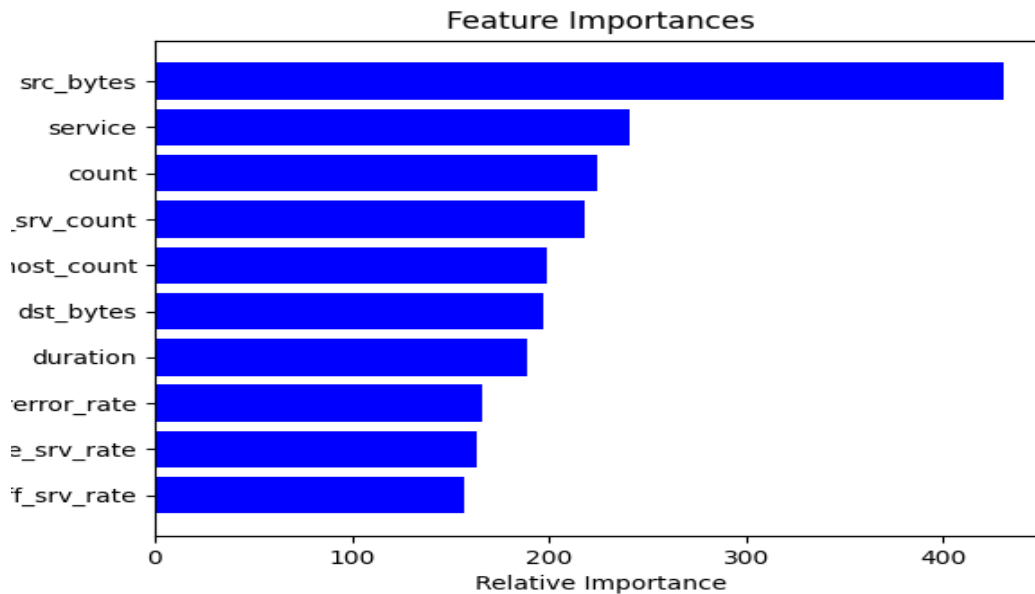
Figure 3.3: Reduced Feature Set

Table 3.3 Stopping Criteria for Feature Selection

Features	Accuracy (%)	Precision	Computation _Time (Sec)
08	98.25	98.29	4.49
10	99.31	99.31	4.58
12	99.34	99.36	5.65

The table 3.3 shows the stopping criteria for feature selection. As shown in the table 3.43 with 8 features the accuracy is 98.25%, precision is 98.29, and computation time is 4.49sec. And with 10 and 12 features, the accuracy and precision time are almost the same but computation time varies greatly. So, this is why we have chosen 10 features to get optimal results.

3.4 Balancing of Data

The imbalanced classification includes developing predictive models on classified datasets that have a very severe class imbalance. The biggest challenge in working with imbalanced datasets is that it mostly ignores the techniques of machine learning. It results in low achievements in the minority and majority classes; the most important is its conduct in both the classes.

One alternative to overcome this challenge is to undersample the majority class and oversample the minority class. The simple approach is to duplicate the examples in the minority class and delete the examples in the majority class. During our research, in data pre-processing, we have balanced the imbalanced data using undersampling and oversampling. We have used Python to develop a script to balance the dataset.

3.4.1 Undersampling methods

The instances are removed in different ways from the majority class in undersampling methods. The typical way of doing it is deleting instances randomly. Undersampling the majority class is a simple technique but can lead to potential loss of information. However, it can lead to good results if most class instances are very close to others classes in a matter of distance.

Some Undersampling Methods Are:

Random Undersampling
This method is generally used for large sets of data. In this method, records are removed randomly from the majority class.

Near Miss Undersampling
The problem of potential loss of information in Random Undersampling is resolved with the Near Miss Undersampling. The nearest neighbor algorithm is the basis of this technique. It has several variations. It calculates the distance between the occurrences of the majority and minority classes.

The k occurrence of the majority class, which has the smallest distance from the minority class, is retained. If the minority class has n instances, this technique will give k x n instances of the majority class.

Cluster Centroids Undersampling
Clustering is an unsupervised learning approach where it creates encircling data points. Undersampling with Cluster Centroids removes the instances that are not important in the majority class. It is decided by using the clustering concept on the geometry of the feature space. Cluster Centroid is obtained from the average of the feature vectors over the data points.

After this, the following steps are taken:

- The least essential instance is obtained from the majority class cluster, which has a certain extent from the cluster centroid within the feature space.

- The most important instance is obtained from the majority class cluster, which is very close to the cluster centroid in the same feature space.

3.4.2 Oversampling
This method adds duplicate instances to find a balance from the minority class. There are various ways to perform oversampling on a dataset:

Random Oversampling
This type of oversampling adds identical data or records from the minority class randomly. It is generally adequate for fewer records. It solely replicates examples of the random minority class. The major disadvantage of this sampling is that it increases the problem of overfitting.

SMOTE
Synthetic Minority Oversampling Technique (SMOTE) creates or synthesizes instances from the minority class instead of creating duplicate records to avoid model overfitting [18]. To obtain the new instances of the minority class in the neighborhood, SMOTE obtains the K-nearest neighbors of each minority instance, selects any one of them randomly, and then computes linear interpolations. In other words, it changes one instance from random instances at a time. This results in the addition of the new points between the neighbors.

ADASYN Oversampling
ADASYN stands for Adaptive Synthetic sampling. Similar to SMOTE, ADASYN also produces samples from the minority class. The difference between them is that the latter uses density distributions resulting in broader observation [19]. Its main motive is to produce samples or data for minority class samples that are difficult to understand in contrast to those minority samples which are uncomplicated to grasp. First, minority instances were measured with the help of the KNN algorithm. After that, using those instances, it evaluates the class ratio of both the minority and majority instances and produces new samples. Repetitive use of this process will ultimately shift the focus of the decision boundary on samples that are difficult to understand.

We have used many balancing methods like a random sampler, near miss, undersampling with cluster centroid, SMOTE, and ADASYN. However, except for SMOTE, every other method generates random samples and does not solve the biasing problem. So, in our research, we use random undersample methods for undersampling and SMOTE for oversampling.
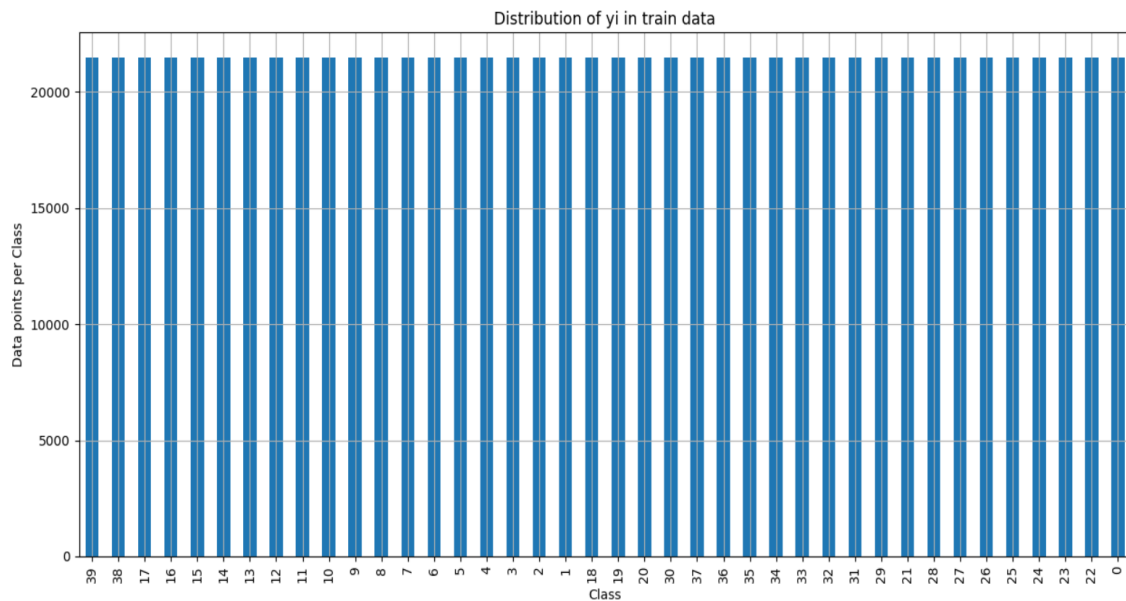
Figure 3.4: Balancing of Proposed Dataset

4. CLASSIFICATION AND EVALUATION

Multiple Algorithms are used to train classification problems. This is usually done to compare more than one algorithm's performance and obtain the best results for the data.

4.1 Logistic Regression

A Machine Learning classification algorithm is used to predict the probability of a categorical dependent variable. Binary variables are dependent variables in this regression used to encode the data in 0 and 1 format, where 0 is a failure and 1 is a success. In logistic regression, the factor level 1 of the dependent variable represents the positive outcome. Also, the model should have little or no multicollinearity. This means that variables should be independent of each other. The independent variables are linearly related to the log odds. Ultimately, a considerable number of samples of datasets is required for this regression.

4.2 Random Forest

It is based on the divide-and-conquer approach, which is technically called an ensemble method of decision trees produced on a randomly split dataset. The troupe of decision tree classifiers is called forest [17]. Attribute selection indicators like information gain, gain ratio, and Gini index for each attribute helps in generating individual decision trees. Each tree depends on an independent random sample. The final result is one of the most popular classes chosen by the votes of each tree in a classification problem. However, the average of all the tree outputs is considered the final result in regression. This technique is very simple and robust in contrast to other non-linear classification algorithms.

4.3 KNN

KNN comes in the category of the lazy and non-parametric learning algorithm. It does not make any assumption for underlying data distribution; this is why it is non-parametric. The dataset highly influences the structure of the model. This property renders KNN the ability to work on most of the real-world datasets which do not adhere to mathematical assumptions. In addition to being non-parametric, KNN is a lazy algorithm which means that it does not require any training data points to generate the model. This saves time in the training phase but makes the testing phase slower and expensive. Thus, it uses excessive memory and takes longer. The worst part of KNN is that it requires a longer time for scanning all the data points and requiring extra memory to store the training dataset.

4.4 Support Vector Machine

A supervised learning algorithm can perform regression, classifier, and outlier detection [16]. This algorithm is very productive where the dimensional space is very high and where the number of features is more considerable than the instances. In this algorithm, a straight line is projected between two classes. The data points which come on either side will be considered in one class, and which drop on the other side will be considered in the second class. The worst case of SVM is overfitting, which is due to the increased number of

samples than the number of dimensions. This classifier is very much in demand when there is uncertainty in the dataset. The best part is its accuracy, robustness, and fast evaluation.
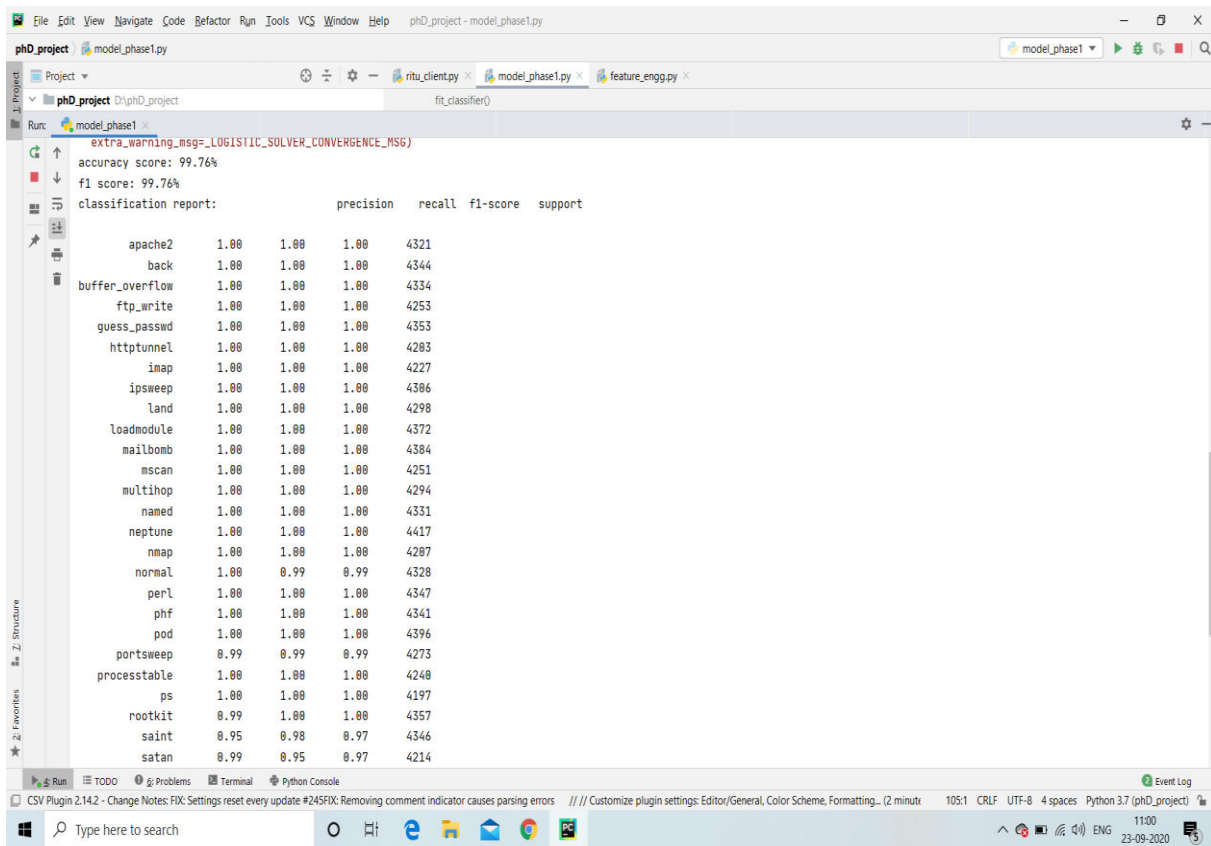
Figure 3.5: Screenshot of Analysis of Logistic Regression
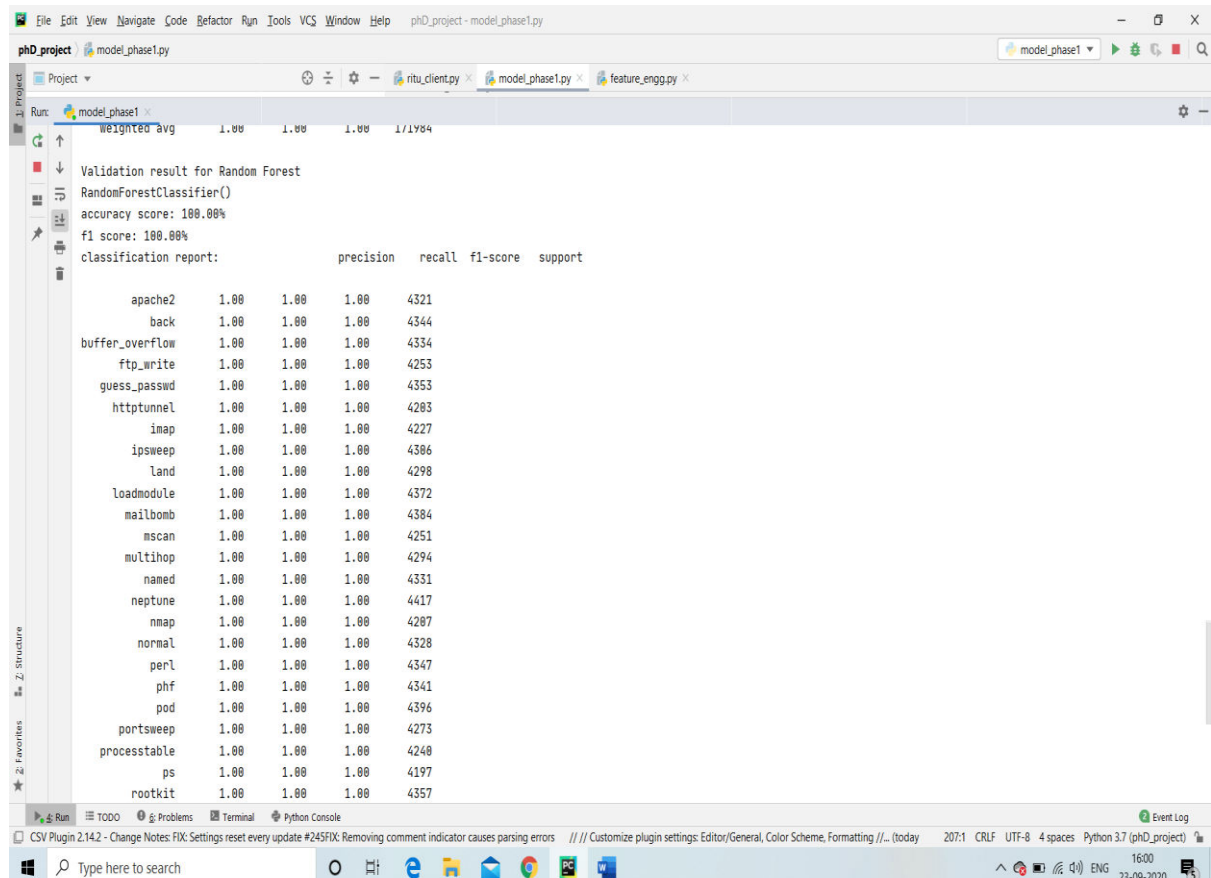
Figure3.6: Screenshot of Analysis of Random Forest

5. EXPERIMENTAL RESULTS

5.1 Parameters Used

Precision: It tells the correct percentage of optimistic prediction.

Recall: It says the no. of actual positive values captured by the classifier.

F1 Score: It represents the harmonic mean of recall and precision.

$$Accuracy = \frac{(TP+TN)}{(TP+TN+FP+FN)} *100 \qquad \text{Eq. (1)}$$

$$Precision = \frac{TP}{TP+FP} \qquad \text{Eq. (2)}$$

$$Recall = \frac{TP}{TP+FN} \qquad \text{Eq. (3)}$$

$$F1\ Score = \frac{2*Recall*Precision}{Recall+Precision} \qquad \text{Eq. (4)}$$

The comparison of different classifiers is performed and shown in Table 3.4. Table 3.4 mainly compares four classification algorithms based on accuracy, precision, recall, and f1 score. It is found that the Random Forest was trained well and gave the highest accuracy among all classification algorithms.
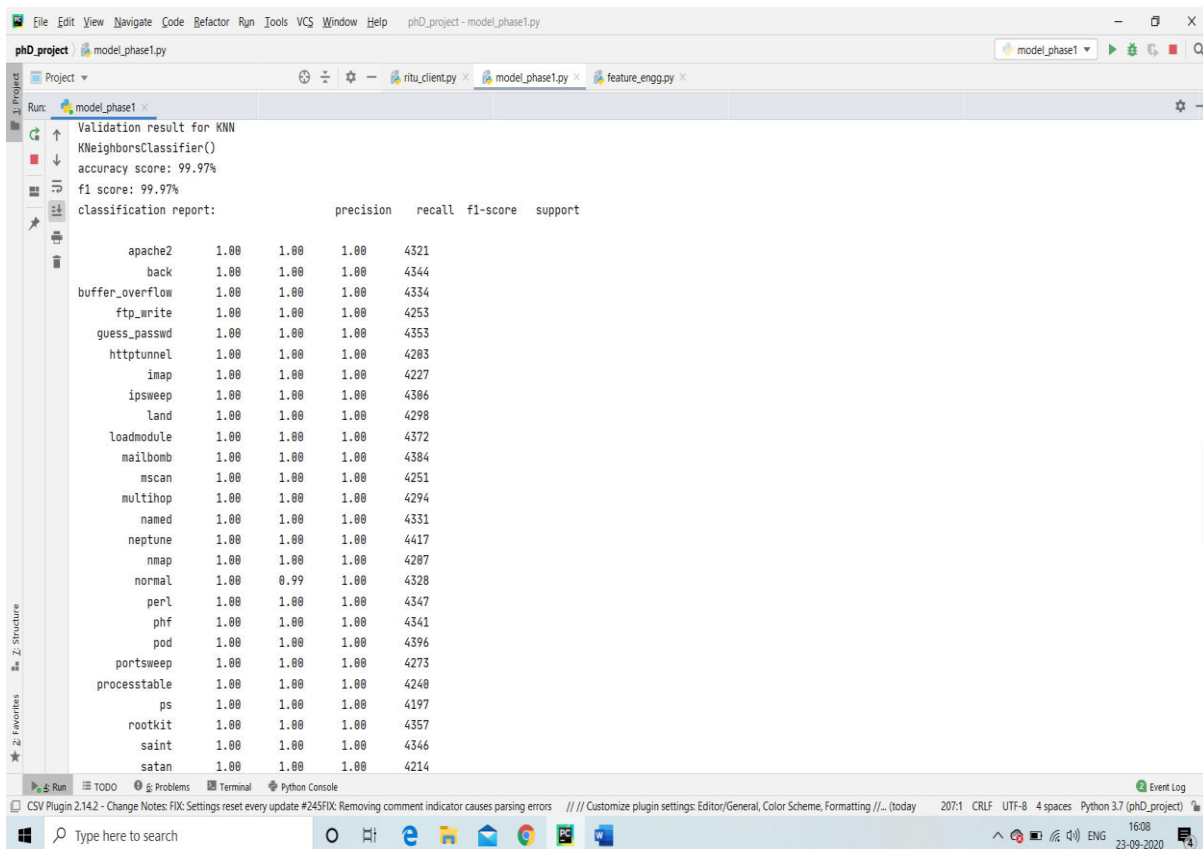
Figure.3.7: Screenshot of Analysis of KNN
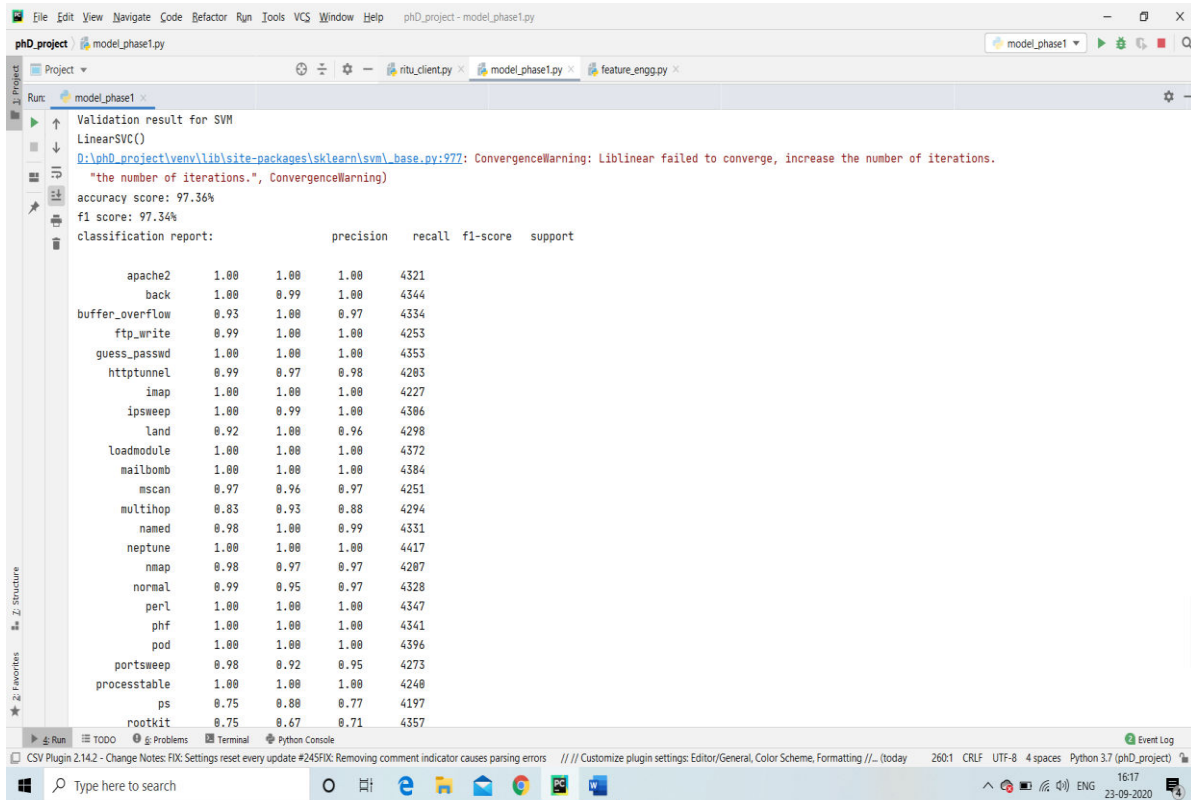
Figure. 3.8: Screenshot of Analysis of SVM

Table 3.4 Experimental Results of Four Classification Algorithms

Algorithm	Accuracy	Precision	Recall	F1 Score
Logistic Regression	99.76	1.00	0.99	0.99
Random Forest	99.8	1.00	0.99	1.00
KNN	99.5	1.00	0.99	1.00
SVM	97.36	0.99	0.95	0.97

6. CONCLUSION

In this paper designed a dataset is designed using inside and outside traffic. Traffic is generated using various traffic generation tools like Tor's Hammer, LOIC/HOIC, Net Tool 5, Smurf, etc. Text files of collected traffic are then converted in CSV format. The proposed dataset consists of 42 features which are the same as KDDCup99. To balance our dataset, we approached under-sampling and oversampling methods. The random sampler is used for sampling, and SMOTE is used for oversampling. For finding the performance of our proposed dataset, four different classification algorithms are used. Based on the results of four classification algorithms, it is concluded that the proposed dataset performs well with all the algorithms, but Random Forest gives better results. Our future work will be to compare our proposed dataset with existing datasets.

CONFLICTS OF INTEREST

"The Author(s) declares that there is no conflict of interest".

AUTHOR CONTRIBUTIONS

Ritu, the corresponding author, works on creating and analyzing the new dataset, and (co-author) Professor Ritu Nagpal guides me during this research work.

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AN APPROACH TO DESIGN TRUST BASED MODEL FOR TRUST EVALUATION IN SERVICE SELECTION OF IOT

SHWETA AND SUNIL KUMAR

ABSTRACT

Internet of things connect virtual and real world together which introduced my service oriented application. Whereas, availing a service from IOT environment becomes a risk oriented work, hence service should be trustworthy. In this paper, a novel trust based generic model is proposed by considering various characteristics of service provider, direct experience of consumer and aggregating them with the indirect recommendation of other users in the system. The basic modeling framework is also described which explains the various phases of service oriented model by considering their sequential connection. The proposed model is scalable, adaptive, secure and quantized in nature which can even work in dynamic environment, several attributes and parameters selection with their effective weight value can result in a very effective and efficient trust model for different real service-oriented applications.

Keywords: Trust, Framework, Internet of Things, Services-Oriented, decision making, Model

1. INTRODUCTION

Internet of Things (IOT) helps in connecting the ubiquitous computing to the real world. It includes everything from the small physical objects to the large living things like human being. Internet of things work by connecting and integrating various things like devices, things, communication media and several protocols. According to the CASAGRAS , IOT is :

"A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities. This infrastructure includes existing and evolving Internet and network developments. It will offer specific object-identification, sensor and connection capability as the basis for the development of independent cooperative services and applications. These will be characterized by a high degree of autonomous data capture, event transfer, network connectivity and interoperability "[1].

Today, IOT can be easily seen in most of the parts of our life. It has several application areas in both domestic as well as real life such as e-health, e-education, smart transportation, smart living etc. [2]. In order to select a particular service from the IOT environment, trust plays a major role. Trustworthy environment helps in reducing the risk factor and enhances the usability and reliability of the various IOT services.

Since, IOT is growing tremendously; it is very difficult for agents to choose one service provider among several similar providers. Thus trustworthiness plays a very vital role here. Reputation of the service provider will be totally based on the trust factor. More the trust, more reliable will be service providers. In this paper, a general framework has been proposed to provide the trust values to the service providers based on various parameters. This framework is conceptual approach which can further lead to the designing of trust model in IOT environment. This paper is categorized as follows: section 2 describes the related work and background history of trust model and their frameworks. Section 3 describes the proposed framework and its various phases. It also explains the generic trust model for selecting a particular service from IOT environment with detailed explanation. Section 4 describes the conclusion and future scope.

2. BACKGROUND AND RELATED WORK

There are many frameworks related to trust management and computation in different fields but these are very limited in context to internet of things. Mostly trust framework is based on the reputation, privacy, security and social relationship. Trust metrics based on privacy and security are explored in the [3], [4], [5] & [6]. The architecture, computational models are discussed in the survey papers of J. Guo [7], [8]. A fuzzy based trust computational model was designed by Chen et al. [9] which uses fuzzy methodology for providing reputation to the IOT service providers. They consider IOT environment with wireless sensors only. And their trust metrics considers energy consumption during packet forwarding.

Various attributes of behavior and computational trust are presented by Gligor and Wing [10] in the trust theory of computer and Humans. They proposed a framework of channels and entities. These entities can be real or non-real such as human being or the network entities. Trust is based on the recommendation or the second opinion only, no other parameters were considered. Thus validation of recommendation was very difficult in such cases.

Leister and Schulz [11] proposed a trust computational model by considering the three main factors, these are the devices in the system, users using them and the connection between the users and the devices. Trustworthiness of the system was calculated using the both prior trust information as well as the trust post experience information of trust.

Trust on the devices, software as well as hardware etc all are discussed by the researcher Koien et al [12] in aspect with Internet of Things. Various trust characteristics are explored and discussed in the trust model designed by the Yan et al [13] for internet of things. Yan has considered both the three layers of the IoT system i.e. physical, network and the application layer. Also analyzed the various characteristics of the trust in the IoT system and its challenges in this field. Trust of the system depends on the connection between all the three layers and on the performance of each layer separately.

3. THE PROPOSED MODEL

The proposed Trust model is divided into parts: part 1 shows the general working with basics phases as describes in modeling framework whereas in second part the detailed model for the trustworthy IOT selection is explained.

3.1 Basic Modeling Framework

Since IOT is growing tremendously in terms of both scale as well as size. For a single service, there are many service providers available in IOT environments which make it difficult for the user to select the most efficient service provider. A light weight model is designed by [14] but it did not consider the trust issue. This paper aim to provide a model for selecting the service provider by considering its trustworthiness value. Quantized trust values can be used if various service provider needs to be prioritized based on their services. Trust can be based on the direct experience or the indirect by using various feedbacks or any recommender system.

Figure1 explains the basic framework design explaining its important phases and their connections. Whenever a user wants to avail any service from the IOT environment it has to undergo following some steps:

Filtering: In an IOT environment, there are many service providers, filtering extracts services similar to the request made by the user and their corresponding service providers. This can be based on the various similarity methods, such as cosine similarity.

Trust Composition: Every service provider is categorized and classified based on their service types. To compose the trust, three main features are used as main trust dimensions, direct trust, indirect trust, and the service provider credentials. Combining these dimensions must be done on the importance of each size; thus, it is weighted. Weights to each dimension are assigned using the AHP technique.

Trust Decision Making: A decision is framed by combining reputation, trust values, feedback, recommendations, and other factors received. This decision can be based on any technique such as fuzzy logic, neural network [Wei04], etc. This step selects a particular service provider based on the outcome. Here a temporary trust value is given to the providers.

Behavior Analysis: The service provider's behavior selected in the decision-making step is analyzed here, i.e., how the service provider is currently behaving based on its actual service received and the one we were expecting.

Behavior score = (Expected service score- Actual service score)

Learning and Updation: Based on our direct experience, we update our database and trust values for that service provider and repeat the steps by adding a learning process for our future selection.

This section briefly explains trust based entity selection model without focusing on the detailed explanations of the internal mechanism used such as ranking, aggregation and recommendation system. This section rather focuses on selecting and updation trust process of the services. This framework can be implemented by using any of the ranking, recommendation system. Various aggregation formulas such as fuzzy logic can be combined to get the most effective result.
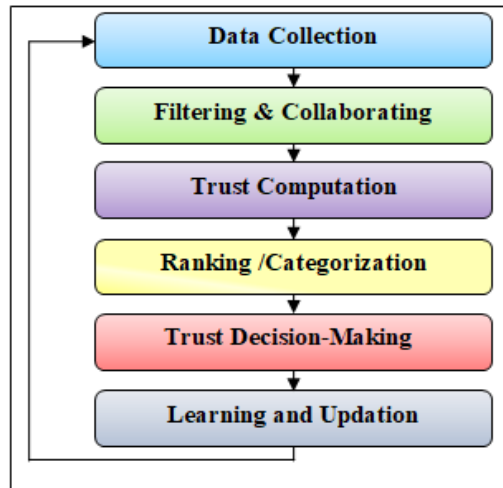
Figure 1. Various phases of Trust Framework Model

3.2 The Architecture of Proposed Trust-Based Model Sa-ORC

Trust is one of the significant parts of any service-oriented application. In this section, a novel detailed trust architecture is presented. To make the service-oriented applications more reliable, trust must be considered a significant part, as it will help reduce the risk. When the services are trusted, applications work more smoothly, and the overall system's performance increases.

The trust-based model for service-oriented internet of things is divided into design and operation parts. The detailed working of the system is described in the architectural diagram shown in Figure 2. The proposed model named Secure and Adaptive ORC (SA-ORC) for trust-based decision-making of a particular service from IoT is shown in an architectural model in Figure 2.
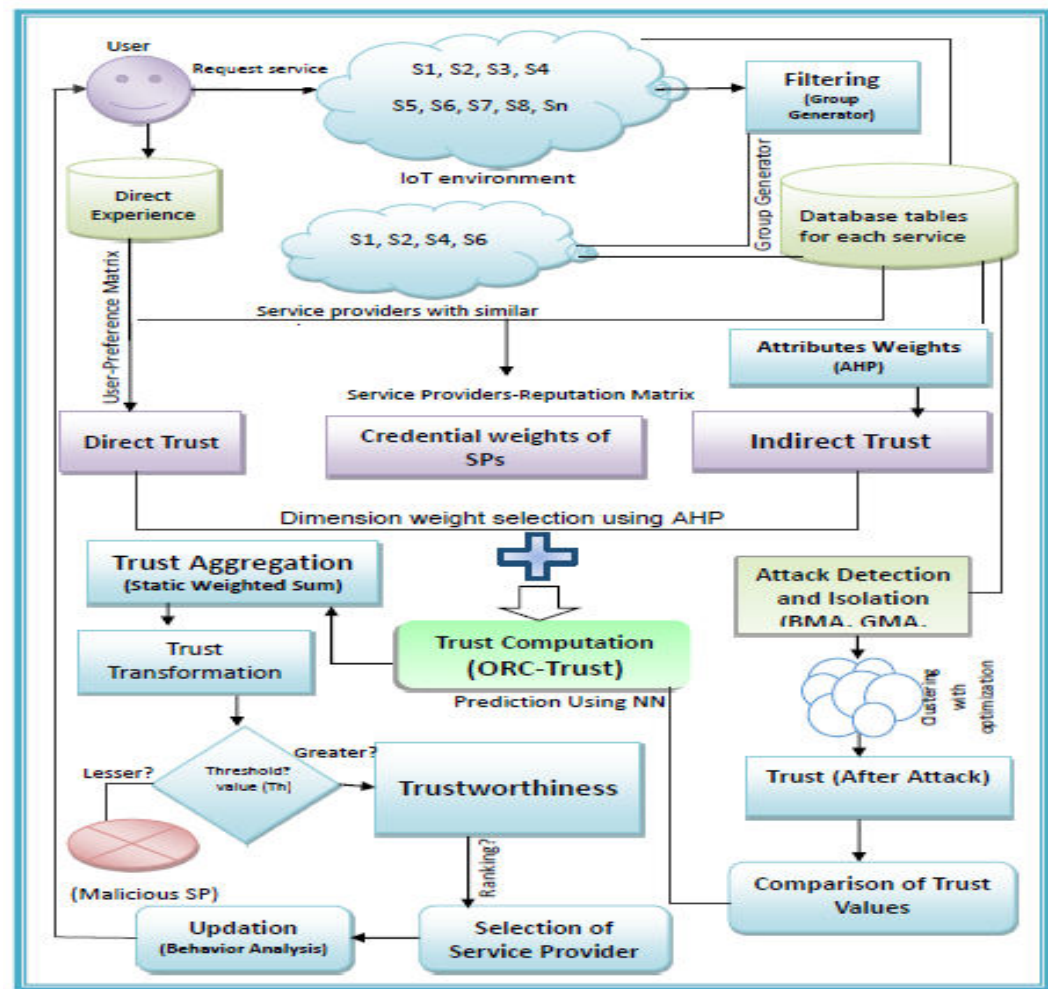
Figure 2: The Architecture of the Proposed SA-IoT Trust-Based Model

The model starts when user X requests service Y. Since the IOT environment comprises many services S (S_1, S_3, S_3, S_n). Thus, it is essential to extract only those service providers that provide similar services as requested by user x.

The architecture is divided into three major parts as trust computation, adaptive trust computation using neural network, and attack isolation part. The proposed SA-ORC is based on the proposed observation, recommendation and credentials based (ORC) algorithm for computing trust, and this trust computation is used as a supervisor for implementing the intelligence-based system, which will effectively handle a large number of IOT user nodes and predict the trust value for new user nodes.

3.2.1   Filtering

Since the service-oriented internet of things network is very vast, it contains many service provider's S (S_1, S_3, S_3, S_n). However, based on user request X, only limited service providers would provide specific services requested by user X. This process is known as filtering, which will extract only those service providers whose services match with requested services. The proposed trust-based model uses the service providers (SPs) group based on the service type they are providing and stored in the database. A new SP added to the system is checked concerning its features and added to the particular group based on those features. A group of SPs with similar services is used for trust computation whenever any user requests a service. If any new user asked for any service in a service-oriented IOT environment, then SPs with the highest trust value, suggested by another user, are recommended. This will avoid the cold start problem of a new user.

The repository contains user-domain matrix A of an order [N×K] where N is the number of SP and K represents the primary domain like smart-healthcare, smart-education, smart-city, etc.[A_{ij}] represents if i^{th} SP belongs to j^{th} domain or not. If [A]=0 this means that i^{th} SP specifies j^{th} domain else [A_{ij}] =1 signifies that i^{th} SP specifies j^{th} domain.

Mathematically SP-domain matrix is represented in equation 1.

$$A[i][j]= \begin{cases} 0 & i^{th} \text{ SP does not belong to } j^{th} \text{ Domain} \\ 1 & i^{th} \text{ SP contains } j^{th} \text{Domain} \\ & and \ i \leq N, j \leq K \end{cases}$$

Table 1 represents the service providers-domain matrix in which rows represent different service providers in the service-oriented internet of things. The column represents different categories based on the various applications of IOT. Since the IOT domain is very vast, so filtering based on service type helps in eliminating unrelated services. The proposed group filtering effectively performs this task. Let's say there are 'n' service providers, and the matrix is formed if the particular service provider belongs in a specific group, then one is assigned under that group else zero is inserted in the whole row.

Table 1: Service Provider-Domain Matrix A

SP/Domain	Smart-Healthcare	Smart -Education	..Agriculture
SP1	1	0	..0
SP2	0	1	..0
…SP$_m$	..1	..0	..0

```
Algorithm: Group Generator

Input:  Service-Provider (SP) Category matrix A

Output: SP groups

Load the Service-Provider Category Matrix A in
memory.
Initialize group variables.
SP_Category= read (A).
While (SP-Category matrix! =null)
{If (SP-Category= smart-education)
{Add to smart-education group.}
If (SP-Category= smart-healthcare)
{Add to smart-healthcare group.}
If (SP-Category= smart-agriculture)
{Add to smart-agriculture group.}
If (SP-Category= others)
{Add to others group.}

4. Return groups.
```

Group Generator

Group generator generates groups of service providers with a similar domain. It takes input from the service-oriented internet of things repository and uses the service provider-domain matrix to create different groups. Trust composition and trust computation then use these groups.

Algorithm 1 generates groups of a service provider based on their domain, i.e., service providers offering similar services will be grouped. Once the groups are generated, specific groups are selected whose services match the user's request. Among the selected group of SP, there are several attributes based on which trust value is computed. However, these attributes are a mixed proportion of essential and less essential features. So the model is weighted based on attributes priority. The selection of attributes weights is very crucial as it has a direct connection with overall trust value. Hence, to effectively evaluate the importance of these attributes, the AHP technique is used, which is very efficient in composing weights based on attributes priority.

3.2.2 Attributes Prioritization and Weight Selection

Depending on the context of IOT applications, there will be different types of attributes with different priorities. However, since not every feature is equally important, some are highly important, but others may not. Some may not even matter for the user. Thus, it became necessary to weigh these attributes [14,15].

Weightage is provided using different methods such as AHP, ANP, and weighted sum. AHP is considered the best method among all. Therefore, we have used AHP for calculating the weighted for each attribute [14].

3.3 Proposed Trust Composition

Since trust is a dynamic process with several dimensions and computing trust, several attributes and properties are used based on the context of IOT. In the proposed trust-based model, three dimensions are used for trust composition, observation, recommendations, and credentials (ORC) extracted from direct, indirect, and service provider's details, respectively.

3.3.1 Direct Trust

Direct trust refers to the trust value based on the past observation of particular User X, w.r.t. the specific service provider Si. User X has its dataset, which holds the information about various service providers, and their services used by user X. It can also store data in tabular form by considering multiple parameters according to its priority. The direct experience can be stored by giving weight to all the factors subject to the estimated expectations from the service provider. The attributes weights are assigned using AHP techniques explained in the previous section. The illustration of direct trust is depicted in Table 2. For simplicity, only limited attributes are shown.

The Table depicts the total service provider S (S_1, S_2, S_3, S_n) list whose services are experienced by user X. Based on their experience certain weight is assigned to each service provider (out of 10). This weight is given corresponding to the various parameters P (P_1, P_2, P_3, P_m). Every parameter is given a different weight factor based on the priority of user X, these weights are decided by using the AHP technique based on attribute preferences.

Table 2: Direct User Preference (DCP) Metrics based on its Direct Experience

Service Provider(S)\ Parameters(P)	Quality(P1)	Timely Deliver(P2)	Price(P3)	…Maintenance(Pm)	Effective Trust(o)
	0.4	0.3	0.2	0.1	
S1	3	1	5	2	2.7
S2	9	10	5	10	8.6
…Sn	5	5	5	5	5

An effective weight is calculated for each user using the formula given below:

$$W\ (C_{k,j}) = \sum_{i,j=1}^{m,n} Pi * Sj \qquad …(2)$$

Whereas, W ($C_{k,j}$) = direct weight computed by user k for the jth service provider, P_i = i^{th} parameter of the service, S_j = j^{th} service provider, m = number of parameters, n = number of service providers.

3.3.2 In-Direct Trust

In-direct trust is the trust value calculated from other users who have experienced a direct interaction with that particular service provider in the past. Based on their experience, they suggest a trust value for the specific SP. Only direct trust itself is insufficient as all users may not have direct interaction with every possible service

provider in the past. Thus, a mechanism is needed to compute trust along with direct trust. This is done by indirect trust, which is based on recommendations from neighboring nodes. It can be calculated using the following formula:

$$T_r(j) = \frac{\sum_{i=1}^{x} T_o(i,j)}{x} \dots (3)$$

Whereas $T_x(j)$ = indirect trust for jth service provider, $T_o(i,j)$= direct trust for jth service provider computed by the ith user, x= The total number of neighboring nodes provided trust value.

3.3.3 Credentials

Credentials refer to the information claimed by the service provider, based on the authorized certifications, guaranty cards, experience, etc. Every service provider is given some weight value for particular attributes out of 5. This information is based on the public description provided by them. This trust dimension will help in eliminating biasness towards new service providers.

The existing trust model only considers direct and indirect trust for computing overall trust. However, these traditional trust models are biased towards new SP entering the environment. Whenever any new service provider enters the service-oriented IOT environment, it scores zero direct and indirect trust value due to the unavailability of past interactions with other users. This will lead to zero overall trust for that service provider, depriving that service provider of selection. Their trust value will remain low even in the future as they will never be selected. It will cause the new service provider to go into the starvation stage. To avoid this, a new solution is proposed by considering service provider credentials as a part of the overall trust computation method. If a new SP joins the network, their credential score will help get trust value, preventing them from the starvation stage. Its explained in Table 3.7 as follows.

Table 3: Service Provider- Reputation (SPR) Metrics

Services(S)\ Parameters(P)	Certifications(P_1)	…Government Awards(P_m)	Services Provider Reputation
	(0.5)	(0.5)	
S_1	2	4	3
S_2	Null	4	2
S_3	4	5	**4.5**
…S_n	3	2	2.5

Data from this matrix will help calculate temporary trust values for the service provider by calculating the reputation with weight based on the public information available. This reputation is calculated by using the following aggregation formula:

$$T_c(j) = \sum_{i=1}^{m} w(P_i) * w(S_j) \qquad \dots (4)$$

Where, $T_c(j)$= credential based trust for j^{th} service provider, $W(P_i)$= weight of ith parameter.

S_j= jth service provider, m= Number of Parameters. Where P_i represents the weight of attributes ($P_1 P_2, P_3 \dots P_n$) such as certificates, honesty, etc., these attributes are given specific weightage based on their importance using the AHP technique. These parameters are context-dependent.

Static Comparison of the Proposed Model to the Traditional Model

The proposed trust model consider certification claim of service providers from the trusted third party, which helps in removing biasness towards the old node in the system. Since there is are no recommendations or observation for the new service provider, their trust value results in poorly evaluated trust, which also affect overall trust in later stages also. This condition is known as starvation. Considering the service provider's specification helps in giving some initial weight to the service provider will help in increasing the trust value at every time cycle. Static comparative evaluation of our trust model to that of the existing model is summarized in Table 4.

Table 4: Static Comparison of Proposed Model Using Various Parameters

Paper Id	Trustworthiness	Conflict Resolution	Direct And Indirect Observation	Starvation Handling
18	Yes	No	Yes	No
19	Yes	No	No	No
20	Yes	Yes	No	No
21	Yes	No	No	No
22	Yes	Yes	Yes	No
Proposed Work	Yes	Yes	Yes	Yes

3.3.4 Neural Network

As the database of service providers and users continuously increases, there is a need to develop an incremental approach that improves scalability. Since IOT is a vast network, thus there is a need for an intelligent model that can automatically compute the trust value for the new user requesting a service. To make the trust model scalable and automated, the neural network is used.

Neural networks are typically organized in layers. Layers are made up of interconnected 'nodes' that contain an 'activation function.' As depicted in Figure 3. patterns are presented to the network via the 'input layer, which communicates to one or more 'hidden layers' where the actual processing is done via a system of weighted 'connections.' The hidden layers then link to an 'output layer where the answer is the output layer.
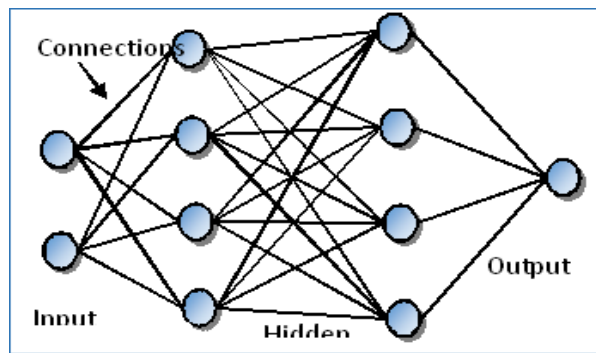
Figure 3: Neural Network

Although there are many different kinds of learning rules used by neural networks, this demonstration is concerned only with one; trainlm network function is used for training the network, which updates the weights and bias function according to the Levenberg-Marquardt optimization technique. Since the computational time of this algorithm is least among all thus this is preferred.

In this neural network, 'learning' is a supervised process that occurs with each cycle or 'epoch' (i.e., each time the network is presented with a new input pattern) through a forward activation flow of outputs and the backward error propagation of weight adjustments. More simply, when a neural network is initially presented with a pattern, it makes a random 'guess' as to what it might be. It then sees how far its answer was from the actual one and appropriately adjusts its connection weights.

In the trust model, we have trained the network using neural first and evaluated the training error rates. Then after training, we have assessed the targets required by the neural network.

3.4 Log Transformation

Since the computed trust value for the SP lies in a range of integers, it is difficult to set the threshold value for the malicious SP. Hence, they Log Transferred so that every value lies between a specific range, making it easier to deal with the trust value and decision-taking.

$$x' = log_{10} x \qquad \dots (5)$$

Where, X' = Transformed Value, X= Data instance

3.5 Malicious Service Provider

Among the several service providers in the service-oriented Internet of Things, some SP may provide poor services to the users, and selecting such a service provider may degrade the system's performance as the user

may end up choosing these service providers, which will result in loss of money and time of those user nodes. Thus it becomes necessary to discard those service providers who may be malicious. These malicious service providers may also cause several attacks. In the proposed method, a threshold mechanism categorizes the service as malicious or trusted SP.

Threshold Method
Trust values of the service providers are in normalized form lying between zero and one. A standard threshold value is selected to categorize service providers as malicious or trusted. The service provider with a trust value above 0.4 is considered in the trusted list; otherwise, they are considered a malicious service provider.

$$\text{Tr(i)} = \begin{cases} Malicious\ SP & if < 0.4 \\ Trusted & if > 0.4 \end{cases} \quad …(6)$$

3.6 Selection
After computing the trust values for the service provider, there comes a need for SP selection. To select the service provider, two methods can be selected. One is the categorization, where service providers are categorized into various categories. Another selection form is the ranking method, where the service providers are ranked from 1 to 10. The ranking of service providers is done based on the computed trust values of each service provider. Users can select the service providers on topmost ranking.

Ranking
In the ranking, service providers are ranked based on their computed trust value, along with the timestamp of computed trust. The higher the trust, the more the rank of a service provider. This is the final output, and it is stored in the database along with the old values in the database and the timestamp. The timestamp is used for refreshing trust values and deleting the obsolete values from the database.

3.7 Trust Conflict Resolution
While computing trust value using the algorithm ORC, some service providers may get the same trust value which occurs conflict stage. So to select the one from the same trustworthiness, the user may choose the service provider with the lowest price or the lowest time constraint. This is done on the requirement preference of the user and is context-dependent. If the user wants service within a time constraint, the service provider with the lowest time-bound will be preferred, but the service provider with the lowest cost will be selected if the user wants a cheaper one.

3.8 Trust Updation
Since trust has a strong decay with time, as time passes, trust starts to decay. Thus it is necessary to update trust. Trust can be updated on a timely basis or an event basis.

1. Timely Driven
In this approach, the trust database is updated periodically without waiting for any transaction to happen. This time can be seconds, hours, days, or even months after every update trust aggregation is reapplied to calculate the final result. More frequent is the updation, better is the computational trust value. If the trust is not updated over a significant decay, the trust outcome value may not be equally effective. In the proposed trust-based model, trust is updated using behavior analysis using trust sharing.

Behavior Analysis using Trust Sharing: Since trust is highly dynamic, it needs to be updated periodically. However, recalculating the trust value of each SP concerning each user is highly time-consuming. Thus, the new behavior analysis method has been proposed for effectively recalculating the trust value of a particular SP for a specific user. A new concept of behaviors analysis using trust sharing is done to show the trust sharing in an IOT system such that any abnormal behavior can be detected and analyzed. It is evaluated using the following formula:

$$\boldsymbol{Tr(updated\ i) = Tr(i) - \sum_{k=0}^{n} \frac{k-i}{n-1}} \quad (7)$$

Where, Tr(i) = current trust value of ith node, K= neighbor node, N= total nodes sharing trust value.

4. PERFORMANCES EVALUATIONS OF PROPOSED TRUST-BASED MODEL SA-ORC:
While implementing, the hotel with attribute ranking dataset is used from the kaggle; different users have provided ranking to its attributes for several hotels. Among them, seven service providers' data is used for the implementation purpose. Table 5. Shows the description of all the seven service providers with the total number of user recommendations and attributes.

Table 5: Description of Dataset Used

Service Providers	Number of Samples	Number of Attributes
Service Provider 1	54	6
Service Provider 2	86	6
Service Provider 3	122	6
Service Provider 4	64	6
Service Provider 5	66	6
Service Provider 6	338	6
Service Provider 7	84	6

5. TRUSTWORTHINESS OF SERVICE PROVIDERS

Overall trust for each service provider is illustrated output console window, as shown in Figure 4. service provider 1 has the highest trust values, while SP4 is the malicious one with the least trust value. The ranking of the service providers is based on the evaluated trust values. The one with the high trust value will rank one and move towards the decreasing ranking. Thus, service provider 4 has the last rank and is also categorized as malicious as its value is less than the threshold.
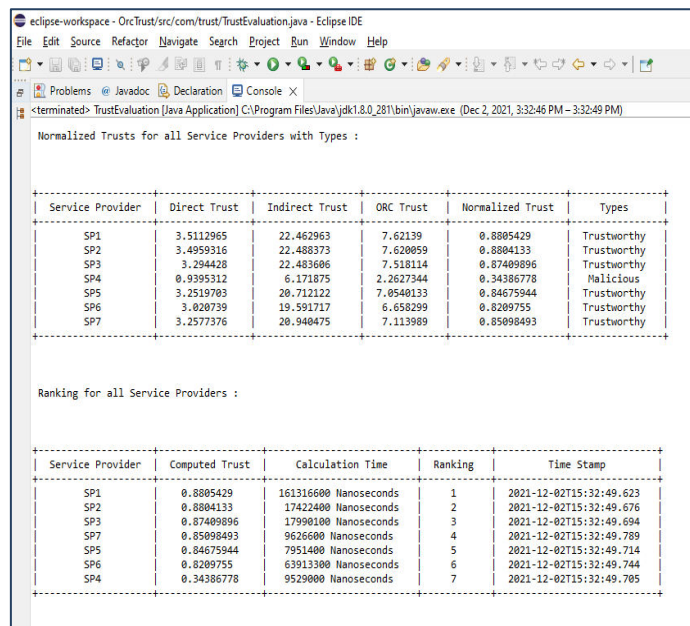
Figure 4: Screenshot of Service Provider's Computed Trust with Ranking

Figure 5 represents the overall ORC trust computation for each service provider in the dataset. The dataset of SP1 shows the highest trust value as 0.8824, followed by the third service provider with a value of 0.882, while sp4 has the least trust value.
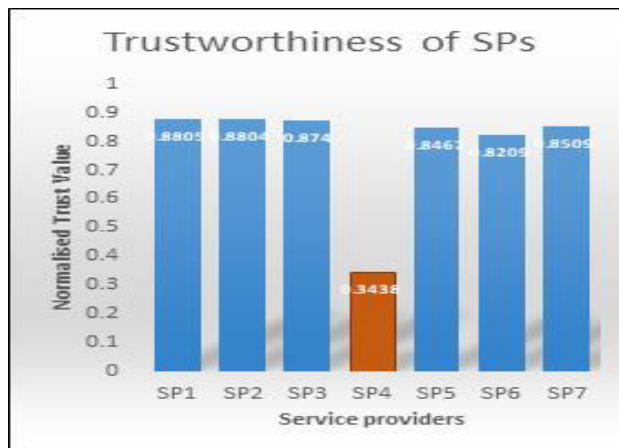
Figure 5: Trustworthiness of Service-Provider

6. COMPARISONS OF THE PROPOSED APPROACH WITH THE TRADITIONAL APPROACH

When the proposed system is analyzed concerning the traditional systems with only direct trust without giving preference to the attribute priority. It shows that the proposed system shows less error than the traditional system. Traditional systems use only direct or indirect trust without the attribute weights. In the proposed system, all three dimensions of the trust are used like direct, indirect, and credential-based trust. Considering all three factors not only removes the biasness but also helps in reducing starvation towards new SP. When the proposed system was implemented using the ORC formula, the errors were much reduced compared to the traditional.

Table 6: Analysis of Proposed System Performance with Traditional Direct Trust

Errors\ scheme	MAE		MSE		RMSE	
	Traditional	**Proposed**	**Traditional**	**Proposed**	**Traditional**	**Proposed**
SP1	0.06209083	0.0068	0.0584309	0.000375	0.0620908	0.006926
SP2	0.059713	0.001314	0.00690131	0.00000707	0.059713	0.001314
SP3	0.006295505	0.005859	0.00225091	0.00059948	0.00629551	0.005859
SP5	0.0515061	0.004579	0.0152108	0.000234	0.05150607	0.004579
SP6	0.0001725	0.00000335	0.0000024	0.000001	0.00154919	0.00000335
SP7	0.0022225	0.00068672	0.00006837	0.00002213	0.00222254	0.00002213

7. CONCLUSION AND FUTURE SCOPE

This chapter describes our proposed trust-based model with its detailed working and process. Starting from the basic framework steps, followed by the detailed architecture with its working. A trust management model is proposed for service-oriented internet of things. While evaluating trust, various steps are followed, from filtering, attributes selection and weightage, trust composition, attack detection and isolation, trust computation, and SP selection. Finally, the trust updation. Our proposed model is scalable and is successfully able to remove the biasness for a new service provider as it considers the SP's credentiality as a major dimension in trust composition. A neural network is used to make the model scalable for a large number of nodes. The proposed model avoids a starvation state for new service providers due to consideration of credentials as a major dimension in trust evaluation.

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PERFORMANCE COMPARISION OF HARD FUSION RULES IN COGNITIVE RADIO NETWORKS

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ABSTRACT
Spectrum sensing plays an important role in cognitive radio networks. The sensing should be more accurate to ensure the primary users to experience least interference, secondary users to get better opportunities for spectrum utilization. But in real time the sensing results are not accurate due to multipath data communication and shadowing. One of the best solutions to improve the sensing accuracy is cooperative spectrum sensing. In cooperative spectrum sensing, multiple secondary users are placed at different locations and transmit their sensing information to a fusion node. The fusion node takes final decision on the primary users' presence based on the data collected from different secondary users and with the help of fusion rule. The impact of different hard fusion rues on sensing accuracy is presented in this paper.

Keywords: Cognitive Radio Networks, Cooperative Spectrum Sensing, Fusion, Sensing Accuracy, signal detection.

I. INTRODUCTION
Day to day the importance of radio frequency spectrum is growing severely due to the following reasons. Usage of number of wireless gadgets is increasing drastically and demanding proportional amount of bandwidth. In the olden days, mobiles are used for message transfers and voice calls only. But now they are being used for transferring images & videos and for video calls also, which need more amount of bandwidth. In addition, the forthcoming technologies like fifth generation communication (5G) and internet of things (IOT) also demand for more amount of bandwidth.

In the wired communications scenario, it is possible to improve the available bandwidth by arranging more number of cables, which is not possible in wireless communications. The available bandwidth is constant for a given physical region and is almost same as one fiber optic cable capacity.

The official applications like military, navigation, radio communications, satellite communications, cellular communications, terrestrial TV transmissions, etcetera use radio frequency spectrum after getting license from corresponding government. As all users can't afford license but need radio frequency spectrum. Government provides some free frequency bands for Industrial Scientific and Medical applications and are termed as ISM bands. The ISM band frequencies are 49 MHz, 900 MHz, 2.4 GHz, and 5.1 GHz. These frequency channels can also be used for other applications like cordless phones, garage door openers, Bluetooth systems, wireless LAN equipment, etcetera also can use the ISM bands. But, ISM bands are crowded due to the occupancy of numerous unlicensed applications in finite number of spectrum bands and in turn leads to bit error rates.

On the counter part, many licensed users are not utilizing the spectrum not even up to 30% of their allotment [1], which results in underutilization of spectrum. So, to address these two issues of spectrum scarcity for unlicensed users and spectrum underutilization of licensed users, there is a need to devise new systems, which ensures solution to both the problems.

Cognitive Radio [2,3]is one of the promising systems to address these two issues. The unused parts of the licensed spectrum can be used by needy unlicensed users in such a manner not to disturb the licensed users is the idea of cognitive radio networks. In this context, the users who got license from government are termed as primary users and the users without license are termed as secondary users.

The main operations of cognitive radio networks are shown in Figure-1 [2,4]. Spectrum sensing is carried out in regular intervals of time for two reasons. One is to identify the vacant spectrum bands for its data communication purpose and the next reason is to leave the spectrum whenever the respective primary user get back while the secondary user is utilizing the spectrum [5,6,7,8].

The sensing accuracy influence both the primary and secondary users. Based on the amount of sensed energy, present or absent status of primary user will be decided and send the same information to fusion center in the case of cooperative cognitive radio networks. Based on the secondary users requests and channels availability spectrum sharing will be done.

In [9], the spectrum is shared among secondary users based on demand and supply principle. In [10], they examined the number of secondary users that can be given access to use free channels without disturbing the others. The secondary user, which is utilizing the channel need to leave the channel whenever the respective primary user returns and this mechanism is called spectrum mobility. During spectrum hand off, the secondary users' data transmissions will be interrupted. One can overcome this problem by predicting the primary users' arrival in advance [11].
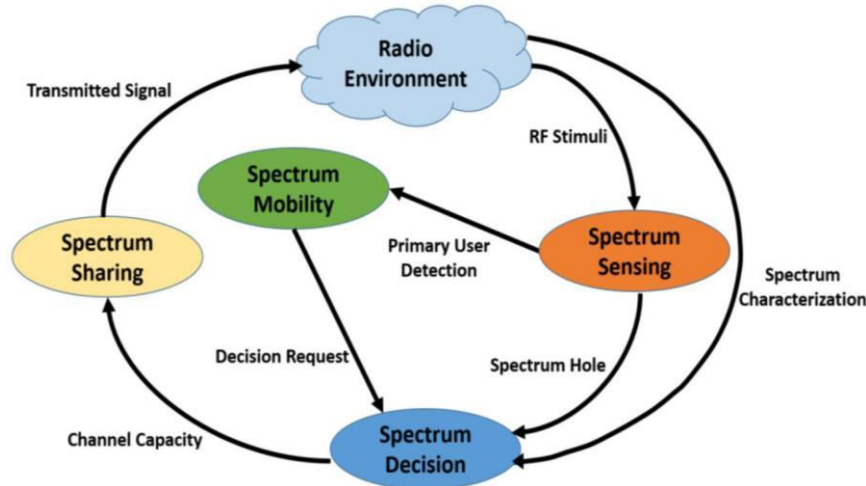
Figure-1: Life cycle of Cognitive Radio Networks

There are four chances of conclusions in spectrum sensing. One is 'deciding primary user is present when it is really didn't exist and is named false alarm. Second is 'deciding primary user is absent when it is really exist' and is named as misdetection. Third is 'deciding primary user is present when it is really exist' and is named as detection. Fourth is 'deciding primary user is absent when it is really didn't exist'. Probability of false alarm and misdetection are high due to multipath data flow, shadowing effect and receiver uncertainty matters.

Because of spatial diversity and multi path fading all CR users won't sense the same amount of energy. This leads to non-uniform conclusions on detection of primary users, some of them are correct and some are wrong. To achieve accurate primary user detection, it is good to collect sensing energies or decisions from all secondary users and by following some fusion rule to decide presence or absence of the primary user instead of taking individual sensing results alone to utilize free channels. This mechanism will improve the primary user detection performance and is called cooperative spectrum sensing [12].

The remaining part of the paper is prepared as follows. Section 2 covers different hard fusion rules, results are described in section 3 and section 4 gives concluding remarks of the paper.

II. HARD FUSION RULES
In hard fusion mechanism, the individual secondary users take the decision on their own based on their sensed energy and send the decisions to fusion center. Based on the received individual decisions and fusion rule the fusion center gives concluding decision. AND rule, OR rule and K out of N rule are the hard fusion techniques [13]. These techniques need less bandwidth as they need to transmit the binary decisions instead of sensed energies [14].

2.1.   AND Rule: If all secondary users' decision is 'channel is busy' then only the fusion center concludes that the 'channel is busy'. Even one secondary user's decision is 'channel is free' then the fusion center concludes that the 'channel is free'.

$$\sum_{i=1}^{N} d_i = N \Rightarrow H_1 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

$$\sum_{i=1}^{N} d_i < N \Rightarrow H_0 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

2.2.   OR Rule: If all secondary users' decision is 'channel is free' then only the fusion center concludes that the 'channel is free'. Even one secondary user's decision is 'channel is busy' then the fusion center concludes that the 'channel is busy'.

$$\sum_{i=1}^{N} d_i > 0 \Rightarrow H_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$\sum_{i=1}^{N} d_i = 0 \Rightarrow H_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

2.3.   K out of N Rule: The other name for this fusion rule is majority rule. If at least K secondary users out of N secondary users decide "channel is busy" then only fusion center decides "channel is busy".

$$\sum_{i=1}^{N} d_i \geq K \Rightarrow H_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(5)$$

$$\sum_{i=1}^{N} d_i < K \Rightarrow H_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(6)$$

Where d_i is local decision of ith secondary user.

III Results and Discussion

The performance of various hard fusion rules is observed with the help of performance metrics like probability of misdetection, probability of false alarm and decision accuracy with the help of MATLAB.
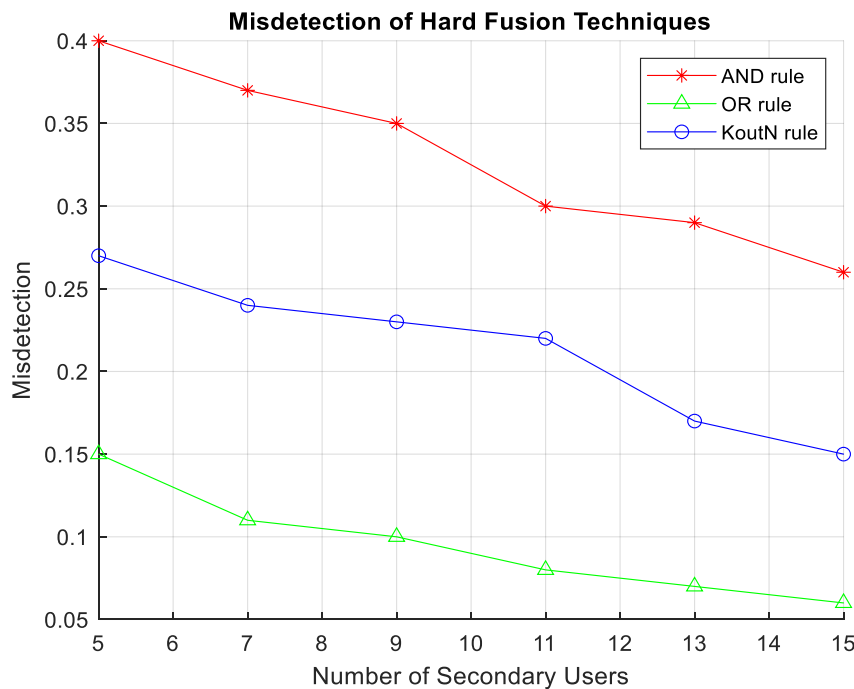
Figure-2: Probability of Misdetection

Figure-2 illustrates the probability of misdetection, which indicates the probability of concluding that there is no primary user when the primary user is present. The probability of misdetection should be as low as possible; otherwise there is a chance of disturbing the primary transmissions by the secondary users, which is not supposed to be happened. From Figure-2, it is evident that OR fusion rule gives better misdetection probability compared AND and K out of N fusion rules. Because, in OR rule even if one secondary user detects the presence of primary user correctly, the final decision is "primary user is present". So very less chance to miss the presence of primary user detection in OR rule. But in AND rule the decision is "primary user is present" only when all secondary users detect the occupancy of primary user correctly. In AND rule, even one secondary user missed to detect the presence of primary user the final decision becomes "primary user is absent" and leads to misdetection problem. That is the reason the misdetection probability is more in AND rule. Coming to K out of N fusion rule if at least K out of N secondary users detects the occupancy of primary user correctly then there is no chance of misdetection. So its misdetection probability is in between OR and AND fusion rules. One more observation from Figure-2 is the misdetection probability is decreasing with increasing number of secondary users in all fusion cases.
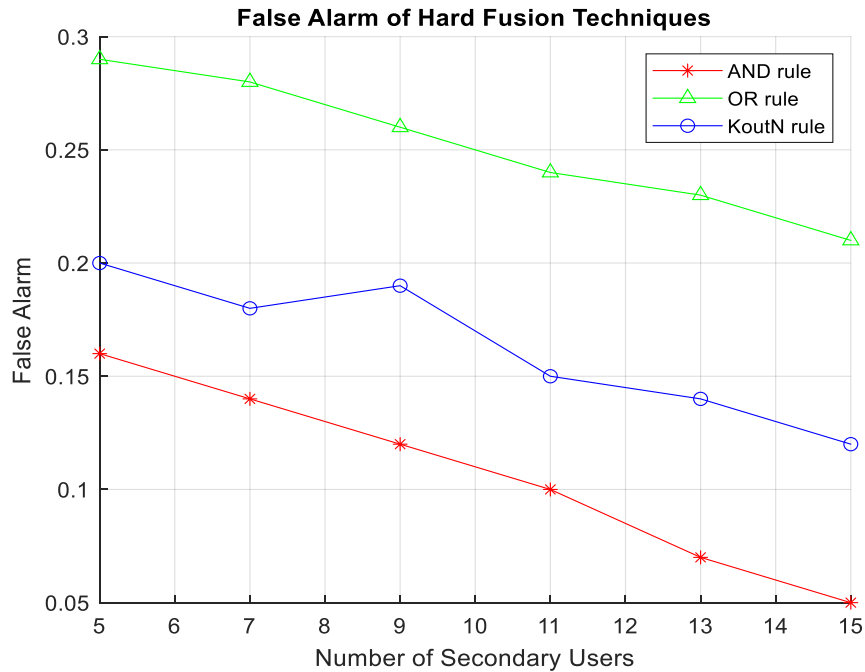
Figure-3: Probability of False Alarm

False alarm probability is shown in Figure-3, which indicates the probability of concluding that primary user is present when there is really no primary user is present. Due to this, the secondary user will lose the opportunity to utilize the spectrum. So it should also be as low as possible. From Figure-3 it can be observed that AND fusion rule gives less false alarm probability compared OR and K out of N fusion rules. Because in AND rule even one secondary user detects the absence of primary user correctly then the final conclusion is primary user is absent. So there is less chance of getting probability of false alarm in AND fusion rule. But in OR fusion rule even one secondary user detects that primary user is present when there is no primary user but final conclusion becomes primary user is present, which results in high probability of false alarm in OR fusion rule. In K out of N fusion rule, there is a probability of getting false alarm only when K or more secondary users detect that there present primary user actually when it is absent. So probability of false alarm of K out of N fusion rule is in between OR and AND fusion rules. One more point to notice is that the value of false alarm probability is reducing when the number of secondary users are increasing in decision making.
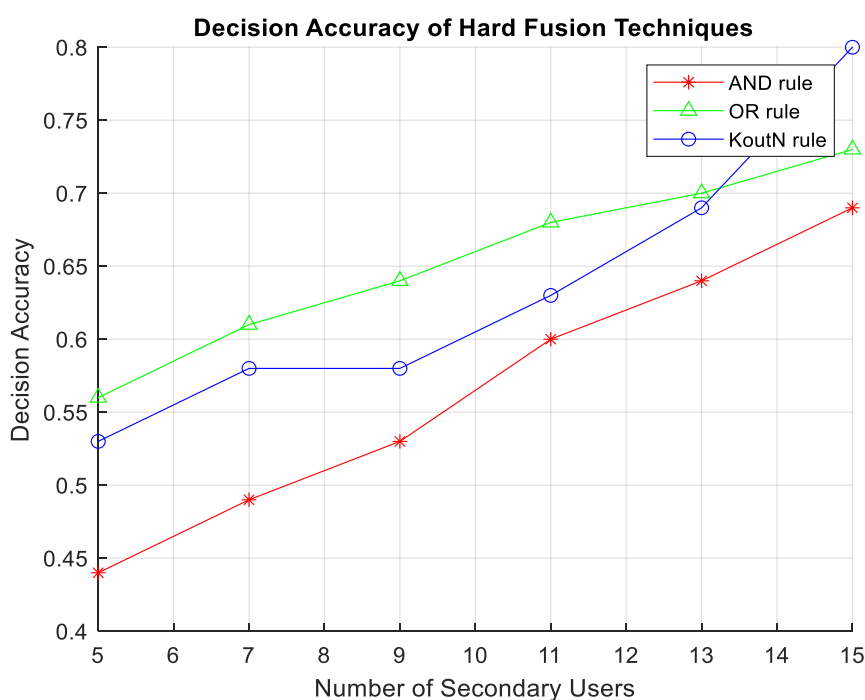
Figure-4: Decision Accuracy

Figure-4 indicates the decision accuracy of OR, AND and K out of N fusion rules, which indicates the correct decision of secondary users. That is, it should conclude that primary user is unoccupied when there is no primary user and primary user is occupied when primary user is using the channel. It should be as high as possible to decrease the disturbance to primary users and to increase the opportunities to secondary users. It can be observed that the decision accuracy of OR rule is high and AND rule is low. It can also be observed that the decision accuracy is increasing with increasing number of secondary users.

IV. CONCLUSION AND FUTURE SCOPE

Cooperative spectrum sensing guarantees better primary user detection with the help of the spatial diversity, in which sensing nodes are kept at different geographical locations. In cooperative spectrum sensing, the decision of primary users is decided by the fusion center by following fusion rules. In this paper the popular hard fusion techniques namely AND, OR and K out of N fusion rules performance is compared in terms of probability of misdetection, false alarm and decision accuracy with respect to number of secondary users. Better misdetection probability is observed in OR rule and better false alarm probability is noticed in AND rule. The detection accuracy is improving with increase in number of secondary users. OR fusion rule is giving good results with respect to AND and K out of N fusion rules.

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THEORETICAL FRAMEWORK OF STUDENT ACTIVISM

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ABSTRACT
Student activism refers to the instances of student unrest posing a significant challenge to the established order or authority. It has created a striking force to act decisively in many nations. A massive wave of student activism emerged in the 1960s worldwide. Student activism usually arises from the conflicts between competing forces in a complex power system. The birth of the university has become the central place for socialising the youth students. The university students have the spirit for more willing to participate in the activities for a change. Many forces have compelled them to become rebels in their activism, resulting in a mass movement receiving enthusiastic support from intellectuals and the public in many events. They organised themselves to launch protests through their organisation against the flawed system. The student organisation has always been a platform for the students to move forward. The collective action of the students constitutes a significant challenge to the harms that fetter the progress of the educational and socio-political life. Their activism has proved to be a legitimate activity in many nations. It is successful in introducing far-reaching changes related to educational and socio-political aspects. The present paper clearly illustrates a theoretical framework of student activism.

*Keywords***:** *Activism, Organisation, Students, University, Youth.*

INTRODUCTION
Student activism represents the way to express students' concerns about educational, socio-cultural and political issues. It is triggered more by socio-political issues rather than education-related issues. Students constitute a social class with a great desire to participate in socio-political activities. They have already been a significant agent of socio-political life. The progress of a society depends primarily on the active engagement of youth students in socio-political activities. A society where students are actively involved in such activities is always moving forward compared to their non-involvement. Their involvement has a huge impact on their society and beyond it. The world was hounded by a massive wave of student activism in the 1960s and 1970s. The student community arose as generational representatives to fight collectively for the common goals. Student activism has significantly captured the inspiration of the youth population. It represents one of the most successful movements characterised by the highest degree of commitment, creativeness and motivation.

OBJECTIVE OF THE STUDY
The specific objective of the present study is to understand a theoretical framework of student activism. It tried to explore the significant insights of student activism, including the birthplace of student activism and its nature and dynamics. It highlighted different forms of student activism, the reasons for engaging more activism by the youth students and the relationship between student activism and student organisation. Lastly, it described the far-reaching impacts of student activism on the world system.

RESEARCH METHODOLOGY
The study is historical, descriptive and exploratory. It relies on information gathered from both primary and secondary sources such as newspapers, reports, books, journals, doctoral thesis and research articles.

THEORETICAL FRAMEWORK OF STUDENT ACTIVISM

Meanings & Definitions
Student activism refers to the instances of student unrest posing a significant challenge to the established order or authority. Students represent the most energetic and volatile element in society. Among their various responsibilities, the most important has been the role that they have played as an activist. Their activism is not limited to educational-related issues. Because they are substantively influenced not only by the academic-related crisis but by the happenings in society. They bear considerable burdens in addressing the problems of their society. A variety of research has been conducted on student activism. Literature on student activism has placed its conceptual framework and definitions within the broader context of social movements. Philip G. Altbach states that a theoretical framework of student activism is hard to analyse. Scholars have posited many theories but failed to provide a clear understanding of activism. However, some scholars have enlightened the specific meanings of student activism. Lewis S. Feuer defined it as a collection of students motivated by goals

that attempt to explicate in a political ideology, and stirred by an emotional uprising indicating a disillusionment with and a denial of the values of the older generation. Wood defined it as students' involvement in non-institutionalised political activities, such as illegal protests against the Vietnam War, illegal protests for civil rights, strikes, sit-in-protests, and others. Philip Altbach said that it is the expression of students' collective ideas to generate a politically relevant public debate on an area that searches for significant socio-cultural and political change. The analysis of student activism within the broader context of social movements is best relevant to the definition of social movement given by Sidney Tarrow. He defined it as a challenge of collective individuals with mutual purposes and solidarity in continued interactions with elites, opponents and authorities. His words, "interactions with elites, opponents, and authorities", are highly relevant in the above two forms of student activism.

Birthplace of Student Activism
Scholars have been interested in finding out the relationship between students and activism. The locus of student activism is primarily confined to higher educational institutions. The birth of the university led the students to an active engagement in socio-political life. The university students constitute a heterogeneous group with diverse ideologies, interests, and political commitments. Such features have been the most fundamental designs of student political activism. They have better opportunities than other groups to mobilise for collective action. They have more access time for gathering groups. The university provides a platform for them to share their views and opinions. Almost every nation has accepted university as an institution in resisting political situations. It offers room for them to develop their ability, potential, and skills to mobilise themselves in all circumstances. The university students have enjoyed broad ideas and exploring them in social life. They have a strong commitment to the justice system.

Keniston stated that university students represent a new class of people who are psychological adults but sociological adolescents. Seymour Lipset put forward that the university atmosphere has allowed them to expose to modern values and ideas. It makes them criticise the outdated traditional norms and existing system supported by their parent's generation. Gill and DeFronzo said that they enjoy the transitory stage of being free from parents and the financial stress of a family. In such a stage, they are very much idealistic with radical ideologies to bring about social transformation. Crossley and Ibrahim argued that the university is the place to meet like-minded actors that establishes bonds for collective actions.

Nature and Dynamics of Student Activism
According to Feuer, the pattern of student activism has three different aspects. The first aspect is the desire on their part to unite with the underprivileged or disadvantaged sections of society. The second aspect has been the central sense of historical mission. The third aspect is the failure of the system resulting in suicidalism (terrorism or nihilism). There have been various causes for the students becoming rebels in their activism. Student activism usually arises from the conflicts between competing forces in a complex system of power, whether the forces may be ideological, political, or economic. Globally, they have witnessed severe disruptions and crises in their nations. It is more likely to happen in a society undergoing sudden change. The socio-political crisis, including social injustices, corruption, oppression, military juntas, and authoritarian regime, has significantly impacted the student community.

The nature of student activism varies considerably from region to region. Some student activism employed non-violent methods, including rallies, demonstrations, sit-in protests, boycotts of classes, roadblocks and hunger strikes. Others carried out violent and unorthodox tactics, including vandalism, destruction of infrastructure, paralysing the administrative machinery and stone-throwing. Radical student activism successfully brings about their social transformation within a short span. Those who are less violent have failed to give immediate impact, but they significantly influenced society sooner or later. Their activism has turned into a mass movement that received enthusiastic support from intellectuals and common people in many circumstances. In fact, student activism is a highly complex and multi-faceted phenomenon. It is highly complex because it is challenging to predict its emergence, and it is complicated to predict its demise. It is multi-faceted because of many variations in terms of the historical circumstances that have led to their activities, the level of socio-political development within which they occur, and the educational system they have been part of. The authority adopted violent repression as a preventive measure to suppress their activism. Such a step is practical for a short duration, but it increases the tendency and size of the students to endure their activism.

Forms of Student Activism
Student activism usually exists in two forms: endogenous and exogenous. While some student activism has taken place within the campus, others take place beyond the campus. Students can mobilise other social groups

and exert pressure on the authority to their cause. Protests within the academic campus by occupying institutions had become unsuccessful when they made demands broader than their academic reforms. They have launched the off-campus protest as the most effective way to seek the attention of the larger supporters. Florencia Polimeni, former secretary of the Buenos Aires University Student Federation (FUBA) and the Argentine University Student Federation (FUA) said, *"It was common sense, when they touch your house, you occupy; if the issue is outside, you need to expand outwards and gain support."* Juan, student activist, also stated, *"There is a correlation of forces to consider based on your objectives…Sometimes occupations become isolated but if you have the capacity to combine them with street mobilisations then you begin to gain visibility and you catch people's attention…."*. They have accepted the effectiveness of off-campus protests to gain the support of outside groups. Pablo Rabey, an anthropologist and youth organiser at the University of Nuenos Aires, has made a similar tone in his words, *"But if you do it with massive mobilisation outside the university, then occupation has a purpose as it allows you to activate the students, organise the movement and generate debate… And you also give the impression that you can do something much greater than disrupting classes, it gets media attention and raises the threat of a general strike"*.

Why is activism more common among youth students?
Sukarno, the first President of Indonesia, said, *"Give me ten youth whose hearts are aflame and I shall move a mountain".* Nelson Mandela also made an inspirational quotation signifying youth activism. He stated, *"Sometimes, it falls upon a generation to be great, you can be that great generation."* There has been a great zeal to study why activism is more common among youth students. Feuer stated that they are attributed to activism on account of *"oedipal conflict."* Their hatred feelings towards their parents are best reflected in the social systems and values of their older generations. Such an attitude has resulted in developing the idea of transforming the existing values supported by their parents. However, the so-called oedipal conflict is criticised for its failure to provide a clear argument for more engaging activism by the university students rather than those who do not attend it. Allerbeck opined that the youths are free from family restraints and it acts as the principal factor for increasing activism. Flacks stated that those youths engaged in activism usually have parents who criticise the values and social systems of the dominant culture. They do not resist the values and systems of their older generation but simply defend the beliefs of their parents. As mentioned earlier, the university has exposed modern ideas and values that make them reject traditional values. They belonged to the group that believed in social transformation through revolutionary means.

Student Activism and Student Organisation
Students can't be treated in isolation from social life. They organised themselves into a group to participate in the issues and challenges confronting society. Such a group has formed a students' organisation representong the most significant socialising agent for the students. Student activism is very successful when it is accomplished through their organisation. Student organisation and student activism represent the platforms for the collective organisation of student politics. Badat offers an apparent difference between the student organisation and movement based on membership. He said that student organisation has voluntary membership within itself. The student movements represent the broader entities comprising of student organisations. They have no formal individual membership. The student organisation is primarily formed and run by the student community for their welfare. It comes forward in the events related to their academic activities. Student activism and student organisation are going hand-in-hand. Their relationship is not only theoretical but historical. The students can't be left aside when their society is confronted with problems. This factor enables them to play a leading role in society through their organisation. The student organisation has been formed with definite objectives, but they are not uniform at all. While some are based on political ideology, others act as pressure groups with or without a political affiliation. The analysis of student activism has relatively understudied student organisations. Many research emphasises student activism as a social movement rather than an institutionalised form of student politics.

Impacts of Student Activism
Barker considered students as catalysts of social action or barometers of the social unrest and political tension in society. Student activism can be described as a crucial developmental part of learning. It imparts democratic values to the students, such as critical thinking, identity consciousness, organising competency, leadership skills and cooperative behaviour. It has intensely reacted against the harms that fetter the progress of social life. Whether it functions on a pure campus or outside, its impacts can be visible beyond it. Students are always conscious of broader socio-political issues and attempt to impact developments beyond their campus. Their activism affects the education system to give disruptive implications to the authority. It has shaped the directions and decisions of the government's agenda. However, it is not always true to denounce student

activism as a negative force. The outlook that it should be eliminated from academic life is full of ambiguity. Because it is indispensable to comprehend the factors that compel student activism and observe its consequences. Student activism has successfully introduced far-reaching changes in the world system. It is usually recognised as a genuine component of the political structure. Its authentic element has resulted in bringing about positive results. Harnessing positive impacts of student activism can influence the educational and socio-political aspects. Many revolutions have acknowledged the commendable roles of the students in making them successful. These revolutions remained the symbolism of students' significant roles in political history.

CONCLUSION

Student activism is an expression of students' voices concerning educational and socio-political matters. It acts as a mediator that helps students discharge their duty to move society forward. It is evident that students' participation in protests and demonstrations has been the primary determinant of student activism. They have significantly brought about reforms and transformation in the education sector. The university students often act as primary agents in the issues related to the educational curriculum. They are moreover very conscious of the problems beyond the educational curriculum. They have employed both mild and violent tactics in realising their ends. They have always been at the forefront in fighting against imperialism, oppressive rules, military juntas, authoritarian regimes and human rights extortion. Their contributions that caused the downfall of the regime through persistent demonstrations are undeniable facts. They have been the real driving force in the movements for change. Their activism has yielded fruitful results. The history of student activism has always left an imprint on the succeeding students to fight for a change.

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A COMPARATIVE STUDY OF CAREER MATURITY AMONG ADOLESCENTS

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ABSTRACT
Career maturity is the readiness of an individual to make informed career decisions and the ability to deal with vocational developmental tasks (Savickas, 1984). It includes the cognitive dimension comprising decision-making skills and the affective dimension, including attitudes towards the career decision-making process. The present study aimed to examine the differences in career maturity among adolescents in relation to their type of school, gender and locale of residence. The sample comprised of 200 senior secondary school students (100 each from government and private schools in Jammu city). Career Maturity Inventory Indian adaptation by Gupta (1989) was used to assess the career maturity of adolescents. Mean, Standard Deviation and t-test were used to analyze the data. Findings of the study revealed female students to be more career mature than their male counterparts, and private school students were more career mature than government school students. However, no significant difference was found in the overall score of career maturity between the rural and urban students.

Keywords: Career maturity, adolescents, type of school, gender and locale of residence.

INTRODUCTION

The nature of work in the 21st century has undergone radical and systemic changes, where career choice and planning have become critical issues in adolescents' lives (Talib et al., 2010). Making a career choice is especially difficult for the adolescents who have not been exposed much to career development interventions or information about careers (Noah, 2002). Although career development is considered a lifelong process, attention is always intensely focused on adolescence, characterized by active vocational development, career decision-making and planning for the future (Arnett, 2010). The transition of adolescents from secondary to tertiary education is considered a critical decision point (Rogers & Creed, 2000), with far-reaching and long-lasting consequences on an individual's life. Hence career education is essential in this stage, especially in recent changes in the education system, which aims to bridge the gap between work-oriented education and mature career choices (Alam, 2013).

The construct of career maturity (or vocational maturity) was introduced by Super (1957). He defined it as "the ability to cope with the vocational or career development tasks with which one is confronted" Super (1977, p.294). Crites (1976) defined it as the eagerness to make sound career decisions and proposed a model that helps understand the factors and variables influencing career development. The model of career maturity consists of affective and cognitive dimensions, which are essential to make realistic career decisions (Crites, 1978). The affective dimension refers to the attitudes toward the career decision-making process, while the cognitive dimension refers to the decision-making skills. According to Jordaan and Heyde (1979), career maturity focuses on 'how' an individual 'responds to emerging demands, problems, challenges, and expectations'. It embodies an individual's coping behaviours and the readiness to employ them toward career-related events faced across different life stages (Srebalus et al., 1982). Hence, it's considered as the collection of behaviours required to identify, choose, plan, and execute career goals (Coertse & Schepers, 2004).

Research on career maturity becomes imperative as it shows significant positive relation with career certainty, decision-making self-efficacy (Sadeghi et al., 2011), self-concept (Gehlawat, 2019), and work role salience (Adekeye et al., 2021). Moreover, people high in career maturity show reduced mental health problems (Hinkelman, & Luzzo, 2007; Seo & Kim 2019) and employment stress (Ko & Park, 2018). Career maturity is influenced by various factors like age (Patton & Creed, 2003), gender (Ahn & Kim, 2018), self-esteem (Migunde et al., 2016), identity status (Salami, 2008), personality traits (Atli, 2017) and more. The compound effect of all these and other factors influences an individual's to be successful in mastering the tasks appropriate to various career development stages (Sirohi, 2013).

Salami (2008) emphasized the school system's responsibility in assisting students to make competent career decisions that align with their abilities, aptitudes, interests, personality characteristics etc. Research on different types of schools with the career maturity of the students has shown different results. Letha and Amin (2012) revealed that the students differ in their career aspirations with respect to the type of schools they attend. Generally, students of private schools possess higher career maturity than those of government schools (Dhillon

& Kaur, 2005; Dhull, 2018; Gehlawat, 2019). Sharma and Ahuja (2017) discovered significant differences in every dimension, i.e. Attitude, Self-Appraisal, Occupational Information, Goal Selection, Planning and Problem Solving, of career maturity between the government and private school students. On the other hand, some studies like Migunde et al. (2015) found students from public schools to be more career mature, and have less career indecision than private school students. Notwithstanding, Sivakumar and Sridhar (2016), Gupta and Mehtani (2017) found no effect of type of school on the career maturity of adolescents.

Career maturity research shows inconsistent results for gender (Sirohi, 2013). Some studies found female students to have more career maturity as compared to their male counterparts (Andleeb & Ansari, 2016; Bishnoi & Kumar, 2014; Dhull, 2018; Gupta & Mehtani, 2017), while other studies favoured male students as compared to females (Hasan, 2006; Ottu & Idowu, 2014). However, some other studies did not find any significant difference between males and females (Birol & Kiralp, 2010; Jeyalakshmi & Nagasubramani, 2018; Rao & Reddy, 2016). Locale of residence has also been a factor affecting the career maturity in adolescents. Alam (2013), Sahu and Agarwal (2016), Jeyalakshmi and Nagasubramani (2018) reported rural students to be considerably less career mature as compared to their urban counterparts. However, Sharma and Kumar (2007), Migunde et al. (2015), Sivakumar and Sridhar (2016), Pandey and Manral (2017) found no significant difference between the vocational interests of secondary students of rural and urban areas.

Adolescence is the transitioning phase between childhood and adulthood. It is characterized by stress and strain. One of the main tasks students has to face and overcome is the development of their career readiness. Generally, adolescents select careers mainly because of the salary, position, glamour and prestige attached to them (Salami, 2000) or as per the criteria set by their family, peers, or parties sponsoring their studies. They usually do not know what it takes to succeed and achieve in those careers (Ogunsanwo, 2000). An apt career decision can only be made after reaching a certain level of career development. So career education becomes crucial at this stage, and career maturity, the most researched aspect of adolescent career development, is under focus in this study.

Studies have shown conflicting and inconclusive results on the relationship between certain demographic variables (type of school, gender and locale of residence) and career maturity. Hence, this study aims to determine the possible connection between the variables in the local context. Furthermore, it is expected that this study will assist the counsellors, parents, and school authorities in recognizing and channelizing the adolescents' career maturity. On the basis of review of literature, it was Hypothesized that-

H1: There is a significant difference in the career maturity of adolescents attending government and private schools.

H2: There is a significant difference in the career maturity of male and female adolescents.

H3: There is a significant difference in the career maturity of urban and rural adolescents.

METHOD
The data was collected with the prior permission of concerned school authorities and the consent of the students. Administration of the test viz., CMI was completed following the instructions given in the manual as far as possible.

Participants
Using multistage random sampling technique, a sample of 200 students (100 each from government and private schools) of class 10th, 11th and 12th studying in schools located in Jammu city of J&K was collected. Using Google forms, data was collected between Sept. 2021 and Feb 2022.

Measures
- **Career Maturity Inventory (CMI) by Gupta (1989)**, initially prepared by J. O. Crites (1978), was used for assessing Career Maturity. It consists of the Attitude scale and Competence scale. The Competence scale is further divided into five subscales – self-appraisal, occupational information, goal selection, planning and problem-solving.

- **Personal Data sheet** to collect information about the demographic variables.

Statistical Techniques Used
Descriptive statistics- Mean, Standard deviation and inferential statistics 't'-test were used for data analysis.

RESULTS AND DISCUSSION

The study's objectives were to compare the career maturity of adolescents concerning their type of schools, gender, and locale of residence. The comparisons were made by testing the significance of the difference between their means by using t-tests.

Table 1: Mean difference of adolescents attending government and private schools on the measure of career maturity (attitude and competency)

Components of career maturity	Government school students (n1=100)		Private school students (n2=100)		t-value
	M	*SD*	*M*	*SD*	
Attitude	21.26	5.32	28.27	4.59	**9.97****
Self-appraisal	4.88	2.45	5.61	2.17	**2.22***
Occupational inf.	4.58	2.87	6.15	3.04	**3.74****
Goal selection	4.17	3.02	6.96	2.60	**6.98****
Planning	2.89	2.39	4.95	2.70	**5.70****
Problem solving	3.23	2.55	5.65	2.91	**6.24****
Career Maturity total	**42.50**	**10.38**	**57.59**	**12.55**	**9.26****

*Significant at 5% level of significance.
**Significant at 1% level of significance.

Table 1 reveals a significant difference between the government and private school students, in all the components, and the overall measure of career maturity. It is evident from the table that students studying in private schools are more career mature than government school students. Thus, hypothesis H1, "There is a significant difference in the career maturity of adolescents attending government and private schools", is accepted. The finding is consistent with the study conducted by Dhillon and Kour (2005). Hence, the students of private schools are better informed about career opportunities than the students of government schools. Additionally, students attending private schools are relatively economically stable and capable of connecting modern means of education compared to their counterparts in government schools (Sharma & Ahuja, 2017).

Table 2: Mean difference between males and females on the measure of career maturity (attitude and competency)

Components of career maturity	Males (n1=94)		Females (n2=106)		t-valve
	M	*SD*	*M*	*SD*	
Attitude	22.50	5.84	26.77	5.58	**5.27****
Self-appraisal	5.14	2.73	5.33	1.94	.53
Occupational information	4.92	2.98	5.75	3.08	1.92
Goal selection	5.40	3.18	5.70	3.11	.68
Planning	3.45	2.64	4.33	2.78	**2.26***
Problem solving	3.87	2.97	4.93	3.07	**2.56***
Career Maturity total	**46.15**	**13.76**	**53.49**	**12.85**	**3.89****

*Significant at 5% level of significance.
**Significant at 1% level of significance.

Table 2 reveals significant differences between male and female students in the full measure of career maturity. The study reveals that the girls are more career mature as compared to boys. Therefore, the hypothesis formulated earlier, "There is a significant difference in the career maturity of male and female adolescents", is accepted. The analysis is supported by the analytical finding of Lau et al. (2013). Thus, it may be concluded that girls' display of higher career maturity is due to overall maturation rates especially at lower grade levels (Omvig & Thomas, 1977).

Table 3: Mean difference between rural and urban adolescents on the measure of career maturity (attitude and competency)

Components of career maturity	Rural (n=89)		Urban (n=111)		t-valve
	M	*SD*	*M*	*SD*	
Attitude	23.43	5.65	25.83	6.22	**2.81****
Self-appraisal	4.93	2.59	5.49	2.09	1.69
Occupational information	4.78	2.67	5.82	3.26	**2.42***

Goal selection	5.41	3.29	5.68	3.03	.60
Planning	4.08	2.90	3.78	2.61	.78
Problem solving	4.41	3.03	4.45	2.97	.10
Career Maturity total	**48.59**	**14.05**	**51.20**	**13.46**	**1.33**

*Significant at 5% level of significance.
**Significant at 1% level of significance.

A perusal of table-3 reveals no significant difference between the rural and urban adolescents on the overall measure of career maturity. Therefore, the hypothesis formulated earlier, "There is a significant difference in the career maturity of urban and rural adolescents", is not accepted. This result is consistent with the findings of Pandey and Manral (2017). Special attention and assistance must be given to the career development and career decision-making process of rural adolescents due to the presence of many detrimental factors in their environment like reduced access to higher education, scarcity of employment opportunities, low expectations for quality employment, a lack of work-related role models (Apostal & Bilden, 1991) etc.

CONCLUSION
The present study has vocational and educational implications, especially for senior secondary school students. It supports the notion that certain demographic factors like the type of school, gender, and locality of residence combine to provide varying educational experiences, affecting the students' career maturity. Hence, young people must be guided and aided in systematic career planning to avoid frustration due to incompatible career choices.

Career maturity prepares adolescents for selecting appropriate career goals according to their aptitudes, interests, and personality traits. According to Patton and Creed (2002), gender differences are evident in work commitment and career maturity. Cassie and Chen (2012) reported that career maturation occurs differentially for males and females, calling for differential career interventions. Studies have shown that career maturity scores can be improved through systematic intervention and career counselling (Bae, 2017), so targeted programs should improve career maturity. As career maturity is viewed as the career counseling goal, adolescents should be given proper career guidance and counselling. Particular attention must be set upon to guide adolescents with low career maturity. The counsellors, teachers, and parents must strive to provide equitable prospects to all students. They must be sensitive to work with rural communities to ensure that biased or stereotypical thinking does not direct the vocational interventions of students (Alam, 2013).

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A CASE STUDY ON PROBLEMS OF TEXTILE INDUSTRY WITH REFERENCE TO POWERLOOMS OF ICHALAKRANJI

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ABSTRACT

Textile industries of India are well known to everyone due to its significant contribution towards economic development. It has gain a prominent position in the Indian & global market. The industry is providing live hood to millions of people by providing them direct & indirect employment opportunities. The composition of cotton textile sector is very multifarious with existence of old technology of hand spinning and hand woven with the most classy automatic spindles and looms. There are several factors responsible for recent growth and development of power looms. India is known for world's biggest installed base of looms. There around 5 million looms in the country. India has 1.8 million Shuttle looms with 45% of world's capacity. Ichalkaranji is one of the renowned powerloom centres in Maharashtra. The center is well known for its multi-coloured product 'Patal' Sarees which is made from imported yarn. There are about 160 sizing units, with 250 sizing machines. The machines include conventional to modern base of technology with more than 1 lakh powerlooms. The powerlooms of Ichalkaranji dealing with issues like (i) Cultural and social issues (ii) Labour Related issues (iii) Raw Material Related issues (iv) Financial Related challenges (v) Managerial and marketing (vi) Technology and knowledge (vii) Government policies

Keywords: Economic Growth Developmentnt spindles and looms, Grey Fabric, Powerlooms of Ichalkaranji, Modern machines.

❖ INTRODUCTION

Textile industries of India are well known to everyone due to its significant contribution in economic development. It occupied the prominent position in the Indian & global market. The industry is providing live hood to millions of people by providing employment opportunities and also by contributing in GDP. It lines second after agriculture. The industry contributes near 16% of industrial production and 2.8% of GDP. Indian textile has classified in three parts which output comes from Mill sector, Handlooms and Power looms. Among that handloom sector is the oldest and form a part of tradition like craftsmanship. The mill sector playing major roll since 1834 with great installed capacity of 37.07 million spindles and 4,89,718 rotors. And the power loom sector which are come before three decades and occupied the dominant position with 22.05 lakh power loom in country

The earlier handloom industry which has handmade operating base gave roots to power loom industry. It was the handloom industry that transformed to present power loom industry. The growth of this industry started with a losing importance of textiles mills during great depression (1929 to 1933) when they started discarding themselves.

The Maharashtra state has 11.06 lakh power loom units. Among that the highest number of power loom unit are unorganized in nature. The State contributes a major share in growth and development of power loom industry. The Power looms of Maharashtra are clustered and segmented in the following prominent power loom centres – Bhiwandi [Thane Dist.], Ichalkaranji [Kolhapur Dist.], Sholapur [Sholapur Dist.], Malegaon [Nasik Dist.], Dhule [Dhule Dist.], and Sangli [Sangli Dist.], Most of these power looms are working in decentralized sector.

STATEMENT OF THE PROBLEM

The purpose of current study is to analyse the profile & problems of power looms of Maharashtra in general and Malegaon & Ichalkaranji in particular. Beside this the study will help to reveal what the factors responsible for growth and development of power looms. Also the study will highlight the challenges facing by the current industry & to recommend the concrete majors to overcome the various problems faced by the sector.

❖ OBJECTIVE OF STUDY
➢ To study the profile of power looms in Ichalkaranji

➢ To discuss the problems & issues facing by the power looms Ichalkaranji.

➢ To conclude with suggested measures and recommendations.

❖ **METHODOLOGY**

The data used in this paper is collected from the secondary source purely taken from various journals, magazines, thesis, article, web links, government websites & books are used as source of information. The scope of study is restricted to power looms of Malegaon & Ichalkaranji only.

❖ **Historical Background**

The history of textile sector is very old which can be traced from British era. The British were arrived at Surat in 1608. The composition of cotton textile sector is very multifarious with existence of old technology of hand spinning and hand woven with the most classy automatic spindles and looms. The initial cotton textile mill was set-up in Ahmadabad in 1861, which was assumed as to be emerging of rival center to Bombay. The enlargement of the textile industry in Ahmadabad was mainly due to the Gujrati community trading class. The textile sector also comprises the textile mills which are extremely complex with the modern, sophisticated and highly mechanized on the one hand and hand spinning and hand weaving (handloom sector) on the other hand and in between these two decentralized powerloom sector falls.

History of weaving fabric on looms can be traced back to 17th century. The first powerloom was invented by Edmund Cartwright in 1785. Originally powerlooms were with shuttle, and they were very slow. But as the industrial demands for faster production accelerated, faster looms without shuttles came in use in early part of 20th century. As developments and innovations took place, various types of looms were developed for faster production.

❖ **Current position**

The role of every sector in the economy and is changing over the period of time, but even today cotton textiles continue to dominate with 74% share. India has world's biggest installed base for looms. There around 5 million looms in the country. India has 1.8 million Shuttle looms which are 45% of world capacity. The power loom industry is in an important position in the economic life of the nation. The total business of this sector is Rs.10, 000 crore per annum. It produces more than 60% of cloth in India and textile ministry's estimation says that more than 60% of the country's cloth exports originated from the above sector. Apart from this sector also provides employment to 4.86 million workers, which comprised approximately 60% of total textile industry employment. The current growth of this sector has been restricted by out-dated technology, inadequate finance, low productivity, low-end quality products and power cut in states like Maharashtra. Changes are taking place in this sector, as many countries would be inventing new style of machinery that is likely to have low manual interface and power cost.

Looms installed capacity (2018-19)	
Item	Units
Looms (Organised Sector)	58000
Powerlooms	3.06 Mn.
Handloom	2.18 Mn.

Source: Office of Textile Commissioner

❖ **Powerlooms of Ichalkaranji**

Ichalkaranji is one of the renowned powerloom centre in Maharashtra. The powerloom were started in 1904 in Ichalkaranji. The center is well known for its multi-coloured product 'Patal' sarees which is made from imported yarn. The afterwards weavers of Ichalkaranji changed their production to grey cloth in fine and superfine dhoties and mulls. Apart from its contribution in cloth production the sector also has the present age of modernization and the weavers are also on the path of modernization of powerlooms.

According to *Textimes'* editorial conveyed that, there are about 35 spinning mills in Ichalkaranji. Units of Ichalkaranji are well operational with modern art of machinery and spinning mills of here are 100% Export Oriented Units. The spinning mills also have easy access to better quality raw material which is required for weaving units. There are about 160 sizing units, with 250 sizing machines, which include conventional to modern machines and more than 1 lakh powerlooms. These powerlooms include plain looms, dobby, drop box, auto and semi auto looms. Such wide ranges of machines are producing fabrics such as cambric, popline, dhoti, printed sari, blouse, interlinings, shirting, canvas and industrial textiles. More than 35 process houses and about 80 hand processing units are fulfilling the needs of the sector. All these units are run on a small scale basis by the various entrepreneurs. Production on powerlooms was mostly catering to local markets, because lack of availability of updated technology. As the quality consciousness and requirements increased since 1980, semi-auto, and fully automatic powerlooms were introduced, producing fabrics for school uniforms and medium weight industrial fabrics etc. Air jet technology is used to produce sheeting fabrics and projectile technology is

used to produce shirting and to some extent, the industrial fabrics. The fabrics (in grey and finished form) produced in Ichalkaranji are in demand at domestic markets like Mumbai, Delhi, Ahmadabad, Kolkata and Bangalore.

Today, in Ichalkaranji state-of-the-art beam warping, sizing and sectional warping machines are in operation. Further small units of garment manufacturing were started in order to add in value of supply chain. Considering today's situation non-automatic tappet powerlooms dominate in Ichalkaranji's de-centralized sector. Almost 80 to 85% looms are of this category

Issues of Powerlooms of Ichalkaranji Identified were:

(i) Personal, Cultural and Social issues

(ii) Labour Related issues

(iii) Raw Material Related issues

(iv) Finance related Issues

(v) Managerial and marketing Challenges

(vi) Technology and knowledge Challenges

- **Personal, Cultural and Social Issues**

Many social and cultural issues were acting as an obstacle in operational functioning of powerlooms. Poweerlooms in Ichalkaranji have reported that they get lack of support from the informal reference groups like relatives and friends due to which the performance of units is affected. Further, the clusters were often formed on the basis of ethnicity and form the basis of support systems in the industry. inequality on the grounds of education is widespread amongst the workers. Startups face restrictions due to the tinted perception of families regarding the working of the industry and preoccupations about a professional and modern work environment. The measure challenge affected on the industry is linguistic insufficiencies and lack of cultural understanding.

- **Labour Related Issues**

The workers of powerloom suffer from depression and mental stress due to work environment. Also the job satisfaction level among the workers is less than 58% found in study. Due to day & night shift many worker have addiction of alcohol and tobacco. Further it was found that owners of loom torturing workers for payment related issues. Many of workers left their jobs due to working conditions and pay. Employees are also facing job skills related issue due to lack of training and development.

- **Raw Material Related Issues**

The powerlooms of Ichalkaranji also reported that they are constantly find hike in the prices of yarn and its availability. For manufacturing cloth basic material required is yarn. The prices of yarn are unstable and continuously going on hike. The reason for hike in price is re-selling of yarn with the help of intermediary. Because of this powerloom owners or weavers get yarn at high price. Many times due to high prices owners find themselves in difficulty and not able to deliver order on time and business operations get stuck.

- **Financial Issues**

For successfully running any organisation smooth flow of finance is necessary. It is found that the powerlooms of Ichalkaranji facing shortage of finance and the reason behind that is earlier M.S.F.C. (Maharashtra state Financial Corporation) was providing finance to these units at low rate of interest but many powerlooms owners could not repaid the on time therefore M.S.F.C. stopped giving loans to these units, same things happen with nationalised banks also they have started resistance in providing loans to the powerloom owners. For smooth functioning industry needs finance in order to purchase new looms, yarn, spare parts. It also requires construction sheds for maintaining large quantity of production. For all these powerloom owners and weavers facing problems of finance. The financial assistance available from the private banks and money lenders is not at affordable, due to high rate of interest cost.

- **Managerial and Marketing Challenges**

In recent times, the importance of management and marketing for the successful working of an enterprise has increased manifold. This has perhaps induced a complacent attitude in the working of the laborers. Lack of education and experience in terms of strategic and goal oriented planning hinders effective communication. The average size of a managing department comprises of mere 5 to 10 employees, which leads to delay in processes and unmanageable work load. Due to a myriad of management and marketing issues which results low sales, many units have been shifted to screen printing and have traditional hand printing techniques.

▪ **Technology and Knowledge Challenges**

For an efficient execution of any task always required experience and knowledge, now this knowledge and experience has a new dynamic dimension called technology. Most of the powerloom owners face challenges due to less experience and knowledge of updated technology. They are not skilled enough to execute tasks effectively and efficiently. Due to lack of skills and underutilization of available technology units are facing financial loss. Opportunity cost of the factors is extremely high & poor infrastructure also a measure hindrance in development. No equipments are used to combat the natural obstructions caused to the industry.

❖ **RECOMMENDATIONS & CONCLUSION**

▪ Being one of the oldest and well known geographically settled industries, state government should try to induce youngsters for entrepreneurship in this industry.

▪ Provisions providing easy loans at low interest rates can serve as an encouragement to the industry.

▪ Symmetric Information related to loans, subsidy, procurement of raw material should be provided from time to time.

▪ Action research on low cost technologies and effluent treatment is required to minimize impact of the industry should be carried.

▪ Skill development and dissemination workshops should be held to familiarize the workers with technology to make industry more prosperous.

▪ Markets should be made available for the ready garments, so that the more production can be sought developing industry further.

▪ Startup and standup schemes should be made available to increase local self employment.

▪ The modernization in industry should be encouraged to enjoy economies of scale and produced quality and standardized finished products.

❖ **CONCLUSION**

Power loom industry is one of the most known businesses after agriculture in India. In Maharashtra, Ichalkarnji based power loom business is well known clothe market and employment creation. The majority of the units are run in this city in comparison to other cities of Maharashtra. The major problems of the industry today are increase in cost of electricity, fall in demand of garments and increase in rate of interest of loans provide. The cost of production is so high that it does not yield adequate profit. Units are being shut down as the cost of electricity is beyond capacity. The initiative of government is neutral somewhere towards this traditionally carried business. In order to keep power loom business going, an immediate attention is needed to be given to survive industry in near future.

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WOMEN AND LAW: A CRITICAL ANALYSIS OF LEGISLATION POLICIES

DR. ARUNA TULASI PUJARI

ABSTRACT

The concept of equality, however, needs equity. The history of social development is also a history of inequality. Inequality between race, religion, ethnicity, class, ethnicity, race, and gender. However, the question of women's rights seems larger, breaking through all levels of social segregation. German philosopher and social scientist Friedrich Engels, in his book The Origin of the Family, Private Property and the State, states: "The woman was the first person to experience slavery. The woman was a slave before the advent of slavery." Women's struggle for equal rights is established by law, be it the Suffragette movement and the right to vote, employment rights, property rights, divorce control, marriage, and child care and medicine about how we live and work as a family, how we access education, health care, and justice.

Keywords: Constitution; Justice; Preamble; Judiciary; Fundamental Rights; Directive Principles of State Policy, Equality, equity

OBJECTIVES

1) Provide awareness on women/gender and law in India.

2) Study the legal provisions for women's access and justice.

3) To look into matters of the application of the law.

4) To identify and prevent sexual harassment of women in the workplace and to prevent and address complaints of sexual harassment and related or related issues.

INTRODUCTION

The concept of equality, however, requires equity. The history of social development is also the history of inequality. Inequality between nations, religions, ethnicity, class, caste, race, and sexuality. However, the question of women's rights looms large, cutting through all the layers of social stratification. German philosopher and social scientist Friedrich Engels in his classical writing *"Origin of the Family, Private Property and the State"* states, *"Woman was the first human being that tasted bondage. Woman was a slave before slavery existed".* The feminist struggle for equal rights has been paved through legislation, be it the Suffragette movement and the right to vote, to employment rights, property rights, rights governing divorce and marriage to child-care and medicine – legislation based on equal rights affects the very values of society, impacting not just the way we vote, but the way we work, live and function as a family, the way we access education, healthcare, and justice.

In India, the constitutionally guaranteed equality for women is often contradictory to the harsh social reality of the land and its cultural norms. The struggle for women's equality began in India in the 20th century, during the struggle for Independence. In the fight against the British, western-educated leaders like B.R.Ambedkar, Mahatma Gandhi, Raja Ram Mohan Roy, and Savitribai Phule encouraged women to step away from their homes and enter the public sphere in the fight for Independence. Indian values, nationalism, and cultural heritage were glorified through the symbolism of 'Mother India'. Perhaps for the first time in India, the idea that a woman is part of the larger Indian tapestry as a legal citizen took root. The inclusion of the female citizen into the public sphere necessitated citizenship rights and changes in the law such as the right to education, inheritance rights, abolition of sati and polygamy as well as an allowance for the widow- remarriage.

While a struggle for nationalism changed the legal landscape of women's rights through the colonial era, the post-colonial era in India has been marked by sweeping changes such as globalization, neo-liberal policies, and the leaps and bounds in technological development. This has expanded women's participation in the public sphere. More Indian women than ever are engaged in business enterprises, international platforms, and multi-national careers like advertising and fashion, and have better opportunities because of the free movement of goods, capital, and ideas. Ideas that question the very nature of laws. Has our legal system kept up with social change? Does our constitution have provisions for equality or equity? Do rights guarantee justice? Is citizenship gendered? The following article gives a brief overview of the current spate of women-centric legal reform in India and concludes with a discussion on its socio-cultural impact on the very fabric of Indian citizenship.

The paper tries to delve into the concept of justice put forth by the Indian Constitution and goes on to analyze its evolution from ancient times to the present day. Further, it goes on to talk as to how the Preamble which serves as an introduction to the Constitution tries to portray justice as the underlying principle governing the Constitution and makes an attempt at putting forth the vibrant judicial pronouncements and as how the Preamble acts as not only as a safeguard to protect but also to promote the cause of justice. The paper additionally goes on to portray how an independent and roaring judiciary in India has helped in protecting the rights of the aggrieved people time and again and how judicial activism can help in improving access to justice in the Indian Scenario.

The main privileges granted to women by the Indian Constitution are:

According to the Constitutional Law, women have equal rights with men, which allow them to participate effectively in governing the country.

Equality before the Law
Article 14 embodies the general principles of equality before the law and equal protection of the law.

Prohibition of discrimination on the grounds of religion, race, caste, sex, or place of birth

- Article 15 (1) and (2) prohibits a state from discriminating against any citizen based on one or more aspects, such as religion, race, caste, sex, place of birth, or any of them.

- Article 15 (3) allows the state to create special provisions to protect the interests of women and children.

- Article 15 (4) provides for the possibility for the state to create special measures to promote the interests and well-being of socially and educationally backward sections of society.

Equality of Opportunity
- Article 16 provides equal opportunities for all citizens in matters of employment or appointment to any position in the state.

- Article 39 requires the state to direct its policy to ensure the equal right of men and women to adequate means of subsistence [Article 39 (a)]: and equal pay for equal work for both men and women [Article 39 (d)].

- Article 39A requires the state to promote justice based on equal opportunities and to promote the provision of free legal aid by appropriate legislation or scheme or in any other way so that no citizen is denied access to justice through economic or other disadvantages.

Humane Working Conditions
Article 42 stipulates that the state must ensure justice and humane working conditions and maternity benefits.

Fundamental Duties of Women
Article 51A (e) requires every citizen to renounce practices that degrade women.

Reservation of places for women in Panchayat and municipalities

Article 243 D (3) and Article 243 T (3) provide for the reservation of at least one-third of the total number of places in Panchaty and municipalities for women, which will be distributed in rotation in different districts.

Article 243 D (4) T (4) provides that at least one-third of the total number of officers of the head of Panchayat and the municipalities at each level must be reserved for women.

Electoral Rights / Electoral Legislation
- At least one-third of the seats must be reserved for women. Such seats may be assigned to different constituencies in Panchayat.

- The office of the head in Panchayat in the village or at any other level should be reserved for SC, ST, and women in such a way that the state legislature may provide by law.

- There are reservations for places for women in municipalities

To comply with its constitutional mandate, the state has taken various legislative measures aimed at ensuring equal rights, combating social discrimination and various forms of violence and atrocities, and providing support services, especially to working women. Although women can be victims of any of the crimes, such as

"murder", "robbery", "deception", etc., crimes against women are characterized as "crimes against women". They are generally classified into two categories.

We are all talking about equality of all genders, but sadly when it comes to the Indian constitution, it is far from the truth. There was indeed a time when the government had to write special provisions in the constitution for women to ensure equality, but clearly, some of these provisions are undoubtedly inappropriate for men.

Legal maintenance is defined as the amount paid to the wife, child, or foster parents to support them. The amount can be paid by making a single lump-sum payment or monthly installments. This name should not be constructed lightly as it is not limited to food, clothing, and shelter. It includes the means of subsistence, provision of services, assistance, support, and assistance that a person needs to survive. It varies according to the person's position and status.

Although the Hind Marriage Act seems to be gender-neutral, all other laws such as Section 125 of the CrPC, Hindu Marriage, and the Adoption Act are still gendered biased and oblige men only to care for their wives and children.

There is fair discrimination based on gender without active discrimination under Section 125 of the CrPC, especially to speculate that a husband, father, or son is considered to be able to obtain and maintain dependents if they are healthy and strong.

Our courts have led to gender equality and gender neutrality through the activism of justice; therefore, gender equality should not be limited to one person, but equally without discrimination and discrimination.

That is why we ask to declare Article 125 of the CPC unconstitutional contrary to Article 14, as the burden of detention lies solely on men. On the other hand, they are asked to read aloud Article 125 so that men and women are not discriminated against.

The rules should apply to both men equally because they are not always the wrong people and victims, sometimes it can be the other way around.

Section 125 of the CPC took a commendable step toward enforcing the detention order, but this section is based on a code of conduct according to which a person with sufficient authority is responsible for maintenance. It can be concluded that Section 125 does not address gender parental care, but prefers the gender issue of marital care.

Laws that deal with the abuse of women, ranging from sexual to economic, do not recognize the violence faced by men, which indicates inequality in the legal system.

The incidence of false accusations after a divorce, when a woman feels disrespectful, is increasing every day in India. The law does not provide men with any protection against these humiliating accusations that lead to extreme measures in the form of suicide.

According to the Marriage Amendment Act (2000), after a divorce, a woman is required to pay child support, and sometimes highly educated women usually hide the fact that they are currently employed, but still require maintenance. Failure to do so could result in criminal liability.

It is a narrow rope on which the country walks, where crime against women is high and crime committed by women is also on the rise, a balance must be struck so that equality is not pushed and reaches its precise definition by uniting with humanism.

There is now a new trend in the name of EQUALITY when a girl marries a guy and after several years of marriage, they make false accusations and shoot several cases under domestic violence, 498A, 125 for service, 406 for jewelry. In most cases, the husband's family also stretches. As a result, the family receives a summons, which leads to harassment. The family finally settles the matter, making large payments and divorcing. Currently, the law is a platform for extortion. Many cases follow the same pattern.

"75 percent of cases have been withdrawn because women use charges to extort money," said Vasif Ali of the Family Preservation Foundation, a men's rights group that offers counseling and legal assistance to "men in need" accused under the law. etc. . "Even out of 15 percent of convicts, many are potentially innocent."

India is regularly dragged for coal for its cruel treatment of women, but never thought about the fact that women persecute men?

Women's rights need to be changed to protect men as well. The need for the hour is a system where women are protected and men are not persecuted for false accusations.

If the use of the rights granted by the Indian Constitution to abuse and maintain security is a women's right, do I not think that we as women deserve these laws? Women's rights are given for protection, and these days women use laws as weapons, not shields, and make the victim sound like their culprit.

Important Constitutional and Legal Provisions for Women in India
The principle of gender equality is enshrined in the Indian Constitution in its Preamble, Fundamental Rights, Fundamental Duties, and Directive Principles. The Constitution not only grants equality to women but also empowers the State to adopt measures of positive discrimination in favor of women. Within the framework of a democratic polity, our laws, development policies, plans, and programs have aimed at women's advancement in different spheres. India has also ratified various international conventions and human rights instruments committing to secure equal rights for women. Key among them is the ratification of the Convention on Elimination of All Forms of Discrimination against Women (CEDAW) in 1993.

1. CONSTITUTIONAL PROVISIONS

India's constitution not only gives women equality but also gives the state the right to take action positive discrimination in favor of women for neutralizing the overall socio-economic, educational and the political shortcomings they face. Fundamental rights, among other things, ensure equality before the law and equal protection of the law; prohibits discrimination against any citizen on religious, racial, or castle grounds, gender or place of birth, and to guarantee equal opportunities for all citizens in matters related to employment.

Articles 14, 15, 15 (3), 16, 39 (a), 39 (b), 39 (c) and 42 of the Constitution are of particular importance in this respect. (regard)

CONSTITUTIONAL PRIVILEGES

(i)   Equality before the law for women (Article 14)

(ii) The state should not discriminate against any citizen solely based on religion, race, caste, sex, or place of residence. Birth or any of them (Article 15 (i))

(iii) The State shall provide for any special provisions in favor of women and children (Article 15 (3)).

(iv) Equal opportunities for all citizens in matters related to employment or appointment to any position under the state (Article 16)

(v)   The State should direct its policies to ensure the equal right of men and women to the proper means of subsistence (Article 39 (a)); and equal pay for equal work for both men and women (Art39 (d))

(vi) Promote equity on an equal footing and provide free legal aid under relevant legislation or a scheme or in any other way to ensure that no one is denied the opportunity to ensure justice citizen due to economic or other defects (Article 39 A)

(vii) The State provides for fair and humane working conditions and maternity benefits (Article 42)

(viii)The state will pay special attention to the educational and economic interests of the weaker sections of the population people and protect them from social injustice and all forms of exploitation (Article 46)

(ix) The state raises the standard of living and the standard of living of its population (Article 47)

(x)   To promote harmony and a spirit of common brotherhood among all the people of India and Russia to renounce practices that degrade women (Article 51 (A) (e))

(xi) At least one third (including the number of seats reserved for women on the schedule Castes and Tribes on schedule) of the total number of seats to be filled by direct election in each Panchayat will be reserved for women, and such places will be distributed in rotation differently constituencies in Panchayat (Article 243 D (3))

(xii) At least one-third of the total number of offices of the President in Panchayat at each level to be reserved for women (Article 243 D (4))

(xiii) At least one third (including the number of seats reserved for women on the schedule Castes and Tribes on schedule) of the total number of seats to be filled by direct election in each The municipality should be reserved for women, and such seats will be rotated differently constituencies in the municipality (Article 243 T (3))

(xiv) Reservation of offices of heads in municipalities for scheduled castes, tribes and women in such a way as the legislature may provide by law (Article 243 T (4)

2. LEGAL PROVISIONS

To comply with the constitutional mandate, the state has taken various legislative measures to ensure equal rights, combat social discrimination and various forms of violence and atrocities, etc. provide support services, especially to working women. Although women can become victims of any the crimes such as "murder", "robbery", "deception", etc., crimes against women are characterized as "crimes against women." They are generally classified into two categories.

(1) Crimes recognized by the Criminal Code of India (IPC)

(i) Rape (IPC Section 376)

(ii) Abductions and kidnappings for various purposes (Sections 363-373)

(iii) Murders of dowry, dowry, or attempted dowry (IPC Section 302/304-B)

(iv) Torture, both mental and physical (IPC Section 498-A)

(v) Corruption (IPC Section 354)

(vi) Sexual harassment (IPC Section 509)

(vii) Imports of girls (under 21)

(2) Crimes Recognized by Special Laws (SLLs)

Although not all laws are gender-specific, the provisions of the law concerning women are significantly effective. Periodically reviewed and amended to keep up with new requirements.

Some acts that have special provisions for the protection of women and their interests are:

(i) The Employees State Insurance Act, 1948

(ii) Plantation labour Act, 1951

(iii) The Family Courts Act 1954

(iv) The Special Marriage Act of 1954

(v) Hindu marriage act, 1955

(vi) Hindu Succession Act 1956, as amended in 2005

(vii) Immoral Trafficking (Prevention) Act, 1956

(viii) Pregnancy and Childbirth Assistance Act 1961 (as amended in 1995)

(ix) Dowry Prohibition Act, 1961

(x) Medical Termination of pregnancy Ac,t 1971

(xi) Contract labor Act (Regulation and Abolition), 1976

(xii) Equal Remuneration Act, 1976

(xiii)Maternity Benefit Act 1961(amended in 2017)

(xiV) Child Marriage Prohibition Act, 2006

(xv) Criminal Law Act (as amended), 1983

(xvi) Factory Act (as amended), 1986

(xvii) Law on Indecent Representation of Women (Prohibition), 1986

(xviii) Sati Commission (Prevention) Act, 1987

(xix) The Protection of Women from Domestic Violence Act, 2005

3. Special initiatives for women

(i)   National Commission on Women: In January 1992, the Government established this statutory body with a specific mandate to study and monitor all issues related to constitutional and legal guarantees for women, review existing legislation to propose changes where necessary, etc.

(ii) Reservations on women in local government: 73 laws amending the Constitution passed In 1992, parliament secured a third of the total number of women in all elected positions in local government whether in the countryside or the city.

(iii) National Action Plan for Girls (1991-2000): The action plan must ensure survival, protection and development of the girl with the ultimate goal of building a better future for a girl.

(iv) National Women's Empowerment Policy, 2001: Department of Women and Children The Ministry of Human Resources Development has prepared a "National Policy for Women's Empowerment "in 2001. This policy aims to make progress, development, and empowerment of women

JUDICIAL PROTECTION FOR WOMEN'S RIGHTS

Widespread outrage over the brutal gang rape and death of Jyoti Singhin New Delhi led to the promulgation of the Criminal Law Amendment Act, 2013 ("Criminal Law Amendment Act"). The Criminal Law Amendment Act, 2013, which came into effect on 3 February 2013, has been amended and added new sections to the Indian Judicial Code on sexual offenses. Other new cases recognized by the Criminal Law Amendment Act are acid attacks, slander, harassment, intentional stripping of women, and sexual assault.

In 2013, India adopted its first law that specifically addresses the issue of sexual harassment in the workplace; Act on Sexual Assault in the Workplace (Prevention, Prevention, and Correction), 2013 ("POSH Act") established by the Ministry of Women and Child Development, India. Sexual harassment in the workplace is a form of sexual harassment that violates a woman's fundamental right to equality and the right to life, guaranteed under Articles 14, 15, and 21 of the Constitution of India. The POSH Act was established to prevent and protect women from sexual harassment in the workplace (including creating a hostile workplace) and dealing with complaints of sexual harassment.

Maternity Benefit (Amendment) Act, 2017 ("Maternity Amendment")

The year 2017 saw a dramatic amendment to the Maternity Benefit Act, 1961 (the "Maternity Act"). Maternity Amendment extends the maternity leave paid to female employees with less than two surviving children, from the first 12 (12) to twenty-six (26) weeks.) weeks. A dose of eight (8) weeks may be taken before the expected date of birth and the remainder after delivery. Women who are expecting their third child are also entitled to 12 weeks of paid maternity leave — six (6) weeks before and after that.

The Maternity Amendment provides for mothers who have a baby less than 3 months old, or "sending mothers" to take twelve (12) weeks of maternity leave from the date of birth. This Pregnancy Amendment enables mothers to work from home after completing 26 (26) weeks' leave on their job details and employer's consent. The Pregnancy Amendment Act also authorizes institutions that employ 50 or more staff members to have the kindergarten they need. limited resources and resources. Female staff members are entitled to visit the crèche four times a day, including downtime.

Decriminalizing of Adultery

On September 27, 2018, a five-judge panel of the Supreme Court of India ("Supreme Court") overturned another colonial law, Section 497 of the Indian Penal Code which mandated five years' imprisonment for men for adultery.

Unlike India's sexual harassment laws, which go hand in hand with a woman's consent, a 158-year-old adultery law would not consider a woman's will. Although women could not be punished under this system, a man could persecute a man who had sexual relations with his wife, even if the wife voluntarily participated in the act.

Joseph Shine, a 41-year-old Indian businessman living in Italy, has appealed to the Supreme Court to overturn the ordinance. He said it discriminated against men by blaming them for extramarital affairs and treating women as objects. All five Supreme Court judges heard the case, claiming that the law was selfish, impartial, and unconstitutional. The Court however made it clear that adultery would be the cause of divorce.

Dipak Misra, the then Chief Justice of India said that"It's time to say that (a) husband is not the master of (his) wife. Women should be treated with equality along with men".Justice R F Nariman who wrote a separate judgment to concur with the judgments of Chief Justice Dipak Misra and Justice Khanwilkar stated that Section 497 was an archaic provision that had lost its rationale. "Ancient notion of man being the perpetrator and woman being a victim of adultery no longer holds good", observed Justice Nariman.

Justice Chandrachud in his separate but concurring opinion said that Section 497 was destructive to a woman's dignity and also emphasized that "Respect for sexual autonomy must be emphasized"." Section 497 perpetuates

the subordinate nature of woman in a marriage", were his concluding remarks. Justice Indu Malhotra noted in her judgment that the Section institutionalized discrimination.

This was the second colonial-era law struck down by the Supreme Court after it struck down the 157-year-old law which criminalized gay sex in India.

Triple Talaq

Instant Talaq or "*Triple Talaq*" or "*Talaq-e-Biddat*" is an Islamic practice that allows men to divorce their wives immediately by uttering the word "*talaq*" (divorce) three times.

Supreme Court, and in its most recent landmark decision by Sayarabano Vs. The Union of India announced on August 22, 2017, setting aside the practice of "Triple Talaq". The bench has declared Triple Talaq unconstitutional with a 3: 2 majority. The decision of the minority bench also instructed the Union Government of India to enact appropriate legislation to legalize the continuation of divorce as Shariat law.

Considering the views of the Supreme Court, the Muslim Women (Protection of the Rights of Marriage) Bill of 2018 ("Triple Talaq Bill") was introduced in Lok Sabha by the Minister of Justice and Justice, in December 2018. She is better known. Like the Triple Talaq Bill, this bill makes all declarations of talaq, including written or electronic form, null and void (i.e. not legally binding) and illegal. It defines talaq as talaq-e-bidder or any other similar type of talaq mentioned by a Muslim man which leads to a quick and irreversible divorce.

The Triple Talaq Bill makes the talaq proclamation a criminal offense, which carries a three-year prison sentence. The case will only be known if the information relating to the case is provided: (i) a married woman (the accused has been declared), or (ii) any other person related by blood or marriage.

Triple Talaq Billis awaits Rajya Sabha's approval. In the short term, a law punishing triple talaq has been announced. A law making the practice of the triple talaq a quick one, the punishment case has been issued for the third time in February 2019.

The Triple Talaq Bill makes a declaration of talaq a cognizable offense, attracting up to three years' imprisonment with a fine. The offense will be cognizable only if information relating to the offense is given by: (i) the married woman (against whom talaq has been declared), or (ii) any person related to her by blood or marriage.

The Triple Talaq Billis is pending the nod of the Rajya Sabha. In the interim period, an ordinance penalizing the act of triple talaq has been promulgated. The ordinance making the practice of instant triple talaq, a penal offense has been issued for a third time in February 2019.

Sabrimala Issue

The Supreme Court on September 28, 2019, delivered one of the most keenly awaited judgments in the Sabarimala case. By a 4:1 majority, the Supreme Court permitted entry of women of all age groups to the Sabarimala temple, holding that 'devotion cannot be subjected to gender discrimination. The lone woman on the bench, Justice Indu Malhotra, dissented. Then Chief Justice Dipak Misra, Justice R F Nariman, Justice AM Khanwilkar, and Justice DY Chandrachud constituted the majority.

The judgment was delivered in a 2006 PIL filed by the Indian Young Lawyers Association challenging the centuries-old tradition of Sabrimala Temple banning entry of women of menstruating age inside the temple.

"Woman is not lesser or inferior to man. Patriarchy of religion cannot be permitted to trump faith. Biological or physiological reasons cannot be accepted in freedom for the faith", said Chief Justice Dipak Misra while reading out portions of the judgment written out for himself and Justice AM Khanwilkar.

Justice Chandrachud in his separate but concurring opinion held that the idea behind the ban was that the presence of women will disturb celibacy, and that was placing the burden of men's celibacy on women. This stigmatizes and stereotypes women, he analyzed.

Justice R F Nariman held that the customs and usages of the Sabarimala temple must yield to the fundamental right of women to worship in the temple.

Women's Reservation Bill

Women's Reservation Bill or the Constitution (108th Amendment) Bill, is a pending bill in India that proposes to amend the Constitution of India to reserve 33 percent of all seats in the Lower House Lok Sabha, and in all state's legislative assemblies for women. The seats to be reserved in the rotation will be determined by the draw

of lots in such a way that a seat shall be reserved only once in three consecutive general elections. The Upper House, Rajya Sabha passed the bill on March 9, 2010.

As of today, the Lok Sabha has not yet voted on the bill and the bill remains in limbo. If the Lok Sabha were to approve the bill, it would then have to be passed by half of India's state legislatures and signed by the President.

CONCLUSION

After the year 2013 witnessed the promulgation of the Criminal Law Amendment Act and the POSH Act, there have been several other changes in the law that have been for the welfare, security, and benefit of women as well as to eliminate gender-based discrimination, one of the fundamentals of the Constitution of India. As we have seen the Supreme Court, has taken several initiatives and in some cases issued directions to the Government as well, but it is the practical implementation of these laws that is required to ensure equality for women.

There are a great many difficulties that many Indian women face, which include poverty, female feticide, sexual harassment, lack of education, and job skill training. India still ranks 108th among 149 countries in the World Economic Forum's (WEF) Global Gender Gap Index, 2018. A lot needs to be done to ensure that Indian women have equal rights and we see an India defined by inclusive citizenship rather than exclusive.

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DETECTION AND ANALYZING THE BRAIN TUMOR USING ANN, SVM AND MACHINE LEARNING (ML) APPROACHES

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ABSTRACT

The human brain, which is made up of billions and billions of neurons, is the body's command centre and most complicated machine. It takes information from the body's sensory organs and transmits it to the muscles. Controlling muscles and coordinating body movements are some of the major activities of the human brain, as are sensory perceptions, memory, learning, speech, emotions, and cognition and consciousness (H. E. M. Abdalla et al. 2018). The objective of this paper is to identify the brain tumor with the help of Artificial Neural Network, Support Vector Machines and Machine Learning approaches. MRI images have been taken into consideration for the analysis, the Machine Learning approach uses the image segmentation process and proves the results to be efficient.

Keywords: Artificial Neural Network, Support Vector Machines, Machine Learning, Sagital Section

INTRODUCTION

The Brain: The forebrain, midbrain, and hindbrain are the three major sections of the brain. "The left and right cerebrums, diencephalon, cerebellum and brain stem are the four primary areas of the brain". Figure 1 illustrates the brain's key components, compositions, and cavities.
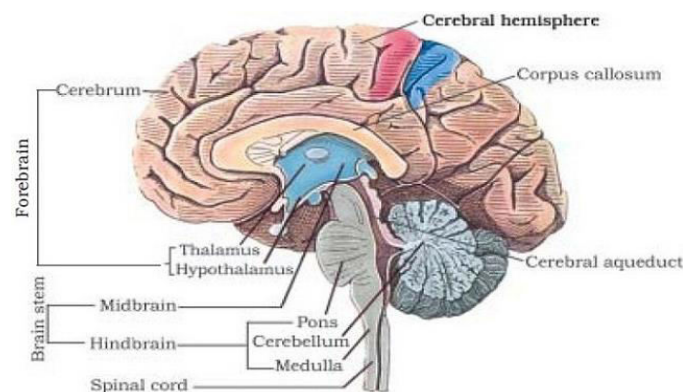
Fig.1: Sagital Section of the Human Brain

The cerebrum (cerebral cortex) is the most important region of the human brain, accounting for roughly 80% of its total mass. The frontal, parietal, temporal and frontal lobes of the cerebrum are divided into four different areas, each with its unique function, such as managing speech, smell, hearing, vision, memory, complicated learning, and behavioral reactions. Its cavity contains Gray Matter (GM) and White Matter (WM) tissue, as well as Cerebral Spinal Fluid (CSF). Glial cells and myelinated axons transmit messages between the cerebrum and the midbrain in the WM. The majority of neurons, dendrites, and capillaries are found in GM. Cerebral spinal fluid is a fluid that travels from the brain's ventricles to the whole central nervous system Any traumas or physical damage to brain tissue in any section of the cerebrum will cause its functioning to decline.

1.1 Characteristics of Brain Tumors:

Brain tumors are cell proliferations that are aberrant and uncontrolled. Some of them begin in the brain itself, and are referred to as primary. Others, known as secondary, spread to this area through metastasis from elsewhere in the body. All of the tumors are quite hazardous. The area of the skull is quite small, and when the cancerous parts spread, there is a danger to human life. The intracranial pressure rises, reducing blood flow to brain areas, resulting in edoema, which causes normal tissues to stop functioning and cells to degenerate.

Primary and secondary are the two types of brain tumors. The tumors can be treated at this stage by taking the appropriate medicines on a regular basis. The main brain tumor is benign and contains aberrant cells that grow slowly. Secondary brain cancers develop from untreated original brain tumors. Malignant refers to a secondary brain tumor that is rapidly growing abnormally. Because the tumor cannot be managed by medication or surgery at this time, the patient with a malignant brain tumor should get radiation treatment. Surgery is used to remove abnormal cells in the brain, and when the surgery is completed, a lot of medicine is required.

1. RELATED WORK

Borase *et al.* (2017) used the source brain MR image was classified as normal or tumor impacted using a Neural Network (NN) classifier. In order to increase classification accuracy, our neural network classifier needed a large number of benign and malignant brain MR images in training mode.

Rajesh Chandra *et al.* (2016) applied the extracted feature vector of the brain MR image was subjected to the Genetic Algorithm (GA). For maximising the set of features retrieved from the brain imaging, the authors used GA. To pick the best number of features from the feature vector acquired from brain MR images, it is subjected to a selection, crossover, mutation, and fitness process.

Kshitija V, Shingare & Pergad (2015) proposed using Probabilistic Neural Network Techniques, an efficient algorithm for brain tumor detection, identification and classification has been developed. The MRI Scanned Images are used in these approaches to detect the tumor in the brain.

Sheela *et al.* (2006) proposed a brain MR images classification system using neural network self organizing maps and Support Vector Machine (SVM) techniques.

Deshmukh & Khule (2014) worked on Brain Tumor Detection Using Artificial Neural Network Fuzzy Inference System (ANFIS). In their proposed methodology, they extracted features and ANFIS (Adaptive neuro fuzzy inference system) was fed raw pictures, which were subsequently processed.

Hussna & Esmail (2018) proposed "Brain Tumor Detection by using Artificial Neural Network, their study aimed to design automatic algorithm to detect the brain tumor from MRI by Artificial neural networks". With the help of available brain tumor MRI, an algorithm was created, developed, and tested. The authors suggested a series of image segmentation methods with feature extraction determined from Haralick's features equations. A feed-forward back propagation neural network with supervised learning was utilised to classify the pictures into those with or without tumours.

Hemanth *et al.* (2019) applied design and implementation of a machine learning technique for detecting brain tumors. The CNN method was utilised to detect brain tumors by the researchers. The proposed technique is tested on a variety of photos, and the rewards are great.

Masoumeh & Mohammad (2019) proposed brain tumor identification using neural network and machine learning approach. The authors developed a new method for tumor detection in brain imaging based on a combination of CNN and feature extraction.

Shankargowda *et al.* (2017) proposed approach for Support vector machines are used to detect and classify brain tumors (SVM). The authors created a mind tumor type to aid radiologists in determining whether a mental tumor is malignant or benign.

Harshini Badisa *et al.* (2019) proposed the CNN based brain tumor detection. The paper outlines the MRI-based brain tumor division techniques. Because of MRI's non-intrusive nature and high delicate tissue differentiation, a large number of current cerebrum tumor division tactics use it.

2. METHODOLOGY

This paper focuses on three methodologies namely Artificial Neural Network, Convolutional Neural network (CNN) and Support Vector Machines (SVM) and Machine Learning (ML) approach.

2.1 Brain Tumor Detection Using ANN:

For this study, we used the ANN approach, which we broke down into three phases: The preparation of MRI images is the first step. The second step involves picture post-processing such as segmentation, morphological operations, feature extraction, and so on. The final phase is implementing image features for pattern recognition in order to detect tumors. Following figure 2 shows the flowchart for the preprocess steps included in brain tumor detection using ANN.
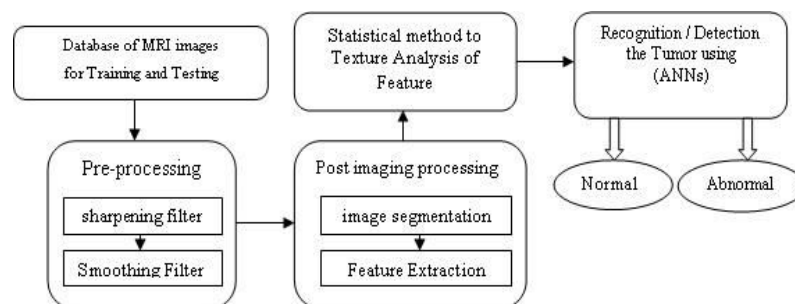
Figure 2: Processing of ANN for brain tumor detection

The best parameter for detecting the tumor is picked after computing all of Haralick's features and showing the characteristics curve for each one. The following photos depict the outcomes of the Graphic User Interface (GUI) design, which depict the whole proposed process from image loading to tumor detection. Figure 3 shows the tumor after Image segmentation then applied morphological operation and feature extraction.
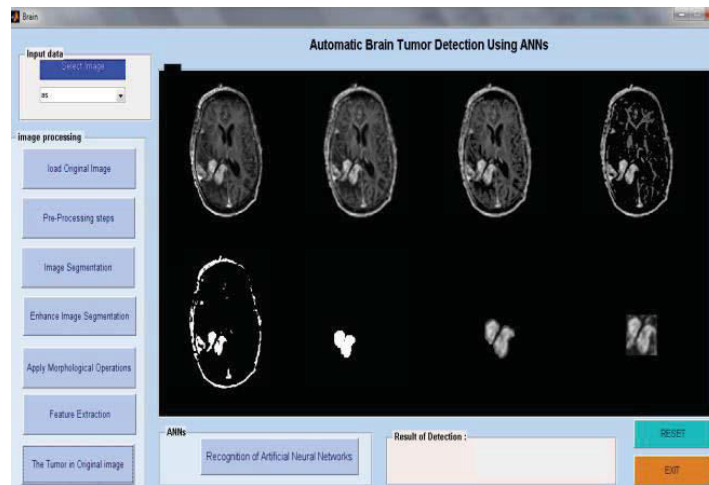
Figure 3: Tumor in source image
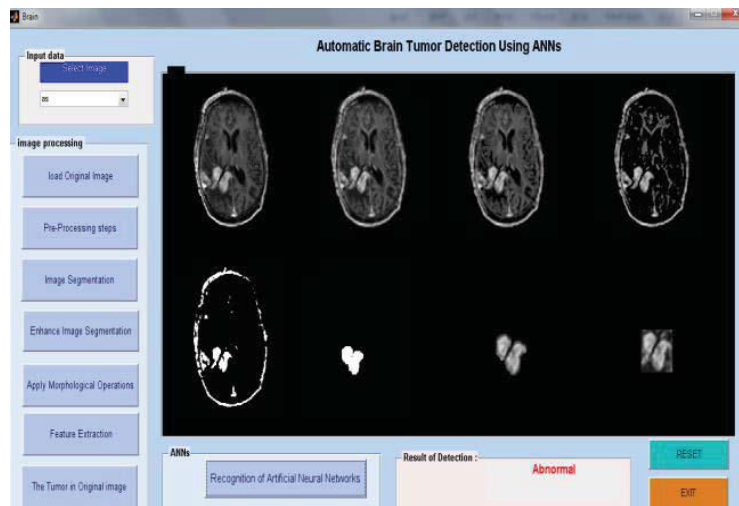
Figure 4: The Result of Detection and use of ANN

Above figure 4 shows the recognition of ANN and with the result of detection as "Abnormal".

2.2 Brain Tumor Detection Using SVM:

The current study uses a set of rules to segment the tumor and uses a Support Vector Machine (SVM) classifier to detect and classify the tumor. Shankaragowda et al. suggested a method for detecting and classifying brain tumors using Support Vector Machines (SVM). Researchers used segmentation and classification to determine which class it belongs to. The classification system for brain tumor detection using SVM is as follows,
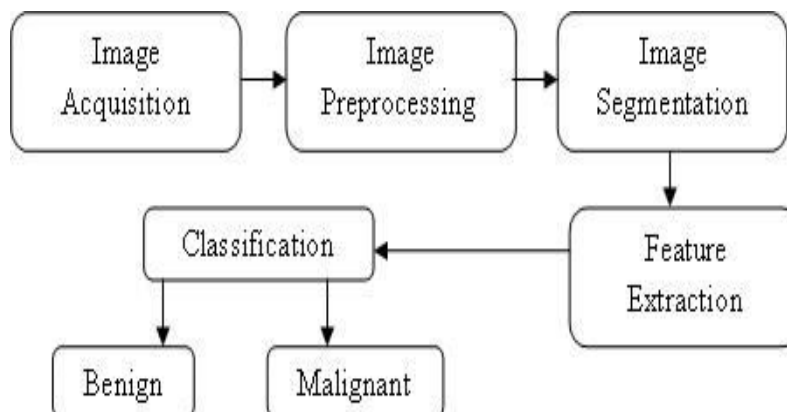
Figure 5: SVM Classification System

The goal of *preprocessing* is to produce photo facts that minimize undesired distortions and improve the image's capacity to be processed further. Pixel brightness transformation, image recovery, geometric preprocessing, and other procedures are all part of picture preprocessing. The technique of splitting an image into a number of sub components is known as picture segmentation. Thresholding schemes, color-based segmentation, and texture-based approaches are all used in *segmentation*. Feature extraction is a sort of dimensionality reduction in which key aspects of a photograph are efficiently represented as a compact function vector. A wide range of choice-theoretic strategies for identifying the identification of snap shots are included in the classification. The numerical houses of various photo features are investigated, and statistics are categorized. In MRI scans, the presence of a tumor is discovered, and the tumor is classed as benign or malignant.

2.2.1 Results:
SVM is a supervised learning methodology, the outcomes with this method is as follows,

Input Image   Processing   Processed Image
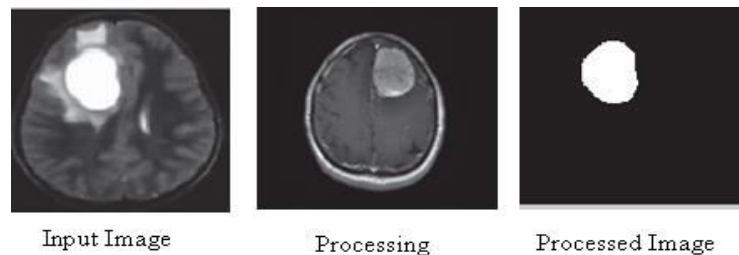
Figure 6: SVM results

Based on the research findings, it can be concluded that the SVM classifier has a high rate of statistical learning. The background of all incoming images is DICOM (Digital Imaging and Communication in Medicine).

2.3 Brain Tumor Detection Using Machine Learning Approach:
Machine learning and data mining techniques have been shown to be effective in detecting and preventing brain tumors at an early stage. Image segmentation is a common digital image processing technique. In the area of medical imaging, brain tumor image sectioning in MRI has recently been a popular area of research. G. Hemanth et al. conduct and test the approach in the Matlab platform, utilising the image processing tool, and the approach is designed and used in a MATLAB environment. The datasets were created using the UCI dataset.

It is observed from the ML approaches while implementing for detection of brain tumor, as this the current work uses a typical neural network methodology for detecting brain tumors, whereas previous work relied on neighborhood pixels for tumor detection. The CNN method is effective in detecting brain tumors.

3. CONCLUSION
The primarily objective is identification of brain tumor detection by ANN (Artificial Neural Network), SVM (Support Vector Machines) and Machine Learning (ML) approaches. The ANN approach employs a series of picture segmentation and feature extraction methods to provide a suitable outcome. The characteristics are computed using Haralick's equations in this methodology. In SVM approach, main focus is given on identification whether or not the tumor nodule is malignant or benign. The ML approach is based on traditional neural network approach for detecting brain tumor. The machine learning algorithms and data sets are implemented on multiple images and the output retrieved is best and effective.

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EVALUATION AND STANDARDIZATION OF A NOVEL HERBAL DENTIFRICES

ASHWINI A. PATIL, ATUL DESHMUKH, JAYA GHORE, AMOL KHEDKAR AND MRUDUL CHITRAKAR

ABSTRACT

Introduction: *Oral health is a part of general health Dental Cavity and sensitivity are the most recent dental problems moving humankind.*

The present study was aimed to formulate and evaluate herbal dentifrice prepared from healthful plants to treat oral problems like dental sensitivity dental caries and to maintain oral health.

The herbal drugs that have been included in this dentifrices i.e., Yashtimadhu, Karanj (bark), Khadir, Vijaysaar (bark), Propolis, and Clove oil are routinely used as medicines. These herbal drugs show antimicrobial property for the various disease condition they possess essential concentration of bound phytochemical present in them which will beneficial human body.

Method: *A herbal toothpaste is prepared by using dry extract powder of Yashtimadhu, Karanj (bark), Khadir, Vijaysaar (bark), Propolis and, clove oil. Toothpaste was prepared in GMP- certified pharmacy under all safety and hygienic precautions.*

Results: *Organoleptic evaluation shows that Dentifrices is smooth, brown in color, with sweet, minty in taste, and pleasant smell. Physicochemical parameters show that herbal toothpaste is stable, possessing good homogeneity and abrasive property with 4715 viscosity, 7.33 pH.*

The antimicrobial activity of the prepared herbal toothpaste was determined. The results showed that the prepared herbal dentifrice has antimicrobial effects against each gram-positive, gram-negative organism and antifungal effect against gram-positive fungus

Conclusion: *Prepared herbal Dentifrices possess all properties of ideal dentifrices and is free from microbes. The prepared herbal toothpaste will be helpful for everyone's dental health.*

Keywords: Dentifrices, propolis, Antibacterial activity.

INTRODUCTION

Kinds of Dentifrices have been used since the long period [1] and are one of the main irreplaceable parts of oral health. Toothpaste is a dentifrice used to clean, maintain and improve the health of teeth. [2][3]

Oral health is integral part of our health [4] and is very important for the development of human beings. Dental sensitivity and dental Cavity are the most current dental problems moving humankind. [2][4]

Any part of the herbal drug can be used for healing and treating disease purposes. Herbal medicines are used widely throughout human history and according to World Health Organization (WHO), about 80% of the human population used herbal medicine for primary healthcare,[4] most of them possess antimicrobial, anti-diabetic, antiviral, anticancer, and antifungal activity. Most common types of infections occur in oral cavity [5] like Dental sensitivity dental caries, if left untreated, create trouble. Toothpaste, toothbrush, and mouthwash that contain antimicrobial agents are routinely used to maintain oral health, [5] Plant based toothpastes have received great attention in reducing gingival inflammation.[6]

It is the responsibility of the oral care professional to understand the ingredients in various toothpaste and direct patients to different products based upon their individual needs.

MATERIALS AND METHODS

Dry extract of *Yashtimadhu, Karanj* (bark), *Khadir, Vijaysaar* (bark). Propolis is taken for preparation of toothpaste (from xxxx Pharma). [7][8][9][10][11][12][13][14] All the extracts are authentified and standardized. Dentifrices was prepared under all hygienic conditions and safety precautions in GMP certified pharmacy. [7][3]

Raw drug standardization was done in certified laboratory refer table no.1 and 2. [8][9][10][11][12][13][14]

METHOD OF PREPARATION OF TOOTHPASTE-

Procedure

Step 1: Check cleaning of mixer & manufacturing area.

Step 2: Check cleaning of all utensils used for weighing. Measurement should be done in the SS container.

Step 3: Check all the material released by QC for weight.

Step 4: Check water temp. (>85˚C) & water level.

Step 5: Check leakage of mixer by taking full vacuum (wait for 1min, pressure shouldn't go down by more than 10mm)

Step 6: Check wire mesh of the sifter & pass ppt. CaCO3, followed by the binding agent, Sod. CMC & Xanthan gum as per the required qty. for batch size.

Step 7: Add Sod. Saccharin, Preservatives (Propyl Paraben& Methyl Paraben) into the mixer, after which add hot purified water into the mixer as per the required quantity

Step 8: Add Sorbitol into the mixer (Note that the scrapper should be "ON" during addition) and mix it well for 3min.

Step 9: Add Glycerine into the mixer (Note that the scrapper should be "ON" during addition) and mix it well for 2min.

Step 10: Add qty. of powder premix i.e., all extract (ppt CaCO3, herbal extracts blend, and Xanthan gum) & mix the content for 5 Min.

Step 11: Then add ppt. silica (Note that the scrapper & both disks should be "ON" during addition). Now mix the bulk to deaerate by operating scrapper & disks for 15 - 20min. & 6 - 8min. respectively.

Step 12: Release Vacuum, add & SLS into the mixer & Mix it well for 5 Min (Note that the scrapper & both disks should be "ON" during addition).

Step 13: Apply full vacuum & then start cooling till the temperature of the mass is <40˚C. Ensure the mass is completely deaerated (Note that the scrapper should be "ON" during the process). Total time -10-15 min.

Step 14: When the temperature falls below 40˚C, add clove flavour into the mixer and mix it for 10min. (scrapper & disks operation to continue for 10mins).

Prepared herbal dentifrices is packed and sealed in a collapsible tube with the help of a collapsible tube sealing machine.

For contains of the Dentifrices refer Table no. 3[3][7][15][16]

EVALUATION OF HERBAL DENTIFRICES

1. Organoleptic evaluation
Organoleptic evaluation (appearance, colour, odour, taste) was done by sensory and visual inspection. [5] [7]

2. Physicochemical Parameters

Abrasiveness
Extrude the content 15-20 cm long on the butter paper, repeat the same process for at least ten collapsible tubes. Press with the contents of the entire length with the fingertip for the presence of sharp and hard-edged abrasive particles. Toothpaste shall not contain such particles. [2][7]

Stability
The stability study was performed as per ICH guidelines. The prepared herbal dentifrices was filled in the collapsible tube and stored at different temperature and humidity conditions, 25ºC± 2ºC / 60% ± 5% RH, 30º C ± 2ºC / 65% ± 5% RH, 40ºC ± 2ºC / 75% ±5% RH for three months and studied for appearance, pH and spreadability. .[3][7]

· Relative Density. Relative density was determined by weight in gram taken in 10 ml formulation and 10 ml distilled water using RD bottle. [7]

• PH-pH of formulated herbal toothpaste was determined by using a pH meter. 10g of toothpaste placed in 150ml of the beaker. Allow the 10ml of boiled and then cooled water. Stir vigorously to make a suspension. [3]

- **Foaming Determination**

The foaming ability of prepared herbal dentifrices was evaluated by taking a small amount of formulation with water in a measuring cylinder initial volume was noted and then shaken 10 times. The final volume of foam was noted. [7][17]

- Determination of Moisture and Volatile matter - 5 g of formulation placed in a porcelain dish containing 6-8 cm in diameter and 2-4 cm depth in it. Dry the sample in an oven at 105ºC. [2][7]

CALCULATION

By mass = 100MI/M MI-Loss of mass (g) on drying

M- Mass (g) of the material taken for the test.

Spread ability- In this method slip and drag characteristics of paste involve. The prepared herbal dentifrices was (2g) placed on the ground slide under study. The formulated paste is placed like a sandwich between this slide and another glass slide for 5min to expel air and to provide a uniform film of the paste between slides. Excess of the paste was scraped off from the edges. The top plate was then subjected to pull of 80g with the help of string attached to the hook and time (sec) required by the top slide to cover a distance of 7.5cm was noted. A short interval indicated better spread ability.[2] [7]

Formula was used to calculate spread ability.

$S=M\times L /T$

Where,\

S= Spread ability

M= Weight in the pan (tied to the upper slide)

L= Length moved by the glass slide

T=Time (sec) taken to separate the upper slide from the ground slide. [7][18]

- **Homogeneity**

The toothpaste shall extrude a homogenous mass from the collapsible tube or any suitable container by applying of normal force at 27±20C. in addition, bulk of contents shall extrude from the crimp of a container and then be rolled it gradually. [2][7]

- **Phytochemical Evaluation**

The phytochemical evaluation was done to evaluate the presence and absence of Tannins, Saponins, Alkaloids, Flavonoids, glycosides and terpenoid Steroid, Anthraquinones. [7]

- **Stability Study**

The stability study was performed as per ICH guidelines. The prepared herbal dentifrices was filled in the collapsible tube and stored at different temperature and humidity conditions, 25ºC± 2ºC / 60% ± 5% RH, 30º C ± 2ºC / 65% ± 5% RH, 40ºC ± 2ºC / 75% ±5% RH for 1 week and studied for appearance, pH and spreadability.[7]

At 250 C

+ -20 C; 60% +- RH (1 week) accelerated study.

- **Antimicrobial Activity**

An anti-microbial test is performed in this case to see the inhibitory effect of the Mentioned toothpaste samples. [7][19]

OBSERVATION AND RESULTS

To standardize and validate the safety of Dentifrices, the final prepared toothpaste was standardized and tested for organoleptic evaluation, physicochemical evaluation, phytochemical evaluation, stability study antimicrobial analysis was done. All these analyses were done in certified laboratories and reputed research institutes.

Herbal Dentifrices is prepared by using dry extract powder of *Yashtimadhu, Karanj* (bark), *Khadir, Vijaysaar* (bark), Propolis, and clove oil.

Evaluation of reading paste was done.

The organoleptic evaluation shows that Dentifrices is smooth, brown in colour, with a sweet, minty taste and pleasant smell. (Refer Table no. 4).[7][18] Physicochemical parameters show that herbal Dentifrices is stable, possessing good homogeneity and abrasive property with 4715 viscosity, 7.33 PH. (refer Table no. 5)

In phytochemical evaluation Tannins, Saponins, Alkaloids, Flavonoids, glycosides, and terpenoids are present. Steroid, Anthraquinones are absent (refer Table no. 6). [7][16]

In Antimicrobial evaluation, prepared herbal dentifrices shows sensitivity towards Staphylococcus aureus, Escherichia coli, and Candida Albicans zone of inhibition was (7mm) (6 mm), and (8mm) respectively. (Refer Table no. 8). The developed herbal dentifrice shows antimicrobial effects against each gram-positive, gram-negative organism and antifungal effect against gram-positive fungus. [7][19]

The formulated Dentifrices show antimicrobial activity against pathogens.

Antifungal Activity Using Agar Cup Method

Standard Condition:
Organism: Candida Albicans

Media used: Mueller Hinton Agar

Quantity of Media: 20ml

Method used: Agar cup method

Culture volume: 1ml

Diameter of the cork borer: 7mm

Diameter of the well: 7mm

Amount of sample used: 50µl

Incubation temperature & time: 37^0 C for 24 hr.

Positive control: Fluconazole (10ppm)

Negative control: Saline

Antibacterial Activity Using Agar Cup Method for Results Refer Table No. 8

Standard Condition:
Organism: S. aureus, E. coli

Media used: Mueller Hinton Agar

Quantity of Media: 20ml

Method used: Agar cup method

Culture volume: 1.0ml

Diameter of the cork borer: 7mm

Diameter of the well: 7mm

Amount of sample used: 50µl

Incubation temperature & time: 37^0 C for 24 hr.

Positive control: Ciprofloxacillin (10ppm)

Negative control: Saline [6][7][20][21][22]

DISCUSSION
A conventional method of *dantamanjan* (toothpowder) consists of powdered forms of herbs. Due to low palatability and patient compliance, it was thought to be modified. [14] Through this study, an effort was made to replace the conventional form of *dantamanjan* with herbal Dentifrices.

The pilot preparation was useful to set process standards for further final preparation in GMP-certified pharmacy. The final preparation was done in two batches. The final product analysis and standardization were

carried out of this preparation. All required safety, hygienic care was taken while preparation using sterilized instruments and microbial assessment.

Propolis is antibacterial, antifungal, anti-viral, antioxidant and shown to be capable of obliterating the dentinal tubules, which in turn decreases the permeability of the tubules and thereby reduces the Dentinal Hypersensitivity. [12][23][24] *Yashtimdhu* acts as an anti-inflammatory component against the gums. [13][14] Clove has been used to relieve toothache, in periodontitis, as an anaesthetic, and also to treat bleeding gums.[4] The Karanj is effective for treating & cleaning gums, teeth. [5][9] *Vijaysaar* is used in the treatment of stomach-ache, cholera, dysentery, urinary complaints, tongue diseases, and toothache. [8]

Mentioned herbal drugs possess minimal side effects and hence can be recommended for long term use. [25]

CONCLUSION
The prepared herbal Dentifrices may be safer to use routinely. Further studies are warranted to prove the safety and efficacy of the prepared herbal Dentifrices.

TABLE INDEXING
1. **Table 1:** Raw drug standardization Report- i)Yashtimadhu *ii) Khadir*(Acacia Catechu) iii) *Vijaysar* Pterocarpus Marsupium) iv) *Karanj (* Pongamia Pinnata)

2. **Table 2:** Raw drug standardization Report- Propolis Powder extract

3. **Table 3:** Formulation table (contains of the Dentifrices)

4. **Table 4:** Result of Organoleptic Evaluation

5. **Table 5:** Result of Physicochemical evaluation

6. **Table 6:** Result of Phytochemical Evaluation

7. **Table 7:** Result of Stability study

8. **Table 8:** Antimicrobial Evaluation

Table 1: Raw drug standardization Report- i) Yashtimadhu *ii) Khadir*(Acacia Catechu) iii) *Vijaysar* Pterocarpus Marsupium) iv) *Karanj (* Pongamia Pinnata)

Sr.no.		Test	**Yashtimadhu**		*Khadir* (Acacia Catechu)		*Vijaysar* Pterocarpus Marsupium)		*Karanj (* Pongamia Pinnata)	
			Observation	**Result**	**Observation**	**Result**	**Observation**	**Result**	**Observation**	**Result**
1		**Organoleptic Characters**								
	A	Appearance	Dry fine powder	Passes	Dry fine powder	Passes	Dry fine powder	Passes	Dry fine powder	Passes
	B	Colour	Brown	Passes	Brown	Passes	Reddish Brown	Passes	Brown	Passes
	C	Odour	Characteristic	Passes	Characteristic	Passes	Characteristic	Passes	Characteristic	Passes
2		Sieve analysis	100% passes through 60#	Complies	100% passes through 80#	Complies	100% passes through 60#	Complies	100% passes through 80#	Complies
3		Loss on drying / Moisture %	NMT 7.0%	3.59 %	NMT 7.0%	4.59%	NMT 7.0%	3.59 %	NMT 7.0%	4.59%
4		Bulk density	0.45 – 0.55 g/100 ml	0.49g/ 100 ml	0.45 – 0.55 g/100 ml	0.47g/ 100 ml	0.30 – 0.45 g/100 ml	0.33g/ 100 ml		
5		Total ash	NMT 18.0%	9.57%	NMT 10.0%	8.57%	NMT 10.0%	6.57%	NMT 10.0%	4.57%
6		pH	3-7	4.87	3-7	4.57	4-7	4.47	3-7	5.42

7	Heavy metal	NMT 20 ppm	Compl ies	NMT 20 ppm	Compl ies	NMT 20 ppm	Compl ies	NMT 20 ppm	Compl ies
8	**Microbial analysis**								
1	Total plate count	NMT 1000 cfu/g	107 cfu/g	NMT 1000 cfu/g	197 cfu/g	NMT 1000 cfu/g	247 cfu/g	NMT 1000 cfu/g	223 cfu/g
2	Yeast &Mould	NMT 100 cfu/g	20 cfu/g	NMT 100 cfu/g	09 cfu/g	NMT 100 cfu/g	11 cfu/g	NMT 100 cfu/g	29 cfu/g
	Pathogens								
1	Escherichi a coli	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absen t
2	Salmonell a	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absen t
3	Pseudomo nas aeruginosa	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absen t
4	Staphyloc occus aureus	Absent	Absent	Absent	Absent	Absent	Absent	Absent	Absen t
9	**Assay (Glycyrrhizin %)**	NLT 5-10 %	8.36 %						
10	**Assay (Tannin %)**	NLT 20%			21.36 %				
11	**Assay (alkaloids %)**	NLT 0.25 %					0.30 %		
12	**Assay (Tannin %)**	NLT 5.00%							6.36%

Table 2: Raw drug standardization Report- Propolis Powder extract

Sr.No	Test	Result	Specification
1	Odour	Characteristic	Complies with standard
2	Colour	Brown	Characteristic
3	Presence of wax	Absent	Absent
4	Flavonoid % by mass	0.5	NLT 0.3
5	Tetracycline	Not detected	5 ppb
6	Chloramphenicol	Not detected	0.3 ppb
7	Sulfonamide	Not detected	5 ppb
8	Tylosin	Not detected	5 ppb
9	Total plate count	180 cfu/gm	NMT10000 cfu/gm
10	Yeast count	< 10 cfu/gm	< 10 cfu/gm
11	Mould count cfu/gm	< 10 cfu/gm	< 10 cfu/gm
12	E.coli in 1 gm	Absent	Absent

Table 3: Formulation table

Sr. No.	Ingredients	Quantity % W / W
1	Precipitate Cal. Carbonate	35.00
2	Sorbitol 70%	30.00
3	Purified Water	18.02
4	Glycerin	1.00
5	SLS Liquid 28%	5.00
6	PPT Silica M-FIL (P)	4.00
7	Karanj bark ext + Vijaysaar bark ext+ Licorice ext + Acacia ext (1:1:1:1 ratio)	4

8	Propolis ext	1
9	Clove flavor	1
10	Xanthan gum	0.75
11	Sodium Saccharine	0.2
12	Methyl Paraben	0.020
13	Propyl Paraben	0.010
	TOTAL	**100.00**

Table 4: Result of Organoleptic Evaluation

Sr.No.	Parameters	Observation
1.	Appearance	Smooth paste
2.	Colour	Brown
3.	Odour	Pleasant
4.	Taste	Sweet and Minty

Table 5: Result of Physicochemical evaluation

Sr.No.	Parameters	Observation
1.	Smoothness	Smooth structure
2.	Relative density	10.60
3.	pH	7.33
4.	Foaming determination	13ml
5.	Moisture	14.48%
6.	Spread ability (cm)	3.2cm/sec
7.	Homogeneity	Good
8.	Abrasiveness	Good abrasives
9.	Stability	Stable
10.	Viscosity	4715
11.	Volatile matter	27%

Table 6: Result of Phytochemical Evaluation

1	Tannins	+
2	Saponins	+
3	Alkaloids	+
4	Flavonoids	+
5	Glycoside	+
6	Steroid	-
7	Terpenoid	+
8	Anthraquinones	**-**

+ = Presence of phytochemical.

- = Absence of phytochemical.

Table7: Result of Stability study:

Duration	Colour	Appearance	Spreadability	PH
Day 1	Brown	Homogenous	3.1cm	7.32
Week 1	Brown	Homogenous	3.3cm	7.34
1 Month	Brown	Homogenous	3.3cm	7.34

Table 8: Antimicrobial Evaluation

Sr. No.	Organisms	Ciprofloxacin	Fluconazole	Sample
1.	E. coli	10 mm	--	7mm
2.	S. aureus	13 mm	--	6mm
3.	C. Albicans	--	10mm	8mm

Figure 1: Closed chamber preparation of Dentifrices

Figure 2: final prepared Novel herbal Dentifrices

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AYURVEDA TOURISM IN KERALA: PEREGRINATION FROM GOD'S OWN COUNTRY TO WORLD'S WELLNESS HUB

DR. HARI KRISHNAN P. K

ABSTRACT

*Kerala, for many centuries, has been acknowledged as the land for alternative medical systems like Ayurveda, Yoga, Unani, Siddha and Naturopathy and is also known for its medical pluralism. Though Ayurveda is being practiced as an alternative stream of medicine all over the globe, in Kerala, this system of medicine still strictly follows age-old traditional Ayurveda texts for treatments and preparation of Ayurvedic medicines. Kerala has recently emerged as the hub for wellness seekers across the globe for their Ayurvedic treatment. Kerala has successfully redefined Ayurveda from customary "medication to medicinal services" which enable tourists to avail **"wellness"** from **"illness".** In the last two decades Ayurveda is gaining global acceptance as many prefer Ayurveda as an alternative treatment for multiple ailments and also due to the side effects that the allopathic drugs might cause. The objective of this study is to explore the prospects of Ayurveda tourism in Kerala, competitive advantages of Kerala as an Ayurveda tourism destination and the problems it encounters.*

Keywords: mitigation of seasonality, medical pluralism, multi-dimensional treatment paradigm, immunity enhancement and post covid management, world's wellness hub

1. INTRODUCTION

Global tourism, amidst global trade tensions, social conflicts and geopolitical uncertainties, witnessed a robust growth in 2019. International tourist arrivals grew at 4 percent and reached 1.5 billion tourist arrivals in 2019 confirming tourism as a major and resilient sector of the world economy (UNWTO 2020). The drivers of this growth are growing global economy, rising middle class in emerging economies, advancements in technology, new business models like Online Travel Agencies (OTA) and mobile apps, better accessibility and affordability and relaxed visa norms like visa on arrival (VoA) and e- visa.

In 2018, France, Spain and USA were the three major leading tourist destinations in global tourism whereas USA, France and Thailand were the top three tourism revenue earners. Among the Asian countries only China and Thailand figure in the top ten global tourism destinations and Thailand, China and Japan in the top ten tourism revenue earners (WTTC, 2019).

The following figure depicts the top 10 destinations preferred by international tourists and leading tourism earning countries in 2018.

Figure 1: Global Tourist Arrivals (2018):   Top 10 destinations & tourism earners
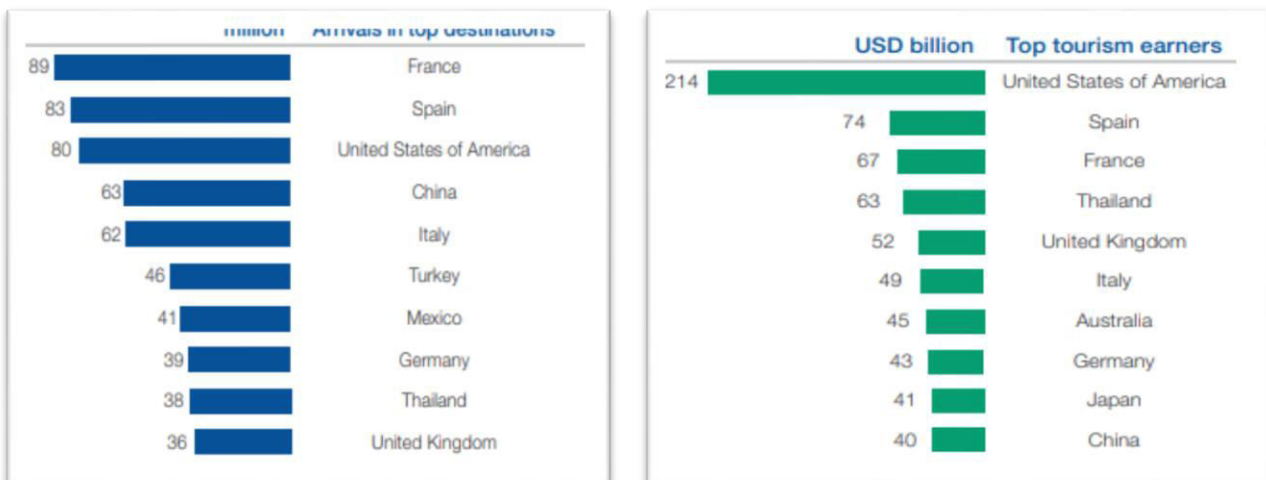
Source: UNWTO: International Tourism Highlights 2019 Edition

In the last decade, India, the second most populous and seventh largest country in the world, has emerged as one of the fastest growing tourist destinations. India improved its ranking from 65

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in 2013 to 34 in 2019 in the Travel & Tourism Competitiveness Index among 140 countries (PIB, 2020).

The following table shows India's ranking in Travel & Tourism Competitiveness Index from 2013 to 2019.

Figure 2: India's rank in Travel & Tourism Competitiveness Index (2013 – 2019)

Source: Ministry of Tourism, Government of India

Kerala has also been reckoned as the most sought-after holiday destination, among the Indian states, by foreign and domestic tourists. Globally acclaimed as 'God's Own Country', Kerala is rated by National Geographic Traveller as one of the fifty must see destinations in one's lifetime (DOT, 2021) Kerala is rated as one of the fastest growing tourist destinations in the international tourism landscape due to its perfect concoction of natural and man -made attractions like arts, architecture, culture, cuisine, history, nature and incredible life experiences. As per the statistics of Department of Tourism, Government of Kerala there is robust growth in the foreign tourist arrivals to Kerala from 5.98 lakhs in 2008 to 1.89 million in 2019 and domestic tourist arrivals from 7.5 million in 2008 to 18.3 million in 2019 (DoT, 2020). The following table shows foreign & domestic tourist arrivals in Kerala from 2008 to 2019.

Table 1: Tourist Arrivals in Kerala: 2008 -2019 (Foreign & Domestic)

Year	No.of Domestic Tourist Visits	% of Increase	No.of Foreign Tourist Visits	%of increase	Total no. of tourists	% of increase
2008	7591250	14.28	598929	16.11	8190179	14.41
2009	7913537	4.25	557258	-6.96	8470795	3.43
2010	8595075	8.61	659265	18.31	9254340	9.25
2011	9381455	9.15	732985	11.18	10114440	9.29
2012	10076854	7.41	793696	8.28	10870550	7.48
2013	10857811	7.75	858143	8.12	11715954	7.78
2014	11695411	7.71	923366	7.6	12618777	7.71
2015	12465571	6.59	977479	5.86	13443050	6.53
2016	13172535	5.67	1038419	6.23	14210954	5.71
2017	14673520	11.39	1091870	5.15	15765390	10.94
2018	15604661	6.35	1096407	0.42	16701068	5.94
2019	18384233	17.81	1189771	8.52	19574004	17.2

Source: Kerala Tourism Statistics 2019

This rise in the tourist footfalls also enabled Kerala to enhance the revenue generated from tourism. This is evident from figures of Department of Tourism (DoT) that the exponential rise of foreign exchange earnings

(FEE) from ₹ 6949.88 crores in 2015 to ₹ 10271.06 crores in 2019 and earnings from domestic tourism from ₹13836.78 crores in 2015 to ₹ 24785.62 in 2019. The total earnings also witnessed surge from ₹ 26689.63 crores in 2015 to ₹ 45010.69 in 2019. (DOT 2020).

Table 2: Kerala's Foreign exchange and domestic tourism earnings (2015 -2019)

Year	Foreign Exchange Earnings	% of Increase	Earnings from Domestic Tourists	Total revenue generated from Tourism(Direct & Indirect)	% of Increase
2015	6949.88	8.61	13836.78	26689.63	7.25
2016	7749.51	11.51	15348.64	29658.56	11.12
2017	8392.11	8.29	17608.22	33383.68	12.56
2018	8764.46	4.44	19474.62	36258.01	8.61
2019	10271.06	17.19	24785.62	45010.69	24.14

Source: Kerala Tourism Statistics 2019

2. AYURVEDA AS A SYSTEM OF TREATMENT

Ayurveda is a natural system of medicine which has its origin in India more than 3,000 years ago. The term *Ayurveda* originated from the Sanskrit words *ayur* which means life and *veda* which means *science or knowledge*. Thus, Ayurveda translates to *science of life*. Ayurveda believes in the concept that disease is the result of an imbalance or stress in a person's consciousness and being healthy is not merely the absence of diseases but the wellbeing of body and mind. Ayurveda encourages lifestyle interventions and therapies (natural) to reclaim the balance among body, mind, spirit, and the environment. Ayurveda treatment system tries to maintain this balance and preserve mental and physical health through medicines made in the traditional and natural ways from locally sourced medicinal herbs and the applying the therapies which are prescribed in the ayurveda textbooks.

Ayurveda treatment encompasses internal purification through herbal remedies, massage therapies, yoga and meditation. Ayurveda, considered as a wellness way of life treats patients by eliminating impurities, enhancing immunity, reducing unhappiness and increasing harmony.

3. AYURVEDA TOURISM

Ayurveda tourism is the convergence of tourism and ayurveda, two fastest growing verticals in the contemporary world. Ayurveda/Wellness tourism is defined as the travel of an individual/s outside his/her own place of residence to a destination for maintaining or enhancing one's wellbeing and becoming healthier rather than treating and curing a specific disease/s. Wellness Tourism Association (WTA) opined this as "a specific division of the global tourism industry defined by the common goal of marketing natural assets and activities primarily focused on serving the wellness-minded traveler and those who want to be.

Global Wellness Institute (2016**)** has defined wellness as "the active pursuit of activities, choices and lifestyles that lead to a state of holistic health". Dunn (1959) defined wellness as a "state of health, which comprises an overall sense of wellbeing and sees a person as consisting of body, mind and spirit.

Ayurveda tourism offers age old, authentic, traditional medical treatment by making use of therapeutic medicinal formulae given in ancient Ayurvedic texts. It encompasses dual aspects of treatment namely inner wellness and physical wellness. Inner wellness intends to improve the mental, emotional and spiritual well-being of wellness seekers through yoga, meditation, aroma therapy whereas the physical wellness includes Ayurveda rejuvenation and revitalization treatments, like Panchakarma, Nasyam, Pizhichil and detoxification. Ayurveda makes use of the tenants of natural ways of medication made from medicated oils and Ayurvedic powders which are made from local medicinal herbs and shrubs.

3.1. Ayurveda/ Wellness Tourism in India

Ayurveda tourism market mainly comprises of two types of tourists: primary ayurveda tourists and secondary ayurveda tourists. Primary ayurveda tourists travel to destinations for availing ayurveda treatment and select their destinations based on the Ayurveda facilities it offers whereas the secondary ayurveda tourists may avail ayurveda treatment in the destinations where they holiday. Global Wellness Institute (2018) estimates that 90 percent of the Ayurveda tourism falls in the secondary one.

Globally India is ranked 7th in the wellness tourism segment in 2017 with wellness tourism expenditure of US $ 16.3 billion which also provides 3.8 million direct jobs, i.e 14 percent of all employment. India had 56 million wellness tourist arrivals in 2017 of which 51 million were domestic tourist arrivals and the wellness tourism

market of India is estimated to grow 22% annually, which is one of the fastest growing wellness markets in the world (Global Wellness Institute, 2018). Based on the report by Research and Markets, the Indian Ayurveda market was valued in 2018 at ₹ 300 billion and is expected by 2024 to ₹ 710.87 billion (Global Wellness Institute, 2018)

The growth of the Ayurveda tourism in India is driven by rising awareness about health, wellness, lifestyle modification, growing demand for natural products, shift towards preventive practices, demand for Ayurvedic cosmetics products and anti-ageing practices.

3.2. Ayurveda Tourism in Kerala

Kerala has a long history of traditional healing practices stretching over to 3 millennia and abundance of medicinal plants and herbs. Before the advent of modern medicine, Vaidyars (traditional Ayurveda physicians) were the only contact points for those seeking treatment for their diseases as Ayurveda was the sole treatment system prior to the advent of hospitals and doctors in Kerala. These physicians interpreted the age-old Ayurveda texts and translated them into effective treatment systems for individuals.

Kerala's success of Ayurveda system of treatment lies in the fact that the state has pleasant weather conducive for various Ayurveda therapies. During summer the temperature rarely exceeds above 38 degrees and in winter seldom falls below 10 degrees, except in few high-altitude destinations like Munnar. Kerala has both South West and North East monsoons and for nearly six months in a year there will be severe to moderate spells of rain. The rain rich weather ensures abundance of medicinal plants and herbs essential for the preparation of Ayurvedic medicines. Moreover, the existence of high alkaloid presence in the soil in Kerala nurtures the growth of medicinal plants and ensures its availability. It is widely acknowledged that this soil constitution increases the potency of Ayurvedic medicines which are made from these plants compared to the medicines made in other Indian states which have a different mix of soil constitution (FE, 2018).

The availability of professional, well trained and skilled masseurs ensures that the Ayurveda treatments are carried out in its pure and authentic style. Also, the availability of genuine medicines prepared by Ayurvedic experts based on the ancient scripts and therapies performed by experienced personnel ensure effective treatment for the tourists. Moreover, the Ayurveda treatment centres require accreditation from Government of Kerala which guarantees authentic treatment.

Ayurveda tourism is an ideal vertical for Kerala to attract more tourists, increase their length of stay (LoS) and facilitate more spending during their stay for Kerala. Though the other Indian states and neighbouring countries like Sri Lanka also offer similar treatment system, Ayurveda tourism has been acknowledged as the Unique Selling Proposition (USP) of Kerala, also branded as "*Destination for Ayurveda*". The availability of multilingual Ayurveda doctors, skilled masseurs, salubrious weather, genuine medicines and Government accredited treatment centres enable Kerala as one of the most sought-after and must visit destinations for Ayurveda tourism.

Ayurveda tourism also provides benefits to associated businesses and stakeholders beyond the Ayurveda sectors and if properly developed, could be an engine for optimum benefits to destinations with minimal negative impacts.

4. AYURVEDA TOURISM FACILITATES THE FOLLOWING BENEFITS TO KERALA

4.1. Mitigates Tourism Seasonality and Transforms Kerala as an All-Year Tourism Destination

Tourism is highly seasonal in nature and it involves concentration of tourists in a destination for a brief span of time during a particular period/month in a year. This seasonality contributes to marginal/underutilization of the physical and human resources during off season of a destination and its optimum utilization in the peak season. This swing of tourist arrivals affects the livelihood of the multiple stakeholders in the destination who solely depend on tourism. The following table depicts the month wise arrival of foreign and domestic tourists in 2019 in Kerala.

Table 3: Foreign / Domestic Tourist arrivals in Kerala in 2019 (Month wise)

Foreign / Domestic Tourist arrivals 2019 (Month wise)												
Percentage/ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Foreign tourist	13.5	12.44	9.57	7.28	4.2	3.84	6.56	6.24	5.29	7.92	10.15	13.01

arrivals												
Domestic tourist arrivals	8.24	7.27	7.28	8.78	9.89	7.3	7.78	7.19	7.99	8.67	8.99	10.62

Source: Kerala Tourist Statistics 2018 (Department of Tourism, Govt. of Kerala)

It is evident from the above table that both foreign and domestic tourists mostly visit Kerala during the months from December to May. The months of June, July and August, often regarded as off season, register minimal domestic and foreign arrivals which leads to employment deprivation and livelihood issues for the stake holders. From December to May the high influx of tourists leads to over tourism which contributes to heavy stress on the physical and natural resources.

The lean months from June to September are dotted by the monsoon rains and is regarded as the ideal time for Ayurveda treatment. The abundance of medicinal plants and herbs required for medicine preparation and the presence of moisture during monsoon months makes this as the apt period for availing the Ayurveda treatment. Moreover, due to off season the hotel/resort tariff will also be minimal thereby making the visit cost effective. Ayurveda tourism has the potential to transform Kerala as a yearlong destination eliminating the off seasonality thereby making optimum utilization of various resources and it also ensures livelihood of stakeholders if marketed appropriately in source markets.

4.2 Ayurveda Tourism Enhances Average Length of Stay (ALOS) of Tourists
Tourism is widely perceived as a tool for economic development and employment enhancement across destinations. In order to leverage the optimum benefits from tourism Kerala has to augment either the tourist arrivals or their length of stay. Ayurveda tourism normally prescribes a minimum period of treatment to get optimum results which varies from one week to four weeks and this can enhance the average length of stay at destinations. Based on the statistics of Department of Tourism, Govt. of Kerala the average duration of stay of a foreign tourist is 16 days and domestic tourist is 8 days in Kerala which means that significant proportion of foreign tourists avail ayurveda treatment compared to the domestic tourists during their visit.

4.3 Ayurveda Tourism is High-Yield Tourism
Destinations Management Organizations (DMO)'s prefer class tourists rather than mass tourists. It is noted that ayurveda tourists spend more money in destinations per trip than average tourists, whether it is domestic or international. It is estimated that in 2017, international wellness tourists on average spent US $ 1,528 per trip, 53 percent more than the average international tourists whereas the domestic wellness tourists spent US $ 609 per trip, 178 percent more than the normal domestic tourist. As per the estimates of Department of Tourism, Govt of Kerala, the minimum stay of Ayurveda tourists in Kerala is 16 days and they spend at least USD 100 /day for their accommodation, food and treatment and for two weeks it is estimated that they nearly spend US $ 1600 in Kerala (DoT, 2019).

4.4. Ayurveda Tourism Ensures Repeat Visits
The term "repeat visit" refers to tourists visiting the same destination again or multiple times. Inorder to leverage the desired outcome from Ayurveda treatment the tourists are advised to avail treatments at specific intervals. A satisfied ayurveda tourist visits the same destination again or multiple times for availing the treatment at regular intervals. Many a time tourist avail treatment on an annual basis and this promotes repeat visitation till the desired results are achieved. Repeat visitors act as brand ambassadors for Kerala's Ayurveda tourism when they share their experiences with their friends and relatives regarding the efficacy of treatment availed in Kerala.

4.5. Ayurveda Tourism Creates Economic Opportunities
Tourism is seen as a generator of various types of income for the stakeholders of a tourist destination: business income, wage earnings, rates and levies. Kumar, S., et al, (2017) opined that the direct spending of tourists has constructive impact on business profitability and growth in the employment. Also, the money generated, circulated and re-spent in the local economy has multiplier effects and tourism caters to the equalization of economic benefits and ensures every stakeholder benefit from tourism activities.

The proceeds from Ayurveda tourism are distributed to accommodation units, treatment centres, food and beverage establishments, sightseeing, shopping, and other allied services. Within each segment, it trickles down to ensure inclusive growth of stakeholders in a destination.

4.6. Ensuring Employment for Ayurveda Professionals

Kerala has 17 Ayurveda colleges, both in government and private sector, and nearly 980 Ayurveda doctors are added annually to the Ayurveda sector from these institutions Economic Review (2021). It is estimated that Kerala has around 17,000 qualified Ayurveda doctors and ayurveda tourism offers employment not only to these Ayurveda doctors but also to nurses, therapists and masseurs. This sector also provides employment in Ayurvedic medicinal farms, medicine manufacturing factories and also in Ayurveda pharmacies.

5. PROBLEMS FACED BY AYURVEDA TOURISM

5.1. Ensuring Quality and Authenticity of Service Providers

The trinity of quality, authenticity and reliability are indispensable for the success of Ayurveda treatment and also for an Ayurvedic destination. The positioning of Ayurveda as the *"USP of Kerala tourism"* and the branding of Kerala as *"Worlds Wellness Hub"* resulted in the mushrooming of Ayurveda treatment centres in and around the tourist destinations in Kerala. Few of these centres are for - profit - only establishments compromising the basic hygiene, employing inexperienced personnel and diluting health and safety standards which could harmfully affect the treatment outcomes and also the image of the Kerala as an authentic Ayurveda destination. To restrain and regulate these centres and to ensure uniformity of service delivery and quality standards, Department of Tourism, Government of Kerala has enacted legislations to ensure quality, authentic service delivery in the Ayurveda Centres. The Kerala Clinical Establishments (Registration and Regulation) Act 2018, is meant to provide registration and regulation of clinical establishments from all recognized systems of Medicine. i.e. Modern Medicine, Ayurveda, Naturopathy, Homoeopathy, Siddha and Unani in the public and private sectors in Kerala (KCEA, 2018).

Government of Kerala has also constituted a committee to classify Ayurveda centres into three categories - Ayur Silver, Ayur Gold and Ayur Diamond. The Ayur Silver category has minimum facilities and Ayur Diamond has the best facilities. This classification enables customers to distinguish between a premium Ayurveda service provider and a mediocre one based on their budget and requirement. This also enables them to weed out the unprofessional and non-classified centres. In addition to this many ayurveda centres have initiated quality management procedures through Quality Council of India (QCI) by getting accredited with National Accreditation Board for Hospitals and Wellness Centres (NABH) certification.

5.2. Scarcity of Medical Plants

Another major problem faced by the Ayurvedic medicine industry in Kerala is the scarcity of the raw materials - medicinal herbs and shrubs - much needed for the ayurvedic medicine manufacturing. This has led to the escalation of the raw materials cost, introduction of inferior/low quality raw materials and the adulteration of raw materials which affect the quality and efficacy of Ayurveda medicines. Inorder to combat this, Government has started financial incentives for the promotion of medicinal plants cultivation, procurement of medicinal plants and herbs through Government agencies at market rates and promote good agricultural practices (GAP) through Kerala State Medicinal Plants Board, Kerala (SMPB).

6. CONCLUSION

Ayurveda, backwaters, beaches and local experiences are considered as the four pillars of tourism attractions for Kerala and Ayurveda tourism is the segment where Kerala has distinct advantage and tremendous potential to attract tourists. Ayurveda tourism offers a consolidative multi-dimensional treatment paradigm where age old and traditional treatment system can provide healthcare along with holidays for tourists.

To increase the Ayurveda tourist footfalls, Kerala needs professional and well-designed promotional strategies and focussed marketing of Ayurveda tourism in source and emerging markets. Ayurveda can be the right prescription for Kerala to ensure year-round tourist arrivals mitigating the seasonality issues and for economic development and employment generation of the stakeholders. In addition to the conventional purification and detoxification treatments Ayurveda should be redefined to offer treatment to Non-Communicable Diseases (NCD), immunity enhancements and also for the post COVID management health issues.

Declaration: The author declares that there is no conflict of interest

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IMPACT OF COMPACTION PRESSURE AND REINFORCEMENT OF MHA IN SI3N4 ON THE PROPERTIES OF ALUMINUM HYBRID COMPOSITES

MOHAMMAD FARIS, DR. MOHD SUHAIB, DR. MUMTAZ AHMED AND MS. SULTANA

ABSTRACT

Composites are manufactured materials that play a vibrant role in human life from the inception of civilization, passing it on to the impending generations. The demand for Aluminum metal matrix composites is increasing in various fields, including the robot industry, aerospace, high-speed types of machinery, marine, aerospace and automobile industry. This paper develops the aluminium hybrid composites by powder metallurgy route. In different compositions, the pure aluminium is reinforced with Si_3N_4 and mustard husk ash (MHA). The pure aluminium mixed with five weight % of Si_3N_4 and 2.5, 5, 7.5 and 10 Weight % of MHA at 500 rpm for 120 minutes. The green composites are developed at 300,400,500,600 and 700MPa compaction pressure and sintered at 500 ^0C for 45 minutes under a inert environment of Nitrogen. SEM shows an even distribution of reinforcement in the base metal matrix. With high compaction pressure, micro-hardness and density improve but porosity decrease.

Keywords: Hybrid composites, Compaction, Reinforcement, Characterization, hardenss tester.

INTRODUCTION

The composites are made up of two or more constituents having different mechanical and physical properties. The historical symbols show that composites are developed and used by people's form 7000BCE in pots, mud bricks, idols, ornaments, etc. In 1200AD, Mongols used animal glue, wood, and bone composite bows. Composites of Ashtadhatu & Panchaloha, called Octo-alloy, were used for casting metallic idols for temples in the ancient world [1]. Aluminium is widely used in the Aerospace and Automobile industry. The ceramic reinforcement materials make it Aluminum hybrid composites (AHCs), having low density, high flexibility and high strength [2,3]. Today, the Agro-waste is rich in silica and is also used to develop hybrid composites [4,5].

The agricultural by-products are low cost and readily available in India; rice husk ash (RHA) and Mustard husk ash (MHA) are among them. The development method and reinforcements are two essential parameters for composites' best properties [6]. Based on the reinforcement, metal matrix composites are four types laminated or layered MMCs, particulate MMCs, whiskers or short fibre MMCs and continuous fibre MMCs [7]. The particulate MMCs are widely used in engineering applications and broadly classified into three categories, agriculture wastes, industrial debris and ceramics particulates [8,9]. Using the Rice Husk ash as reinforcement with aluminium metal matrix composites by stir casting method increases the hardness but density decrease. The Powder metallurgy route is best for developing composites due to its homogeneous mixing of reinforcement and matrix by ball milling process [10, 11]. By this method, a green compact/ sample obtain at high compaction pressure. After that, it sintered to gain strength [12, 13]. The most often used ceramic reinforcement is Si_3N_4, Al_2O_3, B_4C, SiC, and Zr_2O for the development of Aluminum hybrid composites [14]. Silicon nitride is a complex ceramic particle used for high temperature, wear and thermal applications. The development of a composite of Aluminum and silicon nitride through the powder metallurgy route shows the highest hardness [15]. The hardness improves of aluminium7075 reinforced with fly ash with 4,8and 12 wt % , at 12 wt% high hardness obtained compared to monolithic material[16]. The hardness and tensile strength of the hybrid aluminium composites AA6082-Si3N4-Gr increase by varying wt % of Si3N4 [17]. The aluminium metal matrix composites have dynamic mechanical and physical properties using ceramic reinforcements [18-20]. As compared to conventional metals, the properties of aluminium metal matrix composites and metal matrix composites easily differentiate [21-23]. The use of agriculture waste in particulate form for metal matrix composites is significant for manufacturing industries due to its easy availability, processing, and elimination of environmental pollution [24].

The Rice husk ash (RHA) was used as reinforcement with Aluminum LM6 at 6wt% of RHA using the stir cast method. The hardness increased from 54.8 HRB to 78.4HRB [25]. The lightweight reinforcement like MHA reduces the density of the composites and is suitable for the development of low-cost composites [26-28]. Using synthetic reinforcement like TiC with Magnesium increase the density of magnesium-based well-lit weight composites[29].In this research work, aluminium -5 Wt.% of silicon nitride and varying weight % of Mustard

husk ash (MHA) based hybrid composites developed by the P/M route and the effect of compaction pressure and reinforcement on mechanical &physical properties are examined.

2 EXPERIMENTAL PROCEDURES

2.1 Raw Material

Aluminium is the base metal and is used as a matrix to develop hybrid composites. This was purchased from Otto Chemika Reagents Ltd, Mumbai. The density of Aluminum is 2.67 g/cm^3. The fine Aluminum powder is 99.7% purity is having the melting point of 660.37 ^{0}C cas no—7429-90-5 and batch no.0360.The size of the fine powder is ≤44 μm. The α-Si3N4 was used as reinforcement having PC code 1002482943 purchased from Aldrich chemicals Pvt ltd, USA. The size of predominantly α-Phase ≤44 μm and having density 3.44 g/cm3. The mustard husk collected form a farm house of a village, Nasirbas, Haryana and dried in dry atmosphere for 48 hrs to reduce the moisture. After that the Mustard husk converted into ash with the help of Muffle furnace at 600 C for 60 minute to remove carbonaceous and volatile components, in the Material Science laboratory Mewat Engineering College, Nuh Haryana. After cooling at room temperature it was sieved of particle size is ≤75 μm. The details of reinforcement and elements of given below.

Table 1. Details of particles

Element powders	particle size/diameter (μm)	Density (g cm−3)
Al	75	2.67
Si3N4	44	3.44
MHA	44	2.57

Table 2. Content of MHA

Elements	Weight %
SiO$_2$	46
MgO	4.5
Al$_2$O$_3$	7.9
SiO$_2$	18.8
FeS$_2$	2
KCl	2.9
MAD-10 Feldspar	5
Wollastonite	12.87

The microstructure of the powders was analyzed by Scanning Electron Microscopy in the Nano Science Laboratory Jamia Millia Islamia, New Delhi. The SEM images of Aluminum, Silicon Nitride and Mustard Husk ash shown in given below.

(a)   (b)

(c)   (d)
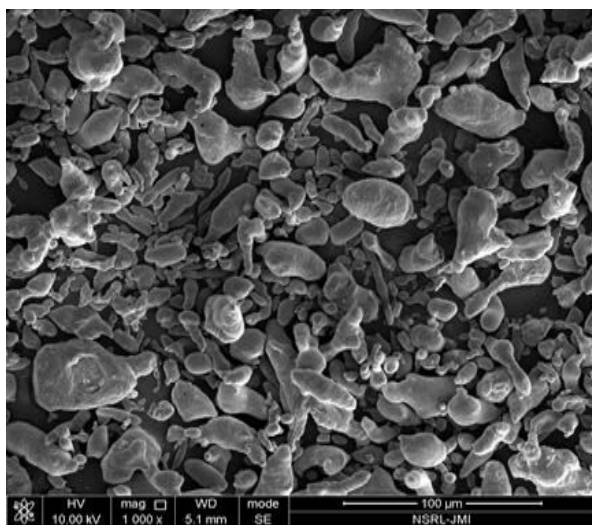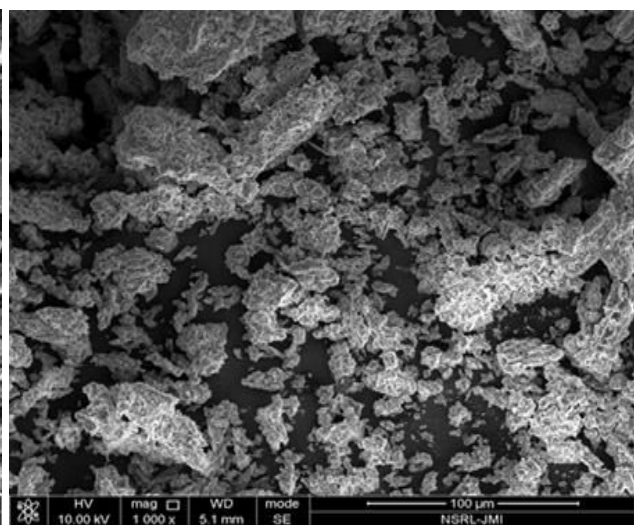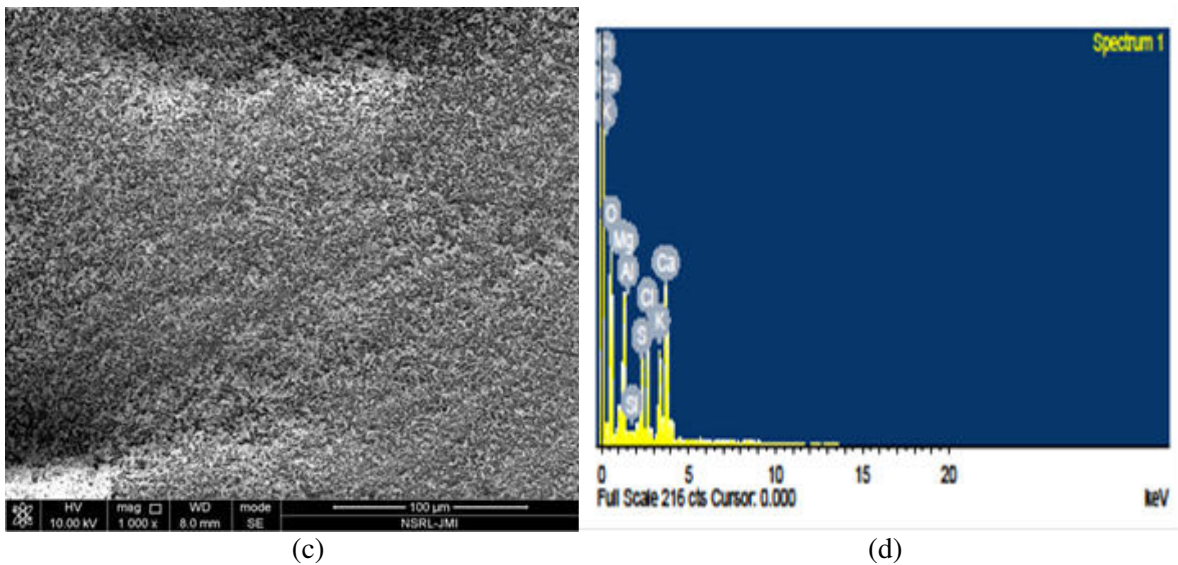
Fig.1: SEM Micrographs of (a) Pure Al (b) MHA (c) Si3N4 (d) EDS of MHA

2.2 Development of Composite

There are many methods for the development of the composites but here the Aluminum hybrid composites were developed by powder metallurgy route. The weight of the powder measured by the Electronic analytical balance KERRO P 7, BL-2204 having accuracy of 0.1mg then blending the powder according to the composition as per research work [30].

Table 3: Weight composition of the powders

S.No.	Pallet	Al	MHA	Si3N4
1	A	100	0	0
2	B	92.5	2.5	5
3	C	90	5	5
4	D	87.5	7.5	5
5	E	85	10	5

The development method of the Al-Si_3N_4-MHA hybrid composites shown in fig.2 .The synthesized powders of Al, Si_3N_4 and MHA blended together according to the composition chart by ball milling machine runs at 500RPM for 150 minute. The SS balls of diameter 10mm are used for grinding medium and BPR ration is 10:1.To avoid the cold welding process 3 wt% of Ethanol having 99.9 purity purchased from Changshu Hongeheng Fine Chemicals Co.Ltd , Changshu, is used as process control during mixing process[31]. The green cylindrical pallets of size length 25mm and 10mm diameter developed by uniaxial hydraulic press at five different compaction pressures 300MPa, 400MPa,500MPa,600MPa and 700MPa.
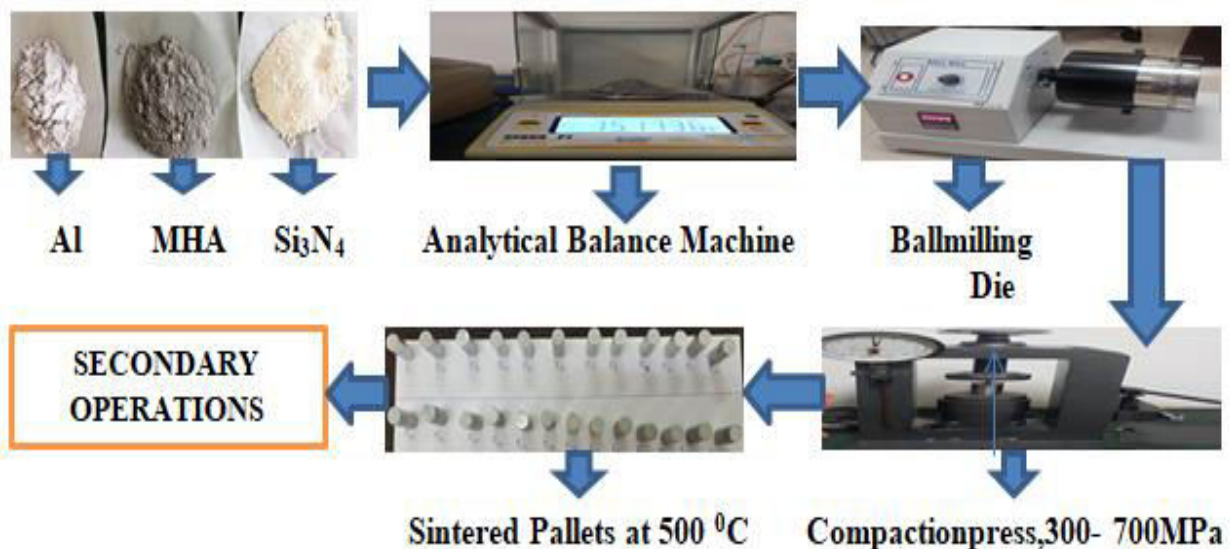

Fig.2: Research Methodology chart

Firstly, die internally clean by hard needle to remove the cold weld powder from the internal walls of die. Further, the acetone is used to clean the die setup and zinc stearate used for lubrication of punches and die instruments. The developed green pallets sintered in the electric tube furnace at 500^0C in the inert atmosphere of Nitrogen for 45 minutes to avoid the oxidation [32]. The supply rate of 50 ml/min. The heating and the cooling maintained at 5 ^{0}C /mm.During the process Nitrogen was flow continuously till room temperature reached.

2.3 Characterization

The phase study of the composite powder done by using the X-Ray diffractometer.The XRD graphs are obtained with value of 2theta ,$\lambda = 1.542$A° and counting rate of 6^0 /min. The SEM was done of green and sintered composites to analysis their microstructure. The pallets were etched and polished by emery paper of 200 grade[33].The Archimedes principle is used for calculating the experimental and theoretical density sintered pallets[34,35].after calculating both of the densities the porosity easily examined[36].The micro hardness test performed at 100kg load for 10sec dwell time before performing the test polishing was done on pallet. The test was perform at Ten locations and average values considered as final value.
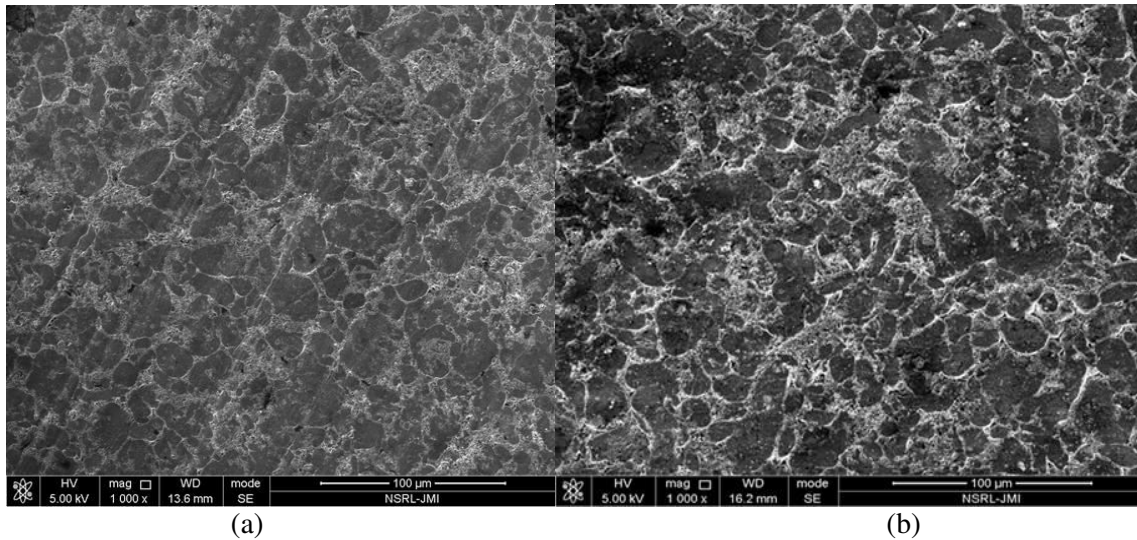
Fig.3: SEM micrographs of Al-Si3N4-10 wt% of MHA (a) Green (b) Sintered

2.4 DENSITY

The change in experimental and theoretical density take place with respect to compaction pressure and change in weight % of reinforcement Mustard Husk Ash. The theoretical density of the Aluminum hybrid composites calculated by the mixture method rule [37].

$$\rho_{AHC} = \rho_{Al} \times V_{Al} + \rho_{MHA} \times V_{MHA} + \rho_{Si3N4} + V_{si3N4}$$

$$\rho_{AHC} = Density\ of\ the\ composite, \rho_{Al} = Density\ of\ Alu\min ium, V_{AL}\ volume\ friction\ of\ Alu\min ium$$

$$\rho_{MHA} = Density\ of\ mustard\ husk\ ash,\ V_{MHA}\ volume\ friction\ of\ MHA, \rho_{Si3N4}\ silicon\ nitride\ and\ V_{Si3N4}$$

When compaction pressure change from 300MPa to 700MPa the density of the composites varies with weight % of Mustard husk ash. The density of the MHA is low compare to Aluminum, obviously the density of hybrid aluminum composites decrease [37]. The adding of synthetic reinforcements like TiC with Magnesium based composites then density increase [38].

3. RESULTS AND ANALYSIS

The scanning electron microscopy of the sintered pallets at 300,400,500,600 and 700MPa pressure describe below.After analysis the SEM at different compaction pressures the porosity have at low compaction but at high compaction pressure porosity disappears and plastic deformation take place along with grain boundaries when stress exceed the elastic limit. At 700MPa compaction pressure work hardening take place and intensity of plastic deformation increase, pores disappears and clusters fully dissolve as fig 4. The reinforcement and the compaction pressure two main components which influence the morphology of the composite. The SEM shows at Al+5 wt % of Si3N4 +10 wt % of Mustard husk ash (MHA) at 700MPa uniformly distributed reinforcement and matrix particles. The reinforcement uniformly distributed at high compaction pressure.
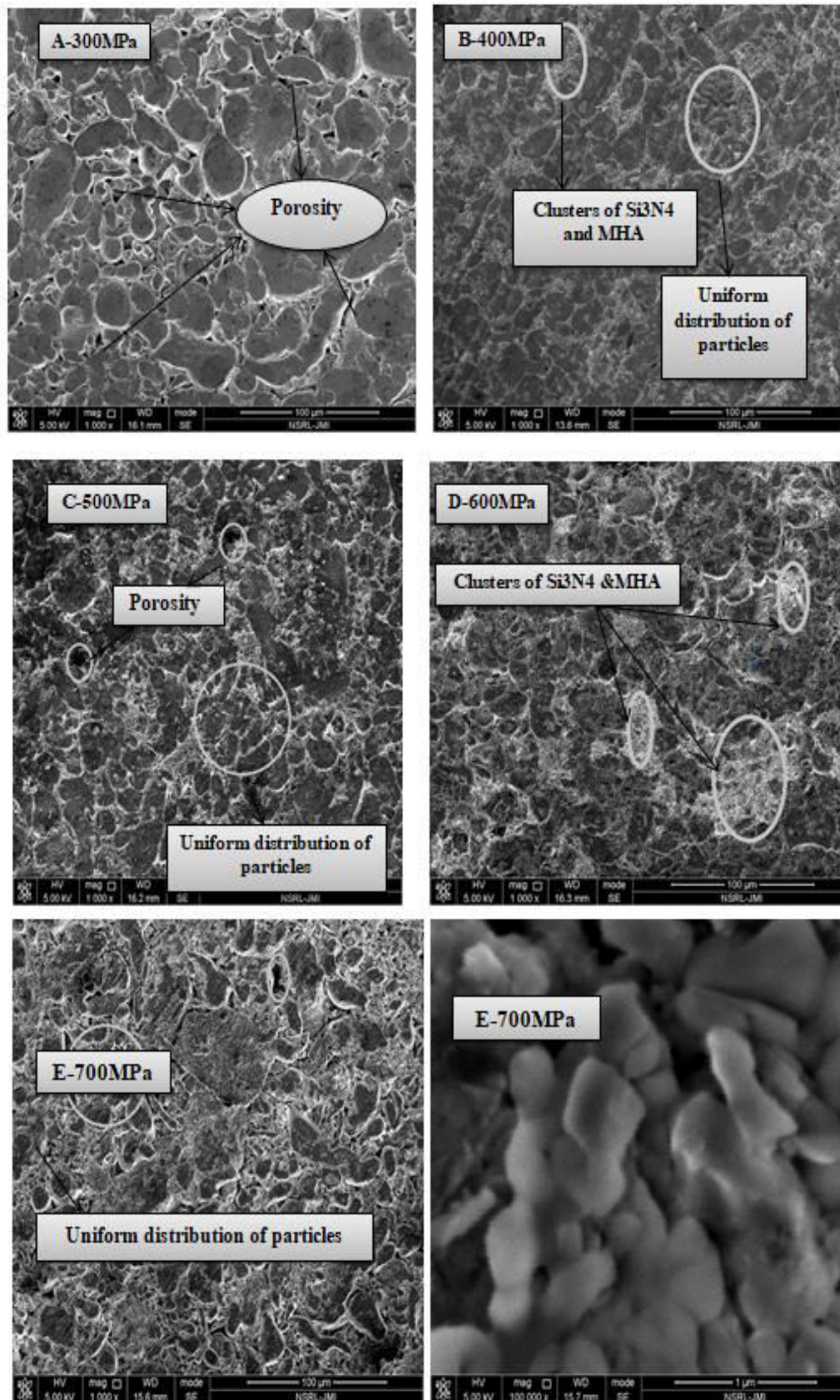
Fig.4:

This is come to observation that the porosity appears at sample/pallet A to C (Al+5%wt of $Si_3 N_4$+5wt% of MHA) because seclusion of particle size of Si_3N_4.The increasing the weight percentages of MHA in the samples of A to E the porosity disappears and it confirmed by fig.4 In this XRD graph the high peaks shows the presence of the Aluminum and small peaks show presence of Si_3N_4 and MHA. No other elements found in the mixing powder so there is no side reaction take place. The compositions of the samples given in table no.2
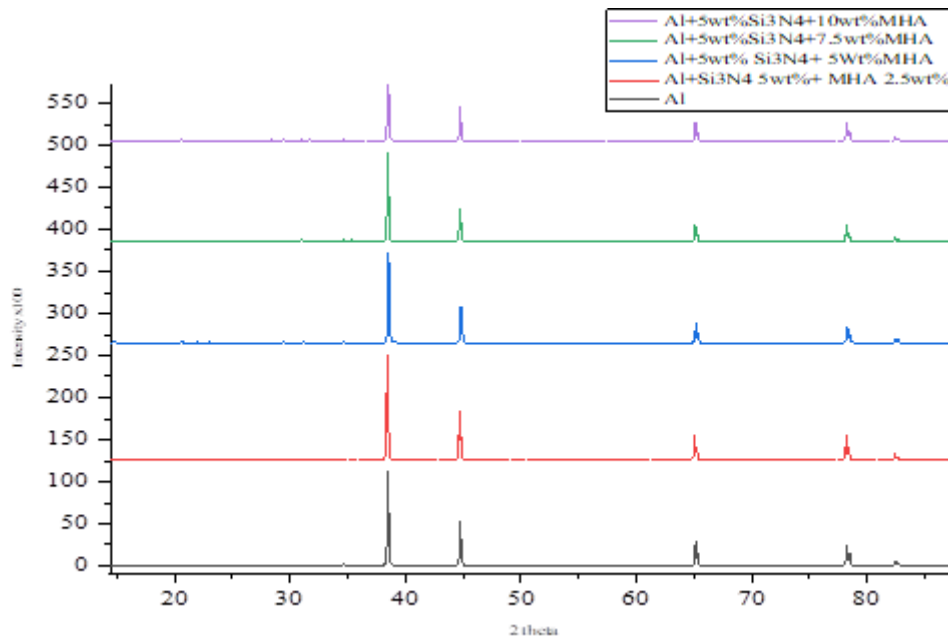
Fig.5: XRD plot

3.2 Micro-hardness

The vikers micro hardness test was performed at Jamia millia Islamia, New Delhi by using Mitutoyo vikers hardness tester of HM-210 series having single intender shaft.The appied force for intender was 1kgf during hardness testing.
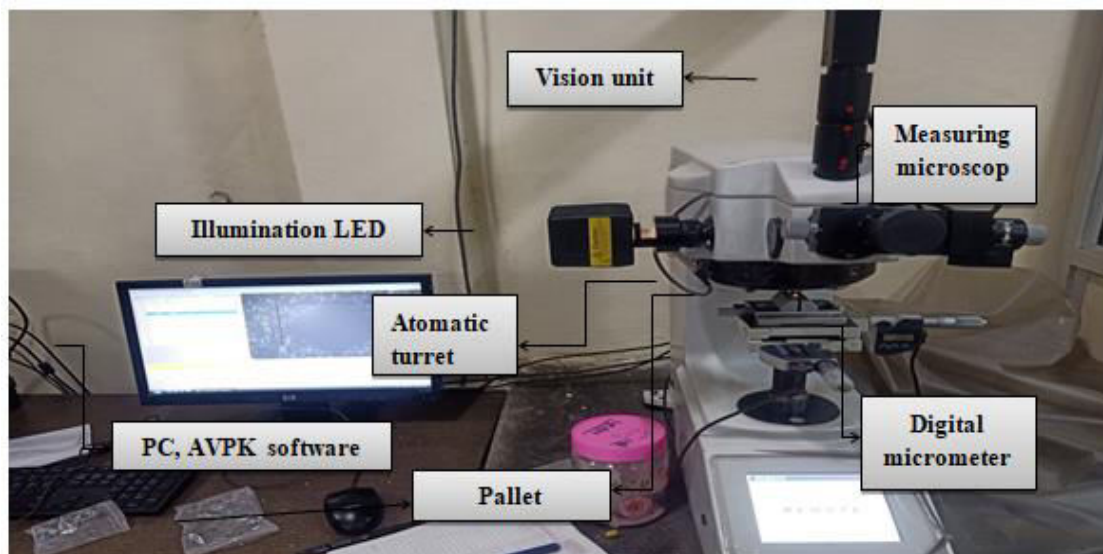
Fig.6: Mitutoyo vikers hardness tester

The micro- vikers hardness is calculated to find out the impact of compaction pressure with varying weight % of reinforcement in samples. The micro hardness of composites increase as compaction pressure varies from 300MPa to 700MPa. If we increase the weight % of reinforcement the micro-hardness also increase or simply say micro hardness increase with compaction pressure and reinforcement. The micro hardness of pallet A at 300MPa is 35.17VHN average value of ten readings and it will increase up to 47.7VHN at 700MPa.the values of micro hardness shown in table.

Table 4: hardness values varies with compaction pressure

Pallet	P1/300MPa	P2/400MPa	P3/500MPa	P4/600MPa	P5/700MPa
A	35.17	36.4	37.1	39.8	47.7
B	36.2	38.8	40.3	42.5	50.2
C	37.1	40.9	42.3	43.7	52.4
D	39.8	41.8	43.8	45.6	54.4
E	40.4	43.5	45.05	46.9	63.7

The formation of pores at low compaction pressure practices voids that impact on the properties of the aluminum hybrid composites. The micro hardness value of pallet E (Al+5wt%Si3N4+10wt % MHA) compacted at 700MPa gives the hardness value of 63.7 VHN. This enhancement in the hardness value from 35.17 VHN to 63.7 VHN occurs by high compaction pressure, presence of high hardness value particles in MHA and uniformly distributed particles in development of composite.
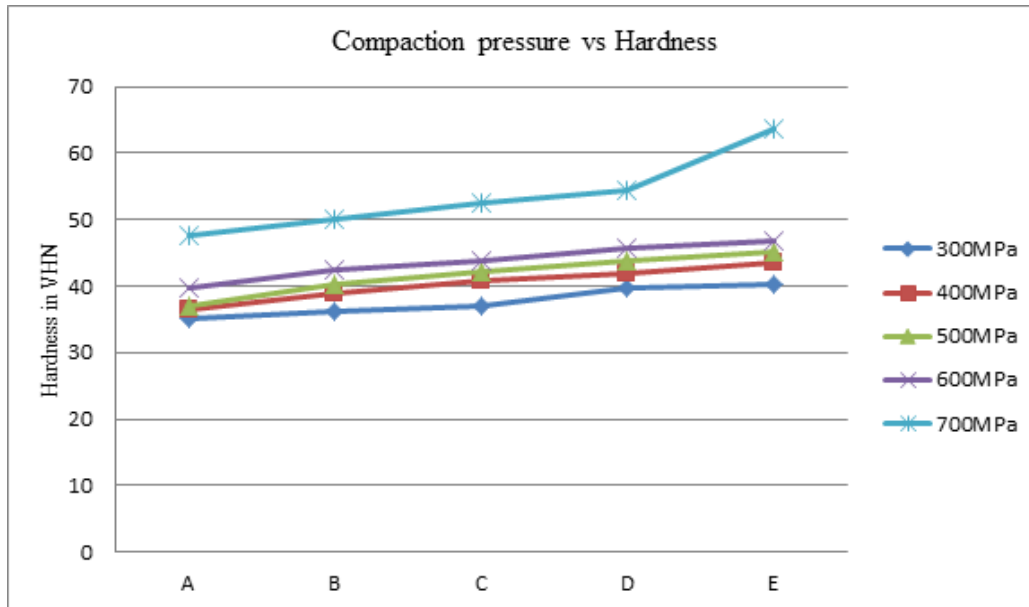
Fig.7:

3.3 Rockwell Hardness

This test was performed at strength of Materials laboratory, Jamia Millia Islamia,New delhi. The Rockwell hardness tester machine by applying 100KN load with 1/16" ball on red dial. The Rockwell hardness test is very easy as compare to other hardness methods and also eliminates mind-numbing calculations. During performing the Rockwell hardness test firstly minor load is applied to set the position established on dial gauge of Rockwell hardness tester followed by the major load [39]. The load is applied on hybrid composites for 30 seconds by load lever. As major load is released the dial indicator gives the Rockwell hardness number.
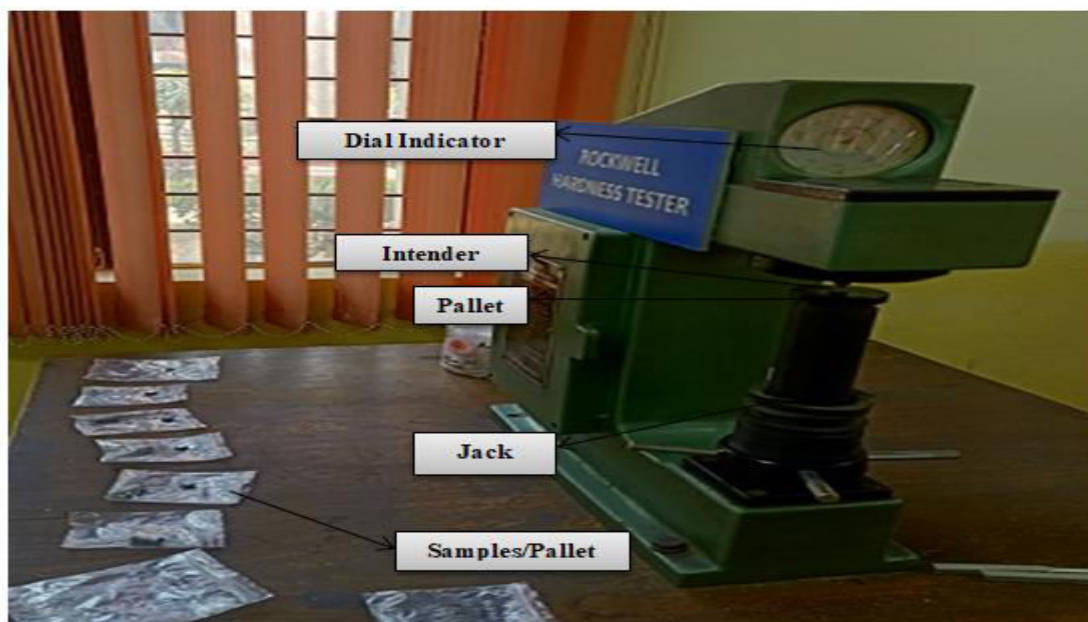
Fig.8: Rockwell hardness Tester

The value of hardness of pure Aluminum is 18.5HRB at 300MPa and 27.7 HRB at 700Mpa and continuously increases with compaction pressure. It is also observed that by adding the MHA weight % the Rockwell hardness also increase and found that (Al+5wt%Si3N4+10wt % MHA) gives value of 36.7 HRB at 700Mpa. It is clear that by increasing the weight % of MHA the value of Rockwell hardness increase.

4. CONCLUSIONS

The Al-Si$_3$N$_4$-MHA hybrid composite developed by powder metallurgy route by varying wt % of MHA and fixed 5% of fixed of Si$_3$N$_4$.The compaction pressure paly very pivotal role to stand up the properties of developed composites. In this research work microstructural, physical and mechanical properties are analyzed. The conclusions are as

(1) In the XRD graph of blended composite powder confirm the presence of Si3N4 and Mustard husk ash (MHA).The top peak shows the presence of the Aluminum and low peaks shows the presence of reinforcement because of its low weight percentages.

(2) The SEM of sintered hybrid composites shows that pores and voids decent with increase of compaction pressure.

(3) The sintered density enhance with compaction pressure and weight percentage of the reinforcements.

(4) With increase of compaction pressure the hardness of the hybrid composites increase. The hardness value increase from 35.17VHN to 63.7VHN at 700MPa pressure. There is 55.21 % of enhancement in hardness.

(5) To explore this research now we can move towards tribological behavior of Al-MHA-Si3N4 composites.

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STUDY THE IMPACT OF COVID-19 ON THE AVIATION SECTOR IN INDIA

DR. BABITA KANOJIA, MR. VIJAYKUMAR MAKWANA AND YASHRAJ KHANNAH

ABSTRACT

The world is currently combatting with Coronavirus (COVID-19) pandemic which had its soils in Wuhan, China in December of 2019. Within a few months this virus had its hands on 215 countries across the globe. With more than 580 cases on the 22nd of January, 2020, infected cases increased to 10.62 million as of 1st July globally. India being no different with just 3 cases reported on the 22nd February, 2020 it quickly surpassed 5, 87,092 on the 26th of June, 2020. It has affected almost all the industries. The preventive actions taken by the government of India drastically dented the airline sector with tremendous losses. With losses ranging from 240 billion to a staggering 270 billion USD only in the April- July quarter. This meant that around 2.67 billion USD loss was incurred by the industry daily. The aim of this study is to study the impact of covid on aviation sector and the roadmap for revival.

Keywords: Aviation industries, Operating cost, Revival

The industry is exposed to high operating leverage. According to DGCA, the airlines operating cost structure consists of nearly 30 to 40% of fuel cost, 15% lease rental, nearly 25% for other operating expenses (including general administrative, operating expenses such as flight equipment, maintenance, overhaul, user charges including landing, airport charges and air navigation charges. In this backdrop, improving PLF by offering lucrative offers is prevalent trend in the industry. As provided, the airlines in India performed at decent capacity of nearly 85% in the month of January, 2020. In the month of February, irrespective of low demand, the SpiceJet, Go Air, Indigo, Air Asia, Vistara have managed high PLF by providing attractive offers to the consumers.

PLF of airlines in India during January and February 2020.
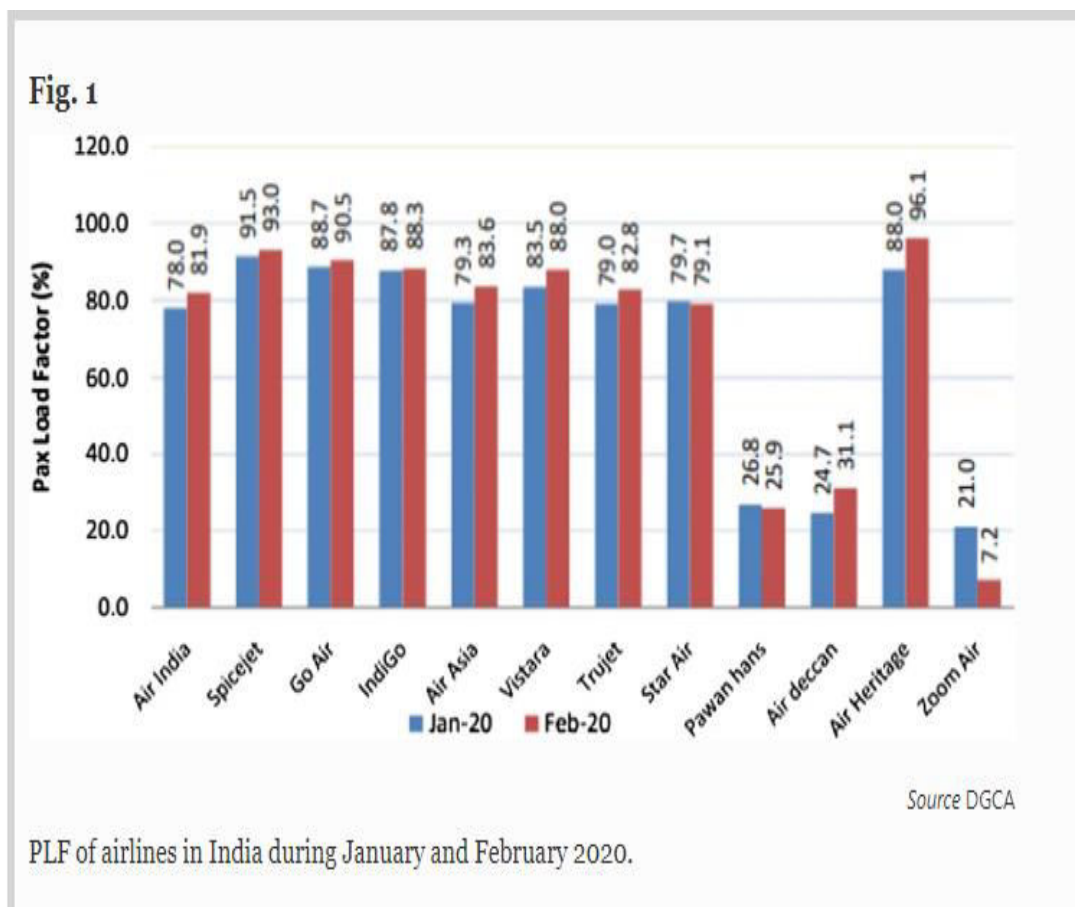
Higher PLF, however, does not imply profitability. It only represents the successful selling of available seats. Operating viability requires the PLF to exceed BELF. The irony is that despite of heavy demand, the airlines strive hard for making break-even due to tough competition.

Fig. 2
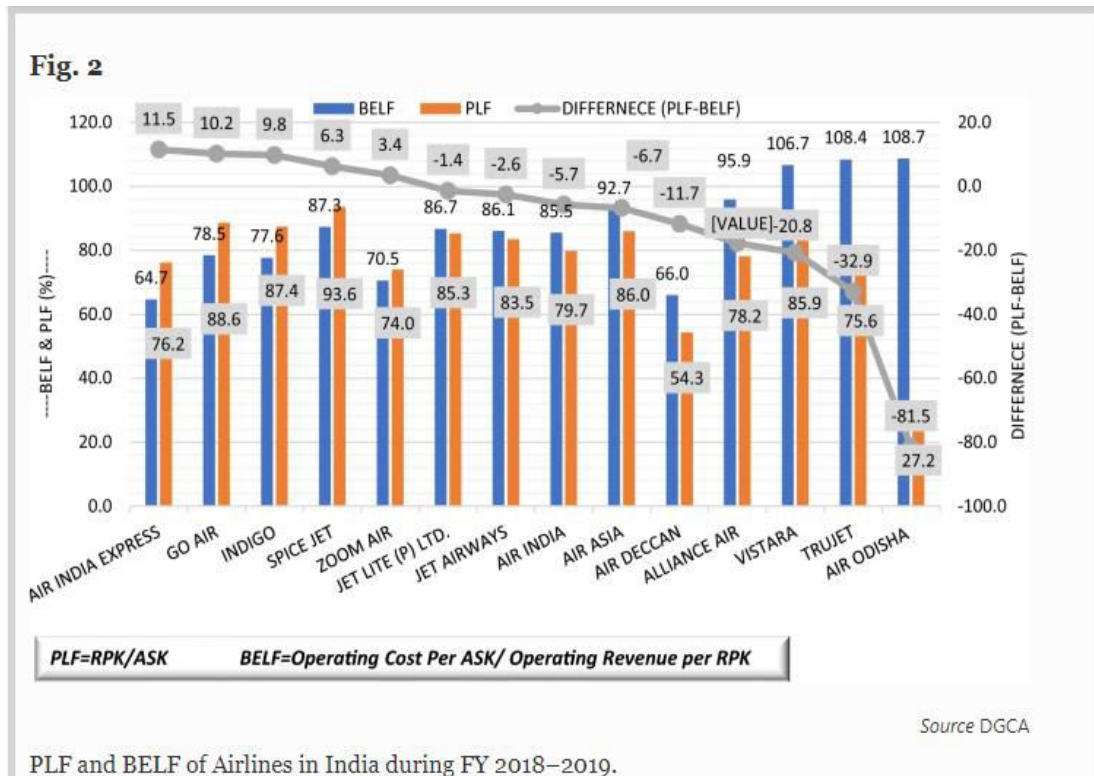
PLF and BELF of Airlines in India during FY 2018–2019.

OBJECTIVES OF STUDY

1. To study the pervious tends of the aviation industry.

2. To study why the aviation industry is so competitive.

3. The challenges faced by the aviation industry due to COVID-19 pandemic.

4. To study the post-lockdown challenges faced by these companies.

5. To study the roadway ahead for this industry.

RESEARCH METHODOLOGY

The study is based on secondary data of various Indian airline companies working in India publishing their financials publicly and previous study.

Now having seen the past difficulties already existing pre COVID era we can therefore put a calculated assumption that during and post COVID era the revenue streams of airline companies in India will face more difficulties. With the dwelling of demand, the revenue of many companies has impacted severely. The extent of this impact is so great that many airlines had reported that they don't expect a breakeven anytime soon.

The fundings of many companies are now exhausting. As of January, 2022 Air India formally a government company now belonging to the TATA group has reported that the company will have to ensure the safety of passengers first and that of the crew serving within and therefore their costs have significantly increased. However, it's not just Air India just a few months back the government of India stated that all airline companies are required to operate only if PPE kits are worn by not only the crew but also the passengers to ensure the safety of all.

REVIEW OF LITERATURE

The Indian aviation industry is one of the fastest growing industries in the world in terms of not only demand but also capacity. The aviation industry globally contributes about 2.7 trillion USD (as per 2018 data) to the Global GDP.

The Indian airline markets despite being the fastest growing market is also the world's toughest market to operate in. Though there have been many reforms in this sector, the sector is still unhappy due to rising fuel and other direct costs and diminishing returns.

The COVID-19 pandemic has brought yet another pile of challenges to the to the already growing pile. Nevertheless, the industry adapted quickly and now is on the recovery path.

It is important to understand the challenges also faced by the companies in this business. Listed below are the known challenges: -

1. Capital shortages.

2. Less profit margins.

3. Increased/ inflated costs.

4. Decreased passenger travel.

5. Increased competition.

6. Less profitable flights.

7. Highly capital-intensive business.

Impact of Suspended Operation Amid Lockdown

The Indian aviation industry is characterized by high fixed costs of nearly 35 to 40%. These costs include lease rental, employees cost, interest charges. Per day of suspended operations has hit the industry at the rate of ₹75–90 crore loss per day. Table 1 exhibits fixed-cost information pertaining of four key airlines of India for last three years (FY 2017 to 2019). The costs mentioned signify the charges that are to be met irrespective of the business operations. The increasing pattern of expenses over years, prima-facie, signify the expanded operations' size over years. Ceteris paribus, no significant change in the operations size and cost for the FY 2019–2020, per day loss of suspended operations for Interglobal Aviation accounts for ₹24 crores, followed ₹ 9.2 crores for SpiceJet, ₹5.83 crores for Go Airlines and ₹3.1 crores for Air Asia (based on the 2018–2019 estimates).

Company	Years	Employee Cost	Aircraft Lease Cost	Rent	Interest	Total Fixed Cost	Cash Per Day For Fixed Cost
Air Asia Ltd	Mar-19	346.86	739.54	10.69	34.06	1131.15	3.10
	Mar-18	264.02	441.00	7.52	13.06	725.60	1.99
	Mar-17	162.74	248.79	2.83	6.45	420.82	1.15
Go Airlines (India) Ltd	Mar-19	594.86	1304.38	8.90	221.42	2129.56	5.85
	Mar-18	420.88	750.86	6.60	202.03	1380.37	3.78
	Mar-17	335.10	Unknown	4.34	217.23	556.67	1.53
Interglobal Aviation Ltd	Mar-19	3137.79	4999.45	116.30	563.40	8816.95	24.16
	Mar-18	2455.02	3610.20	100.96	413.09	6579.27	18.03
	Mar-17	2048.19	3125.37	89.70	406.15	5669.42	15.53
Spice Jet LTD.	Mar-19	1057.01	2080.21	56.72	163.59	3357.53	9.20
	Mar-18	862.57	1665.24	44.71	121.84	2694.36	7.38
	Mar-17	673.54	1451.36	37.62	95.14	2257.66	6.19

Dying Cash Reserves

Aviation industry is a highly capital-intensive business where having a strong cash reserve makes immense impact on the profitability of the airline. During the beginning of the pandemic however, many companies in India like Jet Airways, Spice Jet and Air India had reported a fall in cash reserves to a severe extent.

While Jet Airways being bankrupt the financial statements were released to the public, Air India on the other hand was also bankrupt but because it was a public company it was still functioning at full capacity, having no shortages to the cash reserves.

While Jet and Air India were in fact struggling, Spice Jet, Vistara and some other airlines like Air Asia (India), were having adequate cash reserves but with quite a few creditors.

When the pandemic struck and the economy and the world shut, this left all airline companies with very little room to manoeuvre. Air India though continuing its operations to get back stranded Indians from abroad free of cost or charging a very minimal amount further exhausted its cash reserves.

Some cash rich companies negotiated with suppliers to get their raw materials at cheap rates. This however was not the case with the other set of industries when the economy started to open up.

Deteriorating Solvency

In the backdrop of tight liquidity, thin margins and high burn rate, the airlines have always been fragile to withstand the normal demand shocks, oil price fluctuation, depreciating currency, etc. Industry has vouched the devastating impact of these events ranging deep losses to airlines bankruptcy.

The profit margins of the airlines are highly thin and unsatisfactory to insulate the firms from sudden shocks. Median net profit margin − 0.73, prima-face, corroborate those net profits of all the airlines in India are occasionally positive. There appear only three airlines, Interglobal, Go Air, and Blue Dart (Cargo airline) with positive net profit margin in all the five years. In terms of magnitude, the net profit margin 0.5 to 9% and EBIT margin of 1 to 15% does not seems satisfactory to justify the corpus invested and the risk involved there in.

Oil price hike of 2018 has plunged the sector into deep losses. Interglobal Aviation that appears to be best performer of the industry has experienced deep shrinkage in its net profit margin of 2019 from 9 to 0.5%.

Unable to take the hit, loss running Jet Airways blown out of the race with its operations meeting grinding halt in April 2019. Previously also, Industry has a history of several starts and may failures; East West Airlines and Damania Airways in 90 s, Kingfisher Airlines in 2012 are classic instances of airlines financial failure.
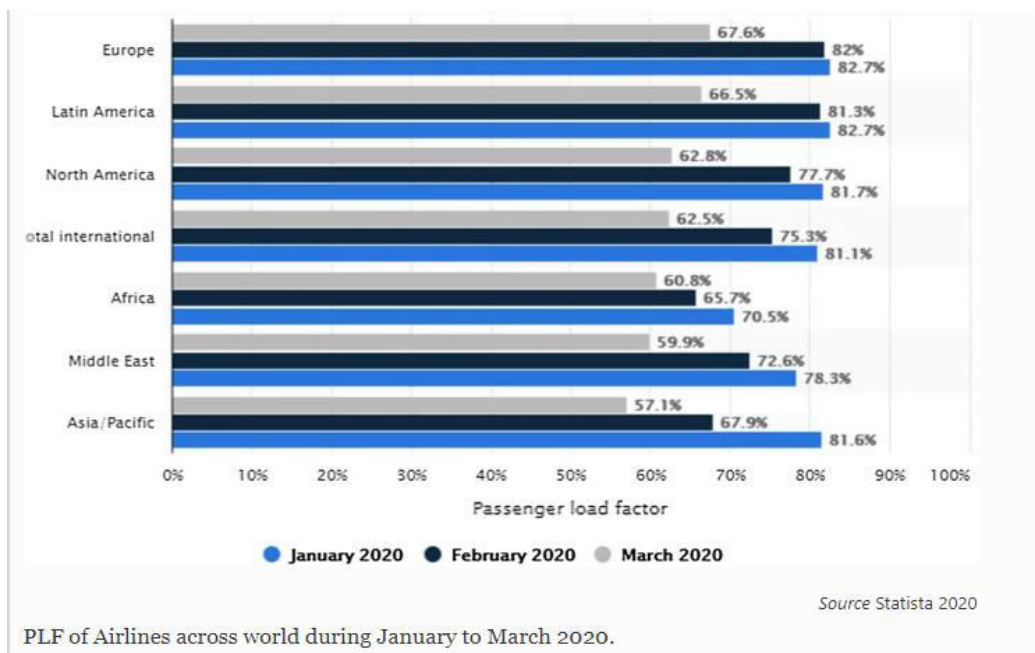
PLF of Airlines across world during January to March 2020.

CONCLUSION

The COVID-19 pandemic has caused disruptions in all parts of the world. Pandemic has extensive impact on the global airline business. Three crucial announcements are selected to be studied, which are (1) the first case reported outside China (Event 1: January 13, 2020), (2) Italy outbreak (Event 2: February 21, 2020), and (3) the declaration by WHO on the global pandemic outbreak and the announcement of President Trump to ban travellers from 26 European countries (Event 3: March 11, 2020). We find the underreaction and overreaction to the announcements in Event 1 and Event 3, respectively. Airlines stocks in Australia, Canada, the U.K., and the U.S., are the worst performers in the post-event period in Event 3. We offer several potential explanations for the findings in this paper. As the COVID-19 pandemic has been ongoing, our results call for the policy implications below.

It was found that the government in each country is at an intersection—whether to provide financial support or guarantee existing debt, or to believe in market mechanisms and let the airline firms file for bankruptcy. In order to back up the airline industry, several alleviation policies may deal with mergers and acquisitions, tax policy, and government subsidies. These policies, of course, will increase the national debt. Otherwise, firm liquidation in the airlines is, perhaps, inevitable and subsequently will disrupt the global supply chain and related businesses.

FINDINGS

Present paper attempts to analyse the vulnerability of airlines in India to withstand Covid-19 aftereffects. Lockdown has been drastic for the fragile airlines business distressed with thin margins, liquidity crisis, over mounting fixed cost and debt.

Zero revenue, though spiralling fixed expenses has been a drain on the cash reserves of airlines dragging them towards insolvency. Above all, the sector is viewing grim recession ahead.

In this backdrop, the operation viability of airlines seems conditional on the recovery of variable expenses. Sustainability of airlines warrants of turnaround changes in their revenue strategies and operating models. Focus on minimizing losses rather than profit maximization possibly can help the airlines to combat current situation.

As the demand recovery will be delayed for FY2022, and reverting to pre-Covid status is likely only in FY2024, the industry need more funds to support operational costs. Consequently, debt levels, expected to be at around Rs 1,200 billion (including lease liabilities) for FY2022, is likely to remain high, with industry likely to resort for an additional funding support of Rs 450-470 billion over FY2022 to FY2024. While some airlines with strong parents will be able to tide over the liquidity crunch and sustain over the challenging period, others are likely to face significant stress. Almost all key airlines have announced fund-infusion plans either from the parent or through the QIP/IPO route. Most airlines have also undertaken several costs.

Coming to earnings, the industry will be adversely impacted in FY2022 due to lower revenues and higher ATF costs, more so demand recovery is likely to be delayed. The bearing on international travel will be more profound and long lasting, compared to domestic travel. The recovery in international travel is also contingent on the opening up of scheduled international operations by the Government of India, the macroeconomic shock to the global economy and the government-mandated travel restrictions and quarantine norms of various countries. Also, the recent threat of the new variant, which has pushed the resumption of scheduled international operations (earlier announced from December 15, 2021 onwards), has the potential to derail the domestic recovery too, if it becomes a source of fresh round of lockdowns/restrictions in the near term. The Indian aviation industry is estimated to report a net loss of ~Rs 250-260 billion in FY2022, due to elevated ATF prices and inability of the airlines to completely pass on the same to the passengers, thereby resulting in reduced RASK-CASK spreads.

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BIOMETRIC TESTING WAS PERFORMED AT BANK AND BANKS TO STOP DATA BREACH AND ITS USE IN DATA SCIENCE USING PYTHON CODE AND DIGITAL IMAGE PROCESSING

MALAY KARMAKAR

ABSTRACT

In this Paper we present the Manufacturing of Digital Computers on How to Fingerprint Sensor and Face Recognition Can Be Used at ATM Deals in India. We also introduced a python program using Machine Learning on how Face Recognition is made and compared to the original.

BIOMETRIC AND SECURITY (HARDWARE)

The need for effective security, used effectively, is evident in today's world. People should be identified to allow or prevent access to secure areas or to be able to use a computer, personal digital assistant (PDA) or cell phone. Biometric signatures, or biometrics, are used to identify people by measuring certain different physical and behavioral features. Almost all biometric techniques are performed using a sensor, to obtain raw biometric data for each individual; output features, processing data obtained to develop a feature set to represent biometric features; pattern matching, comparing a set output element with a saved dB template; and decision-making, where the required user identity is verified or denied.

FINGERPRINT SENSOR

Fingerprint sensor over the past few years has been spotted in banks and smart phones. It is used by bank employees to sign in to the system and is used by android phone applications to indicate if the right phone owner wants to sign in, or any other unauthorized person who wants to log in to the smart phone.

Now the Question is what is a Fingerprint Sensor?

Low cost, fast speed detection system used by Android, Windows or Apple Operating System to identify the right owner of the system.

How Can a Fingerprint Sensor be used in the Bank ATM's to Stop Unauthorised Accesses of the Account Holder's Account?

When an Indian Citizen or Citizen of any country Approaches a bank to open his bank account. Bank officials request a Citizen to send them the details of the AADHAR CARD, VOTE Card, PAN Card, PERMANENT PHOTO and its signature.

1) **AADHAR CARD: -**Aadhar card is required from the bank to know his AADHAR number, DOB of account holder, address proof etc. All this information is stored on the Account Manager's website.

2) **VOTER CARD: -**The voter card is used by the bank to prove that you are a citizen of that country. Saved to the account manager's website.

3) **PAN CARD: -**Pan card is used by the bank to deal with taxes levied by the government on its important financial activities. Saved to the account manager's website.

4) **PASSPORT PHOTOGRAPH: -**Picture size photograph used by the bank to indicate whether the right person is withdrawing money from the bank. Saved to the Account Manager's website.

5) **SIGNATURE: -**The signature is taken by the banking authorities to determine whether the right person is withdrawing money from the bank. Saved to the account manager's website. Like, because one person's Signature is different and different from the other used for its authentication.

Because in our daily life a third-party hacker can create a second-party signature and withdraw money from the Bank.

To increase the level of security recently all banks introduced OTP while processing checks in excess of 5Lakhs.

6) **FINGERPRINTS:** - Fingerprints can be a useful and secure tool that can be used both at ATMs and the person who withdraws money from the bank. It can be stored on the account holder's database and all of his or her details. All ATMs in India must be equipped with a fingerprint sensor and a face recognition camera.

7) FACILITATOR CAMERA: - Face Camera can be a useful and secure tool that can be used both at ATMs and the person who withdraws money from the Bank. It can be saved in the Account Manager Database and all its details. All ATMs in India must be equipped with a Fingerprint Sensor and Face Vision Camera.

How A Fingerprint Sensor Does Works: -?
Everyone in the world has a different model of their fingerprints made of ridge. Ridges creates different Whirls and Loops for everyone. Fingerprints are divided into five types such as whorl, right loop, left loop, tent and arch.

Their images are made up of many curved sections. Where the high places are called ridges and the low places are called the Valleys. Local Discontinuities in the ridge Flow Pattern is used as a discriminatory factor.

Dead skin cells have low electrical activity and the RF sensor receives fingerprint data in the wet border of the skin and is electrically activated as the living cells begin to turn into keratinized cells. This live underground layer is a source of fingerprint pattern and is rarely affected by damage or aging in the finger area.

Few Types of Fingerprint Sensor: -
1) R305 Fingerprint Sensor Module.

2) Fingerprint Sensor Arduino.

3) Au then Tec R True Print Sensor.

4) The Atmel R AT77C104B Finger Chip Sensor.

To name a few

Hardware Interface of an ATM Machine
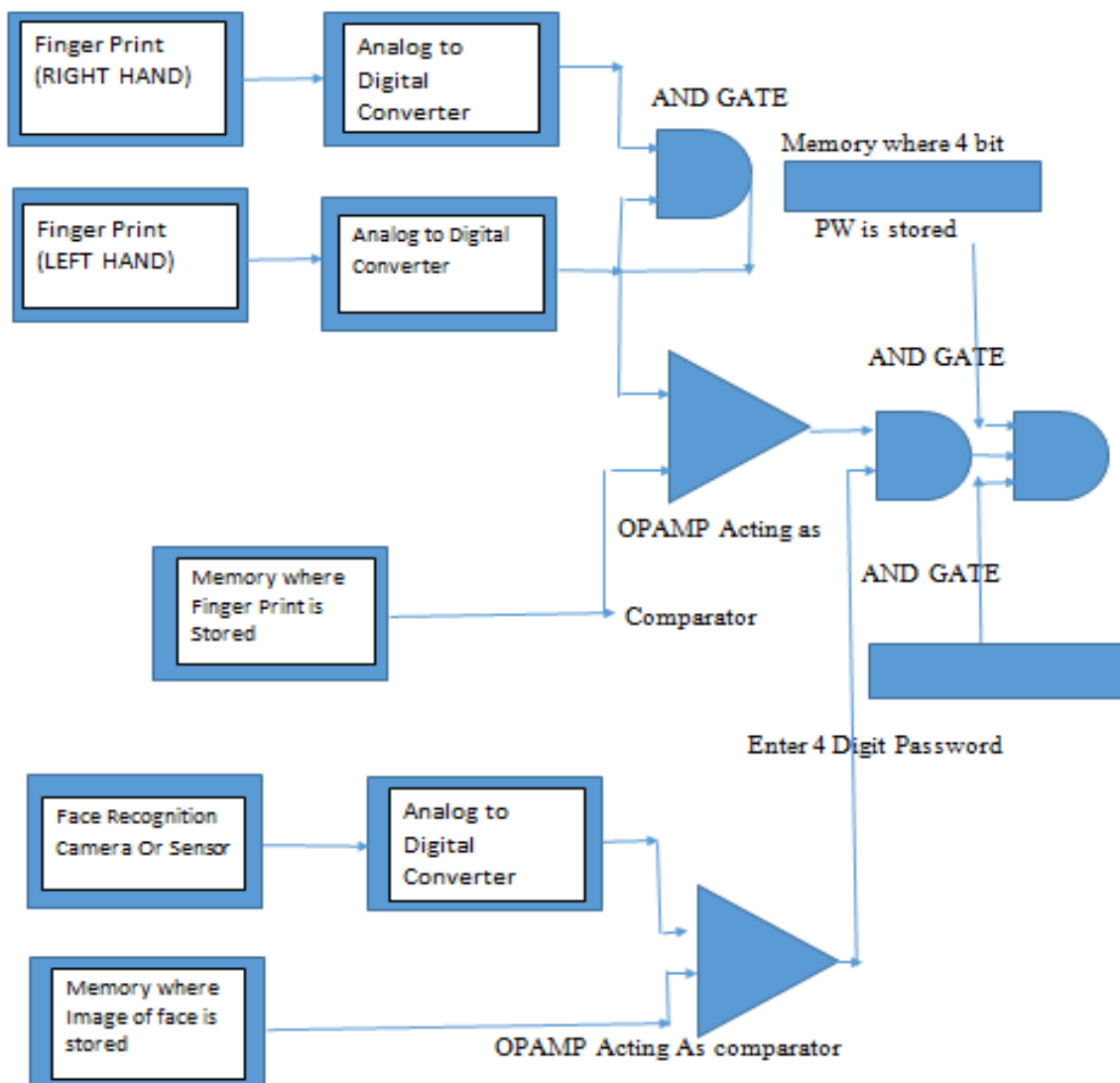
How the above Hardware does works which can be installed in the Indian ATM's?

The above hardware comprises OP-AMP (Active Amplifier), AND Gates, 4-bit memory devices, A-D Converter (Analog to Digital Converter), memory equipment etc.

When we enter the ATM, it asks for an ATM-enabled card to be inserted into the space. The ATM or system identifies the Person and asks if the account holder will withdraw the money from the ATMs or not. Then the ATM displays the account type (either Account current account, savings account or any other account). ATMs request cash withdrawals. Finally, it asks to install 4 Digit-Passwords.

Here in addition to all these 2 security standards can be introduced.

1) It can request the appearance of the right thumb.

2) It can ask for the left thumb.

Finally

3) It may ask to change the face near the sensor or camera.

The hardware or system will match the left and right fingerprints stored on the system website using the device
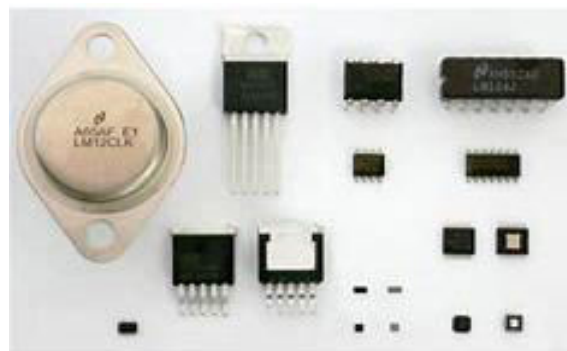
The commonly used comparators are mew A741.But before converting the analog signal into a digital signal using A-D Converter.
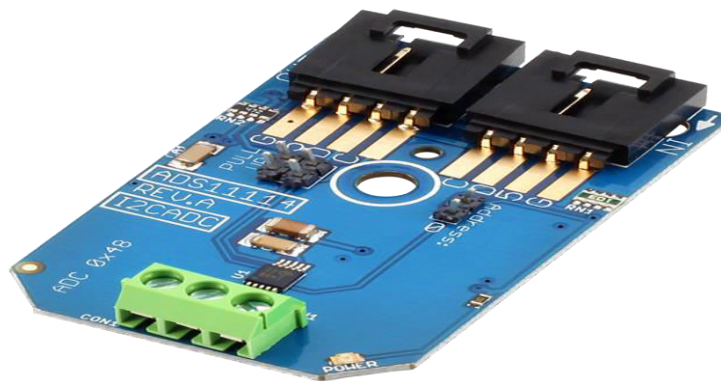
In AND Gate the output of the AND gate is logically or electrically 1(or 5 volt) when both of its Input is 1. Or in All other cases it is logically 0(Or 0 volts)
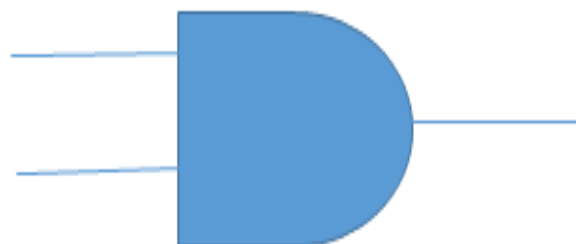
AN AND GATE

Finally, the system asks it to face its mouth near the camera installed at the ATMs. The signal is then converted from analog to digital signal using an A-D converter. If everything is the same, the ATM will withdraw the money and give it to the account holder.

FACE RECOGNITION SYSTEM

Open CV: - OpenCV is the most popular online visual library. It now offers python ties. OpenCV uses the Machine Learning Algorithm to search faces inside an image. Because faces are so complex and every face is unique and different in this world. There are thousands of small patterns and features to be compared. The algorithm breaks the function of face recognition and makes thousands of small tasks that is equivalent of biting.

First we need to find the right setup file for our operating system. Works great on Linux Operating System.

1) First we can distinguish faces by using the Face_Location command.

First we will take the image file as a .jpg (Shared Images Group)

Image (full photo) = face recognition. load_image_file (our .jpg file)

Face_Location = face recognition. Face_Location (finding faces inside an image)

2) Then it will bring in facial attention.

Let's keep a picture of our Father calling Sirshendu.jpg

Here is a popular photo

a) Famous_group = face_ recognition. load_image_file (which is Sirshendu.jpg)

b) Anonymous_code = facial recognition. load_image_file (unknown.jpg)

c) Sirshendu_encoding = face_recognition. Facial coding (Famous_ Picture) [0]

From the rest of the Image File, we must encrypt the Image. Here it is described as Sirshendu_encoding.

Similarly, Anonymous Code is defined as Unknown_encoding.

d) Unknown face = face_recognition. Facial coding (Unknown_photo) [0]

Result = face recognition. compare_face (Sirshendu code text, anonymous_code text).

Camera captures client video and saves it in Video Capture (0)

Then we should draw a rectangle on the face and name it x, y, w, h on the face.

After that we have to apply the loop to the python because (a, b, c, d) by face:

Cv2.nd rectangle (result, (a, b), (a + c, b + d), (0.40,0), 20)

When 0, 40, 20 pixels of an image.

Here c, d means wide and long.

If the edited result looks like a computer screen showing an image found on another, we say the image does not match the image of the account holders.

BIOMETRIC SIMPLIFIED

The diagram above contains two different building blocks a) Installer and b) Discharge

a) Encoder contains mapper, Quantizer and token code.

b) A decoder contains a decoder and a cross map.

The image of f (x, y) is inserted into the encoder, which creates a set of symbols from the input data and uses them to represent the image. If we define x1 and x2 as the information number holding the units in the first image and coded. Compression is then defined as Compression = x1 / x2. A maximum concentration of 30 means that the first image has information that holds 30 units.
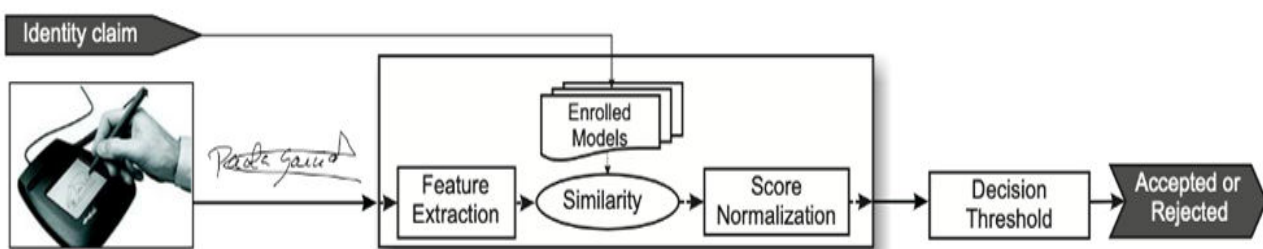
Figure 1 by [1]: Architecture of the proposed on-line signature verification system.

Speaking About Digital Signature Algorithm

Suppose a Private File is sent from one Office to another, where a third party may not be aware of the confidential file. One simple and possible email solution we can send is the original file = old file + 3;

Which means he says;

Hello;

Hello;

How are you;

To be labeled

Fg;

Fbjjl;

Flt cob vlr;

This paper provides one example of a signature.
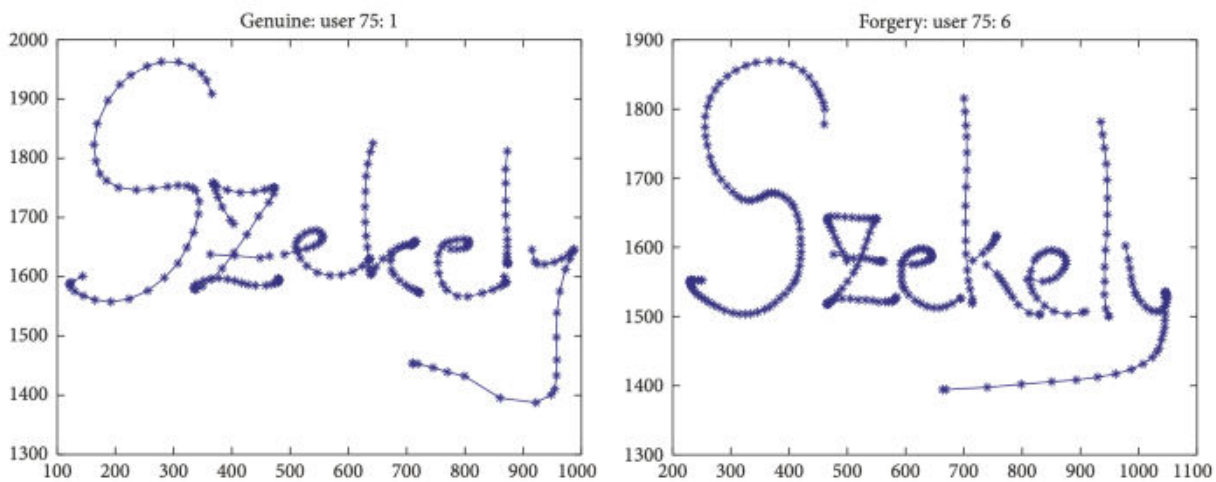
Pseudo signatures from the database. The first column contains genuine signatures and the second column contains forgeries.

The first signature contains the first signature and the second contains false material. It should be noted that if an external company wants to make a signature the signature pixels will be much deeper and will contain a slight change in the Original.The Financial sector around the World will continue to struggle against fraudsters. Despite increased adoption of EMV cards and its robust password creation Policies the banking customers are still falling victims to fraudsters and this is costing the bank in a big way.

The Problem with Password

Using a Password comes with a sensitive caveat. Hackers can use any tactics they know to steal a secret. Moreover, the complexity is easy to forget. A cybercriminal can use a personal profile of a social networking site such as Twitter, Facebook, LinkedIn etc. in order to learn Important information. Social Engineering today has become a popular tactic among hackers. Therefore, if someone is working on social media these days they should use 2 Layer protection. It means that after entering the Password the system will send OTP to his mobile phone to open an Account.

How Facial Recognition Combats Fraud

Although facial recognition can be considered among the most appropriate biometric authentication, it poses a significant risk of impersonation, given the high availability of facial images of the victim. A criminal may try to exploit an image of a person acting, often referred to as a "spoof".

As a result, the owner of the bank notified the management of the matter so that further investigations could be conducted.

Face biometrics can be used to access accounts on a computer. Many computers, for example, have built-in web cameras.

CONCLUSION

Success! We can successfully distinguish between imitated and original signatures. Some state-of-the-art approaches to also map time constraints are Recurrent Neural Networks.

And with the ATM Machine another any three security question points can be added

1) The computer screen can ask who your favorite childhood hero is.

2) What is your Mother's maiden name?

3) What is your Father's name?

Along with this the computer after knowing any one of the above question it may ask for OTP (One Time Password) sent to customers Registered Mobile.

So, After Going through so many Security Checks It becomes almost Impossible for the Hackers to withdraw money from ATM.

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SIMULINK/MATLAB MODELING OF ODES WITH INITIAL CONDITIONS SPECIFIED AT NON-ZERO INSTANTS

PANKAJ MOHINDRU

ABSTRACT

In the paper, methods for simulating differential equations whose initial conditions are specified at non-zero instants of time are presented. Analyzing systems using theoretical computation methods for solving differential equations require a significant amount of time and effort. Thus, to save computing time as well as to have a graphical picture for the mathematical solutions of the equations that depict the behavior of dynamic systems, simulation software is employed. Simulink/MATLAB modeling of differential equations that represent different dynamic systems provides an easy and quick way for analyzing the behavior of systems. Different approaches are employed in Simulink to model a dynamic system that includes differential equations in time domain (integrators based), transfer function based, and state space based. The paper focuses on differential equations with non-zero initial conditions at $t \neq 0$ and compares different approaches used in Simulink for implementing block diagram based mathematical models for them. To conclude, dynamic behavior of circuits and systems is analyzed and examined graphically employing different approaches for specified system parameters.

Keywords: IVP, ODE, Differential Equations, Simulink, Initial Conditions, Block Diagram, Model, Non-Zero

I. INTRODUCTION

In today's world, Simulink (Simulation and Link) is the most used engineering software tool that runs within MATLAB computer software package. It has built-in graphical user interface (GUI) environment where the user can rapidly construct block diagrams based graphical models in order to design, test, simulate, and analyze dynamic systems' behavior to various inputs. A Simulink model may consists of sources and sinks along with intermediate blocks that represent basic dynamical system elements such as combination of resistors, capacitors, inductors, diode/transistors, etc. It is very easy to build a model in Simulink just using click-and-drag mouse operations.

Simulink can solve models for both continuous and discrete-time (sampled time) components/systems or a hybrid of the two graphically and simulate many of the operational problems occur in the real world [4-6]. Most of the dynamic systems contain energy storage elements e.g., masses and springs in mechanical systems or inductors and capacitors in an electrical circuit and due to principle of conservation of energy these systems does not experience instantaneous changes in the state variables. Therefore, transients occur in the systems' response before steady-state response values. Any system can be built and simulated easily in a block diagram representation using Simulink and the simulation results are displayed quickly [7]. Simulation algorithms and parameters can be changed in the middle of a simulation with natural results. MATLAB is undoubtedly an all-rounder tool used by an engineer or scientist for simulations, programming, graphical analysis, measurement & automation, and statistics.

Simulink is used as a tool for numerical solving of differential equations describing systems [1-3]. As an example of continuous system, a pendulum with external source of force, wind created by force of a ventilator, etc. There are many applications in electrical, mechanical, aerospace, robotics and civil engineering technology that require solving differential equations. Differential equations of different orders play a pivotal role in diverse fields like mathematics, physics, electrical, mechanical & civil engineering and biological population modeling [12], etc. For modeling and analyzing systems in diverse engineering and scientific applications, Simulink uses different approaches such as differential equations (integrators based) or transfer function based or state space based [5, 8-11]. It eradicates the need to write a lengthy code or program file in order to formulate differential equations (or difference equations). The simulation analysis provides a great deal of information about the system, such as stability of the system, its step or impulse response, and its frequency response.

Simulink has a graphical editor and an extensive set of blocks for building block diagrams to realize dynamic systems [4-6]. It contains various sub-libraries of predefined blocks that are categorized using all-purpose functions e.g., Math Library (containing mathematical function blocks such as summer, gain, trigonometric, product, etc.), Sources library (containing common input functions such as sine, constant, ramp, clock, etc.), Continuous library (containing integrators), Sinks library (containing Scope, Display, To workspace blocks, etc.). Simulink blocks are available with a set of default parameter values and configurable properties which can

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be easily modified in the related field boxes. For example, the Product block can be configured to multiply or divide two signals by simply double clicking on the block for changing the sign of operation.

Physical systems can be represented mathematically as a set of differential equations or by using transfer function approach for analyzing their performance. Representing complex systems or systems having multiple inputs and outputs with differential equations or transfer functions is cumbersome. To avoid this, state space method is employed.

II. THEORY

Solving Differential Equations with Non-Zero Initial Conditions at Zero Instants/Non-Zero Instants of Time

A differential equation is a mathematical equation for an unknown function of one or several variables that relates the value of the function itself and its derivatives of various orders. Ordinary differential equations (ODE) are derivatives of a dependent variable with respect to one independent variable, usually time. Ordinary differential equations (ODE) play a fundamental role in the modern technological systems where circuit and systems (e.g. RC, RL, RLC, DC motors, robotic arm, etc.) can be described in different ways using differential equations of first order second order and higher order [7, 12-14].

Simulink (leading environment for system simulation and model based design) is a time based simulation software used for solving differential equations numerically and obtaining a graphical picture. Different approaches [13, 15-18] for determining a change in the behavior of a system (represented by an ODE) over time e.g. integrator (time-domain) method, or transfer function (frequency domain) method, and state space method are discussed below.

A. Integrator Based Approach: It includes defining systems first using differential equations, and then implementing the equations with block diagrams that include integrator blocks.

Simulink allows simulation of linear time-invariant (even nonlinear or time-varying) differential equations that can be written in an explicit form given by:

$$\frac{d^n y(t)}{dt^n} = f\left(\frac{d^{n-1}y}{dt^{n-1}}, \frac{d^{n-2}y}{dt^{n-2}}, \ldots, y, u, t\right) \qquad (1.1)$$

A set of mathematical equations representing the system is first derived for computing a linear dynamic system's **time response** that depends on non-zero initial conditions ($specified\ at\ t = 0\ or\ t \neq 0$) and the system input. For some simple systems, a closed-form analytical solution can be easily obtained. But for most of the systems (including nonlinear systems or those subject to complicated inputs), an integration must be carried out numerically to determine the output response that represents how the state of a dynamic system changes in time when subjected to a particular input. Simulink/MATLAB provides all useful resources for calculating time responses to several types of inputs and analyzing them graphically.

Integration of the derivative of a function is equal to the function itself. Thus, an integration is needed in order to determine a time response of a system described by the differential equations so as to get back the function without the derivative. The integrator block available in Simulink library serves the same purpose in the constructed model. It has 1/s as the block symbol and is used to calculate an integral of a signal provided at the input i.e. left side of the block [22-23]. The number of Simulink Integrator blocks required to be added into a block diagram based model depends on the order of given differential equation e.g. for solving & analyzing a 1st order differential equation, only one integral block is needed, and if the equation is a 2nd order differential equation, the number of blocks dragged and dropped into the model is two.

Initial conditions specified at $t = 0$ can be easily entered in the Integrator block. Now, the question arises how to solve differential equations with initial conditions specified at non-zero instants of time ($i.e.\ t \neq 0$). This issue is discussed and resolved here scientifically in the paper. Also, the simulated results are presented in the paper.

B. State Space Approach

A state space representation of a system replaces an nth order differential equation with a single first order *matrix* differential equation. The method is convenient for breaking down a higher-order differential equation into a series of first-order equations for easier solution by matrix methods. For modeling a second-order ODE using state space, the equation is broken down into two first-order state equations. This can be done by assigning a subscripted variable for each state of the system in an order of increasing derivatives as shown below [19-21]:

$x_1 = x$ (1.2)

$x_2 = x' = x_1'$ (1.3)

$x_2' = x''$ (1.4)

This allows a re-statement of the equation in terms of state variables only (x' *implies first order derivative of the function* x).

To begin, select the State-Space block from the Continuous sub-menu of the Simulink library.

At this point the model is very general, and an equation of any order can be set up for solution in the block parameters. The equation inside the State-Space block is

$x' = Ax + Bu$ (1.5)

$y = Cx + Du$ (1.6)

This represents the basic state-space equation, where x' = a vector of the first-order state variables, y = output vector, x = the state variable vector, u = a forcing input function, A = the state matrix, B = input matrix, C = output matrix, and D = transmission matrix.

III. RESULTS

Initial Value Problem (IVP) is an ordinary differential equation together with an initial condition which specifies the value of an unknown function at a given point in a time domain. Modeling a system in physics or other sciences frequently amounts to solving an initial value problem. For solving a differential equation given by Eq. (1.7) using integrator-based approach, first step is to rearrange the given differential equation. On the left-hand side write the highest order derivative and move all the remaining terms on the right-hand side as shown in Eq. (1.8).

$$y''(t) + ay'(t) + by(t) = x(t)$$ (1.7)

Rearrange Eq. 1.7 in such a way that the highest differential term $y''(t)$ is separated from the other terms as shown below:

$y''(t) = -ay'(t) - by(t) + x(t)$ (1.8)

The corresponding integrator block-scheme (to be built in Simulink) is shown in Fig. 1.1.
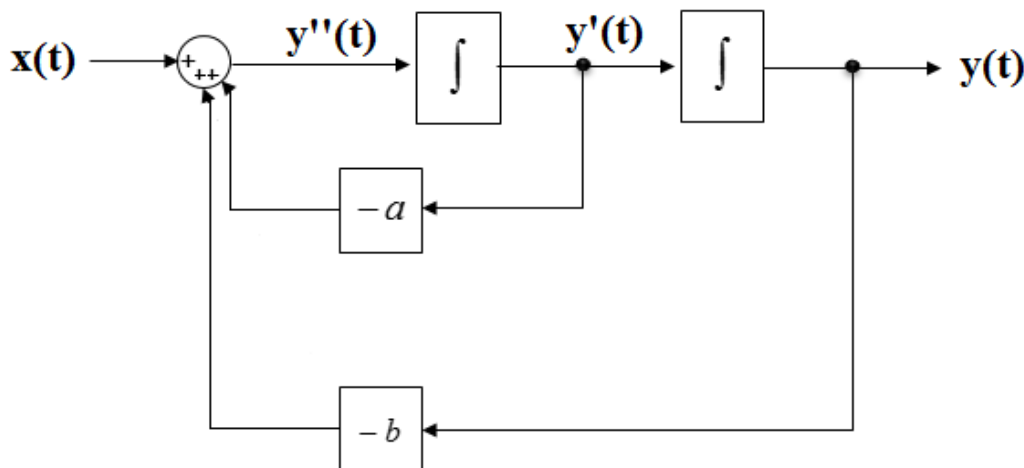
Figure 1.1: Simulink Model Based on Integrator Block Scheme for Solving an Eq. (1.7)

In the paper, an initial value problem differential equation taken for the analysis is as follows:

$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} = \cos(t-3) + 4t, \qquad y(3) = 0 \qquad y'(3) = 7 \qquad (1.9)$$

The above Eq. (1.9) can be simulated in Simulink by first bringing the initial values to be at $t = 0$. Fig. 1.2 below shows the Simulink model for solving the differential equation given by Eq. (1.9) whose initial conditions are not at $t = 0$ but specified at non-zero instants of time. The Laplace transform of the derivatives can be obtained only when initial conditions are specified at $t = 0$. Thus, Eq. (1.9) is formulated in a way so that the initial conditions can be defined at $t = 0$ by using a change of variable method by defining [24]:

$\beta = t - 3 \; or \; t = \beta + 3$ (1.10)

Substituting Eq. (1.10) in Eq. (1.9) for an independent time variable t, and then using substitution $u(\beta) = y(\beta + 3)$ for the output variable, we get the IVP with the new variables and initial conditions at a zero time instant i.e. $t = 0$:

$$\frac{d^2u}{d\beta^2} + 4\frac{du}{d\beta} = \cos(\beta) + 4\beta + 12, \qquad u(0) = 0 \qquad u'(0) = 7 \qquad (1.11)$$

The exact solution of resulting new differential Eq. (1.11) is given by:

$$\frac{1}{2}\beta^2 + \frac{11}{4}\beta + \frac{17}{16} - \frac{273}{272}e^{-4\beta} + \frac{1}{17}(4\sin(\beta) - \cos(\beta)) \qquad (1.12)$$

The solution to the original IVP can be obtained by replacing β in Eq. (1.12) by $t - 3$.

- **Integrator Scheme**

Eq. (1.9) can be implemented by first simulating Eq. (1.11), and then connecting the Transport Delay block having a delay of 3 sec in series with the simulated output (because $y(t) = y(\beta + 3) = u(\beta) = u(t - 3)$ as shown in Fig. 1.2. Initial conditions specified at $t = 0$ can be entered in the Integrator block parameter window.
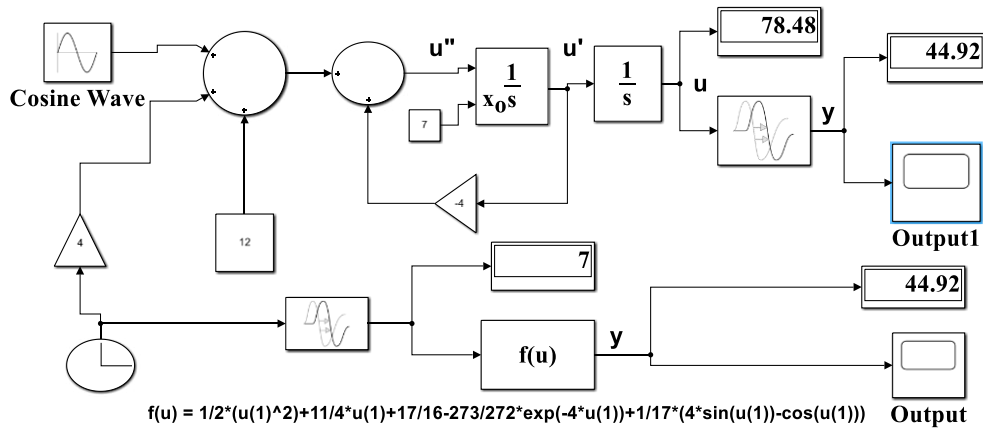
Figure 1.2: The Simulink Circuit Model using Integrator Method and Exact Solution

For simulating the system from t = 0 to t = 5, set the simulation stop time to 10 from the model window. The simulated output after running the simulation is shown below in Fig. 1.3. The Display Sink block is showing the numerical output value of the original IVP at a time instant equal to 10s (the specified current simulation stop time). It is to be noted that sampling issues must be taken care of while running a simulation in Simulink. If the variable-step solver option is selected, the maximum step size parameter in the Max Step Size field box present in the Configuration Parameters window should always have a lower value for better simulation results.
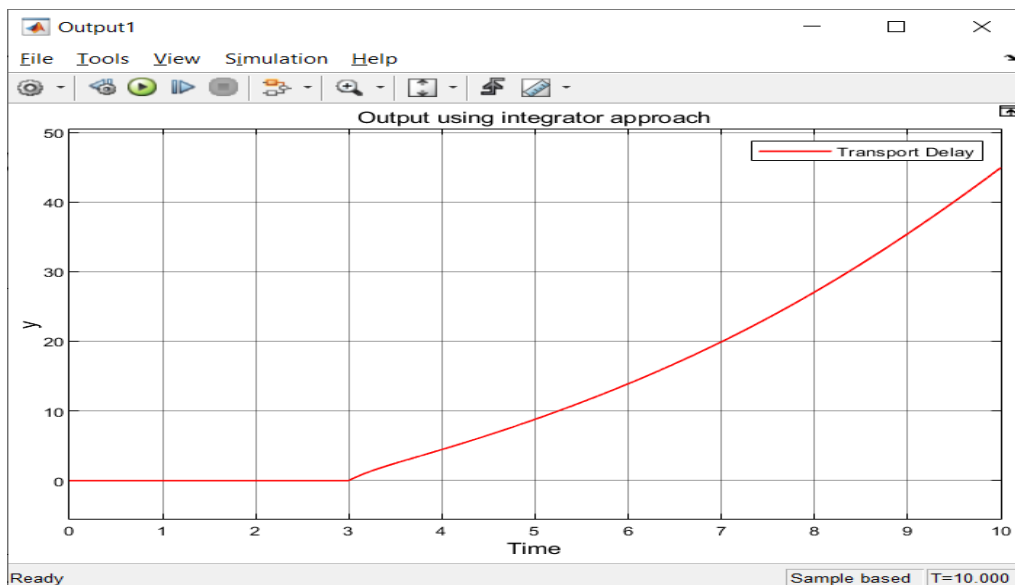
Figure 1.3: The Simulated Output using Integrator Method

The values of the simulated output for time instants t = 3s and t = 5s using integrator based approach are displayed in Fig. 1.4.
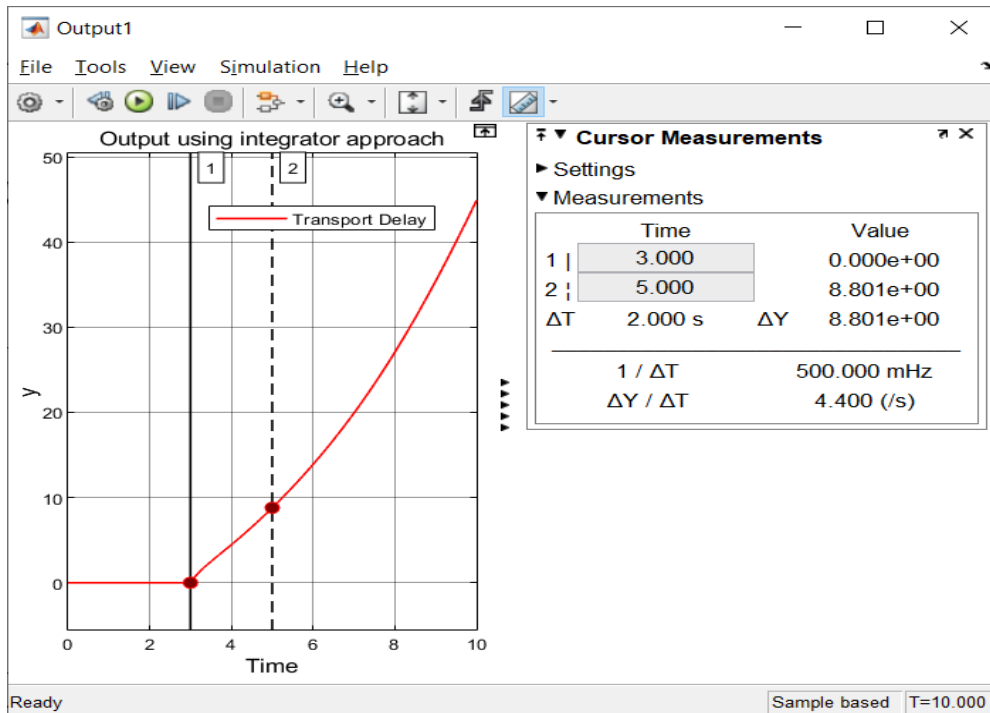
Figure 1.4: The Output Values for Time Instants t = 3s & t = 5s using Integrator Scheme

- **Exact Solution Scheme**

First variable β in Eq. (1.12) is replaced by $t - 3$ using the Transport Delay block and setting its delay parameter value to be equal to 3. Afterwards, the Fcn block is used to build the model for generating an exact output of original IVP that is represented by Eq. (1.12) with a time delay as shown in Fig. 1.2. The simulated exact output of the original IVP using analytical solution is shown in Fig. 1.5.
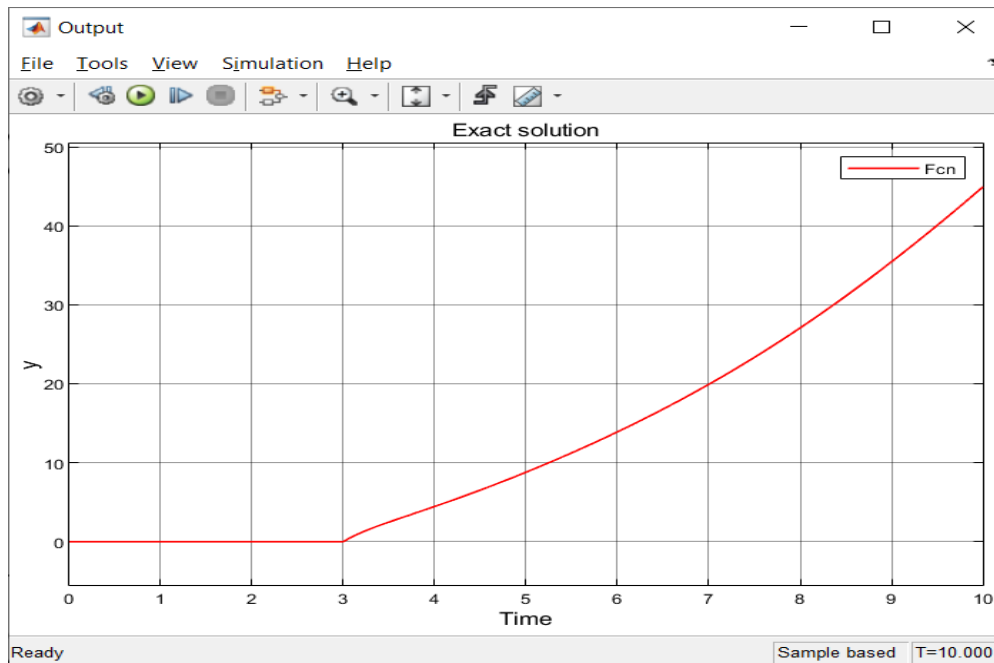
Figure 1.5: The Simulated Exact Output of the Original IVP

The Fcn block applies a specified mathematical expression to its input where the expression can include numeric constants, arithmetic operators, built-in mathematical functions, relational operators, logical operators, parentheses. The Display Sink block is a digital readout of an input signal at a current simulation time (the specified simulation stop time). The Scope Sink Block is used to display a signal as a function of time in a Simulink model.

- **Output Using State Variable Approach**

First, select the state variables for Eq. (1.11). By choosing the state variables as successive derivatives, one gets two first-order differential equations as shown below:

$$x_1' = x_2 \tag{1.13}$$

$$x_2' = -4x_2 + \cos(\beta) + 4\beta + 12 = -4x_2 + f(t) \tag{1.14}$$

These can be re-organized to obtain:

$$\begin{Bmatrix} x_1' \\ x_2' \end{Bmatrix} = \begin{bmatrix} 0 & 1 \\ 0 & -4 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} f(t) \tag{1.15}$$

$$y = x = x_1 = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} + [0]f(t) \tag{1.16}$$

The Simulink model for simulating Equations 1.15 and 1.16 using the state space approach is shown in Fig. 1.6.
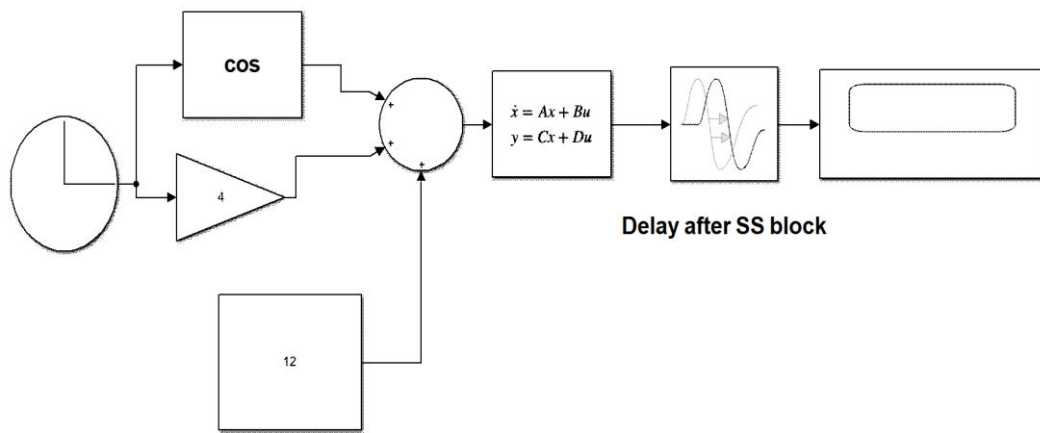
Figure 1.6: The Model for Generating State Space Solution

The State Space block allows entering the direct input values of the A, B, C and D matrixes that are unique to a particular state-space model by going into the block parameter dialog box [17, 21]. The initial conditions are specified separately in a place to enter the ICs in the State Space block parameter window as shown in Fig. 1.7.
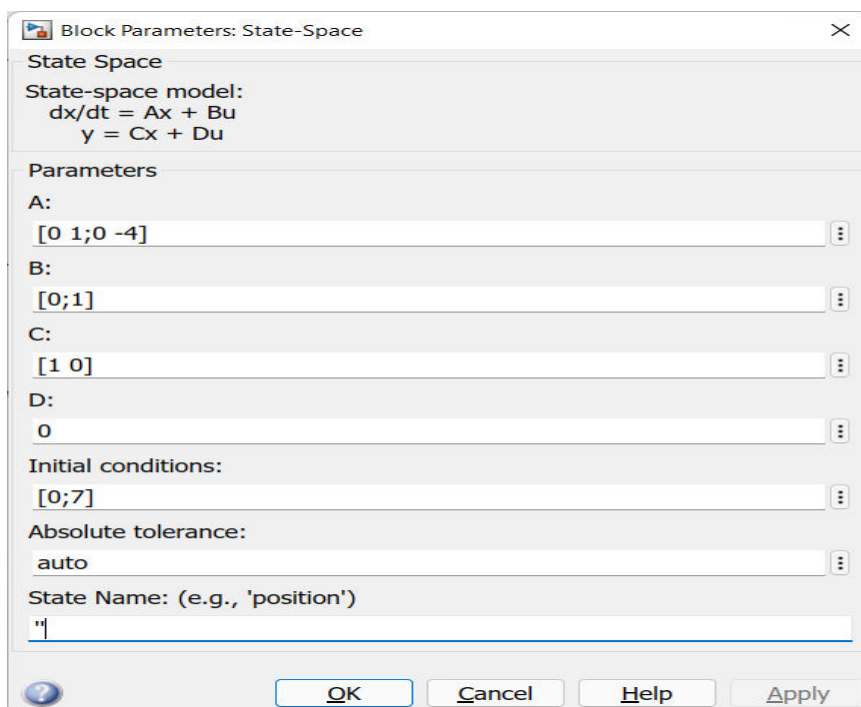
Figure 1.7: The State Space block Parameter Window Dialog Box

The model built using state-space approach can be easily mapped in Simulink environment for a numerical simulation. The simulated output using state space approach is presented in Fig. 1.8.
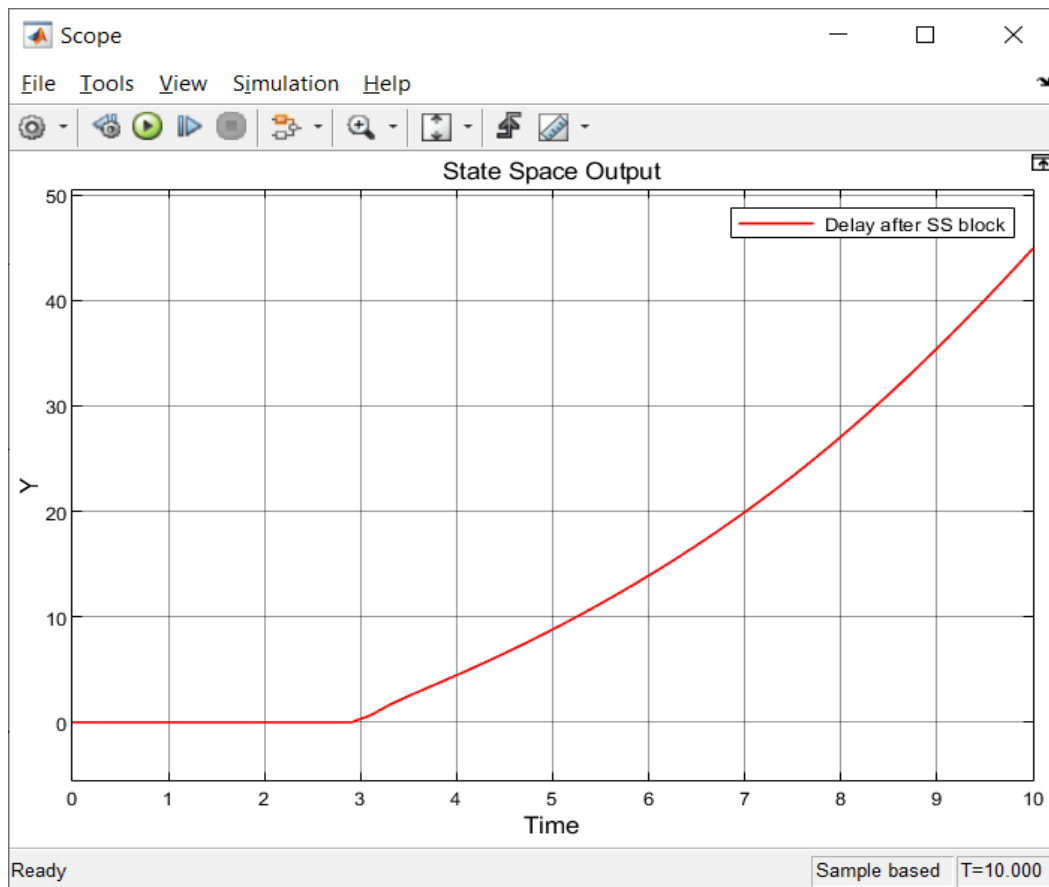
Figure 1.8: The Simulated Output using State Space Approach

The model for comparing the numerically computed outputs of the original IVP using integrator method and state space method with the analytical solution is shown in Fig. 1.9. The simulation results are compared with the analytical one to ensure that numerical approximations give acceptable results.
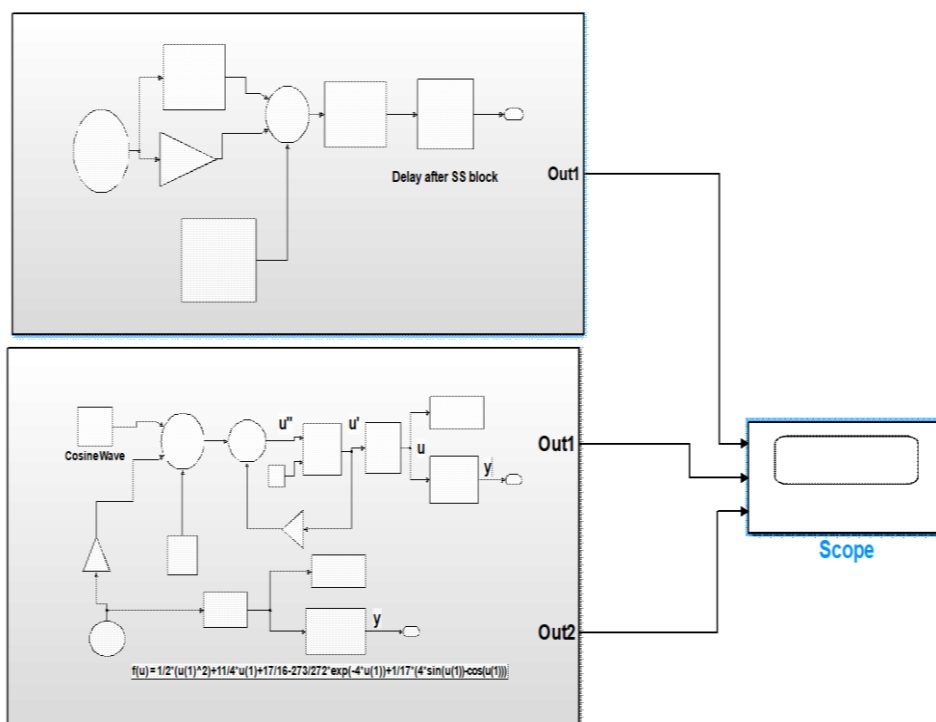
Figure 1.9: The Model for Comparing the Outputs based on Different Approaches

A comparison of outputs of the original IVP using analytical method, state space method, and integrator approach is shown in Fig. 1.10.
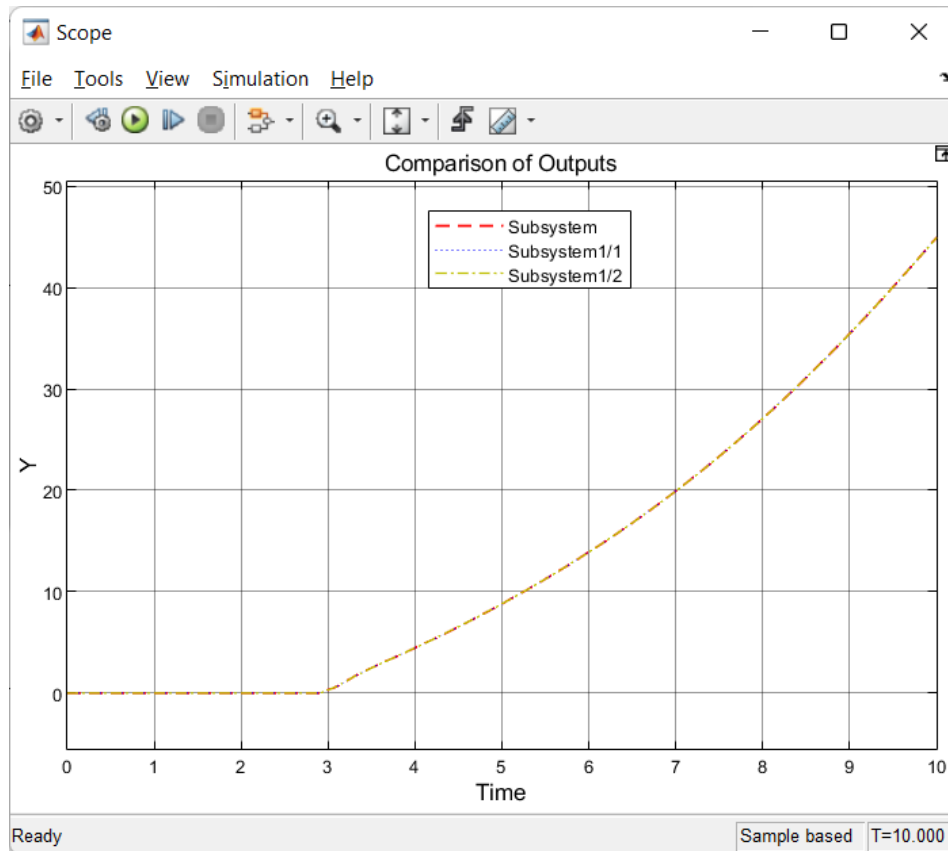
Figure 1.10: Comparing the Outputs using the Analytical Solution as a Benchmark

IV. CONCLUSION

It is observed that while solving initial value problems of differential equations, the simulation results are in accordance with the analytical solution, and therefore the model based design can be related with the theoretical foundation and practical applications. Thus, it is concluded that Simulink can be easily and more effectively employed for solving differential equations representing various systems as it enables the user to change the components to suit any differential equation needed to be solved simply by changing the parameter values or adding or removing the blocks from the system model. Thereby, analyzing physical systems using simulation based software saves time of researchers and promote innovation in engineering and science field. Hence, it can be stated that Simulink provides an actual prediction of how the physical quantities related to a system change their behavior.

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EMOTIONAL RESILIENCE IN ADULTS – A REVIEW OF KEY MEASUREMENT INSTRUMENTS

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ABSTRACT

Emotional Resilience is the ability of an individual to cope up with adversities and bounce back from failures. There are many factors responsible for Emotional Resilience and accordingly many instruments have been designed to measure the same. Each instrument is different in its own way based on applicability, target population, factors involved etc. The objective of this paper is to do a narrative review of the different instruments used to measure emotional resilience, study their target population, dimensions and established psychometric properties, in order to propose the best scales for use for emotional resilience in general adult populations. The key inclusion criteria for selection of scale research papers was original scale development or evaluation papers published in English from 1990 to 2021, addressing adolescents or adults and used or cited in at least one study on emotional resilience. The study concludes CD-RISC, EQ-I, RS-14, DRS-15 and RAW may be the best scales to use with the general adult populations to measure the emotional resilience of individuals and synthesizes 14 unique dimensions from the above-mentioned five scales on emotional resilience. This paper also seeks to serve as compendium of twenty four most popular scales on Emotional Resilience in adolescents or adults and presents their target population and dimensions.

Keywords: Emotional Resilience, Emotional Resilience in Adults, Scales of Emotional Resilience, Instruments for measuring of Emotional Resilience.

I. INTRODUCTION

Often, Emotions, Feelings and Moods are used interchangeably as the same are very closely related to each other, making the distinction hard. However, Scherer (2005) articulates the subtle differences between Emotions, Feelings, and Moods. *Emotions* are defined as interrelated and synchronized changes in the state of mind in response to the external or internal stimulus events relevant to an individual. Emotions are discrete and short-lived like joy, anger, fear or disgust. Emotions are physical and instinctive and originate from the sub-cortical levels of the brain. As per neuroscience, emotions can be measured by galvanic skin response, blood flow, facial expressions, body language, brain functioning etc. *Feelings* are the labels of emotions and are subjective and intangible (Scherer, 2005). *Moods*, unlike emotions, are longer lasting feelings and often emerge without any apparent cause. They are generally low in intensity but longer in duration as compared to emotions. While emotions can be expressed, moods are generally not expressed. Moods can broadly be categorized as positive or negative. For instance, a person may be in a cheerful mood on a particular day and may be feeling down on another day.

Emotional Intelligence

Gardner (1983) propounded the theory of multiple intelligences (MI) which suggested that human beings have seven different streams of intellectual functioning, and that these streams are separate intelligences with separate measurable abilities. These multiple intelligences were identified as logical or mathematical intelligence, linguistic intelligence, musical intelligence, spatial intelligence, bodily or kinesthetic intelligence, interpersonal intelligence, and intrapersonal intelligence. Salovey and Mayer (1990) first used the expression Emotional Intelligence (EI) and distinguished Emotional Intelligence as a mental skill which enables an individual to perceive and recognize his own as well as other's emotions as opposed to good behavior like being sociable or warm. Salovey and Mayer (1990) proposed that emotional intelligence is the part of social intelligence that involves the ability of an individual to monitor one's own emotions, recognize others' feelings, to be able to identify and label such emotions as and when they occur and use this information as a guide towards one's thoughts and actions. According to them, EI includes the awareness and recognition of emotions in self and others; the regulation of emotions in self and others and using the above awareness to modulate self-behavior. Goleman (1995) provided that emotions have a huge impact on the thinking process and it is the thoughts that translate into attitude or behaviors. Goleman (1998) advanced the study in his book "Working with Emotional Intelligence" where he analysed the impact of Emotional Intelligence in the context of a workplace. Goleman concluded that Emotional Intelligence skills are most important for Leaders and managers, more than the technical or the analytical skills. Goleman also found that despite the neurobiological or hormonal impact on Emotions, Emotional Intelligence skills can be learnt like any other intelligence and the said skills can be an important factor for workplace performance or success. In a study conducted by Boyatzis, Goleman

and Rhee (2000), they observed that emotional intelligence comprises individual competencies like self-awareness, self-management, social awareness and social skills. McClelland (1998) reviewed data for executive positions in many professions and from over thirty different organizations. He showed that what distinguished top performers from the average ones was a wide range of Emotional Intelligence competencies and a narrow range of cognitive ones. Those that distinguished most powerfully were Achievement Drive, Developing Others, Adaptability, Influence, Self-Confidence, and Leadership. The one cognitive competence that distinguished as strongly was Analytical Thinking. Albrecht (2005) propounded a model of social intelligence in the modern society. According to him, there are five major components of social intelligence of an individual i.e. situational awareness, presence, authenticity, clarity, and empathy. Crowne (2009) established the relationships among social intelligence, emotional intelligence, and cultural intelligence and proposed that Emotional intelligence is a subset of social intelligence.

Emotional Resilience

Emotional resilience is the ability of individuals to cope up with adversities and bounce back from failures. The Emotional resilience degree of an individual would be characterized by how hard one can bounce back or spring back after such failures. Resilience comprises of individual characteristics which can accentuate the ability of such individual to cope up when he is confronted with difficult situations and stressful life events (Hoge et al., 2007). Resilient individuals can forgive, forget and move on despite adversities and do not keep their heads buried brooding over past problems. What distinguishes high and low resilient people is their capability to learn from setbacks and use this knowledge to cope-up more effectively in future (Salovey et al., 1999). Coutu (2002), described that resilient people possess 3 defining characteristics i.e. they openly accept the harsh realities of life facing them; they find meaning in toughest of the times; and they keep improvising always and make do with whatever resources are available at hand. As per Tugade & Fredrickson (2004), there are certain individuals who bounce back from negative events quite quickly and effectively, whereas others are caught in the past, unable to get out of their negativity. It is not that individuals who are able to move on despite negative events (triggers) are luckier than the others. In fact, it demonstrates a concept known as emotional or psychological resilience. Psychological resilience refers to the ability to adapt and cope up with losses, hardships, or adversities in life (Tugade & Fredrickson, 2004). For example, resilient persons believe they can have a strengthening effect, are more capable of adapting to change, can use past successes to confront current challenges (Rutter, 1985) and use positive emotions to recover from negative emotional experiences (Tugade & Fredrickson, 2004). Other qualities associated with resilience are patience, tolerance of negative affect, optimism (Lyons, 1991), and faith (Connor & Davidson, 2003). Newman (2005) described resilience as the capability to adapt oneself to any tragedy or trauma or any other significant stressful circumstances. It is a process and outcome of successfully adapting to difficult or challenging life experiences, especially highly stressful or traumatic events (O'Leary, 1998). Resilience is related to well-being, overall satisfaction with one's life (Bajaj and Pande, 2016) competence, excellence, tenacity, self-belief, tolerance, adaptability, trustworthy relationships and spirituality (Connor and Davidson, 2003). Kobasa (1979) discovered that hardy individuals demonstrated a stronger self-commitment, a proactive attitude, meaningfulness, and an internal locus of control. Whereas Kobasa measured commitment, control, and challenge as the larger factors from which she drew her resilience conclusions, Bartone et al. (1989) studied commitment, control, and change among military personnel dealing with trauma from a military plane crash involving fatalities. Fredrickson (2001) propounded the broaden-and-build theory in relation to positive and negative emotions. According to the broaden-and-build theory theory, positive and negative emotions have distinct and complementary physiological effects in a human body. This theory provides that negative emotions in an individual narrow one's momentary thought–action repository by propelling one to behave in a specific way (e.g., attack when angry, escape when afraid etc.). In contrast, various positive emotions (e.g., joy, contentment, interest etc.) broaden one's mindset, expanding the range of cognitions and behaviors that come to mind. These broad mindsets develop one's physical, intellectual and emotional resources and therefore those who experience positive emotions amidst stress are able to successfully regulate their negative emotional experiences. Resilient people use positive emotions to rebound from stressful encounters and find positive meaning in adverse or negative situations. Thus, according to the broaden-and-build theory, positive emotions have a unique ability to physiologically regulate negative emotions.

The below figure 1 explains the interplay of triggers and emotions at the workplace and how they bring out whether an individual is Emotionally fragile or resilient.
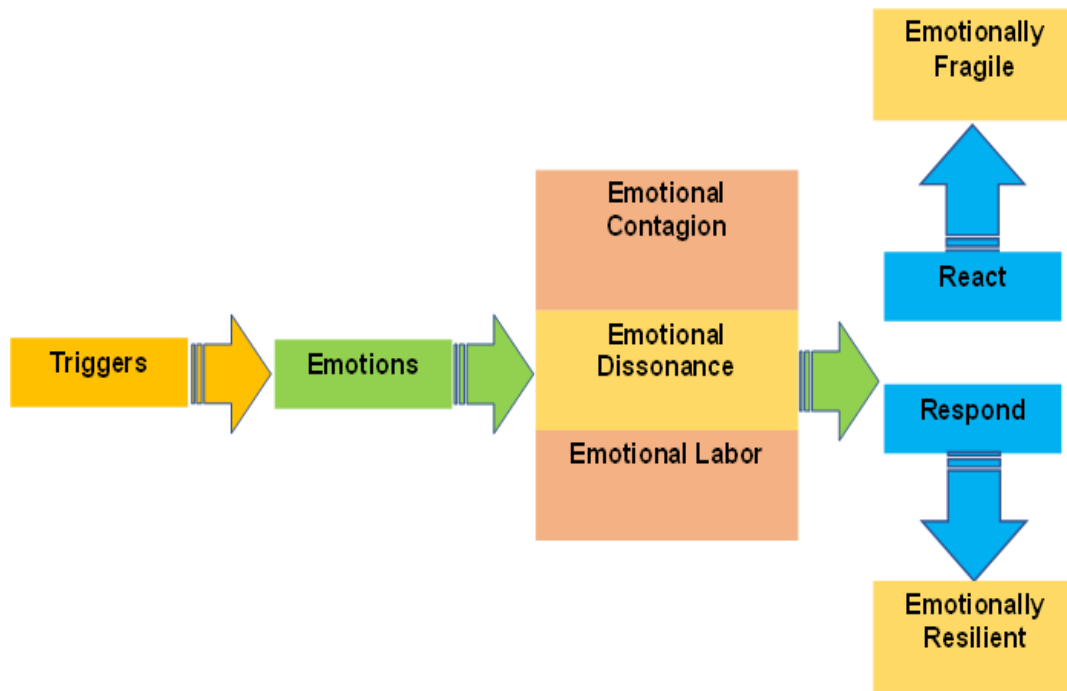
Figure 1: Flow of Emotions at Workplace
Source: The Authors

II. RESEARCH OBJECTIVES

The objective of this paper is to do a narrative review of the major instruments available to measure emotional resilience, study their respective dimensions, present brief psychometric properties indicating the reliability and validity of the said instruments and derive the key emotional resilience scales for adults. This paper will also serve as a compendium of the key emotional resilience scales in adults which will aid future research on the subject.

III. RESEARCH METHODOLOGY

A review was undertaken to identify scales that measure resilience in adults and the following steps were followed:

Step 1: Finalizing the Review Questions

The research questions considered in the review included the following:

a. What scales are available to measure emotional resilience in adults?

b. What are the psychometric properties and factors of the identified scales?

c. What is the target population of the scales?

d. Which scale is most appropriate to measure resilience in the adults?

Step 2: Identifying Keywords and Conducting a Search

A literature search was done using the electronic EBSCO (licensed version), JGate (licensed version), and Google Scholar (free version) for papers published between 1990 to 2021, to identify scales measuring emotional resilience. The search terms that were used were "Scales for Resilience in Adults" and "Instruments for Resilience in Adults". The majority of articles were found in the initial few searches, with mainly duplications occurring when using the latter search strategies. After the scales were identified, a second search was conducted with the author names, instrument or scale names and / or journal names to identify at least one peer-reviewed research paper citing the said scales. Attempts were also made to retrieve the "gray" literature (e.g., unpublished articles or literature not available through usual bibliographic sources or databases) using the broad internet search on the above keywords.

Step 3: Reviewing Abstracts of Research Papers

After the search was complete and all duplicates eliminated, the abstracts of the remaining research papers were reviewed to ensure that they address the review questions. These selected scales were then reviewed for the following information viz. background for the development of the scale, description of the scale, target population, factors and other psychometric properties for each scale.

Step 4: Inclusion and Exclusion criteria

Based on the above research questions, a list of inclusion and exclusion criteria was developed for the scales. Although general adults are the target population, it was decided to also evaluate instruments studied in adolescents and specific adult populations like clinical staff, nurses, hospitals, armed forces etc. All the inclusion and exclusion criteria had to be met in order for the scale to be included in the review. The inclusion and exclusion criteria is mentioned in Table 1 below.

Table 1: Inclusion and Exclusion criteria for scales in resilience

S No.	Inclusion Criteria	S No.	Exclusion Criteria
1	Target Population o Adults or Adolescents (12+ age) o Any race or geography	1	The paper contains no original data
2	Time Period o Published from 1990 to 2021 in a peer reviewed journal	2	The paper did not measure resilience
3	Publication Criteria o Published in English o Original Papers in electronic databases attributable to the author(s) or a paper evaluating psychometric properties of the scale	3	The target population of the scale was not adolescents or adults
4	Admissible Criteria o Study included presentation of scale items o Eligible research papers include: • All types of designs • Minimum sample size of 50 • When several papers from the same research were published, the original psychometric paper was included	4	The paper did not contain scale items
5	Used or cited in at least one study on emotional resilience	5	The original paper for development or evaluation of the scale was not readily available to the researcher or could not be retrieved

Step 5: Evaluation of Quality and Strength of Evidence

The reviewer evaluated the papers using the inclusion and exclusion criteria as defined above. The main reasons for exclusion of certain scales included no original data, paper did not measure resilience, target population was not adolescents or adults, paper did not contain scale items or the relevant paper could not be retrieved. Forty two papers were selected for the in-depth review. All of the papers retained for review were studies that described the psychometric development or evaluation of the individual instrument. Target populations ranged from undergraduate students to adults in general and clinical populations. All the instruments evaluated were self-report Likert scales (4-point, 5-point or 7-point), which also included reliability and validity values. The yield and the final count of research papers included in the narrative review are elaborated in the Table 2 below.

Table 2. Literature search: Yield and final article count of papers selected for review

Database	Total Papers Identified	Papers excluded	Papers retained for full review*	Papers rejected after full review	Papers included in the narrative review
EBSCO	527	514	13	8	5
J Gate	2256	2252	4	1	3
Google Scholar	180	158	22	7	15
Internet	3	0	3	2	1
Total	2966	2924	42	18	24

* **Note:** Numbers retained for review reflect deletion of duplicates.

Step 6: Documenting the Results

The research papers were then summarized and a comparative table of the resilience measurement instruments was drawn. The said scales were then compared for their psychometric properties.

Key Search Terms = Scales for Resilience in Adults / Instruments for Resilience in Adults
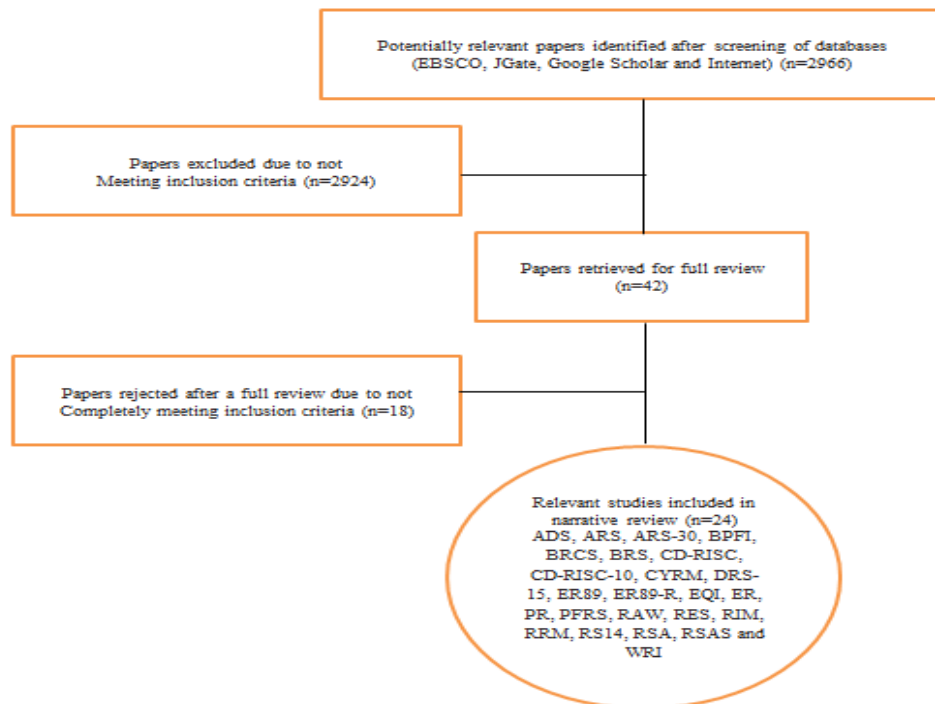
Figure 2: Flow diagram of paper selection process
Source: The authors

IV. RESULTS & DISCUSSION – DATA EXTRACTION AND SYNTHESIS

From the papers reviewed, the data was extracted related to the dimensions, target population, objective of the research, number of items, scaling and psychometric properties. All of the papers were related to the measurement of resilience, either directly or indirectly. All the papers included either the development or the evaluation of the instruments and contained the instrument items. The papers also represented psychometric properties of the scales including validity and reliability values, many of which were within the acceptable limits. A narrative review of the key measurement instruments related to resilience in adolescents or adults is as follows:

1. **ADS - Youth Resiliency: Assessing Developmental Strengths (Donnon & Hammond,2007):** The scale consists of 94 items intended to measure the protective factors, intrinsic developmental strengths (e.g. self-esteem, self-efficacy) and extrinsic developmental strengths (e.g. family, school, community, peers) of adolescents aged 12-17 years over a 5-point Likert scale. It assesses 10 major areas of an individual which are Parental support, Positive Relationships, Community Cohesiveness, Commitment to Learning, School Culture, Cultural Sensitivity, Self-Control, Empowerment, Self-concept and Social Sensitivity. The internal reliability coefficients (Cronbach alphas) of the 10 resiliency factor subscales are Family, $\alpha= .96$; Community, $\alpha= .92$; Peers, $\alpha= .85$; Commitment to learning, $\alpha=.88$; School culture, $\alpha=.86$; Social Sensitivity (awareness), $\alpha=.87$; Cultural Sensitivity (awareness), $\alpha= .80$; Self-concept (self-efficacy), $\alpha= .82$; Empowerment, $\alpha= .75$; and Self-control (emotion regulation), $\alpha = .82$. Face validity and content validity was conducted on the items and variables. An exploratory factor was conducted using the principal components factor analysis with extraction by orthogonal varimax rotation. The resulting 10-factor solution accounts for 55% of the variance and the salient loadings for the items assigned to one of the 10 factors ranged from .33 to .81.

2. **ARS - Adolescent Resilience Scale (Oshio et al., 2002):** The scale consists of 21 items intended to measure the psychological features of resilient individuals aged 19-23 years over a 5-point Likert scale. It assesses 3 major areas of an individual which are Novelty Seeking, Emotion Regulation and Positive Future Orientation. The internal reliability coefficient (Cronbach alpha) of the scale was .85 and that of the 3 factor subscales were Novelty Seeking, $\alpha=.79$, Emotion Regulation, $\alpha=.77$ and Positive Future Orientation, $\alpha=.81$. The total ARS score was calculated as the mean of the 21 items score. For construct validity, a cluster analysis was done using the General Health Questionnaire and Negative Life Events Scale and the respondents were divided in 3 clusters i.e. (1) Well Adjusted: mentally healthy with little experience of

Negative Life Events (2) Vulnerable: poorer mental health with many experiences of Negative Life Events and (3) Resilient: mentally healthy despite many experiences of Negative Life Events. One-way analysis of variance was conducted on the mean differences in scores on the ARS among the three groups. The mean scores of both the Well Adjusted and Resilient groups were higher than that of the Vulnerable group thereby supporting the construct validity of the Adolescent Resilience Scale.

3. **ARS-30- Academic Resilience Scale (Cassidy, 2016):** The scale consists of 30 items intended to to develop an instrument for measuring academic resilience based on academic adversity for British undergraduate university students (mean age=22.4 years, SD=6.2) over a 5-point Likert scale. It assesses 3 major areas of an individual which are Perseverance, Reflecting & Adaptive Help-Seeking and Negative Affect & Emotional Response. The internal reliability coefficient (Cronbach alphas) of the scale was .90 and that of the three subscales were between .78 to .83. There was a significant positive correlation between ARS-30 and academic self-efficacy (r=0.49) which confirms the concurrent validity of the scale. The scale also demonstrated discriminant validity.

4. **BPFI - Baruth Protective Factors Inventory (Baruth and Carroll, 2002):** The scale consists of 16 items intended to assess the four primary protective factors that contribute to the presence of resiliency in individuals over a 5-point Likert scale. The study was conducted over 98 undergraduate students in a Human Development course at a university in US of whom 86% were 24 years or younger. It assesses 4 major areas of an individual which are Adaptable Personality, Supportive Environment, Fewer Stressors and Compensating Experiences. The internal reliability coefficients (Cronbach alpha) of the overall scale was .83 while that of the 4 individual subscales were Adaptable Personality, α= .76; Supportive Environment, α= .98; Fewer Stressors, α= .55; Compensating Experiences, α= .83. The Fewer Stressor items did not corelate highly with the other 3 sub-scales. The Reliability and validity of BPFI needs to be further investigated to ensure the accuracy of the instrument in measuring the protective factors that contribute to resilience.

5. **BRCS - BRCS Brief Resilient Coping Scale (Sinclair & Wallston, 2004):** The scale consists of 4 items intended to measure the ability to cope with stress in a flexible manner. The scale was developed with two samples of individuals (n=90 and 140) with rheumatoid arthritis which is an autoimmune condition often accompanied by pain, fatigue and functional disability. The mean age of the two samples was 46 years (SD=11.8) and 57.8 years (SD=13.35) respectively. It assesses 3 major areas of an individual which are Tenacity, Optimism and Creativity over a 5-point Likert scale. The internal reliability coefficients (Cronbach alphas) of the overall scale was .79. Stability of the scale was ascertained through test retest reliability where the test-retest correlation over a 5-6 weeks period was .71 (n=87, p<.001) and that over a 3 months period was .68 (n=83, p<.001). The validity testing demonstrated that BRCS scores correlated with scores from a variety of personal coping resources, pain coping behaviors and psychological well-being. While the BRCS presents initial evidence for construct and criterion validity, the authors acknowledge that more validity testing needs to be conducted.

6. **BRS – Brief Resilience Scale (Smith et al., 2008):** The scale consists of 6 items as a brief measure of the ability of an individual to bounce back or recover from stressful circumstances, of adults aged 19-62 years over a 5-point Likert scale. It assesses 4 major areas of an individual which are Personal characteristics, Social relationships, Coping and Health related outcomes. The internal reliability coefficients (Cronbach alphas) of the scale was between .80-.91 in 4 samples. The BRS demonstrated test-retest reliability of .69 for one month and .62 for three months. The BRS also showed convergent and discriminant predictive validity. The BRS was positively correlated with other resilience scales, optimism, purposefullness, social support, active coping, positive reframing and exercise and it was negatively correlated with pessimism, negative interactions, behavioral disengagement, denial, self-blame, perceived stress, anxiety, depression, negative affect, physical symptoms, fatigue and pain.

7. **CD-RISC - The Connor-Davidson Resilience Scale (Connor & Davidson, 2003):** The scale consists of 25 items to measure the stress coping abilities. The scale was developed with samples from primary care outpatients, psychiatric outpatients, clinical trials of generalized anxiety disorder (GAD) patients and posttraumatic stress disorder (PTSD) and in general population, over a 5-point Likert scale. It assesses 5 major areas of an individual viz. (i) personal competence, maintaining high standards, and perseverance or tenacity (ii) self-belief & tolerance (iii) positive adaption of change and strong relationships (iv) control over life and (v) spirituality. Cronbach's alpha for the full scale was 0.89 for Group 1 i.e. general population (n 577). Test–retest reliability was assessed in 24 subjects from the clinical trials of GAD (Group 4) and PTSD (Group 5) in whom little or no clinical change was observed from time 1 to time 2. Convergent

validity was established as CD-RISC scores were positively correlated with the Kobasa hardiness measure in psychiatric outpatients (Group 3, n =30; Pearson r=0.83, P<.0001) while it showed a negative correlation with Perceived Stress Scale (PSS-10) (Group 3, n =24; Pearson r= 0.76, P<.001) indicating that higher levels of resilience corresponded with less perceived stress. Discriminant validity was established as the CD-RISC was not significantly correlated with the ASEX (a measure of sexual functioning) at baseline (Group 4, n=23; r = -0.34, P=.11) or at endpoint (n=19; r= -0.30, P=.21).

8. **CD-RISC-10 – The Connor-Davidson Resilience Scale -10 items (Cambell-Sills & Stein, 2007):** Pursuant to some further empirical studies on the CD-RISC scale, certain modifications were made to the instrument, which resulted in a 10-item scale that showed good onstruct validity and reliability for efficient measurement of resilience. Potential participants were 1,743 undergraduates from San Diego State University (SDSU) who completed questionnaires for course credit in 2004–2005. Using exploratory and confirmatory factor analysis, the factors were reduced to 2 factors i.e. hardiness and persistence. Additional analyses confirmed the construct validity of the 10-item scale. Scores on the 10- item CD-RISC moderated the relationship between retrospective reports of childhood maltreatment and current psychiatric symptoms assessed through using Childhood Trauma Questionnaire Short Form Brief Symptom Inventory 18 respectively. However, the reliability, factor structure and validity of the 10-item CD-RISC cannot be determined for older adults and individuals with different levels of education and income.

9. **CYRM-28: The Child and Youth Resilience Measure (Ungar and Liebenberg, 2011) :** The scale consists of 28 items intended to develop a measure the resilience of children and youth aged 12-23 years in 11 countries across 4 broad areas viz. individual, relational, community and culture over a 5-point Likert scale. It assesses 7 major areas of an individual which are Access to material resources (i.e. (availability of financial, educational, medical and employment assistance, resources, or opportunities, as well as access to food, clothing and shelter), Relationships (i.e. Relationships with significant others, peers and adults within one's family and community), Identity (i.e. Personal and collective senses of purpose, self-appraisal of strengths and weaknesses, aspirations, beliefs and values, including spiritual and religious identification), Power and control (i.e. Experiences of caring for one's self and others; ability to affect change in one's social and physical environment in order to access health resources), Cultural adherence (i.e. Adherence to one's local and/or global cultural practices, values and beliefs), Social justice (i.e. Experiences related to finding a meaningful role in community and social equality) and Cohesion (Balancing one's personal interests with a sense of responsibility to the greater good; feeling of being a part of something larger than one's self socially and spiritually). In developing the CYRM, the authors moved away from the procedures which are typically used for design of any instrument where validity of the instrument is sought through validity coefficients (i.e. testing a new measure against already existing measures) or group comparisons. The authors instead chose to engage with subjects through focus group discussions and mixed methods data collection to compensate for this limitation. Though the CYRM demonstrates content validity, convergent validity remains unknown. Other limitations include the positive wording of all questions used in the scale and the absence of Confirmatory Factor analysis.

10. **DRS-15 - The Dispositional Resilience Scale (Bartone et al., 2007):** The Dispositional Resilience Scale (DRS) is designed to measure psychological hardiness of individuals and seeks to differentiate individuals who remain healthy under stress as compared to those who develop problems due to stress based on commitment, control, and willingness to overcome challenges in Life (Kobasa, 1979). Hardiness is recognized as a personality trait, which is not a fixed trait but is amenable to change (Bartone, 2017). The original 45-item DRS scale was developed by Bartone (1989) primarily for military survival assistance officers and was later simplified to a 15-item version (DRS-15) for working adults. The DRS-15 has 15 items over a 4-point Likert scale and the tool is effective both for people under stress and also for healthy people. The scale measures general hardiness and also has three sub-dimensions i.e. commitment, control, and challenge. The DRS-15 has been translated into many languages and is used to assess hardiness. The internal reliability coefficients (Cronbach alphas) of the overall scale in the Norweigan sample was .79 and that of individual sub-scales was Commitment (0.76), Challenge (0.62) and Control (0.74). Exploratory and confirmatory factor analysis was done with a large sample of working adults (N = 7,280) and DRS-15 has demonstrated satisfactory validity and reliability (Bartone et al., 2007). However, DRS-15 as a measure of Resilience only includes Hardiness whereas Resilience as a construct has many more facets and dimensions (Pahwa and Khan, 2022).

11. **ER89- Ego Resiliency Scale (Block & Kremen, 1996):** Block and Kremen (1996) introduced a unidimensional self-report scale (the ER-89) consisting of 14 items designed to measure ego-resiliency (a

stable personality characteristic) for your adults aged 18-23 years over a 4-point Likert scale. The psychometric properties of the ER-89 scale have been investigated in several studies both in young adults and in adults. The ER-89 has shown good construct validity and good internal reliability (Cronbach's α = 0.76) (Block & Kremen 1996).

12. **ER89-R – The Ego Resiliency Scale Revised (Alessandri et al., 2011):** ER-89-R is a brief self-report scale that measures ego-resiliency with subjective self-ratings. The scale consists of 10 items intended to measure the Optimal Regulation and Openness to Life Experience of adults aged 17-58 years over a 7-point Likert scale. The samples were drawn from Italy (n = 1,020), Spain (n = 452), and the United States (n = 808). The internal reliability coefficients (Cronbach alphas) of the were .79 (Italy), .81 (Spain), and .73 (United States). For establishing construct validity, Pearson correlations were calculated between the individual mean score on the ER89-R and measures of the depression and psychological well-being. Higher levels of ego-resiliency were strongly associated with the positive poles of the Big Five traits of the Big Five model, (John & Srivastava, 1999) across all examined countries, especially with Extraversion, Openness, and Emotional Stability. Moreover, ego-resiliency showed a positive correlation with psychological well-being in every country. Finally, ego-resiliency was negatively correlated with depression in Italy and Spain, but not in the United States. Future research on the ER89-R can be done for assessing related constructs using other methods like clinical interviews, information processing tasks etc. and with multiple respondents like parents, peers etc. Further investigation in different samples, varying in age and culture, are also needed.

13. **EQ-I: Emotional Quotient Inventory (Bar-On, 1997):** The scale consists of 133 items which can be used in clinical, educational, forensic, medical, corporate, human resources, and research settings and can assess an individual's emotional intelligence, potential for emotional health, and psychological well-being. The scale is relevant for individuals aged 16 years and older over a 5-point Likert scale. It assesses 5 major areas of an individual which are Intrapersonal (Self-Regard, Emotional Self-Awareness, Assertiveness, Independence, and Self-Actualization), Interpersonal (Empathy, Social Responsibility, and Interpersonal Relationship), Stress Management (Stress Tolerance and Impulse Control), Adaptability (Reality Testing, Flexibility Problem Solving) and General Mood Scale (Optimism and Happiness). The scale is based on over 20 years of research by Dr. Reuven Bar-On and tested on over 85,000 individuals worldwide. Test-retest reliability refers to the stability of an instrument over time. Based on one study, the average stability coefficient is 0.85 after 1 month and 0.75 after 4 months (Bar-On, 1997). This suggests that the degree of correlation is not too high signaling that non-cognitive or emotional intelligence may change over time. Other correlations were also done with unrelated scales and the same were found to be statistically significant for the purpose of establishing construct validity.

14. **ER-Ego Resiliency (Klohnen and Vandewater, 1996):** The scale intends to assess whether emotional resilience assessed at the beginning of middle life i.e. at age 43 can predict life adjustments and directional changes assessed at late middle ages i.e. 48 and 52. The scale uses 3-5-point Likert scale for different factors and uses two other scales i.e. Self-report and Observer comprising 20 items. It assesses 5 major areas of an individual which are Psychological Well-being, Quality of romantic relationship, Engagement in the Work domain, Indicators of Physical Health and Body image. The Observer method uses California Adult Q-Set (CAQ) (Block, 1961, 1978) which consists of 100 descriptive statements about personality, cognitive and interpersonal characteristics. The internal reliability coefficient (Cronbach alphas) of the CAQ scale was 0.97 indicating high reliability. The Self-report ER scores were obtained by using a previously developed 29 item CPI based ER scale (Gough, 1957, 1987). The self-report ER scale had good internal consistency with a coefficient alpha reliability of .88 and there was substantial convergent validity between the observer and the self-report measures (r = .62). This scale focused on how women with differential levels of Ego Resiliency experience the middle age. The study did not focus on the specific life events that the women were facing.

15. **PR- Psychological Resilience (Windle, Markland & Woods, 2008):** The scale consists of 19 items intended to assess the psychological resilience (i.e. factors protecting against adversities and risks) of older adults aged 50-90 years over a 7-point Likert scale. It assesses 3 major areas of an individual which are Self-Esteem, Interpersonal Control and Personal Competence. The internal reliability coefficients (Cronbach alphas) of the overall scale was 0.83 indicating high reliability. Self-esteem was assessed with the 10-item Rosenberg Self Esteem Scale, α=.84 over a 5 point Likert Scale. Interpersonal control is a distinct dimensions of the Spheres of Control scales consisting of 10 questions rated on a seven-point Likert scale. Cronbach's alpha was 0.80 for interpersonal control (seven items). Personal competence was derived from the Resilience Scale (Wagnild & Young, 1993). The scale contains 25 questions and answers are scored on a 7 point Likert scale. Confirmatory factor analysis was conducted. medium-sized correlations were found

between the measures suggesting that these may represent a common construct as found in the work of Judge et al. (2002). (Self-esteem and personal competence r=0.45, p<0.001; self-esteem and interpersonal control r=0.46, p<0.001; interpersonal control and personal competence r=0.39, p<0.001). The reliability coefficient of the overall scale was 0.83.

16. **PFRS - The protective factors for resilience scale (Harms et al., 2017):** The scale consists of 15 items intended to develop a scale to measure protective factors and psycho-social resources associated with resilience of individuals aged 18+ years over a 7-point Likert scale. It assesses three major areas of an individual which are Personal Resources, Social Resources-peers and Social Resources-family. The correlation between the scores of the PFRS, various coping styles, self-esteem and life satisfaction provided good initial evidence in relation to the construct validity of the PFRS. It's a fairly recent scale and the study was based on the responses of students of Australian university and North American Adults (N=240). Further research will need to focus on examining the reliability and validity of the instrument across different age, genders and cultural backgrounds.

17. **RAW - Resilience at Work Scale (Winwood et al. 2013):** The scale consists of 20 items intended to develop an effective measure of resilience at work for use in individual work-related performance and emotional distress contexts for individuals with mean age of 44.6 years (standard deviation [SD] = 11.8 over a 7-point Likert scale. It assesses seven major areas of an individual which are Living authentically, Finding your calling, Maintaining perspective, Managing stress, Interacting cooperatively, Staying healthy and Building networks. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.84 and the Cronbach alpha of individual subscales was between 0.60-0.89.

18. **RES - Resilience Evaluation Scale (Van der Meer et al. 2018):** The scale consists of 9 items intended for identification and measurement of psychological resilience after adversities for individuals with mean age=37.2 years, SD=13.04, n=522 over a 4-point Likert scale. It assesses two major areas of an individual which are Self-Confidence and Self-Efficacy. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.83. Cronbach alpha of individual subscales was between 0.79-0.84.

19. **RIM - The Resilience in Midlife Scale (Ryan and Caltabiano, 2009):** The scale consists of 25 items intended to develop a new scale to measure resilience in midlife for individuals aged 35-60 years over a 5-point Likert scale. It assesses five major areas of an individual which are Self-efficacy, Perseverance, Internal locus of control, Coping and adaptation and Family and social networks. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.87.

20. **RRM - Rugged Resilience Measure (Jefferies et. al. 2021):** The scale consists of 10 items intended to develop a short measure of resilience that focuses specifically on psychological protective factors associated with resilience for individuals aged 16-29 years (N=5880) over a 5-point Likert scale. It assesses internal protective factors associated with positive functioning under stress. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.87.

21. **RS-14 - Resilience Scale (Wagnild, 2009):** Wagnild and Young (1993) developed the scale with 25 items called the Resilience Scale (RS) intended to measure the degree of individual resilience for individuals from all age groups from adolescents and above over a 7-point Likert scale. It assesses five major areas of an individual which are Meaningfulness of life, Perseverance, Self-reliance, Equanimity and Existential aloneness. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.942 and the Cronbach alpha of individual subscales was between 0.60-0.89. However, largely the sample used in the studies of RS was treatment-seeking or non-working population. Later, a shorter version of RS was introduced with 14 items and the same was termed as RS-14 reflecting all the above five factors (Wagnild, 2009). A study on the working population from the Indian sample provided further support on the factor structure and the validity and reliability of RS-14 with working adult population, specially from developing countries like India (Paul & Garg, 2014).

22. **RSA - Resilience Scale for Adults (Friborg et. al., 2003):** The scale consists of 45 items intended and is intended to measure the protective resources (both interpersonal and intrapersonal) that promote adult resilience. The scale was developed with samples from mental health outpatients in Norway/control group. The scale is valid for adults and uses a 5-point Semantic differential response format. It assesses five major areas of an individual which are Personal Competence, Personal structure, Social competence, Social support and Family coherence. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.93 and the Cronbach alpha of individual subscales was between 0.74-0.92. Construct validity of the scale was

established by negative correlation with Hopkins Symptoms Checklist (HSCL) (which measures symptoms of anxiety and depression) and positive correlation with the Sense of Coherence Scale (SOC) (how people use their internal resources to maintain their health and well-being). RSA is used in clinical psychology to assess the presence of protective resources which are important to maintain and regain mental health.

23. **RSAS - Resiliency Scale (Jew, Green, and Kroger, 1999):** The scale consists of 37 items intended to develop a measure based on the cognitive appraisal theory of resiliency first posed by Mrazek and Mrazek (1987) on 12 life skills and abilities for students from age group 7th grade to 12th grade over a 5-point Likert scale. It assesses four major areas of an individual which are Optimism, Future Orientation, Belief in Others and Independence. The internal reliability coefficient (Cronbach alpha) of the individual subscales was between 0.66-0.82.

24. **WRI - Workplace resilience instrument (Mallak and Yildiz, 2016):** The scale consists of 20 items intended to build and test a resilience instrument for use in the workplace for Healthcare executives and hospital-based nursing staff in the age of 16-75 over a 5-point Likert scale. It assesses four major areas of an individual which are Active Problem Solving, Team Efficacy, Confident Sense Making, Bricolage. The internal reliability coefficient (Cronbach alpha) of the individual subscales was between 0.77-0.83. However, the study sample was solely in the healthcare sector, the majority of the sample being nurses. Therefore, care must be taken when attempting to generalize these findings to other sectors and future work may be conducted to to assess the validity of using the WRI in sectors other than healthcare such as manufacturing, service, and education etc.

V. PRINCIPAL FINDINGS

While extensive research has been carried out in the field of Emotional Intelligence, however, Emotional Resilience as a subject is relatively less explored for general adult population and in workplace context. Britt et al. (2016) observe that given the stressful conditions often endured by soldiers, significant research on resilience among workers till date has been conducted in the military. Although military personnel are also employees, however, the stressors faced by military personnel may rather be unique. Military organizations also have a strong and distinct culture and therefore findings in this context may not be generalized to the broader working population. Therefore, they have encouraged future work on resilience to expand and include a wider cross section of workers and occupations in which significant adversity / stress may be likely to occur. Through the above narrative review of the scales on resilience, it can be seen that though there are many scales to measure resilience, however, they are quite different in terms of their target population and the factors or dimensions which they seek to measure, as detailed below:

Target Population – Adolescents (1 Scale):
Youth Resiliency: Assessing Developmental Strengths (ADS) (Donnon & Hammond, 2007) targets adolescents i.e. 12-17 years of age.

Target Population - Older Adolescents to Young Adults (9 Scales):
Adolescent Resilience Scale (ARS) (Oshio et al., 2002) targets 19-23 years old; Academic Resilience Scale (ARS-30) (Cassidy, 2016), Baruth Protective Factors Inventory (BPFI) (Baruth and Carroll, 2002) and The Connor-Davidson Resilience Scale -10 items (CD-RISC-10) (Cambell-Sills & Stein, 2007) target undergraduate students; The Child and Youth Resilience Measure (Ungar and Liebenberg, 2011) (CYRM-28) targets 12-23 years old; Ego Resiliency Scale (ER89) (Block & Kremen, 1996) targets 18-23 years old; Rugged Resilience Measure (RRM) (Jefferies et. al. 2021) targets 16-29 years old and Resiliency Scale (RSAS) (Jew et al., 1999) targets students from 7th - 12th grade.

Target Population – Adults with Specific Conditions or Background (2 Scales):
BRCS Brief Resilient Coping Scale (BRCS) (Sinclair & Wallston, 2004) targets older adults with rheumatoid arthritis; Workplace resilience instrument (WRI) (Mallak and Yildiz, 2016) to measure emotional resilience of employees in the healthcare sector, primarily, healthcare executives and hospital-based nursing staff in US regions aged 16-75 years.

Target Population – General Adults (Limited Scope) (4 Scales):
Brief Resilience Scale (BRS) (Smith et al., 2008) targets adults between 19-62 years of age. However, this scale contains only 6 items across 4 factors viz. Personal characteristics, Social relationships, Coping and Health related outcome. Its effects were specific to reducing negative outcomes (e.g., anxiety, depression, and negative physical symptoms hence, is limited in scope and lacks generalizability. The Ego Resiliency Scale Revised (ER89-R) (Alessandri et al., 2011) targets adults between 17-58 years of age. However, this scale contains only

10 items across 2 factors viz. Optimal Regulation and Openness to Life Experience from samples in Italy, Spain and United States, hence, is limited in scope and lacks generalizability. The Protective Factors for Resilience Scale (PFRS) (Harms et al., 2017) targets adults above 18 years of age. However, this scale contains only 15 items across 3 factors viz. Personal Resources, Social Resources-peers and Social Resources-family, hence, is limited in scope and lacks generalizability. Resilience scale for adults (RSA) (Friborg et al., 2003) targets adults, however, this scale was developed with samples from mental health outpatients in Norway/control group. Therefore, while it is a reliable scale to assess factors required to maintain mental health, it is limited in scope and lacks generalizability.

Target Population – Older Adults (3 Scales):
The Resilience in Midlife Scale (RIM) (Ryan and Caltabiano, 2009) targets middle age adults between 35-60 years; Ego Resiliency (ER) (Klohnen and Vandewater, 1996) targets middle age adults between 43-52 years; Psychological Resilience (PR) (Windle et al., 2008) targets older adults between 50-90 years of age

Target Population - General Adults (Wide Scope and Good Adoption) (5 Scales):
Connor-Davidson Resilience Scale (CD-RISC) (Connor & Davidson, 2003): CD-RISC targets general population/psychiatric patients. It assesses 5 major areas of an individual viz. (i) personal competence, maintaining high standards, and perseverance or tenacity (ii) self-belief & tolerance (iii) positive adaption of change and strong relationships (iv) control over life and (v) spirituality. The above 5 factors were drawn based on the following characteristics of resilient people identified in previous research viz. view change or stress as a challenge/opportunity, Commitment, Recognition of limits to control (Kobasa, 1979); Engaging the support of others, Close, secure attachment to others, Personal or collective goals, Self-efficacy, Strengthening effect of stress, Past successes, Realistic sense of control/having choices, Sense of humor, Action oriented approach, Adaptability to change (Rutter, 1985); Patience, Tolerance of negative affect (Lyons, 1991), Optimism and Faith.

Resilience Scale (RS-14) (Wagnild & Young, 1993): RS-14 targets individuals from all age groups from adolescents upwards and also has evidence of applicability in working adult populations. It assesses five major areas of an individual which are Meaningfulness of life or the realization that life has a purpose and recognition that there is something for which to live; Perseverance or the act of persistence despite adversity or discouragement; Self-reliance or belief in oneself with a clear understanding of own capabilities and limitations; Equanimity is balanced perspective of life and experiences and might be viewed as sitting loose and taking what comes, thus moderating the extreme responses to adversity; and Existential aloneness is the realization that each person is unique and that while some experiences can be shared, others must be faced alone.

The Dispositional Resilience Scale (DRS-15) (Bartone, 1989): The original 45-item DRS scale was developed by Bartone (1989) primarily for military survival assistance officers and was later simplified to a 15-item version (DRS-15) for working adults. The Dispositional Resilience Scale (DRS) is designed to measure psychological hardiness of individuals and seeks to differentiate individuals who remain healthy under stress as compared to those who develop problems due to stress based on commitment, control, and willingness to overcome challenges in Life (Kobasa, 1979). Kobasa, Maddi and others defined hardiness as a collection of personality traits which function as resilience resources while dealing with stressful life events (Kobasa, 1979; Kobasa, Maddi & Kahn, 1982). Hardy people completely involve and engage in whatever they do (commitment), think and believe that they can control the events happening in their lives and act accordingly (control), and view change as normal and an essential part of growth and development (challenge). (Kobasa, 1979)

Resilience at work Scale (RAW) (Winwood Et Al. 2013): RAW seeks to be a measure of resilience at work for use in individual work-related performance and emotional distress contexts for individuals with mean age of 44.6 years (standard deviation [SD] = 11.8. It assesses seven major areas of an individual which are Living authentically i.e. knowing and holding onto personal values, deploying personal strengths, and having a good level of emotional awareness and regulation; Finding one's calling i.e. seeking work that has purpose, a sense of belonging and a fit with core values and beliefs; Maintaining perspective i.e. having the capacity to reframe setbacks, maintain a solution focus, and manage negativity; Managing stress i.e. using work and life routines that help manage everyday stressors, maintain work life balance, and ensure time for relaxation; Interacting cooperatively i.e. a workplace work style that includes seeking feedback, advice, and support as well as providing support to others; Staying healthy i.e. maintaining a good level of physical fitness and a healthy diet; Building networks i.e. developing and maintaining personal support networks (which might be both within and outside the workplace).

Emotional Quotient Inventory (EQ-I) (Bar-On, 1997)

The scale can be used in clinical, educational, forensic, medical, corporate, human resources, and research settings and can assess an individual's emotional intelligence, potential for emotional health, and psychological well-being and is relevant for individuals aged 16 years and older over. It assesses 5 major areas of an individual which are Intra-personal (Self-Regard, Emotional Self-Awareness, Assertiveness, Independence, and Self-Actualization), Interpersonal (Empathy, Social Responsibility, and Interpersonal Relationship), Stress Management (Stress Tolerance and Impulse Control), Adaptability (Reality Testing, Flexibility Problem Solving) and General Mood Scale (Optimism and Happiness).

Other Scales with Group Applications

Besides, certain resilience scales have been developed for limited applications like Family resilience assessment scale (FRAS) (Sixbey, 2005) aimed to measure the family resilience; Benchmark resilience tool (short form) (BRT-13B) (Whitman et al., 2013) designed to measure the organizational level resilience, to monitor organizations' progress over time, and to compare resilience strengths and weaknesses with other organizations; Conjoint community resiliency assessment measure (CCRAM) (Leykin et al., 2013): designed to measure community resilience for adults aged 18–86 years; Organizational Resilience Potential Scale (ORPS) (Lee et al., 2013) designed to measure the resilience of an organization; Team Resilience Scale (TRS) (Sharma and Sharma, 2016) designed to measure the resilience of a team. Besides, the PSG Resilience Scale (Keerthika & Naachimuthu, 2018) was also found during literature review, however, the same has not been used or cited in any publication, hence not included in the above narrative review. The scale consists of 43 items intended to develop and validate a resilience scale of GenY focusing on four dimensions of resilience which describe the resilient behavior of individuals aged 18-30 years over a 4-point Likert scale. It assesses four major areas of an individual which are Social Support, Life Orientation, Adaptability and Emotional Maturity. The internal reliability coefficient (Cronbach alpha) of the overall scale was 0.555 and the Cronbach alpha of individual subscales were, Social Support, α= .66, Life Orientation, α= .613, Adaptability, α= .586 and Emotional Maturity, α= .367. The Cronbach alpha less than 0.70 indicates low reliability. Sample size N=300 was taken for the purpose of the study.

Below is the Summary of the key Factors of the Above-Mentioned Five Emotional Resilience Scales for General Adult Population:

(i)   Meaningfulness of life or the realization that life has a purpose and recognition that there is something for which to live; Finding one's calling i.e. seeking work that has purpose, a sense of belonging and a fit with core values and beliefs

(ii)   Notion of personal competence, high standards;

(iii)   Commitment, tenacity, perseverance or the act of persistence despite adversity or discouragement;

(iv)   Impulse Control i.e. the ability to resist or delay an impulse, drive, or temptation to act, and to control one's emotions; Flexibility means the ability to adjust one's emotions, thoughts, and behavior to changing situations and conditions; Reality Testing means the ability to assess the correspondence between what is experienced and what objectively exists

(v)   Living authentically i.e. knowing and holding onto personal values, deploying personal strengths, and having a good level of emotional awareness and regulation; Self Regard means the ability to be aware of, understand, accept and respect oneself

(vi)   Self-reliance or belief in oneself with a clear understanding of own capabilities and limitations; trust in one's instincts; independence i.e. the ability to be self-directed and self-controlled in one's thinking and action and to be free of emotional dependency; Self-Actualization i.e. the ability to realize one's potential capacities;

(vii) Maintaining perspective i.e. having the capacity to reframe setbacks, maintain a solution focus, and manage negativity; Existential aloneness i.e. the realization that each person is unique and that while some experiences can be shared, others must be faced alone; Control; Willingness to overcome challenges in Life; Problem Solving i.e. the ability to identify and define problems as well as to generate and implement potentially effective solutions.

(viii) Stress Tolerance i.e. the ability to withstand adverse events, stressful situations, and strong emotions without falling apart by actively, positively coping with stress, using work and life routines that help manage everyday stressors, maintain work life balance, and ensure time for relaxation

(ix) Accepting change positively; Equanimity i.e. balanced perspective of life and experiences and might be viewed as sitting loose and taking what comes, thus moderating the extreme responses to adversity

(x) Assertiveness means the ability to express feelings, beliefs, and thoughts and defend one's rights in a non-destructive manner

(xi) Secure interpersonal Relationships i.e. the ability to establish and maintain mutually satisfying relationships that are characterized by emotional closeness, intimacy, and by giving and receiving affection; Building networks i.e. developing and maintaining personal support networks, both within and outside the workplace; Social Responsibility i.e. the ability to demonstrate oneself as a cooperative, contributing, and constructive member in one's social group; Interacting cooperatively i.e. a workplace work style that includes seeking feedback, advice, and support as well as providing support to others

(xii) Spiritual influences

(xiii) Staying healthy i.e. maintaining a good level of physical fitness and a healthy diet

(xiv) Happiness i.e. the ability to feel satisfied with one's life, to enjoy oneself and others, and to have fun and express positive feelings

VI. CONCLUSION

The dominant resilience scales found in the literature have been developed primarily with clinical populations and not workplace populations. As such, the validity of these instruments for use in the work-place is questionable until psychometric properties can be established with a workplace population. The measurement of resilience or facets of resilience has been undertaken by a number of researchers. Many of these scales, however, are limited in scope and lack generalizability (Connor & Zhang, 2006) and most of them being applicable to military organizations or patients. Although each of the twenty four instruments possess some limitations in terms of their psychometric properties, the findings of the review indicate that CD-RISC, EQ-I, RS-14, DRS-15 and RAW may be the best to use with the general adult population. Few other scales that may have more potential are BRS, ER89-R, PFRS and RSA as they were tested in the adult populations, however they lack convincing evidence for their use due to a lack of adequate research applications especially with respect to general adult populations. PSG and RRM had very limited or no applications. Moreover, it appears that much work needs to be done for developing or evaluating the resilience scales for adult populations in the context of a workplace. Further, Pahwa and Khan (2022) proposed twelve factors affecting emotional resilience of an adult viz. purposefulness and meaning, self-awareness, emotion regulation, self-efficacy, problem solving, learning attitude, hardiness and grit, adaptability and flexibility, optimism and positive thinking, social support and relationships, physical fitness and health and Spirituality. Future work may focus on developing scales using the above-said factors. Much can be learned from the work of others. The process for evaluation of the psychometric properties of an instrument is a time-consuming and complex exercise. Reading the report of the psychometric evaluation that an instrument developer has completed allows the novice to gain a better understanding of what is necessary to scale, norm, standardize, and establish acceptable reliability and validity statistics.

VI. LIMITATIONS AND SCOPE FOR FURTHER RESEARCH

A limitation of the review was the inability of the reviewers to obtain all known research papers for the development of instruments measuring emotional resilience. Certain papers found were secondary papers describing or validating the psychometric properties of an instrument or they were related to application of the instrument and they were not original papers for the construction of the said instrument. Some more original dissertation literature can be sought in future to provide a more thorough review of potential measurement instruments on the concept of resilience especially for a more thorough review and analysis of the psychometric properties of the said instruments.

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INVOLUTIONS AND IDEMPOTENT DECOMPOSITION OF SOME BC – MODULES

MAMTA AMOL WAGH AND DILIP KUMAR

ABSTRACT

The present study provides module structure to some entire bicomplex sequence spaces. We define different involutions (conjugation as involution) on these modules and decomposition based on these involutions. Moreover, we construct Bicomplex modules from subspaces of the sequence space. Further, some other bicomplex modules and norms on the same are investigated.

Mathematics Subject Classification: 97I30

Keywords: Bicomplex Numbers, Entire Bicomplex Sequence Space, Bicomplex modules.

1. INTRODUCTION

The inception of Bicomplex Numbers took place in 1892 by an Italian mathematician Corrado Segre (1863 – 1924). He published a paper [S1] in which he gave the concept of multicomplex numbers. He talked about an infinite set of algebras. So there is an infinite sequence of multicomplex spaces. He defined the n – complex algebra and at n=2 we get bicomplex algebra. Bicomplex algebra is denoted by C_2.

Definition 1.1: Bicomplex Numbers

If $x_1, x_2, x_3, x_4 \in C_0$, where C_0 is the set of real numbers. Then a bicomplex number is defined as $x_1 + i_1 x_2 + i_2 x_3 + i_1 i_2 x_4$ where $i_1^2 = i_2^2 = -1, i_1 i_2 = i_2 i_1$. Here $i_1, i_2, i_1 i_2$ are independent imaginary units.

$C_2 = \{\zeta = x_1 + i_1 x_2 + i_2 x_3 + i_1 i_2 x_4 : x_1, x_2, x_3, x_4 \in C_0, i_1^2 = i_2^2 = -1, i_1 i_2 = i_2 i_1\}$ is the set of bicomplex numbers. It can also be written as

$C_2 = \{\zeta = \vartheta_1 + i_2 \vartheta_2 : \vartheta_1 = x_1 + i_2 x_2, \vartheta_2 = x_3 + i_1 x_4 \in C_1, i_1^2 = i_2^2 = -1, i_1 i_2 = i_2 i_1\}$.

Here C_1 is the set of complex numbers. In other words, a bicomplex number is composed of two complex numbers. The binary compositions of addition and scalar multiplication on C_2 are defined coordinate wise and term wise respectively. C_2 becomes a commutative algebra with identity concerning these binary compositions. Bicomplex space differs from complex space in many respects which can be seen in Price [P1].

2. PRELIMINARIES

Lets see some classes which are of our interest.

2.1 Class B of Entire Bicomplex Sequences

$$B = \left\{ f : f = \left\{ \xi_k \right\} = \left\{ {}^1\xi_k e_1 + {}^2\xi_k e_2 \right\} : \sup_{k \geq 1} k^k \left| {}^1\xi_k \right| < \infty, \sup_{k \geq 1} k^k \left| {}^2\xi_k \right| < \infty \right\}.$$

Every element of class *B* is the sequence of coefficients of an entire function and is, therefore, an entire bicomplex sequence. This class was defined by Srivastava & Srivastava [S2] and further studied by Wagh [W1, W2, W3].

Algebraic Structure of B

Binary compositions on *B* are defined as follows:

Let $f = \left\{ \xi_k \right\}$ and $g = \left\{ \eta_k \right\}$ be arbitrary members of *B* and $a \in C_0$

1. Addition : $f + g = \left\{ \alpha_k \right\}$ where $\alpha_k = \xi_k + \eta_k, \forall k \geq 1$.

2. Scalar multiplication : $a.f = \left\{\beta_k\right\}$ where $\beta_k = a.\xi_k, \forall k \geq 1, a \in C_0$.

3. Weighted Hadamard Multiplication : $f \times g = \left\{ \gamma_k \right\}$, where $\gamma_k = k^k \xi_k \times \eta_k, \forall k \geq 1$

They have shown that B is a commutative algebra with identity, the element $u = \{k^{-k}\}$ being the identity element of B.

Two Subclasses of the Class B [W1]

$$B' = \left\{ f : f = \{^1\xi_k e_1\} : \sup_{k \geq 1} k^k \ \left|^1\xi_k\right| < \infty \right\}$$

$$B'' = \left\{ f : f = \{^2\xi_k e_2\} : \sup_{k \geq 1} k^k \left|^2\xi_k\right| < \infty \right\}$$

The elements of B' and B'' are the sequences with members in A_1 and A_2, respectively where A_1 and A_2 are the auxiliary space. Note first that B' is closed with respect to the binary compositions induced on B' as a subset of B, owing to the consistency of idempotent representation and the algebraic structure of bicomplex numbers.

The norm in B' is defined as follows:

$$\|f\| = \sup_{k \geq 1} \left|^1\xi_k\right|, f = \{^1\xi_k.e_1\} \in B'$$

This paper is an extension to [W3]. Now and onwards, whenever we talk about bicomplex modules then we shall use the notation BC for C_2.

3. MAIN RESULTS

3.1 Involutions on B

We know that B and its subspaces B' and B'' are BC - modules [W3]. Let us define involutions on this class.

I. i_1 - involution on B i.e., i_1 - conjugation as involution

Define the map $In_{bar} : B \rightarrow B$,

Where In_{bar} is the i_1 - involution i.e., i_1 - conjugation as involution is being taken.

Let $f = (\xi_k), g = (\eta_k) \in B$

Then we shall prove that

(1) $In_{bar}(f + g) = In_{bar}(f) + In_{bar}(g)$

That is, we have to show that bar - involution of the sum to two sequences of B is same as the sum of bar-involution of two sequences taken separately.

$In_{bar}(f + g) = In_{bar}(\xi_k + \eta_k)$

$= In_{bar}(\xi_{1k} + i_1\xi_{2k} + i_2\xi_{3k} + i_1 i_2\xi_{4k} + \eta_{1k} + i_1\eta_{2k} + i_2\eta_{3k} + i_1 i_2\eta_{4k})$

$= In_{bar}\{(\xi_{1k} + \eta_{1k}) + i_1(\xi_{2k} + \eta_{2k}) + i_2(\xi_{3k} + \eta_{3k}) + i_1 i_2(\xi_{4k} + \eta_{4k})\}$

$= \overline{((\xi_{1k} + \eta_{1k}) + i_1(\xi_{2k} + \eta_{2k}) + i_2(\xi_{3k} + \eta_{3k}) + i_1 i_2(\xi_{4k} + \eta_{4k}))}$

$= \overline{(\xi_{1k} + \eta_{1k}) + i_1(\xi_{2k} + \eta_{2k})} + i_2\{\overline{(\xi_{3k} + \eta_{3k}) + i_1(\xi_{4k} + \eta_{4k})}\}$

$= (\xi_{1k} - i_1\xi_{2k} + i_2\xi_{3k} - i_1 i_2\xi_{4k}) + (\eta_{1k} - i_1\eta_{2k} + i_2\eta_{3k} - i_1 i_2\eta_{4k})$

$= In_{bar}(f) + In_{bar}(g)$.

(2) $In_{bar}^2(f) = In_{bar}(In_{bar}(f)) = In_{bar}(x_{1k} - i_1 x_{2k} + i_2 x_{3k} - i_1 i_2 x_{4k})$

$= x_{1k} + i_1 \, x_{2k} + i_2 \, x_{3k} + i_1 \, i_2 \, x_{4k} = f.$

Thus $In_{bar}{}^2 = I$, the identity map.

(3) For all $\xi = z_1 + i_2 z_2 \in C_2 \, \& f = (\xi_k) = (x_{1k} + i_1 x_{2k} + i_2 x_{3k} + i_1 i_2 x_{4k}) \in B$

$In_{bar}(\xi f) = In_{bar}(\xi \xi_k) = In_{bar}((z_1 + i_2 \, z_2).(x_{1k} + i_1 \, x_{2k} + i_2 \, x_{3k} + i_1 \, i_2 \, x_{4k}))$

$= In_{bar}\{(z_1 + i_2 \, z_2)(z_{1k} + i_2 z_{2k})\}$

$= In_{bar}(z_1 \, z_{1k} + i_2 \, z_1 \, z_{2k} + i_2 \, z_2 \, z_{1k} - z_2 \, z_{2k})$

$= In_{bar}\{(z_1 \, z_{1k} - z_2 \, z_{2k}) + i_2(z_1 \, z_{2k} + z_2 \, z_{1k})\}$

$= (\overline{z_1} \, \overline{z_{1k}} - \overline{z_2} \, \overline{z_{2k}}) + i_2(\overline{z_1} \, \overline{z_{2k}} + \overline{z_2} \, \overline{z_{1k}})$

$= (\overline{z_1} + i_2 \, \overline{z_2})(\overline{z_{1k}} + i_2 \, \overline{z_{2k}})$

$= \overline{\xi}.In_{bar}(f)$

II. i_2 **- involution on B i.e.,** i_2 **- conjugation as involution or** $\dagger$ **- involution**

Define the map $In_\dagger : B \to B$,

Where $In_\dagger$ represents the i_2- involution i.e., i_2- conjugation as involution is being taken.

Let $f = (\xi_k), g = (\eta_k) \in B$

Then we shall prove that

(1) $In_\dagger(f + g) = In_\dagger(f) + In_\dagger(g)$

That is, we have to show that $\dagger$- involution of the sum to two sequences of B is same as the sum of $\dagger$-involution of two sequences taken separately.

$In_\dagger(f + g) = In_\dagger(\xi_k + \eta_k)$

$= In_\dagger(\xi_{1k} + i_1 \, \xi_{2k} + i_2 \, \xi_{3k} + i_1 \, i_2 \, \xi_{4k} + \eta_{1k} + i_1 \, \eta_{2k} + i_2 \, \eta_{3k} + i_1 \, i_2 \, \eta_{4k})$

$= In_\dagger\{(\xi_{1k} + \eta_{1k}) + i_1(\xi_{2k} + \eta_{2k}) + i_2(\xi_{3k} + \eta_{3k}) + i_1 \, i_2(\xi_{4k} + \eta_{4k})\}$

$= (\xi_{1k} + i_1 \, \xi_{2k} - i_2 \, \xi_{3k} - i_1 \, i_2 \, \xi_{4k}) + (\eta_{1k} + i_1 \, \eta_{2k} - i_2 \, \eta_{3k} - i_1 \, i_2 \, \eta_{4k})$

$= In_\dagger(f) + In_\dagger(g).$

(2) $In_\dagger{}^2(f) = In_\dagger(In_\dagger(f)) = In_\dagger(x_{1k} + i_1 \, x_{2k} - i_2 \, x_{3k} - i_1 \, i_2 \, x_{4k})$

$= x_{1k} + i_1 \, x_{2k} + i_2 \, x_{3k} + i_3 \, x_{4k} = f.$

Thus $In_\dagger{}^2 = I$, the identity map.

(3) For all $\xi = z_1 + i_2 z_2 \in C_2 \, \& f = (x_{1k} + i_1 x_{2k} + i_2 x_{3k} + i_3 x_{4k}) \in B$

$In_\dagger(\xi f) = In_\dagger(\xi \xi_k) = In_\dagger((z_1 + i_2 \, z_2).(x_{1k} + i_1 \, x_{2k} + i_2 \, x_{3k} + i_3 \, x_{4k}))$

$= In_\dagger\{({}^1\xi \, e_1 + {}^2\xi \, e_2)({}^1\xi_k \, e_1 + {}^2\xi_k \, e_2)\}$

$$= In_\dagger \left({}^1\xi \cdot {}^1\xi_k \, e_1 + {}^2\xi \cdot {}^2\xi_k e_2 \right)$$

$$= \left({}^2\xi \cdot {}^2\xi_k \, e_1 + {}^1\xi \cdot {}^1\xi_k \, e_2 \right)$$

$$= \left({}^2\xi \, e_1 + {}^1\xi \, e_2 \right)\left({}^2\xi_k \, e_1 + {}^1\xi_k \, e_2 \right)$$

$$= \xi^\dagger \cdot In_\dagger (f)$$

III. $i_1 i_2$ **- involution on B i.e.,** $i_1 i_2$ **- conjugation as involution or** $*$ **- involution**

Define the map $In_* : B \to B$,

where In_* is the $i_1 i_2$ - involution i.e., $i_1 i_2$ - conjugation as involution is being taken.

Let $f = (\xi_k), g = (\eta_k) \in B$

Then we shall prove that

(1) $In_* (f + g) = In_* (f) + In_* (g)$

That is, we have to show that $*$ - involution of the sum to two sequences of B is same as the sum of $*$-involution of two sequences taken separately.

$$In_* (f + g) = In_* (\xi_k + \eta_k)$$

$$= In_* \left(\xi_{1k} + i_1 \xi_{2k} + i_2 \xi_{3k} + i_1 i_2 \xi_{4k} + \eta_{1k} + i_1 \eta_{2k} + i_2 \eta_{3k} + i_1 i_2 \eta_{4k} \right)$$

$$= In_* \left\{ (\xi_{1k} + \eta_{1k}) + i_1 (\xi_{2k} + \eta_{2k}) + i_2 (\xi_{3k} + \eta_{3k}) + i_1 i_2 (\xi_{4k} + \eta_{4k}) \right\}$$

$$= (\xi_{1k} + \eta_{1k}) - i_1 (\xi_{2k} + \eta_{2k}) - i_2 (\xi_{3k} + \eta_{3k}) - i_1 i_2 (\xi_{4k} + \eta_{4k})$$

$$= (\xi_{1k} - i_1 \xi_{2k} - i_2 \xi_{3k} - i_1 i_2 \xi_{4k}) + (\eta_{1k} - i_1 \eta_{2k} - i_2 \eta_{3k} - i_1 i_2 \eta_{4k})$$

$$= In_* (f) + In_* (g).$$

(2) $In_*^2 (f) = In_* \left(In_* (f) \right) = In_* \left(x_{1k} - i_1 x_{2k} - i_2 x_{3k} - i_1 i_2 x_{4k} \right)$

$$= x_{1k} + i_1 x_{2k} + i_2 x_{3k} + i_3 x_{4k} = f.$$

Thus $In_*^2 = I$, the identity map.

(3) For all $\xi = z_1 + i_2 z_2 \in C_2$ & $f = (\xi_k) = (x_{1k} + i_1 x_{2k} + i_2 x_{3k} + i_3 x_{4k}) \in B$

$$In_* (\xi f) = In_* (\xi \xi_k) = In_* \left((z_1 + i_2 z_2) \cdot (x_{1k} + i_1 x_{2k} + i_2 x_{3k} + i_3 x_{4k}) \right)$$

$$= In_* \left\{ (z_1 + i_2 z_2)(z_{1k} + i_2 z_{2k}) \right\}$$

$$= In_* \left(z_1 z_{1k} + i_2 z_1 z_{2k} + i_2 z_2 z_{1k} - z_2 z_{2k} \right)$$

$$= In_* \left\{ (z_1 z_{1k} - z_2 z_{2k}) + i_2 (z_1 z_{2k} + z_2 z_{1k}) \right\}$$

$$= \left(\overline{z_1}\,\overline{z_{1k}} - \overline{z_2}\,\overline{z_{2k}} \right) - i_2 \left(\overline{z_1}\,\overline{z_{2k}} + \overline{z_2}\,\overline{z_{1k}} \right)$$

$$= \left(\overline{z_1} - i_2 \overline{z_2} \right)\left(\overline{z_{1k}} - i_2 \overline{z_{2k}} \right)$$

$$= \xi^* \cdot In_* (f)$$

3.2 Decomposition in *B* by Involutions

Each of these involutions induces a corresponding decomposition in *B*. We shall discuss † - involution. Define

$$B_{1,\dagger} = \left\{ f \in B : In_{\dagger}(f) = f \right\} \text{ and } B_{2,\dagger} = \left\{ f \in B : In_{\dagger}(f) = -f \right\}$$

Theorem 3.2.1: $B = B_{1,\dagger} + B_{2,\dagger} = B_{1,\dagger} + i_2 \, B_{1,\dagger}$ $\qquad\qquad\qquad$ (3.2.1)

Proof: First we prove that $B_{2,\dagger} = i_2 \, B_{1,\dagger}$

Let $f \in B_{1,\dagger}$, then $\qquad\qquad\qquad In_{\dagger}(i_2 \, f) = (i_2)^{\dagger} \, In_{\dagger}(f)$

$$= -i_2 \, In_{\dagger}(f)$$

$$= -i_2 \, f$$

That is $i_2 \, f \in B_{2,\dagger}$. This implies that $i_2 \, B_{1,f} \subset B_{2,\dagger}$. Conversely,

Let $g \in B_{2,\dagger}$, then $\qquad\qquad\qquad In_{\dagger}(-i_2 \, g) = (-i_2)^{\dagger} \, In_{\dagger}(g)$

$$= i_2 (-g)$$

$$= -i_2 \, g$$

$\Rightarrow -i_2 \, g = f \in B_{1,\dagger}$ or equivalently, $g = i_2 \, f$. Thus $i_2 \, B_{1,\dagger} = B_{2,\dagger}$. Moreover, given $f \in B$, define

$$f_1 = \frac{1}{2}\left(f + In_{\dagger}(f)\right), \quad f_2 = \frac{1}{2}\left(f - In_{\dagger}(f)\right)$$

$f_1 \in B_{1,\dagger}$, since $In_{\dagger}(f_1) = In_{\dagger}\left[\dfrac{f + In_{\dagger}(f)}{2}\right] = \dfrac{In_{\dagger}(f) + In_{\dagger}(In_{\dagger}(f))}{2} = \dfrac{In_{\dagger}(f) + f}{2} = f_1$

and,

$f_2 \in B_{2,\dagger}$, since $In_{\dagger}(f_2) = In_{\dagger}\left[\dfrac{f - In_{\dagger}(f)}{2}\right] = \dfrac{In_{\dagger}(f) - In_{\dagger}(In_{\dagger}(f))}{2} = \dfrac{In_{\dagger}(f) - f}{2} = -f_2$

And $f = f_1 + f_2 = f_1 + i_2 \, (-i_2 \, f_2)$. Hence $B = B_{1,\dagger} + B_{2,\dagger} = B_{1,\dagger} + i_2 \, B_{1,\dagger}$.

Note 3.2.1: $B_{1,\dagger}$ is the set of $C_1(i_1)$ - elements in *B*, since it is a $C_1(i_1)$ - linear subspace of *B*.

It is known that any † - involution on a BC - module is consistent with its idempotent representation. So same is true for *B* also. Let $f = (\xi_k) \in B$, $f = f_1 + i_2 \, g_1$, $f_1, g_1 \in B_{1,\dagger}$

We have that

$$f = e_1 (f_1 - i_1 \, g_1) + e_2 (f_1 + i_1 \, g_1)$$

Now the idempotent representation that we already have for a bicomplex number gives us:

$$f = \xi_k = z_{1k} + i_2 \, z_{2k} = (z_{1k} - i_1 \, z_{2k}) e_1 + (z_{1k} + i_1 \, z_{2k}) e_2 = {}^{1}\xi_k \, e_1 + {}^{2}\xi_k \, e_2$$

Then both the above representations are consistent since we can take

$$f_1 - i_1 \, g_1 = {}^{1}\xi_k \text{ and } f_1 + i_1 \, g_1 = {}^{2}\xi_k.$$

We can do the same exercise for the other two types of involutions.

3.3 This Section is divided into two Subsections

In the first section we have constructed a BC module using two subclasses of B. and in the other section we have given an example of construction of a BC – module using two complex spaces.

3.3.1 Construction of a BC - Module from the two Subclasses $B'\,\&\,B''$

We have $B_1 = \{^1\xi_k : \sup_k k^k |^1\xi_k| < \infty\}, B_2 = \{^2\xi_k : \sup_k k^k |^2\xi_k| < \infty\}$

Here $^1\xi_k$ and $^2\xi_k$ are complex sequences. As we can easily observe that B' and B'' which can also be written as $B' = B_1\,e_1$ and $B'' = B_2\,e_2$. B_1 and B_2 are two complex linear spaces i.e., they are $C_1(i_1)$ - linear as well as $C_1(i_2)$ - linear spaces.

Theorem 3.3.1: *Prove that* $e_1\,B_1 + e_2\,B_2$ *defines a* BC *- module.*

Proof: We want to construct a bicomplex module with the help of B' and B''. Lets give precise meaning to the symbols $e_1\,B_1$ and $e_2\,B_2$. Consider the $C_1(i_1)$ - linear space $e_1\,C_1(i_1)$ which is a $C_1(i_1)$ - linear subspace of C_2 or BC. Define the tensor product

$e_1\,B_1 = e_1\,C_1(i_1) \otimes_{C_1(i_1)} B_1$ and $e_2\,B_2 = e_2\,C_1(i_1) \otimes_{C_1(i_1)} B_2$

It is clear that both $e_1\,B_1$ and $e_2\,B_2$ are $C_1(i_1)$ - linear spaces. Any elementary tensor in $e_1\,B_1$ will be of the form $e_1\,\lambda \otimes f$ with $\lambda \in C_1(i_1), e_1\,\lambda \otimes f = e_1 \otimes \lambda\,f = e_1 \otimes f_1, f_1 \in B_1$.

Similarly any elementary tensor in $e_2\,B_2$ is of the form $e_2\,\lambda \otimes \mu$ with $\lambda \in C_1(i_1)$,

$e_2\,\lambda \otimes \mu = e_2 \otimes \lambda\,\mu = e_1 \otimes \mu_1, \mu_1 \in B_2$.

Now consider the cartesian product $e_1\,B_1 \times e_2\,B_2$, where $e_1\,B_1$ is seen as $e_1\,B_1 \times \{0\}$ and $e_2\,B_2$ is seen as $\{0\} \times e_2\,B_2$. Since $e_1\,B_1 \times e_2\,B_2$ is an additive abelian group, the sum $e_1\,B_1 + e_2\,B_2$ is given the meaning. For any $f_1 \in B_1, f_2 \in B_2$

$e_1\,f_1 + e_2\,f_2 = (e_1\,f_1, e_2\,f_2) \in e_1\,B_1 \times e_2\,B_2$

Now we are going to endow it with the structure of a BC - module. For any $\lambda = \beta_1\,e_1 + \beta_2\,e_2 \in BC$ and $f = e_1\,f_1 + e_2\,f_2 \in e_1\,B_1 \times e_2\,B_2$

$\lambda(e_1\,f_1 + e_2\,f_2) = (\beta_1\,e_1 + \beta_2\,e_2).(e_1\,f_1 + e_2\,f_2)$

$= e_1\,\beta_1\,f_1 + e_2\,\beta_2\,f_2$

$= e_1\,(\beta_1\,f_1) + e_2\,(\beta_2\,f_2)$.

This is a well-defined multiplication of elements of $e_1\,B_1 \times e_2\,B_2$ by bicomplex scalars (bicomplex numbers in idempotent representation can be multiplied this way, as $e_1^2 = e_1, e_2^2 = e_2, e_1.e_2 = 0$). If we take another element $g = e_1\,g_1 + e_2\,g_2 \in e_1\,B_1 \times e_2\,B_2$, then

$\lambda(f + g) = (\beta_1\,e_1 + \beta_2\,e_2)\big[(e_1\,f_1 + e_2\,f_2) + (e_1\,g_1 + e_2\,g_2)\big]$

$= (\beta_1\,e_1 + \beta_2\,e_2)\big[e_1(f_1 + g_1) + e_2(f_2 + g_2)\big]$

$= \{\beta_1(f_1 + g_1)e_1 + \beta_2(f_2 + g_2)e_2\}$

$= (\beta_1\,f_1\,e_1 + \beta_2\,f_2\,e_2) + (\beta_1\,g_1\,e_1 + \beta_2\,g_2\,e_2)$

$$= \left(\beta_1 e_1 + \beta_2 e_2\right)\left(f_1 e_1 + f_2 e_2\right) + \left(\beta_1 e_1 + \beta_2 e_2\right)\left(g_1 e_1 + g_2 e_2\right)$$

$$= \lambda f + \lambda g .$$

Now if $\lambda_1 = \beta_1 e_1 + \beta_2 e_2$ and $\lambda_2 = \alpha_1 e_1 + \alpha_2 e_2$ be two bicomplex scalars

$$\left(\lambda_1 + \lambda_2\right) f = \{(\beta_1 + \alpha_1)e_1 + (\beta_2 + \alpha_2)e_2\}\left(f_1 e_1 + f_2 e_2\right)$$

$$= (\beta_1 + \alpha_1) f_1 e_1 + (\beta_2 + \alpha_2) f_2 e_2$$

$$= \beta_1 f_1 e_1 + \beta_2 f_2 e_2 + \alpha_1 f_1 e_1 + \alpha_2 f_2 e_2$$

$$= \lambda_1 f + \lambda_2 f .$$

We can easily prove that $\left(\lambda_1 \lambda_2\right) f = \lambda_1 \left(\lambda_2 f\right)$. It can also be proved that

$1_{BC} f = f$, 1_{BC} is the multiplicative identity of BC. Hence $e_1 B_1 + e_2 B_2$ defines a BC - module.

3.3.2 Construction of BC – Module from, c and l_∞, an Example.

Theorem 3.3.2(i): *If $X_1 =$ The space c of all convergent sequences $x = (x_n)$ with the norm $\|x\| = \sup\limits_{1 \le n < \infty} |x_n|$*

$X_2 =$ The space l_∞ of all bounded sequences $x = (x_n)$ with the norm $\|x\| = \sup\limits_{1 \le n < \infty} |x_n|$

Prove that $X = e_1 X_1 + e_2 X_2$ forms a bicomplex module.

Proof: Consider two complex linear spaces or $C_1(i_1)$ - linear spaces (as we know that there are two imaginary units in the bicomplex space and complex space has one imaginary unit, we have assumed the first imaginary unit i_1 of C_2 same as the imaginary unit i of C_1).

$X_1 =$ The space c of all convergent sequences $x = (x_n)$ with the norm $\|x\| = \sup\limits_{1 \le n < \infty} |x_n|$

$X_2 =$ The space l_∞ of all bounded sequences $x = (x_n)$ with the norm $\|x\| = \sup\limits_{1 \le n < \infty} |x_n|$

X_1 and X_2 are two $C_1(i_1)$ - linear spaces. We wish to construct a BC - module X with the help of X_1 and X_2 with the suitable meaning of the symbols,

$$X = e_1 X_1 + e_2 X_2$$

This means the symbols $e_1 X_1$ and $e_2 X_2$ have to be given a precise meaning. To this purpose, consider the $C_1(i_1)$ - linear space $e_1 C_1(i_1)$ which is a $C_1(i_1)$ - linear subspace of C_2 or BC. Define the tensor product

$$e_1 X_1 = e_1 C_1(i_1) \otimes_{C_1(i_1)} X_1 \text{ and } e_2 X_2 = e_2 C_1(i_1) \otimes_{C_1(i_1)} X_2$$

$e_1 C_1(i_1)$ is the $C_1(i_1)$ - linear space and X_1 is also a $C_1(i_1)$ - linear space. So $e_1 X_1$ which is a product of two complex linear spaces is also a $C_1(i_1)$ - linear spaces. Similarly $e_2 X_2$ is also a $C_1(i_1)$ - linear space.

Any elementary tensor in $e_1 X_1$ will be of the form $e_1 \lambda \otimes x$ with $\lambda \in C_1(i_1)$, $e_1 \lambda \otimes x = e_1 \otimes \lambda x = e_1 \otimes x_1, x_1 \in X_1$. Similarly any elementary tensor in $e_2 X_2$ is of the form $e_2 \lambda \otimes v$ with $\lambda \in C_1(i_1)$,

$$e_2 \lambda \otimes v = e_2 \otimes \lambda v = e_1 \otimes v_1, v_1 \in X_2 .$$

Now consider the Cartesian product $e_1 X_1 \times e_2 X_2$, where $e_1 X_1$ is seen as $e_1 X_1 \times \{0\}$ and $e_2 X_2$ is seen as $\{0\} \times e_2 X_2$. Since $e_1 X_1 \times e_2 X_2$ is an additive abelian group, the sum $e_1 X_1 + e_2 X_2$ is given the meaning. For any $x_1 \in X_1, x_2 \in X_2$

$$e_1 x_1 + e_2 x_2 = (e_1 x_1, e_2 x_2) \in e_1 X_1 \times e_2 X_2$$

Now it will be endowed with the structure of a BC - module. For any $\lambda = \beta_1 e_1 + \beta_2 e_2 \in BC$ and $x = e_1 x_1 + e_2 x_2 \in e_1 X_1 \times e_2 X_2$

$$\lambda (e_1 x_1 + e_2 x_2) = (\beta_1 e_1 + \beta_2 e_2).(e_1 x_1 + e_2 x_2)$$

$$= e_1 \beta_1 x_1 + e_2 \beta_2 x_2$$

$$= e_1 (\beta_1 x_1) + e_2 (\beta_2 x_2) .$$

This is a well-defined multiplication of elements of $e_1 X_1 \times e_2 X_2$ by bicomplex scalars (bicomplex numbers in idempotent representation can be multiplied this way, as $e_1^2 = e_1, e_2^2 = e_2, e_1.e_2 = 0$)

If we take another element $y = e_1 y_1 + e_2 y_2 \in e_1 X_1 \times e_2 X_2$, then

$$\lambda (x + y) = (\beta_1 e_1 + \beta_2 e_2) \big[(e_1 x_1 + e_2 x_2) + (e_1 y_1 + e_2 y_2) \big]$$

$$= (\beta_1 e_1 + \beta_2 e_2) \big[e_1 (x_1 + y_1) + e_2 (x_2 + y_2) \big]$$

$$= \{ \beta_1 (x_1 + y_1) e_1 + \beta_2 (x_2 + y_2) e_2 \}$$

$$= (\beta_1 x_1 e_1 + \beta_2 x_2 e_2) + (\beta_1 y_1 e_1 + \beta_2 y_2 e_2)$$

$$= (\beta_1 e_1 + \beta_2 e_2)(x_1 e_1 + x_2 e_2) + (\beta_1 e_1 + \beta_2 e_2)(y_1 e_1 + y_2 e_2)$$

$$= \lambda x + \lambda y .$$

Now if $\lambda_1 = \beta_1 e_1 + \beta_2 e_2$ and $\lambda_2 = \alpha_1 e_1 + \alpha_2 e_2$ be two bicomplex scalars

$$(\lambda_1 + \lambda_2) x = \{ (\beta_1 + \alpha_1) e_1 + (\beta_2 + \alpha_2) e_2 \}(x_1 e_1 + x_2 e_2)$$

$$= (\beta_1 + \alpha_1) x_1 e_1 + (\beta_2 + \alpha_2) x_2 e_2$$

$$= \beta_1 x_1 e_1 + \beta_2 x_2 e_2 + \alpha_1 x_1 e_1 + \alpha_2 x_2 e_2$$

$$= \lambda_1 x + \lambda_2 x .$$

We can easily prove that $(\lambda_1 \lambda_2) x = \lambda_1 (\lambda_2 x)$. It can also be proved that $1_{BC} x = x$, 1_{BC} is the multiplicative identity of BC. Hence $e_1 X_1 + e_2 X_2$ defines a BC - module.

Note that X_1 and X_2 are not in general the Cartesian components of a BC - module and we can construct a new bicomplex module if we start with two $C_1(i_2)$ - linear spaces.

Theorem 3.3.2(ii): *Show that the complex normed spaces X_1 and X_2 defined in theorem 3.3.2(i) above, generates a bicomplex module, with a norm of complex type.*

Proof: It is known to us that $X_1 = c$ and $X_2 = l_\infty$ are complex ($C_1(i_1)$ - linear) normed spaces with norms defined as follows:

$X_1 =$ The space c of all convergent sequences $x=(x_n)$ with the norm $\|x\|_1 = \sup_{1 \le n < \infty} |x_n|$

$X_2 =$ The space l_∞ of all bounded sequences $x=(x_n)$ with the norm $\|x\|_2 = \sup_{1 \le n < \infty} |x_n|$

It is already proved that $X = e_1 X_1 + e_2 X_2$ defines a BC - module. For any $x = e_1 x_{1n} + e_2 x_{2n} \in X$, set

$$\|x\|_X = \frac{1}{\sqrt{2}} \sqrt{\|x_{1n}\|_1^2 + \|x_{2n}\|_2^2} \qquad (3.3.2)$$

We shall show that (3.3.2) defines a norm on X in the sense of Definition 1.8.1. We refer to it as the Euclidean – type norm on $X = e_1 X_1 + e_2 X_2$. It is well known that (3.3.2) defines a real norm on the real space X. But beside we have, for any $\mu = \mu_1 e_1 + \mu_2 e_2 \in BC$, $\mu_1, \mu_2 \in C_1(i_1)$ and any $x = e_1 x_{1n} + e_2 x_{2n} \in X$:

$$\|\mu x\|_X = \|(\mu_1 e_1 + \mu_2 e_2)(x_{1n} e_1 + x_{2n} e_2)\|_X$$

$$= \|(\mu_1 x_{1n})e_1 + (\mu_2 x_{2n})e_2\|_X$$

$$= \frac{1}{\sqrt{2}} \sqrt{\left(\sup_{1 \le n < \infty} |\mu_1 x_{1n}|\right)^2 + \left(\sup_{1 \le n < \infty} |\mu_2 x_{2n}|\right)^2}$$

$$= \frac{1}{\sqrt{2}} \sqrt{|\mu_1|^2 \left(\sup_{1 \le n < \infty} |x_{1n}|\right)^2 + |\mu_2|^2 \left(\sup_{1 \le n < \infty} |x_{2n}|\right)^2}$$

$$\le \frac{1}{\sqrt{2}} \sqrt{2 \cdot \|x\|_X^2 \left(|\mu_1|^2 + |\mu_2|^2\right)}$$

$$= \|x\|_X \cdot \sqrt{|\mu_1|^2 + |\mu_2|^2}$$

$$= \sqrt{2} |\mu| \cdot \|x\|_X$$

And for any complex number $\mu \in C_1(i_1)$ we have $\|\mu x\|_X = |\mu| \cdot \|x\|_X$, so (3.3.2) defines a norm of $C_1(i_1)$ - type. In fact it defines a norm of $C_1(i_2)$ - type also, since we can take $\mu = a + i_2 b = (a - i_1 b)e_1 + (a + i_1 b)e_2 \in C_1(i_2) \subset BC, a, b \in R$

$\mu = a + i_2 b, a, b \in R$ is a complex number which is in $C_1(i_2)$. Thus for this also we have $\|\mu x\|_X = |\mu| \cdot \|x\|_X$. Hence the complex normed spaces X_1 and X_2 generates a bicomplex module, with a norm of complex type.

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A COEVAL REVIEW ON ENVISAGING TOWARDS TO ENERGY ENHANCEMENT IN WIRELESS SENSOR NETWORKS

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ABSTRACT

The wireless sensor network (WSN), as the most essential technological developments of the twenty-first century, has been rapidly evolving during the last ten years. Many research have been performed in order to enhance its architectural, contractual operating systems, routing algorithms, data collection and combining, positioning method, time synchronisation, as well as other components. In addition, a slew of promising techniques have emerged and also been deployed in a variety of contexts, such as infrastructure protection, scientific instruments, surveillance systems, traffic management and monitoring, mining security and shipment, protection of the environment, target tracking, military control, and so on. The conveniences of the WSN have had a huge impact on human life and have transformed them in a variety of ways. The WSN, on the other hand, continues to confront a slew of problems.

Keywords: WSN, Energy Efficiency, Applications

INTRODUCTION

WSNs (Wireless Sensor Networks) are a enormous growing sector of wireless communication that has grown dramatically in few years. Micro-Electro-Mechanical Systems (MEMS) are rapidly developing, and technological developments in the field are enabling the deployment of compact, cheap, affordable, and unique sensors in physical settings linked by wireless networks. [1]. It clear a improvised opportunities for spotting physical properties such as motion, pressure, temperature, sound, vibration, and assaults in a variety of civilian and military applications, but it has considerable limitations. It has a limited quantity of energy and can only perform certain computations. [2].

Sensor Protocols for Information via Negotiation, developed by W. R. Heinzelman et al. in a 1999 publication, employs meta-data as a marketing technique earlier delivering correct data. When a node gets the output, it promotes it to its partners (ADV), with only those that are interested sending a query message (REQ) [3]. Data (DATA) can then be transferred from the data-carrying node to the other nodes which have requested it. It reduces flooding issues such double data transmission and detecting area overlap, resulting in higher energy efficiency. The fundamental problem of SPIN data distribution was its inability to ensure data transport, especially in the context of faraway nodes. In their research, C.Intanagonwiwat et al. looked into Direct Diffusion as a verification, with the goal of diffusing data across sensor nodes using a mechanism for information based on communication preferences. The sink makes a phone call to its companions [4].

LITERATURE SURVEY

Nodes that are interested in responding to the query may send data. In addition, there are several gradient fields in the entry for interest. A gradients was a return connection to the person who sparked the curiosity in the first place. The bit rate, duration, and expires time derived from the fields of the receiving interest were used to define it. As a result, interest and gradients were used to create routes linking sinks and sources. A number of pathways can be designed in such a way that it is strengthened.

As a result, the approach that uses the minimal energy was picked. If the connection between the origin as well as the sink breaks, a different path is employed to connect the two places. As a result of keeping the alternate channels, the overhead was elevated. As a result, using it to large sensor networks may be unfeasible. The "Power Efficient Collecting in Sensor Information Systems" (PEGASIS) protocol was defined by Lindsey et al. (2002) in their work [5] as an updated version of the LEACH protocol. In a variety of respects, this chain-based method beats LEACH algorithms. Every node aggregates the data it has gathered and then sends it to the next node in the chain.

A greedy algorithm is used to group nodes in a chain; the base station then calculates the chain and broadcasts it to additional sensor nodes. PEGASIS saves power in a number of ways when compared to LEACH: To begin, the majority of sensor nodes travelled substantially shorter distances during local data gathering than they did when broadcasting to a root node in LEACH. Each communication cycle, on the other hand, just one node transmits to the Ground Station.

In addition, the number of BS broadcasts has been reduced. It uses various hop transmission and only chooses one node to send data to the sink or BS, whereas LEACH uses one hop transmission. Due to the reduction of the overhead involved with the construction of dynamic clusters. In larger networks, PEGASIS introduces excessive delay for remote nodes. Furthermore, because it is responsible for data transfer to BS, the one chosen node may operate as a bottleneck. It was based on a number of assumptions that made solutions impossible in the real world, including any node sending data to BS directly. The positions of the sensor network are known to all WSN nodes.

Younis et al. (2002) proposed the EAR [6] Energy Aware Routing approach. Grouping heads and gateways were defined in their work as energy-aware routing nodes. Gateways keep track of node statuses and create multi-hop pathways. The sink only communicates with the gateway. The gateway informs other nodes of the time frame in which they should monitor for transmissions from other nodes and the time slot in that they should transmit the data they have acquired. The nodes can be configured to work in one of four modes: sensing-only, monitoring, sensing-relaying-only, or inactive.

In terms of energy utilisation, delay minimization, and other assessment criteria, a cost function was created that could be applied in between two nodes. The shortest path between sensor network and the gateway was determined using the value of that kind of cost function. In their article, F. Akyildiz et al., (2002) discussed electro-mechanical systems technology. Additionally, the elements affecting sensor networking architecture, as well as sensing jobs and potential sensor networks, were explored. Because of the high sensitivity, fault tolerance, versatility, and low cost qualities, a variety of applications are available.

They also talked about pre-defined and focus on the improvement, and also the re-deployment of previously deployed phases. In their study [7], Chee-Yee Chong et al. (2003) gave a history of sensor node research, as well as technology trends, novel technologies, and technical challenges in sensor network development. Wireless multi - hop networks have been implemented for a range of applications thanks to small, economical, and powerful sensing properties on micro - electronic control system, broadband wireless capabilities, better secure communication, as well as a low-power CPU. In their study [8], Limin Meng et al. developed power service quality techniques for routing that also were efficient for point - to - point traffic. They showed how to employ dynamic clustering to improve first-order energy efficiency and multi-objective programming models to improve service quality. Xu Li et al. (2007) showed how to acquire information from sensors for the research purpose and analysis in a certain field [9] in their study. They also exploited sink mobility to reduce and balance the amount of energy required by sensors.

They looked at the theoretical potential of unequal energy reduction events in a vessel sinks wireless sensor network, as well as the issue concerning power distribution of data to mobile sinks. In their paper [10], Basilis Whether during et al. looked into clustering nodes, multilayer routing, various methods of data collection that help with scalability. Hierarchical clustering uses less energy and communicates more efficiently. It allowed for quick convergence while using as little energy as feasible.

The clustering algorithm's nodes produce quick decisions. They also talked about inter communication and multi-level clustering. In their paper [11], Sudhanshu Pant et al. (2010) studied data caching methods in wireless networks. Caching algorithms were used to improve the capacity of wireless sensor networks. If sensors within networks are distributed uniformly and use the same quantity of electricity, and the system is kept operational for as long as possible, energy can be saved. Saravana Kumar R. et al. (2010) [12] investigated WSN. It includes a large number many sensors, and since each sensor has a limited power source, developing a power routing mechanism that can give an accurate while still offering better energy efficiency and prolonging the network's lifetime is tough.

A new routing and data convergence approach is provided that does not require reclustering, as well as a network re-scheduling framework based on each node's residual energy. The suggested routing technique utilises much less energy and improves the total lifetime of the wireless networks when matched to the LEACH protocol. Jang, Seongsoo Ho-Yeon Kim, and colleagues (2011) developed a WSN approach that will become a standard in the near future. Increasing the total energy productivity of the overall network [13] is a basic topic that must be solved in the WSN.

A variety of methods, including clustering, can be used to increase energy efficiency. The "Energy Efficient Clustering Scheme with Concentric Hierarchy (EECCH)" is a new approach that is a centralised clustering scheme that attempts to save energy. By constructing rounds with the ground station as the centre, the base point splits network nodes into layers. It is now crucial to increase energy efficiency using this method. In their

paper [14], Mehrdad Ahad et al. (2012) investigated interaction in Wireless Sensor Networks. The data collected by Network elements should be transmitted to the ground station. It aids in the computation of data and the development of informed decisions.

The density of packets of data increases as you get closer to the sink. The scenario was nicknamed the Energy Hole. In Wireless Sensor Networks, the issue of power leakage should be minimised. It was a crucial component in large-scale wireless sensor design. They created a variety of sink models to help close the energy difference. This was attributed to the increasing number of nodes in close proximity to the sink. This model is made up of a variety of sink intensities. Sensor nodes have been given the role of analysing their surroundings. It sends the data it collects to a node specified as the sink. Energy management is important to the networks' long-term viability. Lohan, P. et al. (2012) [15] applied the Geographically Sleep Sequencing and Linking Based Routing (GSSC) method to a wireless sensor network. Since detector nodes are power-constrained, node energy can be effectively used to increase the system's lifespan. GSSC conserves energy by recognising similar nodes in terms of routing based on geological data.

It recognises data that is nearly identical and disables superfluous nodes to reduce data duplication. The results demonstrate that GSSC greatly outlasted LEACH and PEGASIS in terms of network lifespan. Ahmad, A., et al. (2013) [16] investigated the clustering method, that is the most well-known directing approach in WSNs. The use of creative vitality for directing conventions remains an attractive research subject due to the varied requirements of WSN applications. The researchers introduced a new power guiding strategy in their study. This strategy is used to solve the energy and coverage inadequacies that are at the heart of the problem. They've employed density in their plan to deal with these issues. This concluded in an ideal cluster head selection and uniform hub flow within each cycle.

A networked energy-efficient adaptive clustering technique for WSN was proposed by Gherbi Chirihane et al. (2015) [17]. With scattered cluster heads, clustering techniques perform well. The network node proportion is disabled for a time in order to lower the cost function. To reduce simulation time, nodes are randomly placed and resource savings are used. With data collection, the global efficient energy cluster based protocol (DEACP) minimises total energy consumption of the network, optimizes energy usage among sensors, and extends network lifetime. The homogeneous distribution of clump across the network minimises transmission power, lowering energy consumption. G. S. Brar et al. (2016) [18] presented the PDORP method, which is a transfer energy-aware routing system. The proposed protocol PDORP represents a both energy sensor data network (PEGASIS) and a DSR routing algorithm. A routing approach for distinguishing energy-efficient optimal pathways has been suggested.

The execution investigation, which employs a hybridized technique to connect the proposed scheduling convention, produces a superior result with a reduced piece error rate, less latency, reduced energy consumption, and more throughput, resulting in higher QoS and system longevity. In their research, Sabri Y. et al. (2019) [19] created a novel approach for calculating energy usage in WSNs and examined the DSR routing mechanism in the given network situation. The power usage of the variable origin routing protocol in transmitting, getting, and idle modes was measured by the authors.

In transceiver modes, the generic model used the greatest power, while the mica-mote model used the least. Hussein A. A. et al. (2020) looked into the performance of a number of chain-based routing protocols, including one of the most popular. The performance of the PEGASIS system has been studied from its inception through later upgrades in terms of the number of stations that already have expired and that this affects overall network lifetime. Ibrahim et al. (2021), on the other hand, released a survey on crucial subjects in the WSN domain, highlighting the main solutions to problems, as well as major roadblocks in WSN technology. The main purpose of their research is to help researchers understand a variety of disciplines and fields, and also their flaws and strengths [21].

1. Energy Efficient Wireless Sensor Network

Energy plays very imperative role in versatile regions, one such a vicinity is wireless sensor based network. The future scope can be assessed by latest research findings in this domain has to be reviewed as much as possible. So, the consolidation is shown in the following table – 1.

Table. 1: Consolidation of energy efficient wireless network

S. No	Method	Description	Application	Reference
1.	Adaptive Zone	Assisted Iterative Localization	Identifying the most effective search zone	22

2.	Frame Forwarding Algorithm	Hierarchical Layer-Balanced Clustering	Battery lifetime intensification	23
3.	Coupled Oscillator Algorithm	Random Traveling Wave Pulse	Transmission	24
4.	Probabilistic algorithm	Optimize energy	Sustainable mobile networks	25
5.	Smart-antenna	Medium access control	Bridge structural health monitoring	26
6.	UAV – based	In hilly terrains	Fast Data Collection	27
7.	Automated lightweight encryption	Improvement in terms of delay and encryption time	Security	28
8.	Hybrid Data Aggregation	Node density for the gathered data from sensor	Agriculture, security areas	29
9.	Improved deep convolutional neural network	Energy-efficient data transmission	Malicious node detection	30
10.	Q-learning-based data-aggregation-aware	Routing protocol	Determine the optimal path	31
11.	Fuzzy logic	Unequal clustering protocol depend on a balanced energy technique	To enhance the performance	32
12.	Localization-free	Augmenting network lifetime	Underwater	33
13.	An improved energy efficient routing	Enhancing lifespan of the nodes	Underwater	34
14.	Clustering approach	Minimum distance	Underwater	35, 42
15.	Single-hop fuzzy and Fuzzy-C	Mechanism for cluster formation	Underwater	36
16.	Grid-routing	Enhanced residual energy	Underwater	37, 43
17.	3-cluster-depend routing	Sparse area	Underwater	38
18.	Layer-depend routing	Remaining energy	Underwater	39
19.	Multi-layer cluster-depend	Elucidate the hotspot problem	Underwater	40
20.	Adaptive clustering algorithm	Sphere-structured monitoring area	Underwater	41
21.	Node priority clustering and magnetic induction	Homogeneously distributed haphazard network	Underwater	44, 45
22.	Cube grid-depend clustering method	Optimized cluster formation	Underwater	46
23.	Region-aware proactive routing	Identifying the shortest distance	Underwater	47
24.	Software-based networking	Centralized management	Underwater	48
25.	Reliable energy-efficient routing	Link quality along with residual energy increased	Underwater	49-51 58,59
26.	Channel-aware routing	Relay node selection calculations time reduced	Underwater	52
27.	Grid-depend multipath	Local gateway picks a valid path	Underwater	53
28.	Cooperative energy-efficient routing	Signal-to-noise ratio along with channel capacity.	Underwater	54
29.	Energy-efficient cooperative	Fuzzy logic is utilized to choose the best relay	Underwater	55-56

	opportunistic routing			
30.	Cooperation-depend routing	Maximum residual energy	Underwater	57
31.	Geographic routing protocol	Residual energy and distance	Underwater	60
32.	Channel-aware cooperative	Data packet directly without many relay	Underwater	61
33.	Voronoi-Glowworm Swarm Optimization-K-means algorithm	Coverage optimization	Mobile network	62
34.	Geographic routing schemes	Proximity of a complicated hole	Mobile network	63
35.	Hidden Poisson Markov with Fault detection and recovery management	The detection accuracy is improved by up to 12%	Underwater	64
36.	Protocol clustering	Life time augmenting	Network	65
37.	Hierarchical routing protocol	Trust management	Network	66
38.	Trusted routing	Cognitive energy efficient	Security in Network	67,68
39.	Genetic algorithm	Data routing	Sink mobility	69
40.	Fuzzy	Unequal multihop clustering	Network	70,71

The inference from the above the table is that, in the recent years the energy efficiency is enhanced with the aid of inclusion of AI components like fuzzy logic, genetic algorithm and so on. These techniques being used for versatile purposes including the monitoring, identifying the faults, providing the solutions to data flow, cluster formation, and so on. Another trend is using unmanned aerial in the wireless network communication. So, it urges us to moving further to learn more about the future. The better way to assess the future scope is to rely on the patent database because it is updated every now and then.

2. Envisaging the Wireless Sensor Network

The future scope is assessed with the aid of patent database herein, because the data can be every fresh. It is means that, patent published today would be get updated in it. So, therein get a better vision to near future about the growth of technology. The patent analysis is carried out the keyword – ("wireless sensor network" "Energy efficient"), in the entire English category, means document in English and published and or granted patent in the globe. It reveals the number count as 1887. The other parameters considered for the analysis is including "Stemming" and "Single Family Member".
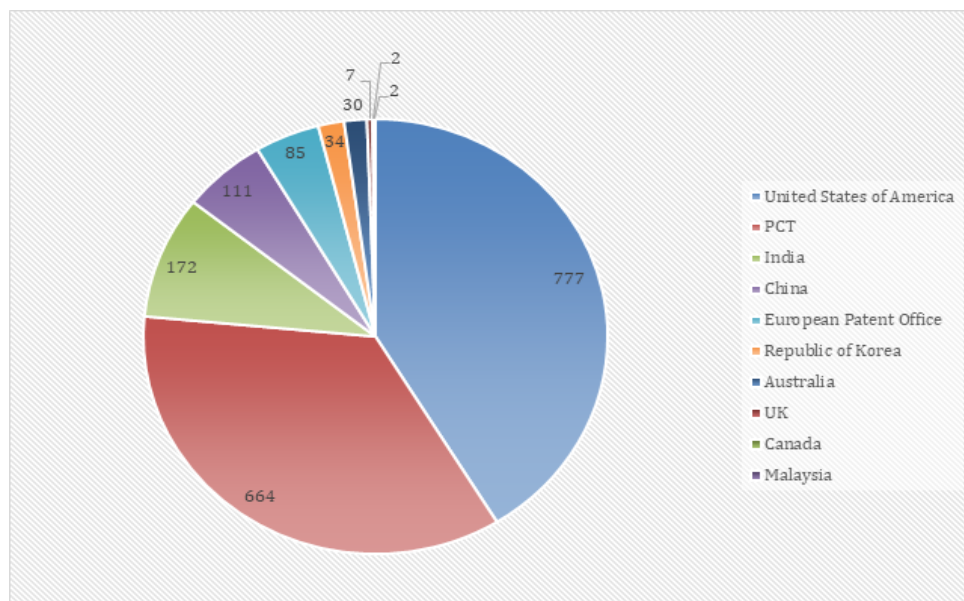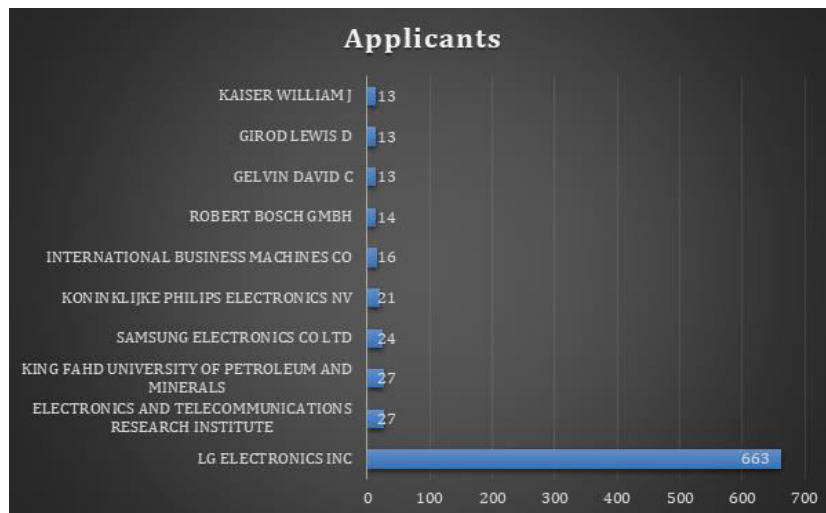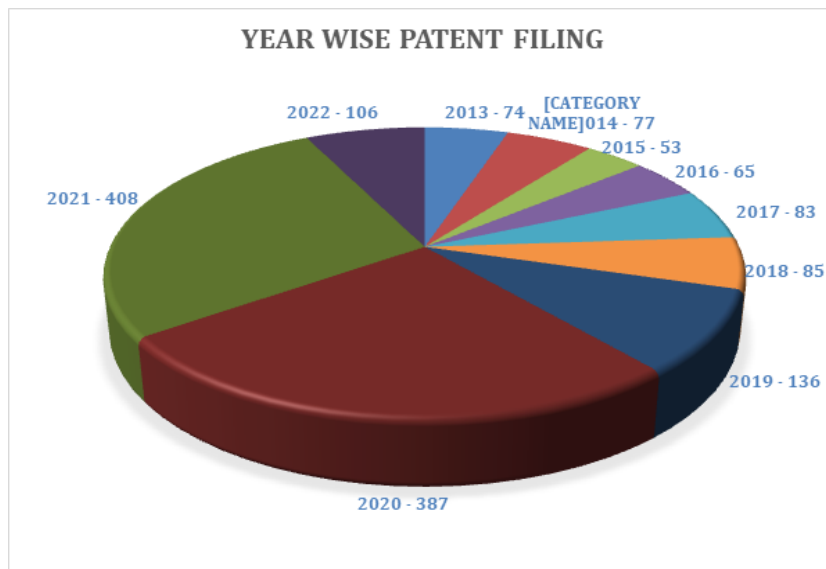

Fig. 1: Country wide patent filing

Fig. 2: Applicant wise patent filing

Fig. 3: Year wise patent filing

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A DISSERTATION ON PERFORMANCE ENHANCEMENT IN WIRELESS SENSOR NETWORKS

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ABSTRACT
WSNs are made up of a large number of sensors that are spread out over a vast region to perform specific computations. Each node in the network has a battery, however changing or charging batteries is nearly impossible, hence WSNs are used to detect events such as objects or physical differences at a high/low frequency sampling. As a result, "How can the network lifetime be extended for such a long time?" is the most essential question. "Well how it detects events at a High/Low Frequency Sampling" and "How to Detect Events at a High/Low Frequency Sampling" Thus, maximizing the network's lifetime through saving energy is a major challenge in WSN, and tackling the problem in two stages to identify high/low frequency sampling events is a solution to save energy. To begin, e-Sampling provides an adaptive sampling approach that dynamically switches between high- and low-frequency intervals to conserve resources while lowering false negative detections. Next, e-Sampling provides an event identification technique suitable for decentralized computing in resource-constrained WSNs by evaluating the frequency content. This article focuses on duty cycling schemes, which are the most compatible technique for saving energy, as well as data-driven approaches that can be used to improve energy efficiency and by applying e-Sampling to structural health monitoring (SHM), which is a common application of high frequency events. The benefits of e-Sampling in low-cost event monitoring and boosting the capacity of WSNs for high-speed data collection have been validated through simulations and tests. The benefits of e-Sampling in low-cost event monitoring and improving the capacity of WSNs for high-data-rate applications have been verified through simulations and experiments. Finally, we'll go over some of the communication protocols that have been developed for sensor networks.

Keywords:-Wireless sensor networks, Energy saving, Data driven, Duty cycling, Wireless sensor networks, Energy saving, Data driven, Duty cycling.

1. INTRODUCTION
A sensor node is often a small device with three fundamental components: 1) a sensing subsystem for collecting data from the physical environment, 2) a processing subsystem for local data processing and storage, and 3) a wireless communication subsystem for data transmission.

In addition, the power supply provides the energy required for the device to perform the programmed task. This energy source often consists of a battery with a limited energy balance. However, WSNs are currently used in many civilian applications. It was initially motivated by military applications such as battlefield surveillance. When the low-cost characteristics, utilization, limited weight, and ad hoc deployment manner are the limits set by WSN.Each sensor has a limited amount of energy.

Moreover, charging the battery may not be practical because the node can be placed in a hostile or inconvenient environment. Moreover, network life has a great impact on the performance of network applications. The alternative lifespan definition is actually very similar to the one used here. In a well-designed network, sensors in a particular area behave similarly to achieve energy balance. This means that if a sensor fails, the node's neighbours will have to take responsibility for the sensor, which is expected to soon run out of power and have a lifespan of months to years. We also described the general approach to energy savings in sensor nodes (duty-cycle, data-driven) and the main causes of energy loss in WSNs.

On the other hand, the WSN is provided to detect events such as objects and physical changes to high and low frequency scans. For the following critical limitations:

- Sensors cannot act to adapt their rates and spacing. All they rely on all the central units (or sinks) that know everything (the complexity of all sensors) and periodically sending the appropriate sampling rate.

- Especially for the application of urgent police, it is difficult to sample rates in a particular field that occurs in an interesting event.

The WSN has been proposed for many high-speed data collection applications such as physical activity monitoring, structural health monitoring (SHM), bright events, etc. WSNS is expected to monitor these long-term use events. However, the sensor generates data of data that contains too many data, especially audio,

seismograph, imaging and vibration, in these applications. In most cases, this data can not be sent in real time because the bandwidth is limited. The task is to present an accurate picture of the event process and environment variable changes. This can only be achieved when events are detected from the environment at an accurate rate or scanned from the environment. Thus, the sampling rate should be considered as a function of dynamic phenomena and application.

We layout e-Sampling, which results in decreased useful resource utilization in WSNs in stages,

- In the primary stage, every sensor has "short" and recurrent "bursts" of high-fee sampling, and samples at a far decrease fee at some other time. Depending at the evaluation of the frequency content material of alerts, on every occasion one in every of the fast periods of high-fee sampling is longer than normal, probable because of the presence of an occasion, the frequency content material of alerts will become crucial. Each sensor mechanically switches (takes movements on) its charges and each the high- and low-fee periods. Previously mentioned barriers are overcome, as e-Sampling allows dependable evaluation to estimate suitable destiny sampling charges and internet discount in received samples.

- In the second one stage, e-Sampling allows sensors to compute a light-weight indication of the presence of an occasion with the aid of using reading best the crucial frequency content material in a decentralized manner. A size able extrude within side the content material (referred to as occasion-touchy or thrilling data) shows that a likely occasion came about in a given tracking application. If the occasion has sincerely came about, the sink who gets the indicators may also need designated records from the sensors in particular regions (e.g., that are positioned across the occasion) and might ask queries; otherwise, within side the absence of the occasion, sensors lessen data (referred to as dull data) transmission to the sink.

The remainder of this paper is organized as follows. In section 2, major sources of energy waste in WSNS. A general approach to energy saving is proposed in section 3. Section 4, gives concluding remarks.

2. MAJOR SOURCES OF ENERGY WASTE IN WSNS

Energy is an extremely scant asset for such sensor frameworks and should be pains taking figured out how to broaden the existence of the sensor hub during a specific mission. Sensor hub energy utilization can be expected to "valuable" or "inefficient" sources. Moderate power utilization can be brought about by sending and getting information, handling question demands, and moving inquiries and information to neighbouring hubs. Squandered energy utilization can be because of at least one of the accompanying realities:

1) One of the major causes of wasted energy is idle listening (listening to free channels to receive possible problems), and the second reason for wasted energy is collisions (nodes multiple packets at once). These packets are said to have collided when they receive)), even if they are partially corrupted. All packets that caused the collision has been dropped, and those packets will be retransmitted, which increases power consumption.

2) The next reason to waste energy is eavesdropping (nodes receiving packets destined for other nodes). The fourth is the result of control packet overhead (which is minimum number of control packets must be used to complete the data transfer). At last, wasted energy is the excess emission caused by sending a message when the destination node is not ready. Given the above facts, it is necessary to consider a well-designed protocol to prevent this waste of energy.

3. BASIC APPROACHES FOR ENERGY SAVING

From the above issues and power outages, multiple approaches had been used at the same time to reduce the power consumption of the WSNs. At a most general level, we identify basic techniques to reduce loss are:

1) Duty-cycle,

2) Data-driven approach and

3) Mobility-based.

Duty cycles are primarily focused on network subsystems. The most effective power saving operation is to put the wireless transceiver into sleep mode (low power consumption) when communication is not needed. Ideally, you should turn off the radio when you run out of data to send / receive and restart it when new data packets become available. In this method, the node alternates between the active and idle phases depending on network activity. Duty cycle is defined as the percentage of time a node has been active for its lifetime. You can further improve energy efficiency by using the data-driven approach described in detail in the next section.
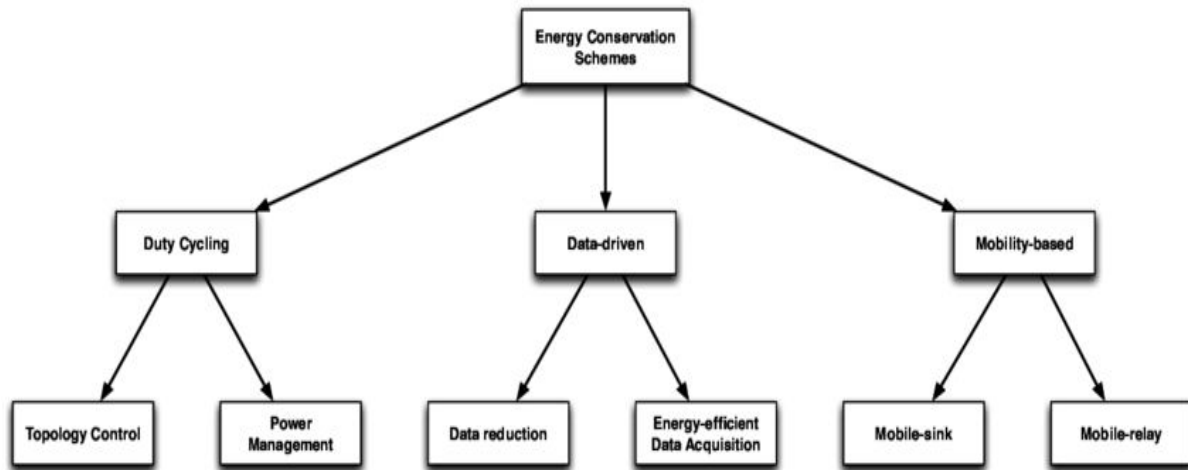
Figure 1: Taxonomy of approaches to energy saving in sensor networks.

3.1. Duty-Cycling

Generally, a sensor radio has 4 operating modes: 1) Transmission, 2) Reception, 3) Idle listening and 4) Sleep. These shows that the maximum power consumption is due to transmission, and in most cases the power consumption in sleep mode is about the same as the power consumption in receive mode. In contrast, energy consumption in sleep mode is significantly low.

Duty-cycling may be completed in different and complementary approaches. From one side, it is feasible to take advantage of node redundancy that is traditional in sensor networks and adaptively pick outmost effective a minimal subset of nodes to stay lively for preserving connectivity. In a few applications, the activities are generally uncommon and consequently sensor nodes spend a majority in their time in the idle duration which reduces the lifetime and the application of the sensor networks. Nodes that are not currently wanted for making sure connectivity can fall asleep and save energy. Finding the most efficient subset of nodes that assure connectivity is referred to as topology control. On the alternative hand, active nodes do now no longer want to hold their radio constantly on. They can transfer off the radio when there may be no network activity, hence alternating among sleep and wakeup periods. Throughout we are able to talk over with duty cycling operated on active nodes as strengthen in the executives.

Therefore, topology manage and power control are strategies that put into effective duty cycling with unique parallelism. Power control rules might be carried out both as independent sleep/wakeup protocols running at the top of a MAC protocol. Several criterions may be extensively utilized to determine which nodes to activate/deactivate and when. In this regard, topology control protocols may be extensively labelled within side the following categories: location driven protocols describe which node to turn on and when. Depend on the area of the sensor nodes is said to be known as geo-adaptive fidelity (GAF), geographically random transfer (GeRaF). On call for protocols including Span which is a connection-focused protocol that selects the "coordinator" of all network nodes and the Adaptive Self-Configuring Sensor Network (ASCENT) topology; Location-based topology control protocols require that sensor nodes be able to determine their exact location. This is usually done by supplying the sensor with a GPS unit. On-demand protocols use maximum visualization techniques for power control.

The general concept is that a node must wake up simplest while some other node desires to communicate with it. The important trouble related to on-demand schemes is how to tell the sleeping node that a few different nodes are willing to communicate with it. To this end, such methods normally use a couple of radios with extraordinary energy/overall performance trade-offs. An alternative answer is composed in the usage of a scheduled rendezvous approach. The basic concept at the back of scheduled rendezvous schemes is that every node must wake up on the identical time as its neighbours. Typically, nodes wake up in step with a wakeup time table and stay active for a brief time interval to communicate with their neighbours. Then, they fall asleep till the subsequent assignation time. At last, an asynchronous sleep or wakeup protocol can be used. With such protocols, a node can wake up while it needs and still be capable of communicate with its neighbours. This aim is done through properties implied within side the sleep/wakeup scheme hence no specific data change is wanted among nodes. On demand procedures are primarily based totally at the concept that a node must be awaken simply whilst it has to obtain a packet from a neighbouring node. This reduces the strength intake hence makes On-Demand schemes especially well matched for sensor network programs with a completely low duty

cycle (e.g., fire detection, surveillance of system disasters and more commonly; all event-driven structures). Therefore, in brief numerous criterions may be used to determine which nodes to activate/deactivate and while. So, topology manage protocols may be widely categorized in the following methods: the primary location driven; the selection approximately which node to show on, and while, is primarily based totally at the location of sensor nodes which is believed to be known.

The simple concept is that a node has to awaken simplest while every other node desires to talk with it. The primary trouble related to on-call for venture is how to tell the napping node that a few different nodes are inclined to talk with it. From this conclusion, such venture normally use more than one radios with special power/overall performance trade-offs. An opportunity answer is composed in the usage of a scheduled assignation approach. The simple concept in the back of scheduled rendezvous schemes is that every node has to awaken on the identical time as its neighbour's. Typically, nodes awaken in line with a wakeup agenda and continue to be lively for a brief time c programming language to talk with their neighbour's. Then, they doze off till the following assignation time. At last, an asynchronous sleep/wakeup protocol can be used. With such protocols, a node can awaken while it desires and nonetheless be capable of talk with its neighbour's. This purpose is done via way of means of houses implied within side the sleep/wakeup scheme consequently no specific facts trade is wanted amongst nodes. On call for schemes are primarily based totally at the concept that a node has to be wake up simply while it has to acquire a packet from a neighbouring node. This reduces the power intake consequently makes on-demand schemes especially well matched for sensor community packages with a completely low responsibility cycle (e.g., hearth place detection, surveillance of device screw ups and greater; all event-pushed scheme). Therefore, in brief numerous criterions may be used to determine which nodes to activate/deactivate and while. So, topology manage protocols may be extensively categorised within side the following categories: the primary region pushed; the choice approximately which node to show on, and while, is primarily based totally at the region of sensor nodes which is thought to be known.

MAC (Medium Access Control) protocol directly controls the communication module. the MAC protocol has a significant effect on the power consumption of the node. According to the top five causes of energy waste, researchers suggest different types of MAC protocols to improve energy efficiency and prolong network life. A suitable MAC protocol for wireless sensor networks requires the following characteristics: the first attribute for extending network life is energy efficiency, the second and third attribute is scalability, and adaptability. With changes in network size, node density, and topology, the MAC protocol must efficiently and quickly adapt to changes so that network connectivity and topology can be restored. Other important properties such as latency, throughput, and bandwidth usage can be secondary to sensor networks.

3.2. Energy Efficient Mac Protocols for Wsns
The typical contention-based MAC protocols are S-MAC (Sensor-MAC), T-MAC (Timeout-MAC), and U-MAC (Utilization-MAC).

3.2.1. S-MAC
There are two states in the time frame: 1) Active state and 2) Sleep state. S-MAC applies effective mechanisms to solve the energy-wasting problem of regular listening and sleep. When a node is idle, it is more likely to go to sleep instead of continuously listening to the channel. S-MAC reduces listening time by putting the node into a periodic sleep mode. Two techniques can be used to make regular listening and sleep S-MAC robust against synchronization errors. First, all time stamps exchanged are relative, not absolute. Next, the listening period is significantly longer than clock error or drift compared to the TDMA method, which has a very short time slot. With S-MAC, synchronization between adjacent nodes is much looser.
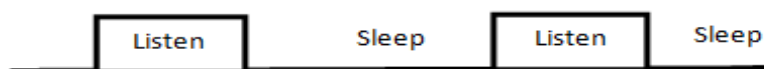

Figure 2: Periodic Listen and Sleep

This protocol is explained as follows. The main goal of S-MAC is to reduce power consumption including three major elements. After listening to protocols, nodes RTS or CTS packets, the Duration field in each transfer package is the message that the remaining transmission will be over and the sender communication occurs. As the CTS and RTS packages are examined, when the auditory / sleep system is displayed, the update schedule is realized as it needs to be achieved by the adjacent node and the update schedule transmit a synchronization packet. The results of this study are to reduce energy waste caused by idle suit, reduce sleep and sleep, and reduce sleep and duration and reduce the efficiency of algorithms under the shift traffic load. Sensor MAC

Protocol Advantages: Sleep planning and simplicity in addition to implementation minimize energy loss caused by the idle list.

3.2.2. T-MAC

T-MAC is an extension of the previous protocol that adaptively adjusts sleep and wake periods based on estimated traffic flow to improves power savings and minimize the latency. T-MAC minimize sensor inactivity time compared to S-MAC. Therefore, it is more energy saving than the S-MAC. Basic scheme of the T-MAC protocol with adaptive active time This protocol is a S-MAC protocol under variable traffic load by ending the listening period when no activation event occurs at the time threshold. Suggested to improve bad results. Sends all messages in variable length bursts and sleeps between bursts to reduce idle listening. This type of MAC has the advantage of causing a timeout when it is not heard. Comparing S-MAC and T-MAC It can be said that T-MAC improves performance under variable load, causes early sleep issues, and puts the node to sleep when the neighbour still has a message.

3.2.3. U-MAC

U-MAC provides solutions that improve power consumption performance for a variety of WSN applications. With U-MAC, transmissions can end at a scheduled listening time such as "a" or a scheduled idle time such as "b". If the send ends at the scheduled idle time b, the node continues listening until the next scheduled idle time d, wasting energy between b and the next scheduled listening time c. U-MAC is based on the S-MAC protocol and offers three major improvements over S-MAC. Variable duty cycle, usage-dependent duty cycle adjustment, and selective sleep after transmission. Different duty cycles are assigned to different nodes, which exchange schedules and synchronize with neighbours within a certain period of time. Moreover, the time of the node's next idle state is piggybacked back into the ACK packet. Avoid unnecessary retransmissions of RTS caused by missing update schedules from neighbours. Broadcasts can end at a scheduled idle time or a scheduled listening time.
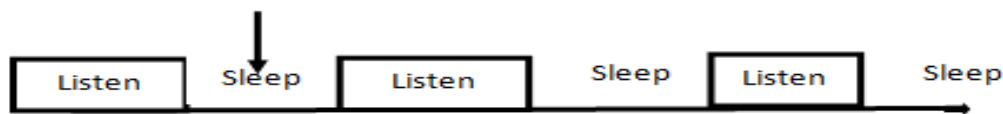

Figure 3: Sleep time and Listen time of U-MAC

3.3. Data-Driven Approaches

A data-driven approach will further maximize the energy efficiency. Sampled data will have strong spatial or temporal correlations. Performance suffers because you don't have to send redundant information to the sink Sensor subsystem consumption. Communication reduction is not enough with sensors He himself is hungry for power. In the first case, unwanted samples lead to wasted energy consumption. Even the smallest sampling costs can lead to unwanted notifications. Secondly, this issue always occurs when the consumption of the sensor subsystem is not negligible. Data driven the approach can be divided into data reduction schemes that address the case of unwanted samples, but energy efficient data acquisition schemes are primarily aimed at reducing energy consumption. Through the acquisition subsystem. Data reduction can be divided into network processing and data predict. This is explained in general in these sections. In-network processing exists Performing data aggregation on an intermediate node (for example, calculating the average of several values) between the source and the sink. In this way, the amount of data passed is minimized. Network towards the sink. Data prediction consists of creating an abstraction of perception A model that describes a phenomenon, such as the evolution of data. The model can predict the value Detected by the sensor node within a specific error limit, with the sensor Bathroom sink. Once the required accuracy is met, the user's query can be evaluated in the sink. Through the model without fetching accurate data from the node.
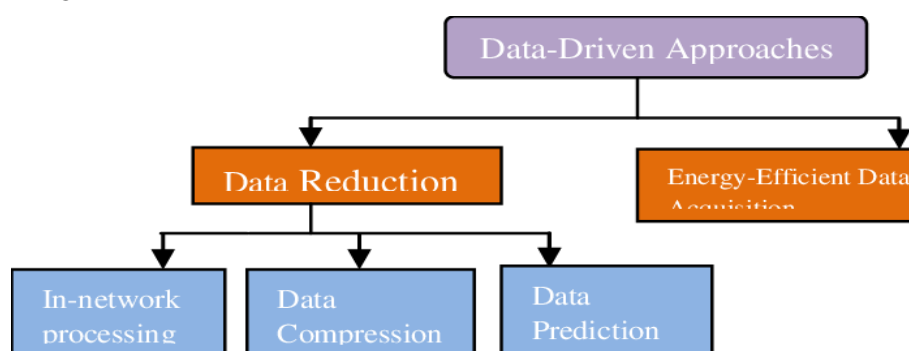

Figure 4: Taxonomy of data-driven approaches to energy conservation.

3.4. Design for Monitoring High Frequency Events

E-Sampling is designed as follows: At the beginning of the interval, the sensor starts with a short, repetitive burst of samples at high speed (R_h) and examines these samples to analyze F_h. When sampling at a low / set rate (R_1) at another time, the sensor samples the entire bandwidth, not just the bandwidth displayed at one sampling point. Dh is the duration of each sample burst in R_h, followed by D_l, and the sample rate used is calculated based on the F_h result. The time between two adjacent sample points is called the "discrete sample interval".

Every time an event occurs, F_h is important (where, this change of F_h is great. Events and D_h are sufficient). Therefore, the sampling rate is stored R_h to F_h are not important. In this case, D_l will be short interval. Before F_h is known, that is, long D_l. As soon as F_h is not important, the sampling condition is Relaxed again: That is short and D_l. has been extended. So, that is, D_l, R_h and R_l are automatically changed F_h. This technique in event detection detects analysis of F_h is stored at each discrete interval A better sampling rate will be selected while the wrong thing is negatively decreasing detection This reduces energy costs of almost all sensors. Side (sampling, ADC, calculation, and transmission).

The procedures of e-Sampling are simply shown below, and are executed by each sensor node individually. E-Sampling reduces the amount of data in two stages:1) During the period of sampling, and 2) During the period of decision making on an event. Both stages are performed at individual sensors. The ADC task is performed within an interrupt routine, and the main program performs the sampling rate selection computation. If you have enough samples Is collected, Decentralized Control is executed Sampling rate. The entire set of F_h is stored in the sensor Local storage (or flash storage). Sensors can suppress them It is in memory until you receive a confirmation message from the sink or full memory. After each is completed Sample period I, the sensor calculates the event display.

Overview of E-Sampling Showing two Stages Data Reduction

Decentralized Control{ //1st stage data reduction

While (True) {

S.RateComp in *Dh* = True { // start Sampling Rate Computation at the beginning of the system or at a certain interval

Run the Algorithm 1; // Sampling rate and interval adaptation

Compute new R_h; //set a new sampling rate

Compute *Dl*;}}} //set the duration for the new rate

ComputeEventIndication{ //2nd stage data reduction

Run the Event Indication Algorithm

If indication.Strength ! 40%

transmit the indication;

else transmit an acknowledgment; }

3.5. Mobility-Based Schemes

Mobility based schemes will be classified depending on the mobile sink and the mobile relay scheme. It is worthwhile to point out here that, It is an important topic when looking at the mobile system. There is a type of control for sensor network designer node mobility detailed description of this point. Mobile node can be shared Two wide categories: you can become specific for this, it signed as part of a network infrastructure, Part of the environment. If you are partial under that Structure, their mobility can be completely controlled by generally robotized. If there is part of the mobile node an environment that could not be controlled. If you follow lowering a strict schedule is completely predicted type less mobility (eg, public transport shuttle (23]). Otherwise, you can have random behaviour, so no trusted assumptions can be done with your mobility. finally, you can follow a mobility pattern that is not predictable, it is possible to randomly. For example, this is the case of a bus traveling in a city where the speed fluctuates greatly Deviation due to traffic conditions. In such cases, mobility You can learn patterns based on continuous observation It can be estimated reasonably and accurately.
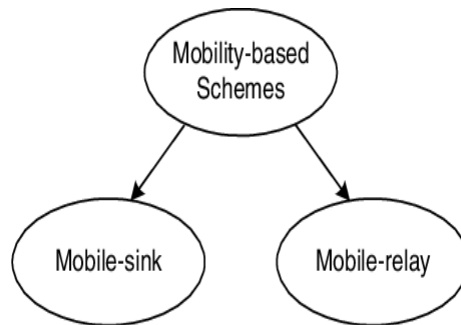
Figure 5: Taxonomy of mobility-based energy conservation schemes.

3.5.1. Mobile-Relay-Based Approaches

The Mobile Relay (MR) model for data collection in multihop ad hoc networks has already been explored in the context of opportunistic networks. One of the most well-known approaches is given by the message ferrying scheme. Message ferries are special mobile nodes which are introduced into a sparse mobile ad hoc network to offer the service of message relaying. Message ferries move around in the network area and collect data from source nodes. They carry stored data and forward them towards the destination node. Thus, message ferries can be seen as a moving communication infrastructure which accommodates data transfer in sparse wireless networks. A similar scheme has also been proposed in the context of sparse wireless sensor networks through the data MULE system. In detail, the data MULE system consists of a three-tier architecture

1) The lower level is occupied by the sensor nodes that periodically perform data sampling from and about the surrounding environment.

2) The middle level consists of mobile agents named Mobile Ubiquitous LAN Extensions, or MULEs for short. MULEs move around in the area covered by sensors to gather their data, which have previously been collected and temporarily stored in local buffers. Data MULEs can be for example people, animals, or vehicles too. Generally, they move independently from each other and from the sensor positions by following unpredictable routes. When-ever they get within reach of a sensor they gather information from it.

3) The upper level consists of a set of Access Points (APs) which receive information from the MULEs. They are connected to a sink node where the data received is synchronized and stored, multiple copies are identified, and acknowledgments are managed.
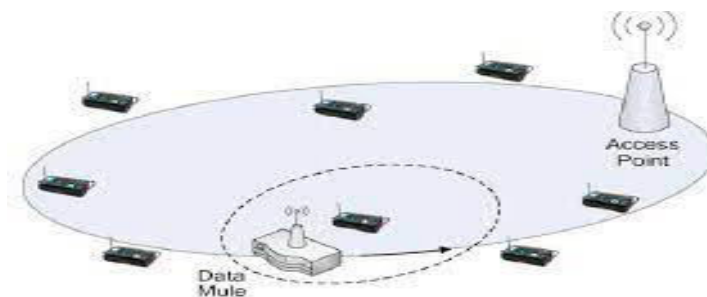
Figure 6: System architecture of a wireless sensor network with mobile relays.

4. CONCLUSION

In this paper, we have surveyed the major techniques to energy conservation in wireless sensor networks. Special attention has been dedicated to a systematic and comprehensive classification of the solutions proposed in the literature. We did not restrict our discussion to topics that have received broad interest in the past, however we have also stressed the significance of specific methods such as data-driven and mobility-based schemes. It is worth noting that the regarded strategies have to no longer be considered as alternatives, they have to rather be exploited together. First, Energy is one of the most critical resources for WSNs. Most of works in the literatures about WSN routing have emphasized energy conservations as an important optimization goal. However, merely saving energy is not enough to effectively prolong the network lifetime. The uneven energy depletion often results in network partition and low coverage ratio which deteriorate the performance. Energy saving in wireless sensor networks has attracted a lot of attention in the recent years and introduced unique challenges compared to traditional wired networks. Extensive research has been conducted to address these limitations by developing schemes that can improve resource efficiency. In this paper, we have summarized some research results which have been presented in the literature on energy saving methods in sensor networks.

Although many of these energy saving techniques look promising, there are still many challenges that need to be solved in the sensor networks. Therefore, further research is necessary for handling these kinds of situations.

And We have designed e-Sampling, a novel scheme of adaptive data acquisition and low-cost monitoring in WSNs, as an alternative to the traditional event-insensitive schemes. e-Sampling is capable of high-rate data acquisition and multi-hop wireless transmission in an energy-efficient way. It is quite flexible, as it supports diverse WSN applications—all the while it is able to run on small and low power microcontroller-based sensor nodes. Evaluation results show that, when both algorithms of adaptive sampling and decentralized event indication are used, e-Sampling saves up to 87% of the energy consumed by Imote2 sensors. There are some limitations in this paper that will be improved in the future:

(i) Snalysing the performance of the current scheme for monitoring different high-frequency events and the event detection accuracy;

(ii) A detailed analysis of the proposed algorithms, a comparison of their performance with more related schemes, under a sophisticated energy model.

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INVESTIGATIVE REPORT ON ENERGY SAVING METHODS IN COGNITIVE RADIO SENSOR NETWORKS

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ABSTRACT

Wireless cognitive radio sensors are discussed in this article. It is the network that is put in each sensor node. Networks and cognitive radio are multi-carrier systems. Operation in the allotted time. Each slot brings the user new traffic. Demand is aware of the entire range and seeks out what is offered. Set of subcarriers Given the data rate and power constraints, To save costs, fully distributed subcarrier selection and power allocation algorithms are recommended for each user. On all subcarriers, minimise energy consumption per bit. It interferes with existing users in a negative way. The Properties that are multidimensional and non-quasi-convex / concave Optimization of energy efficiency in multi-carrier systems Single carrier issue or energy efficiency issue system is more challenging than throughput / performance improvement. A two-step procedure is used to find the optimal option.

Keywords: Resource allocation, Cognitive radio, Wireless sensor network, Adaptive modulation, Cognitive radio, Wireless sensor network, Lifetime

1. INTRODUCTION

Long network lifetime is one of the key requirements for WSNs that consist of resource constrained sensor nodes. Wireless sensor networks (WSNs) are now employed in numerous applications, including battlefield surveillance and environmental monitoring[1]. Furthermore, when the WSN wants to collect a significant amount of data quickly, several users may need to submit data at the same time. To achieve great power efficiency, it is vital to avoid or limit interference from concurrent transmissions in this circumstance[2]. Cognitive Radio (CR) is a potential method for increasing spectrum utilisation and for avoiding low power efficiency in multicarrier systems. CR is assumed to be implemented at each sensor node in this investigation[3]. The sensor network is a network of sensors.

This paper builds on prior work by allowing users to transfer data over several subcarriers. The fact that a single subcarrier may not be adequate to meet data rate requirements justifies this[4]. To improve power efficiency and meet QoS requirements, additional design concerns such as distributed channel selection and power allocation must be considered. This is the paper's main point[5]. Existing users are not harmed by new users, although channel interference might develop because the same subcarriers can be selected independently in the same time slot. This study can share some new users in the same Sub-carrier as long as each BEEP interface and noise ratio (SINR) are acceptable [6].

In this paper, the aid allocation hassle in CR-WSNs is investigated from the component of strength performance [[7]. A completely disbursed subcarrier choice and electricity allocation scheme is proposed to limit strength according to bit over all subcarriers, problem to required facts price and electricity constraints[8]. This in flip outcomes in an extended community lifetime even as retaining QoS. The multi-dimensional and non-quasi-convex/concave nature of the optimization hassle in multi-provider structures makes it extra hard than the throughput maximization/electricity minimization troubles or the strength performance hassle in a unmarried provider system[9]. The most reliable answer is derived through the use of a two-level set of rules in which the unique hassle is decoupled into an unconstrained hassle and a department and certain approach is carried out thereafter to lessen the hunt space[10]. In addition, a disbursed electricity manipulate is carried out to manipulate the co-channel interference amongst new customers whilst needed[11]. It is established through simulation that the proposed disbursed scheme plus disbursed electricity manipulates plays near the centralized most reliable answer, in which all of the channel profits amongst new customers are assumed to be regarded to a principal controller and all of the new customers collaborate[12].

Adaptive modulation assumes that routing is performed and that the route is specified between any source / destination pairs[13]. Adaptive modulation technology is used to control the power consumption of each node on the physical layer[114]. You can achieve different data rates by adjusting the constellation size. This directly affects the power consumption of each node and affects the life of the entire sensor network[15]. Suppose QAM is used as the modulation method. The optimal QAM constellation size that maximizes network life is

analytically derived and verified by simulation[16]. The effects of subcarrier detection errors and subcarrier selection errors can also be investigated through simulation [17].

The remainder of this paper is organized as follows. In section 2, System model and the problem formulation for wireless cognitive radio sensor[18]. A fully distributed channel selection and power allocation scheme is proposed in section 3. In Section 4, a distributed power control algorithm is suggested for co-channel users[19]. Section 5system model and problem formulation. In section 6, contains lifetime maximization using adaptive QAM modulation. In section 7, the simulation results and discussions. Section 8, gives concluding remarks[20].

2. SYSTEM MODEL AND PROBLEM FORMULATION

A CR-WSN in which each node uses only a small amount of battery power for data transmission and reception at its radio transceiver is proposed. The system is time-slotted and has a set number of time slots (TS). A node either sends data, receives data, or sleeps in each time period. To save power, a node turns off and goes to sleep after transmitting or receiving data. We believe that slot synchronisation can be accomplished by some type of mutual assistance. Before each time slot, a guard interval is inserted, which is required for time synchronisation, spectrum detection, channel selection, and power allocation. We also assume that each node in the network communicates with one another.

The channel is considered to be a change in an independent variable Rayleigh fading channel at the physical layer, and the entire range is suitably segmented into M subcarriers, each with flat Rayleigh fading. Primary users may have already occupied some sub - carriers of the system during a given time period. If a node wants to start a new transmission in this time slot, it must first detect available sub - carriers and use only those sub - carriers that will not interfere with existing primary users. Our earlier work describes a sub - carrier detection method, and it is expected that perfect detection is obtained in this paper. Each new user will allocate power to the available sub - carrier range after receiving it.

After receiving the available sub - carrier set, each new user will allocate power to the selected sub - carriers in order to increase energy efficiency while achieving data rate and power limitations. We'll reduce the amount of energy used per bit among all sub - carriers in each time slot. The distributed sub - carrier selection and power allocation problem can be defined as follows for each new user:

$$Min_{Pt} \sum_{i=1}^{M} P_t + P_r / B. \sum_{i=1}^{M} \log(1 + \alpha_i p_t)$$

Subject to,

$$\sum_{i=1}^{M} R_i = B. \sum_{i=1}^{M} \log(1 + \alpha_i p_t) \geq R_{tar} \forall i=1, 2 ..., N$$

$$\sum_{i=1}^{M} P_i \leq P_{max} \forall i =1, 2 ..., N$$

The transmission power allocated on sub - carrier (i) is Pt (i) where the total circuit power consumption is Pr. Since power leakage in sleep mode is minimal, it is removed from this list. One sub-carrier's bandwidth is B. The Channel State Information (CSI) of sub - carrier is represented by i. The channel selection is also implied by the power allocation. Pt (i)=0 indicates that sub-carrier I is not active.

3. OPTIMAL CHANNEL AND POWER ALLOCATION ALGORITHM

The issue (P.1) is a combinatorial optimization problem with a non-quasi-convex/concave optimisation problem. As a result, the Lagrange multipliers method isn't applicable. To decrease the search process, we propose a two-stage technique that separates the original problem into an unconstrained problem. In order to find the final optimal solution, the power and data rate restrictions will be examined after the optimal solution for the unconstrained issue is found in stage 1.

Stage 1. Unconstrained Optimization

If we remove the constraints, the original problem (P.1) is reduced to an unconstrained optimization problem

$$Min_{Pt} \sum_{i=1}^{M} P_t + P_r / B. \sum_{i=1}^{M} \log(1 + \alpha_i p_t) \forall \quad i =1, 2 ..., N$$

The optimal transmission power P

$$\sum_{i=1}^{M} P_t + P_r / B. \sum_{i=1}^{M} \log(1 + \alpha_i p_t) = \zeta^*$$

Here is the optimal energy per bit. Details of derivatives are defined in Annex A. The value of ζ * can be obtained to a numerical manner by giving numerical methods M, B, αi, PR. Then you can determine p *. P * has been observed to have a similar type of "diluent" / "section glance" waste results, and we call it "energy efficiency" water filling. However, the basic differences between them are at their optimal points. The

maximum "desired" water filling maximizes the achievable data rate is the largest in the fixed current state, and the "piecewise-involved" transaction means minimizes the total transfer capacitance subject to fixed speed limitations. The proposed "energy efficient" clothes select energy efficient operating point (i.e., optimal data rate to minimize energy per bit), and energy by meeting the required data rate and performance limitations Maximize efficiency. In fact, water fill "Rate Adaptive" or "Margin Adaptive" can be regarded as special cases that are special cases in this paper. ΣPt (i) = pconde≦pmax or σr (i) = rtar, our problem is shortened to the problem of "Rate Adaptive" / "Margin Adaptive" waterfall.

Under certain conditions (determined by the settings of M, B, Pr, and αi), multiple solutions of ζ * can be obtained. The unique optimum value of ζ * can be determined by examining the corresponding P *. All elements of P * must be non-negative to get the optimal solution.

Stage 2. Constrained Optimization

Given the optimal solution P * = [Pt (i) *], ∀i = 1, 2… .M of (P.2), the solution of the constrained problem (P.1) based on the four subspaces. You can divide the space. For performance and data rate limits.
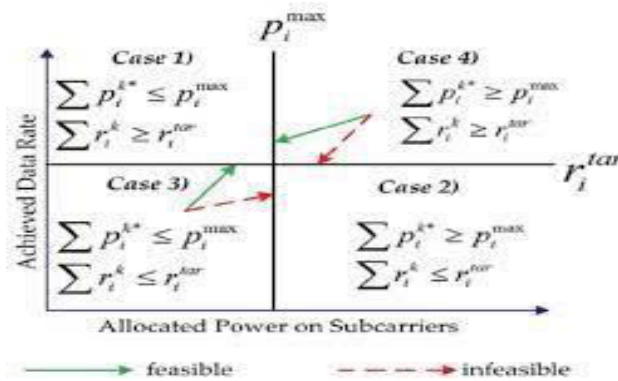
Figure1: Partitions of the constraint space

Case A: -$\Sigma Pt(i)^* \leq Pmax$ and $\Sigma R(i) \geq Rtar$

In this case, the optimal solution P* of (P.2) satisfies the data rate and power requirements. Apparently, P* is the optimal solution of the original problem (P.1)

Case B: - $\Sigma Pt(i)^* \geq PMax$ and $\Sigma R(i) \leq Rtar$

In Case B, the total power allocated to all subcarriers has already exceeded the maximum power limit, but even under optimal channel and power allocation, the data rate requirements are not yet met. Therefore, there is no effective solution to the original problem (P.1).

Case C: - $\Sigma Pt (i)^* \leq PMax$ and $\Sigma R(i) \leq Rtar$

If both of the power allocated to all subcarriers do not meet the maximum power limit, and if the data rate requirements are not met, then the power needs to be increased to meet the data rate requirements below the maximum power limit. I have. Based on (P.2) and (1), you can change the original problem as

$$Min_{Pt}(\sum_{i=1}^{M} Pt (i)^* + \Delta P_i) + P_r/ \text{B}. \sum_{i=1}^{M} \log(1 + \alpha_i (p_t + \Delta P_i))$$

As the power ΔP (i) of subcarrier i increases, β is constant for all subcarriers, so it is observed that the increase in the data rate of subcarrier i does not depend on its channel state. That is, if ΔP (i) = ΔP (j), then ΔR (i) = ΔR (j). Also, because the subcarriers are different, the new energy consumption ζ'per bit does not change. Assuming that the required additional power (ΔP) allocated to all subcarriers is known to meet the data rate requirements, ΔP = ∑ΔP (i), then the increased power for each subcarrier (ΔP (i)) Must be the same. The minimum overhead (ΔPMin = Min (ΔP)) required to meet the data rate requirement Rtar is the optimal solution. The minimum required additional power ΔPMin gives the following results: If ΔPmin is greater than the remaining power, that is, ∑Pt (i) * + ΔPmin ≥ PMax, then there is no acceptable solution for (P.3). Therefore, there is no feasible solution to the original problem (P.1). If ∑Pt (i) * + ΔPmin ≤ PMax, the optimal solution to the original problem is (P.1).

$$Pt (i) = Pt (i)^* + (\Delta P_{min} / \text{M})$$

Case D: - $\Sigma Pt(i)^* \geq PMax$ and $\Sigma Ri \geq Rtar$

In Case D, both data rates and current assignments have exceeded the upper limit. To obtain a feasible solution and minimize energy consumption, you need to reduce all subcarriers allocated performance. This solution is omitted here according to the same procedure as C. The details of the solution are founded.

4. DISTRIBUTED POWER CONTROL

In the previous section, you will individually get the best subcarrier selection and power allocation for each new user, without considering other new users. However, you may decide that multiple new users will experience the same channel interference using the same subcarrier. This section uses distributed generation control schemes to handle the same channel interference. Assuming that there are N (i) new users who have decided to use the same subcarrier i in the current time slot, it can be shown that the following distributed generation control algorithm converges, if possible. I can do it.

$$P_n^{(i)} (k+1) = (\gamma_n^{tar.(i)} / \gamma_n^i (k)$$

Where γtar, (i) is the target SINR and can be calculated from the optimally allocated data rate Rn (i) *. γn (i) (k) and Pn (i) (k) are the measured SINR and transmit power of the new user n on subcarrier i in step k, respectively. During the power control phase of this scheme, each node only needs to know the SINR received by the specified receiver to update the transmit power. It is available through feedback from the receiving node over the control channel. As a result, the proposed scheme will be fully distributed. The convergence properties of this type of algorithm. The interference function I (P) is standard when the three conditions of positive, monotonic, and scalability are met. It proves that the standard iteration algorithm P (k + 1) = I (P (k)) converges to a unique equilibrium corresponding to the minimum energy input. Distributed generation control scheme (7) is a special case of standard iterative algorithms. If power control issues are not feasible, a distributed media access control (MAC) scheme is needed to resolve the conflict. This will be one of our future efforts.

5. SYSTEM MODEL IN ADAPTIVE MODULATION

Consider a wireless sensor network of evenly distributed nodes. Each node operates on limited battery power and is consumed primarily by sending and receiving data through wireless transceivers. The sensor network is expected to be in a limited area. This system is a fixed slot period TS time slot system, assuming that slot synchrony can be achieved with some kind of beacon. A guard interval is inserted before each time slot. It is used to achieve time synchronization, perform spectral detection, and select the optimal modulation scheme. The network also assumes that each node sends with a probability pt in each time slot and the transmission is directed to one of its one-hop away neighbours. Routing within the network is taken for granted, and this task does not take into account routing issues**.**

At the physical layer, the channel is assumed to be a frequency-selective Rayleigh fading channel, the entire spectrum is properly divided into M subcarriers, and each subcarrier experiences flat Rayleigh fading. Given the time slot, some primary users may already occupy part of the system's subcarriers. If you have a node that wants to initiate a new transmission in this time slot, you should first discover the available subcarriers and use only the available subcarriers that do not interfere with the existing primary user. So the first problem is: (P.1) Given the current spectral conditions, the detection scheme needs to be designed to detect the entire spectrum and find the available subcarrier set Fi of node i that needs to be transmitted in this particular time slot. there is. The available subcarrier set Fi contains the number and location of these free subcarriers in the spectrum. Under perfect condition, i.e., no detection error, Fi should be the same for every user; however, due to the detection error, Fi may be different for different users

Considering the available subcarrier statements of each user, the best subcarriers can be selected for data transfer. This task assumes that complete channel status information (CSI) is available through biological estimation programs. Therefore, considering the maximum energy of each node EMAX, the second question is the second question. (P.2) If QAM is selected as a modulation scheme, can it maximize the life of various system parameters, especially the network, with a constellation size? In the following, we first consider the detection of availability of each subcarrier via the pilot sound scheme and then propose an energy efficient adaptive QAM modulation approach to maximize network life.

6. LIFETIME MAXIMIZATION USING ADAPTIVE QAM MODULATION

This section first defines the life of the network given the maximum energy Emax for each node. The following shows how to express network life as a function of system parameters such as noise power, required BER, and modulation scheme, and how to maximize network life through the proposed adaptive modulation scheme. The lifetime of node i under the maximum energy constraint Emax is given by:

H_1 : r(t) = A cos(ωt + Θ) + n_0(t) , 0 ≤ t ≥T

H_0 : r(t) =n_0(t) , 0 ≤ t ≥T

Here, νt (i) and ∂r (i) are the average energy of the average energy and node I reception of transmission in each time slot. (I) is the average power consumption in the sleep mode of node i. The TI unit is the number of slots. The life of the wireless sensor network is the period before the first node is run in the network. Therefore, the life of the entire network can be expressed as follows**.**

= I_0($2A_q$ / N_0)exp(-A^2/ $2N_0$)

Note that maximizing the life of a network is equivalent to maximizing the life of the smallest node of all nodes. Therefore, the problem of network life optimization can be written as:

d = ∫ ½ (exp(−jw_dt)) dt

Because the network is assumed to be composed of uniformly distributed sensor nodes and every node has the same traffic pattern, it is sufficient to consider any one of the sensor nodes, and "(i)" in the formulation can be dropped. In other words, we need to minimize the sum of the average energy of transmission, reception and sleep. And the network lifetime maximization problem becomes, It is clear that the average transmit energy $\bar{E}$T is the product of the average number of bits transmitted by the node during the time slot and the average transmit energy $\bar{E}$bt per bit. On the other hand, the average reception energy $\bar{E}$R can be approximated as the product of the average reception time Tr and the average reception power Pr as follows.:

d = ∫ ½ (exp(−jw_dt)) dt

$E_r = P_r + T_r$

Pr is assumed to be constant due to the power consumption of the receiving circuit, and Tr is related to the modulation scheme and the amount of data transmitted, as described below. First, derive the average transmission energy $\bar{E}$bt per bit.For QAM modulation, the target BER and the constellation size b can be related according to

P_b = 4/b (1-(1/$2^{1/2}$) Q (($\frac{3b}{2^b} - 1$)$^{1/2}$)

When calculating BER on the Rayleigh fading channel, γb is the average SNR per bit and is defined as γb = $\bar{E}$b / N0. Where $\bar{E}$b is the required energy per bit at the receiver for a particular BER requirement and N0 / 2 is heat. It is noise power.And we can obtain the average transmission energy per bit, $\bar{E}$bt, as follows

E_{bt} ≤ 2/3 (1+α)($\frac{P_b}{4}$)$^{-1}$

Here, α is related to the drain efficiency of the RF power amplifier and can be regarded as a constant. It is assumed that d is the distance between the transmitter and the receiver and that path loss follows the law of squares. G is a parameter related to both transmitter and receiver antenna gains.

In what follows, we assume that;

1). A node can either send data, receive data, or sleep in each time slot. Also, after sending and receiving data, the node shuts down and goes to sleep to save power. where a node sends data in the first slot, sleeps in the second slot, and receives data in the third slot. TS is the duration of each time slot, TTX is the transmit time, TRX is the receive time, and TSX = TSX1 + TSX2 + TSX3 is the idle time.

2). The transmission and reception probabilities of a node in each time slot are represented by pt and pr, respectively. Where pt is equal to pr. This is because the traffic pattern is uniform with the node, and the node has the same probability of sending or receiving in any time slot.

3). The amount of data that a node sends and receives in a time slot is L bits. This corresponds to the general situation where a node sends and receives fixed-length packets in a particular time slot.

4). Since all the nodes in a particular area are evenly distributed, we can further assume that the nodes have an average of H 1-hop away neighbors.

7. NUMERICAL AND SIMULATION RESULTS AND DISCUSSIONS

This section evaluates the proposed approach based on network life. In addition, we will investigate the effect of the false alarm probability Pf and the ratio of the number of users (N) to the number of available subcarriers (M). Suppose 20 nodes are evenly distributed in an area of 150mx150m. The simulation uses experimental data measured by the Mica2 Berkeley sensor particles. The experiment setup is as follows**:**

1). The maximum distance between the neighboring of OneHOP is 50 m and is the transmission range of MICA2-Berkeley Moten.

2). Interference occurs only under the athopeneighborhood.

3). For each time slot, the probability of transmission is 0.2, which corresponds to the probability of reception mentioned above.

4). Each time slot Ts has duration of 1 millisecond.

5). The average number of 1-hop neighbors for each node is about 6 (using the approach of [12], 1 5.98 150 150 20 (50) $2 - = \times \pi$).

6). In addition, the mica2 mote is powered by two AA batteries, each with an output of approximately 1.5V, 25000mAh.
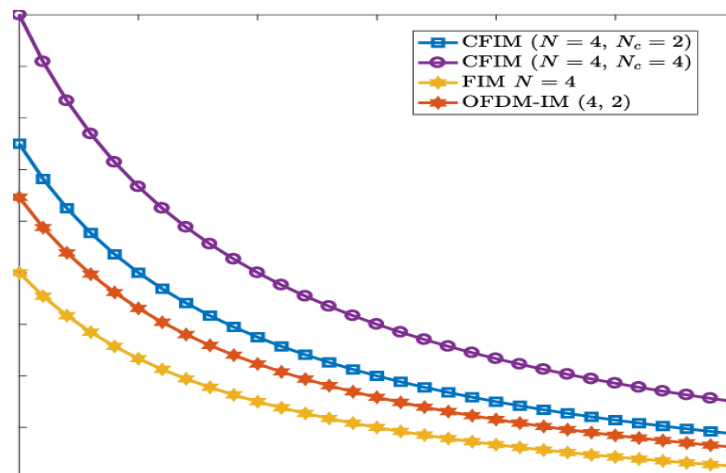

Figure2: Energy efficiency vs. number of available subcarriers

The energy efficiency and number of subcarriers available are: It is plotted in Figure shown above. Energy efficiency It will improve as the number of available subcarriers increases. In In other words, the solution to the optimization problem is working From Case C to Case A as the number of subcarriers available Will increase as more available subcarriers are available More achievable data rate.Both overall performance and two randomly selected performances The subcarriers are shown in above Figure to show convergence. Of distributed power control. That power is observed The control algorithm converges very quickly (in 4 steps).

8. CONCLUSION

In this study, distributed channels and power allocation Schemes have been proposed for individual users to maximize Energy efficiency of wireless cognitive wireless sensor networks. Distributed generation control algorithms have also been proposed Multiple new users to efficiently share the same subcarrier While maintaining the required data rate by managing Same channel interference. Providing proposed channel allocation and power control A fully distributed solution for optimization problems. Another motivated by the iterative water supply algorithm of You can get a distributed solution by solving a multi-user problem. Distributed channel and power allocation issues are repeated. However, each user can only detect interference from other users User after everyone has started data transfer. Can take a lot of time Procedure for the iterative algorithm to converge when it converges on Everything, and the delay can be too great. Moreover, the complexity of the additional calculations can be high. Therefore, in addition to the proposed distributed channel allocation Power control method is efficient and practical A solution for dynamic access to the spectrum of wireless cognitive Wireless sensor network with multi-carrier modulation. This task assumes that subcarrier detection will occur. It also includes, energy efficient designs are very important because nodes are working on batteries. Most previous tasks deal with routing issues to maximize network life by forming sensor node power consumption. This article explores the energy efficient design in wireless sensor networks from another point of view. First, a general design of cognitive radio and multicarrier modulation has been proposed to achieve both high bandwidth efficiency and power efficiency. Subcarrier detection mechanism is proposed and analyzed in detail. Second, after each user determines its optimal subcarrier, use adaptive modulation technology to minimize power consumption at each node by setting the constellation size B and maximizing the life do. Simulation results show the effectiveness of the proposed schema. Furthermore, the ratio between the erroneous alarm probability PF and the ratio between the number N of the network life up to the network life and the

available subcarrier M can be investigated by simulation. It should be noted that the proposed schema acts on the physical layer but can be combined with the power saving technology at other levels and the impact of detection errors. This is one of our future efforts.

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DOMESTIC TOURISTS' PARTICIPATION IN WATER-BASED ADVENTURE ACTIVITIES ON THE NORTH GOA BEACHES AND THEIR PERCEPTION TOWARDS AN 'ADVENTURE ACTIVITY' – AN EXPLORATORY STUDY

DR. RAJEEV H. NARVEKAR

ABSTRACT

Tourism in Goa is the backbone of its economy and its subset Adventure tourism is an ever-growing industry. As per the maiden Adventure tourism market study submitted to the Government of India (Neilsen,2016), Goa stands in 4th position with respect to revenue generation after, Uttarakhand, Himachal Pradesh, and J&K with a market size of IR 107.67 crore. Availability of water-based adventure activities for more than the last two decades, especially on the North Goa beaches has become one of the 'must do' activities for domestic tourists. However, not much research has been done regarding these activities. This study looks at the types of adventure activities which are undertaken by domestic tourists in the north Goa beaches. 'Adventure' is a subjective concept, wherein the people have their apprehensions defining it. An attempt is made to understand the tourist's perception of adventure activity. This study was undertaken during the last quarter of 2019-20. The data for this research was collected from the domestic tourists who filled the questionnaire on the North Goa beaches viz., Calangute, Baga, Anjuna, and Vagator. More than 400 domestic tourists participated in this survey. 'Risk' was not significant with respect to 'satisfaction 'but 'Recreation' and 'Excitement' was found to be significant. The tourists on vacation after participating in adventure activities perceive it as recreational tourism. This study also points towards further research, wherein 'Mindset' may play a decisive role in perception.

Keywords: Adventure tourism, perception, water-based adventure, domestic tourist, North Goa.

INTRODUCTION

One of the tiniest states of India, situated on the strategic western coast of the Indian peninsular has always been a center of attraction as a hub for maritime traders and travellers (Trichur,2013). More than 400 years of Portuguese rule, out of which approximately, first 100 years saw one of the most brutal *Inquisition* (Ginio, A. M.,1999) being leashed by the Roman Catholic church leading to a tremendous impact on the culture of locals which has differentiated it from the rest of India. This has been a major attraction for tourists across the world. By mid of 20th century, due to the increase in the visit of foreign dignitaries with their friends and relatives saw the need for luxury hotels in Goa.

Hotel Mandovi was the pioneer of the advent of tourism in Goa. After the Liberation of Goa (December 1961), a union territory along with Daman and Diu, the Department for Information, Publicity and Tourism was formed a year later in 1962.

This was followed by the setting up of Department tourism in 1982. The arrival of Hippies or the 'flower children' in the 1960s seeking peace and seclusion made Goa famous internationally (DeSouza,2009).

TOURISM IN GOA

The clean beaches and safe environment were the important attractions for the tourists. This was supplemented by the unique Hindu- Portuguese culture in India and friendly and hospitable locals. Although an airport was functional during the Portuguese rule since the 1920s, it was after liberation in 1966 one saw the start of the domestic airline, erstwhile Indian airline operate from and to Goa. Towards the end of 1985, charter plane 'condor' started from Germany which was followed by 'Inspirations east' and 'Air Europa' from the UK. Tatas made a foray into Goa by opening the first five start resorts in North Goa, named 'Fort Aguada.' Over the period, more High-end hotels were established especially in South Goa.

Sun, Sea, and Sand (3s) have been the cornerstones of beach tourism. In the mid-18th century, the coastal area was of therapeutic use with the combination of all three elements. As time progressed, the industrial revolutions, economic development supplemented by transport and communication have added up to the core offering of the coastal belt. As of now, the number of activities available is very diverse. Apart from the basic requirement of food, clothing, and shelter, body massage, tattoos, water sports, etc., have added to the pull dimension for the tourist.

As tourists flocked to Goa, entertainment apart from sightseeing was necessary. Water sports became the natural choice as the properties were near the beaches and tourists were attracted to the beaches of Goa. Boat rides,

water scooters sowed the seed for Adventure tourism in Goa, although Trekking was being done at Goa, where the local enthusiasts associated with the Youth Hostels Association of Goa and Goa Hiking Association were organizing treks in and around Goa (R. H. Narvekar, 2020). Tourists were spending time on the clean and serene beaches of Goa, and the availability of water sports has become a must-do activity over time. This was possible due to an important factor i.e., Time. An activity like trekking takes a minimum of a day to be spent in the wilderness. In the case of adventure sports which are water-based, the time required is relatively less. This will depend on the type of activity and the number of activities one wished to undertake.

North Goa beaches have been the one which has been commercially explored since tourism started in Goa. The four main beaches are Calangute, Baga, Anjuna and Vagator. Over the period more beaches have come into prominence, but this four were the pioneers of beach tourism in Goa.

Some of the activities which are readily available on these beaches are listed below:

Parasailing   **Jet skiing**

Banana ride   **Snorkelling**

Flyboarding   **Kayaking**

Bodyboarding   **Snorkelling**

Adventure boat trip

The following tables give the details about the tourist's inflow in Goa up to May 2018-19.

Table: I Tourists Arrivals (Domestic and Foreign)

Year	Domestic	Foreign	Total	Percentage Change
2012	2337499	450530	2788029	4.38
2013	2629151	492322	3121473	11.96
2014	3544634	513592	4058226	30.01
2015	4756422	541480	5297902	30.55
2016	5650061	680683	6330744	19.50
2017	6895234	890459	7785693	22.98
2018	7081559	933841	8015400	2.95
2019 (P) Up to May 2019	2272002	447152	2719154	0

Source: (goatourism.gov.in)

LITERATURE REVIEW

The word 'Adventure' comes from '*ad venio*' (Zwig, 1974) meaning 'whatever comes' signifying uncertainty. "Deliberate seeking of risk and uncertainty of outcome … only in outdoor adventure pursuits is there a deliberate inclusion of activities that may contain a threat to an individual's health or life" as further defined by (Ewert, 1989 cited in Walle, 1997). It is one of the fastest-growing subsets of Tourism worldwide. The demanding work-life balance followed by ever-growing aspirations is one of the major factors driving the masses to outdoor activities and to pursue some form of adventure. According to Pomfret, Swarbrooke, Leckie, and Beard (2003), '*Adventure is better defined by the approach of the participant or state of mind rather than defining according to activities*.' Adventure is not a passive activity and involves active participation. Mental preparation, planning, and commitment too are very important aspects of adventure, though it will depend on the type of activity. Risk has been considered an inherent part of the adventure. Environment, experience, and activity are important attractions of adventure travel (Sung, 2004: 345). Adventure has been defined as "deliberate seeking of risk and uncertainty of outcome … only in outdoor adventure pursuits is there a deliberate inclusion of activities that may contain a threat to an individual's health or life" (Ewert, 1989 cited in Walle, 1997).

Adventure tourism may be defined as "commercially operated activities involving a combination of adventure and excitement pursued in an outdoor environment [and may] incorporate a broad spectrum of activities ranging from high-risk adventure activities (e.g., white water rafting) to low-risk ones (e.g., tramping)" (Bentley, Page, & Laird, 2001). The reason for this pursuit of risk may be a combination of thrills, excitement, and fear (Holyfield, 1999; Palmer, 2002; Walle, 1997).

Different dimensions affect the adventure experience, like the type of risk, type of travel, and group types. Adventure activities have been classified by different authors and organizations like Adventure Trade and Travel Association (ATTA).

Weiler and Hall (1992, p. 91) have defined adventure tourism as being:

"A broad spectrum of outdoor tourist activities often commercialized and involving interaction with the natural environment away from the participant's home range and containing elements of risk; in which the outcome is influenced by the participant, setting, and careful management of the experience."

Although there is no definition given by the World Tourism Organization of Adventure tourism, it does endorse the one given by Adventure Travel Trade Association which is

"An individual is outside his or her regular environment on a trip exceeding 24 hours maximum which includes out of the following three at least two activities: a visit to a natural environment, participation in a physical activity and a culturally immersive experience."

Revised definition of adventure travel by Sung, Morrison, and O'Leary is as follows:

"A trip or travel with the specific purpose of activity participation to explore a new experience, often involving perceived risk or controlled danger associated with personal challenges, in a natural environment or exotic outdoor setting (Sung, Morrison and O'Leary, 1997)."

Colin Mortlock, an Adventurer himself, in his "The Adventure Alternative," explores wok on Adventure experience. He was the pioneer to look at Adventure activities across all ages and how they could benefit all. He has put forth four stages of Adventure experience (Mortlock, 1984, pp. 22–23):

First Stage - Play: During the activity, the participant generally feels safe where his capabilities are not fully utilized. Thus, concentration, mental control, skill, and emotions are not involved. The participant may experience a state of 'boring,' 'pleasant' 'fun' to 'waste of time.'

Second Stage – Adventure: At this point, experience and skill are of use to the participant which facilitates overcoming hurdles to have control. Depending on the place, whether or environment there could be a feeling of danger, fear, etc.

Third Stage - Frontier adventure: At this juncture, the participant is not having mastery over the situation and experiences psychological harm or fear of physical. Although the participants can feel the uncertainty glaring at them, still has the confidence to overcome it by effort and concentration. So, it could be experienced to cherish lifelong if successful.

Fourth Stage – Misadventure: In this scenario, participants' capabilities fall short, resulting in injuries that could be minor or serious or even lead to death. The outcome of such a situation can be negative, too, wherein the participant may never venture into such activities. Although there is a chance of the participant losing his confidence and deciding never to undertake such an adventure, it can also be a great learning experience

The general classification of adventure sports is Land-based, Water-based, and Air based. However, further classification is done on the level of risk that a participant is exposed viz., Hard and Soft adventure.

Soft Adventure	Suitable and involving family which is introduced to a unique and new activity. Activities like, horse riding, hot air ballooning or river rafting will be part of soft adventure activities (Hill et al., 1995).
Hard Adventure	These are the activities demanding a high level of risk and commitment. The participants have extensive own experience and deep interest (Hill et al.,1995).

A global report by World Tourism Organization on adventure tourism in 2014, had classified 03 activities as 'hard' out of the listed 34 activities. These were Rock climbing, Caving, and Trekking.

Various studies have been undertaken concerning adventure tourism. It has divulged the fluid nature of the concept of 'adventure' and more so with respect to the classification of the activities into 'hard' and 'soft'.

Studies included 'Playing with risk? participants' perception of risk and management implication' by Carl I. Carter (2006); The study showed that participants in commercial adventure activity look for 'fear' and 'thrill' rather than 'risk'. The tour operators who have reduced the risk and commodified the thrills are the ones who are most successful.

'Analysing an adventure: a leisure lifepsychle?' by Ralf C. Buckley (2018); This study looked throughout human lives the psychological changes in adventurousness. It involved the stage of life where it comes into our life, becomes important, and influences happiness and health.

'No risk, no fun: The role of perceived risk in adventure tourism' by Tracey Dickson and Sarah Dolnicar (2004); The general tendency of the people is to stay away from risk, however, a subsegment of tourism, works oppositely. Perceived risk is attraction rather than repulsion. A review paper looked at the initial phase of exploratory research to understand the concept of demand increasing perceived risk.

'Adventures in Paradox' by Dr. Pip Lynch and Dr. Kevin Moore (2004); The study was undertaken to explore the idea of adventure as a socio-historical construct. The purpose of the paper was to come out with a new framework to study the idea of adventure outdoor recreation and outdoor education.

'Measuring Expectations and Experiences of Tourists: A Study of Adventure Tourists in Himachal Pradesh' by S.P. Bansal, P. K. Gautam, and A. Singh Thakur (2013). The study was undertaken in the state of Himachal Pradesh to study the adventure tourist's satisfaction levels and availed services during the tour. The gap between the adventure tourists' expectations and experiences was assessed.

'Beyond "Because It's There" - Motivations for Pursuing Adventure Recreational Activities' by Alan Ewert (2013). This study was undertaken over six years comprising of the independent variables' activity type, gender, and experience level consisting of 801 participants. Out of the three factors viz., Sensation seeking, social, and self-image, the social factor was a successful predictor of group membership among the level of experience, activity type, and gender.

NEED FOR STUDY
The various studies carried out in Adventure tourism have looked from the perspective of tourists participating in sports like river rafting, bag packing, etc. "According to Mortlock 'adventure is a psychological palliative against the ravages of everyday life (see also Mortlock, 2001 and Bowles, 2002/3 for an overview of Mortlock's personal withdrawal into an 'inner journey' of adventure). Similarly, Ewert (1989) draws almost exclusively on psychological theories and models: examples are motivation theories, arousal theories, and attribution theories. In this literature, then, adventure exists as a 'natural phenomenon, a propensity in the human genome, conveniently accessible for application in a wide variety of enterprises throughout time and space." (Lynch P., Moore K., 2004).

The authors have further stated, "adventure activities are typified and exemplified by action in backcountry (wilderness, remote, 'natural environment') locations, geographically distant from everyday life and society."

Hence, we see that type of environment plays a major role in understanding the construct 'adventure'. This study will throw light on the perception of tourists participating in the water-based adventure activities mentioned above. More precisely the perception concerning 'adventure' or 'recreation' will be of paramount importance. As the domestic tourists in Goa are on vacation their perception of activities will be studied with respect to 'adventure.'

Thus, the perception of the tourists who have participated in such water-based activities and their satisfaction will be studied.

ADVENTURE – DIMENSIONS AND MEASUREMENT
The literature review as mentioned above divulged the attributes associated with the construct 'adventure'. The researcher's experience in adventure activity too helped in finalizing a total of 30 attributes for the questionnaire which are as follows.

Risk	Mental alertness	Entertainment	Remote area
Stress	Dangerous	Sightseeing	Impress friends
Thrill	Not common	Pleasure	Risky
Fear	Achievement	Self esteem	Nature
Uncertainty	Control	Fun	Hustle and bustle
New activity	Escape from routine	Passing time	Peace and quiet
Exciting	Different culture	Challenging	
Physical fitness	relaxation	satisfying	

Tourism satisfaction is an emotional state after an experience and is not attribute-based (Baker and Crompton 2000:788). The construct satisfaction consisted of 03 attributes 1) Satisfied with my decision 2) It was a wise choice 3) It was a good experience (Oliver, 1997).

RESEARCH DESIGN
The research was the outcome of the survey carried out in 2020, in January/ February. It was carried out on the four major beaches of North Goa.

1) Calangute, 2) Baga, 3) Anjuna and 4) Vagator.
The domestic tourists were given the questionnaire to be filled on the beach. The primary data capture included their demographics, their perception regarding the construct 'adventure', and their satisfaction level.

Questionnaires after testing were given to those participants who have participated in the water-based adventure activities, as specified on the questionnaire. Thus, the method of data collection was purposive sampling. Total, 09 activities were mentioned on the questionnaire which is as follows:

1. Banana ride

2. Jet Skiing

3. Parasailing

4. Scuba diving

5. Flyboarding

6. Adventure boat trip

7. Snorkeling

8. Bodyboarding

9. Kayaking

The participants of the survey were asked to tick mark the activities undertaken by the.

To study the construct 'adventure', a five-point Likert scale was used. There was a total of 30 attributes associated with the construct 'adventure' were identified from the literature and researchers' own experience. Exploratory factor analysis of these attributes yielded 05 factors.

Over 400 samples were collected and only those questionnaires wherein the participants have taken part in at least 03 of the total 09 activities mentioned on the questionnaire were considered for this study. The final count of the respondent after the cleaning of the data was 381.

The analysis was done by using structural equation modeling (IBM SPSS Amos 26, software). SEM enables us to construct and also test the measurement model which gives a comprehensive test of confirmatory construct validity i.e., convergent and discriminant validity (Anderson and Gerbing 1988).

DATA ANALYSIS

The KMO and Bartlett's Test yielded the following satisfying results for sampling adequacy.

A value above 0.6 is considered satisfactory and above 0.8 is considered good.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.897
Bartlett's Test of Sphericity	Approx. Chi-Square	4517.605
	df	435
	Sig.	.000

The Principal Axis factoring was carried out using varimax rotation which divulged five factors as seen below.

	Recreation	Risk	Exciting	Fulfillment	Serenity	
Act_16_Relaxation	0.572					
Act_17_Entertainenment	0.735					
Act_18_sightseeing	0.671					
Act_19_Pleasure	0.789					26.921
Act_20_Selfesteem	0.711					
Act_21_Fun	0.711					
Act_22_Passingtime	0.640					
Demand Phy risk_		0.691				
A_02_Stress		0.739				
A_04_Fear		0.650				
Act_05_Uncertainity		0.694				12.760
Act_10_Dangerous		0.589				
A_03_Thrill			0.626			
Act_06_New			0.561			
Act_07_Excitig			0.615			
Act_09_Mentalalert			0.506			5.153
Act_11_Notcommon				0.419		
Act_12_Acheivement				0.670		

|					0.797		4.337
Act_13_Control					0.797		4.337
Act_28_Nature						0.600	
Act_29_hustle						0.455	4.182
Act_30_peace						0.471	
						Total	53.352

He following research questions are to be considered during this research,

a) What is the perception of 'adventure' by the tourists participating in the water-based activities?

b) Which dimensions of the construct adventure will be significantly related to the satisfaction?

c) Does gender act as a moderator between the construct adventure and satisfaction.

The following hypothesis was framed after going through the literature review.

H1 – Recreation has a significant relationship with satisfaction in tourists participating in water-based activities.

H2 - Risk has a significant relationship with satisfaction in tourists participating in water-based activities.

H3 - Excitement has a significant relationship with satisfaction in tourists participating in water-based activities.

H4 – Fulfilment has a significant relationship with satisfaction in tourists participating in water-based activities.

H5 - Serenity has a significant relationship with satisfaction in tourists participating in water-based activities.

H6- Gender moderates the relationship between recreation and satisfaction.

H7 - Gender moderates the relationship between risk and satisfaction.

H8 - Gender moderates the relationship between excitement and satisfaction.

H9 - Gender moderates the relationship between fulfilment and satisfaction.

H10- Gender moderates the relationship between serenity and satisfaction.

Conceptual framework
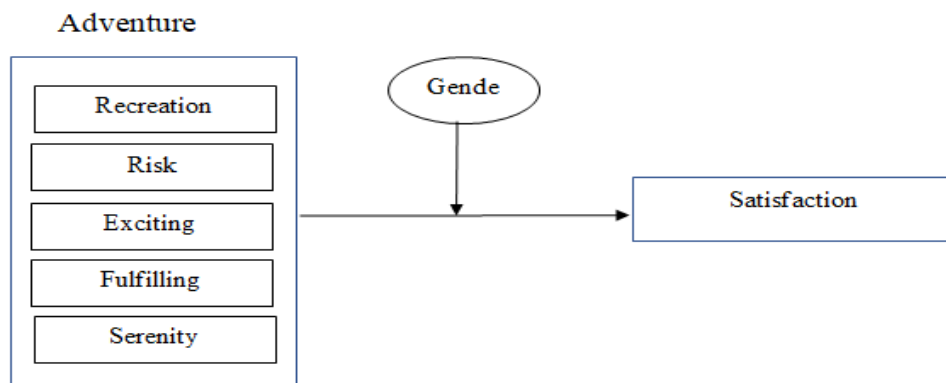
Demographic Profile of the Sample

Profile of the adventure tourist participants

		Frequency	**Percent (%)**
Gender	Male	222	58.3
	Female	158	41.5
Age	Under 20	16	4.2
	21 -30	224	58.8
	31 – 40	85	22.3
	41-50	31	8.1
	51-60	16	4.2
	Above 60	8	2.1
Marital status	Married	173	45.4
	Unmarried	208	54.6

	Family of 02	26	5
Family size	03-04	331	59
	05-08	188	33
	>08	18	3
State	Maharashtra	117	30.7
	Karnataka	67	17.6
	Kerela	42	11
	Delhi	35	9.2
	Up	15	3.9
	Others	105	28

The domestic tourists participating in water sports on the Goan beaches comprise 58.3 % males and 41.5% females. The majority of the age group is from 21 to 30 years i.e., 58.8 % followed by the age group between 31 to 40 at 22.3%. Married persons were at 45.4 % and unmarried stood at 54.6%. Family size of 3 to 4 members was comprised of 59%. AT 30.7% of tourists from Maharashtra were at highest followed by Karnataka17.6%, and Kerela at 11%. At 48%, Banana ride was the most sought-after activity followed by Jet skiing and parasailing at 43% and 35% respectively.

Measurement Model

To know whether the latent variable is measured by the specified items, CFA is used. It assesses the reliability, validity, and unidimensiolity of the latent variables (Zainuddin, 2012). Thus, the first step of structural modeling was the relationship between the observed variables and the latent construct. A total of 03 indicators were removed one each from 'Risk', 'Excitement' and 'Fulfilment'. Accordingly, the model fit statistics between the data and the study variables were examined. The scores yielded by the model fit were satisfactory except the p-value, (x^2= 557.92, *df* = 260, X^2/df = 2.030, RMSEA = 0.052, CFI = 0.920, TLI=0908, GFI = 0.903 and IFI=0.921). These values close to zero indicate a good model fit.
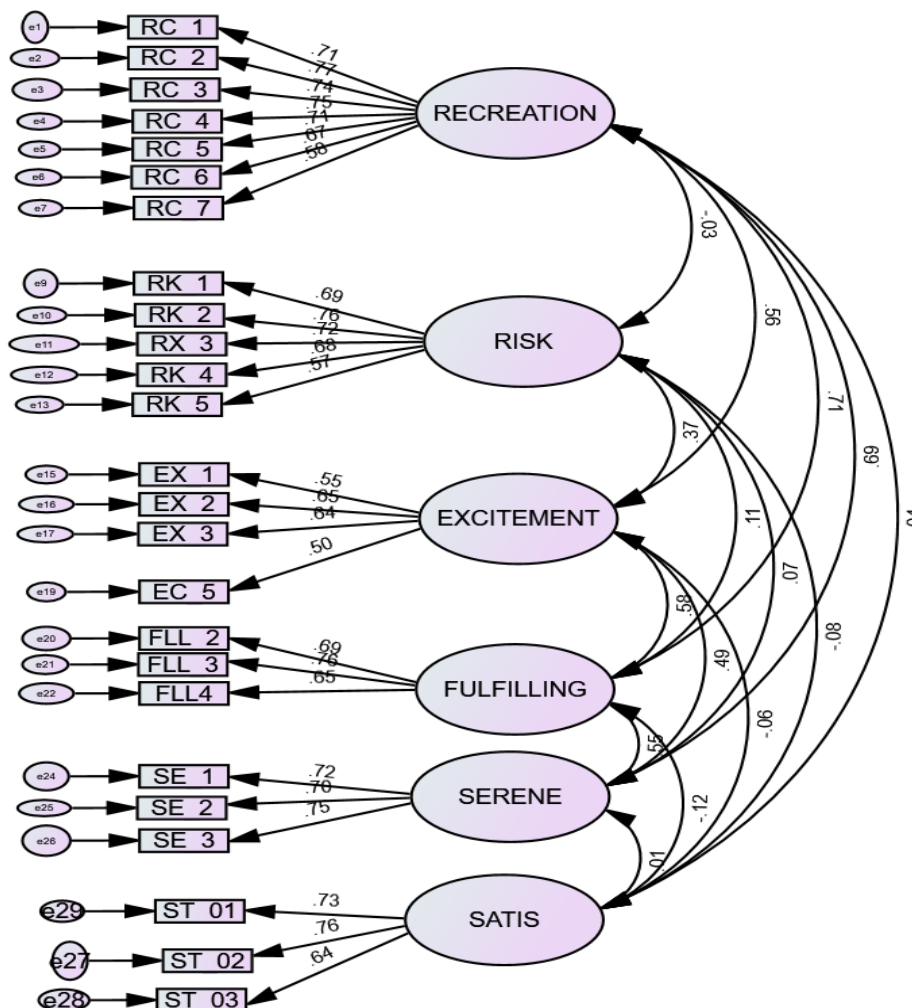
Reliability and Validity

The internal consistency of a measure is known as reliability. The scale item measures an aspect of the construct and should be reliable i.e., consistent with respect to construct indicator. As seen in the table below the average variance extracted is greater than 0.4 and with Composite reliability above 0.6 is acceptable (Hair J, Hult GTM, Ringle C, Sarstedt M 2014). Hence the data was considered reliable.

Reliability Test

Latent variables	AVE	Composite Reliability
Recreation	0.50013	0.707189
Risk	0.47313	0.687844
Exciting	0.406673	0.637708
Fulfill	0.455562	0.674996
Serene	0.506667	0.711805
Satisfaction	0.50889	0.710555

The discriminant was established by squaring the AVE (average variance extracted) and checking with the correlation of each pair, which should be less than AVE as seen in the table below. Hence, discriminant validity is established.

Discriminant Validity

Latent variable	Recreatio	Risk	Exciting	Fulfilling	Serene
Recreation	**0.707189**				
Risk	-0.031	**0.687844**			
Exciting	0.559	0.368	**0.637708**		
Fulfilling	0.616	0.125	0.542	**0.674996**	
Serene	0.691	0.069	0.490	0.506	**0.711805**

Structural Equation Modeling

Having successfully tested the model, the next step was to test the hypothesis for the latent constructs. Similar procedure was followed for the structural model and the fit indices of the model too are satisfactory (x^2 = 527.920, *df*= 260, x^2/df = 2.030, CFI =0.920, TLI = 0.908, IFI=0.921, RMSEA =0.025, GFI = 0.903 and PGFI =0.723).

The path analysis of satisfaction on its variables was as follows:

	Estimate	S.E.	C.R.	P
Satisfaction ←---------- Recreation	0.317	0.065	4.882	***
Satisfaction ←---------- Risk	-0.037	.042	-.882	.378
Satisfaction ←---------- Excitement	-.494	.088	-5.617	***
Satisfaction ←----------Fulfillment	.035	.051	.684	0.494
Satisfaction ←----------Serenity	-.044	0.070	-.636	.0525

As seen in the above table, Recreation and Excitement were significantly related to satisfaction and the highest impact is of Recreation with β= 0.317. Hence Hypothesis H1 and H3 are supported. Risk, Fulfilment, and Serenity were not significantly related to satisfaction, and hence we hypothesis H2, H4, and H5 are not supported.

The second step was to study whether gender acts as a moderator the relationship between the latent variables and satisfaction.

The critical ratios for differences in the parameters were calculated by using the same software which yielded the following results. The pairwise comparison is shown below.

Gender as a Moderator

Satisfaction ←---------- Recreation	-1.638
Satisfaction ←---------- Risk	1.557
Satisfaction ←---------- Excitement	-0.011
Satisfaction ←----------Fulfillment	-0.68
Satisfaction ←----------Serenity	-0.505

As we see from the results, the critical 't' value for all the latent variable comparisons is less than 1.94, the null hypothesis is accepted i.e., gender does not moderate the relationship between the five latent variables and satisfaction in this context. Hence, we fail to accept the hypothesis from H6 to H10.

DISCUSSION

The exploratory research was undertaken to understand the perception of tourists taking part in the water-based activities on the beaches. The construct understudy was 'adventure' which is very subjective. The factor analysis divulged five factors. Adventure as a construct is incomplete without 'Risk'. Thus, it is an inherent part of adventure tourism. It is this factor that pulls the participants towards adventure activities. As observed by Walle, "the absence of risk may decrease the satisfaction the participant receives from a would-be adventure" (Walle, 1997)

It is "deliberate seeking of risk and uncertainty of outcome … only in outdoor adventure pursuits is there a deliberate inclusion of activities that may contain a threat to an individual's health or life" (Ewert, 1989 cited in Walle, 1997).

'Entertainment', 'Fun' and 'self-esteem' were the dominating attributes from the first factor, Recreation. 'Demands physical risk', 'Stress', 'Fear' and 'uncertainty' had major attributes in 'Risk' factor which dominated. 'Thrill' and 'Exciting' dominated from the factor 'Excitement'. 'Control' and 'Achievement' dominated the factor 'Fulfilment'. The last factor 'Serenity' had the attribute 'bringing close to Nature' as dominant.

Thus, for any activity to be considered as an 'adventure' activity, 'risk' has to be an important component.

However, the results of this study have shown that 'Risk' is not a significant factor in participants' perception, and on the contrary, 'Recreation' is significant with the highest impact($\beta=0.317$). Similarly, excitement was found to be significant but the impact (β=-0.494) leading to a decrease in the satisfaction by the beta for every unit increase of the 'Excitement' variable. Hence, the perception of the participants in these activities is not of adventure. As such, the participants are tourists on vacation. The recreational variable was significant and had the highest impact on satisfaction. Thus, we can say that water sports activities which are offered on the beach though, having an element of Adventure, are perceived as 'recreational' and hence it's a case of 'Recreational' rather than 'Adventure tourism'. The word 'Recreational' is defined as 'Connected with activities that people do for enjoyment when they are not working (https://www.oxfordlearnersdictionaries.com). 'Recreation is also voluntarily undertaken, primarily for pleasure and satisfaction, during leisure time' (Swarbrooke et al., 2003).

The subjectiveness of the construct 'adventure' to a large extent can be realized when we refer to the reports like 'Adventure tourism market study -2013', 'Global report on adventure tourism-2014'. In the case of the former study, five activities have been categorized as 'hard' adventure activities and in the case of the latter, the activities have gone down to three. Similarly, different researchers have classified activities as soft and hard differently. Adventure is absorbing, engaging, involving commitment and effort; preparation at the physical and mental level or training is a requisite (Page et al., 2006; Patterson & Pan, 2007).

One of the important concepts which come out of this study is 'state of the mind' (a person's emotional state: mood; https://www.merriam-webster.com) which is of paramount importance for the perception of an activity to be adventurous or not. According to Pomfret, Swarbrooke, Leckie, and Beard (2003), '*Adventure is better defined by the approach of the participant or state of mind rather than defining according to activities*.'

As in this research, the domestic tourist on vacation have participated in an adventure activity, but perceive it as a recreational activity.

CONCLUSION AND FUTURE RESEARCH

This research attempted to find the perception of tourists taking part in adventure activities while on vacation and satisfaction. The result has shown that, although the participants are taking part in adventure activities, their perception is that of recreation and risk is not significant factor with respect to satisfaction. As mentioned earlier, the construct under study is subjective in nature. The concept of 'State of mind' can be researched to find out, the impact it has on one's perception. Whether a tourist knowing that he/she is taking part in an adventure activity will have any effect on the perception or not. What will be the perception of tourists who come specifically for adventure sports and take part in the same type of activities? In this case, will risk be significant with respect to satisfaction?

Further research is required to understand the perception of 'Risk' in this context and the mitigation strategies used by the supply side. Do these mitigation strategies are the crucial factors that cause the participants to underestimate or overlook the risk component?

A study undertaken of backpackers in New Zealand (Cave, Jenny & Ryan, Chris, 2007) showed little gender difference using *t-test* but there was variation between the two when factor analysis was undertaken. In this research gender as a moderator did not have any impact on satisfaction.

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ENHANCING SUPPLY CHAIN EFFICIENCIES THROUGH MRO INVENTORY MANAGEMENT AND SUPPLIER COLLABORATION IN INDIAN STEEL INDUSTRY

SUNEET MATHUR AND DR. PRASANTA KUMAR MOHANTY

ABSTRACT
Cost reduction strategies have been in forefront of many Indian Steel mills to remain competitive against the imported steel from other low cost producing nations. Various operational cost reduction methods have been adopted by steel manufacturing companies. This hypothetical research model focusses on adopting strategies on Maintenance, Repairs and Overhaul (MRO) type of inventories and the use of Vendor Managed Inventory (VMI) practice, while integrating digital information system to prevent down-time cost and, timely availability of spares, with assistance from quality vendors. This in turn would provide for timely availability of spares, and quicker turn around in the operations side.

Keywords: Supply Chain Management, Steel Industry Cost, MRO, Vendor Selection, Inventory Management, Cost Reductio

1. INTRODUCTION
Increasing profitability and productivity improvements have been an important priority with Indian steel mills. While steel companies work on their operating philosophies, efficiency in operating cost is crucial to their profitability. Supply chain practices can play a crucial role in delivering operational cost reductions in the given state of uncertainty. By their integrated nature, Steel mills carry a whole different type of inventory to cater to their production needs. These include raw material, MRO (Maintenance Repair and Operation), work in progress, finished goods and pipeline inventories. Synchronizing operations and maintenance become a challenge wherein timely availability of critical spares through vendors, and on-time availability reduces downtime.

In contrast, savings on inventory capital cost by supplier collaboration through vendor managed inventory (VMI) Kamalpur et al., (2013) spares demand planning is essential in inventory management. (Zu et al., 2019) have argued that inventory control is forward-looking while enhancing cost savings greater than 20 % in maintenance cost. The key to such planning is through proper information exchange between operating, equipment, maintenance, supply chain, and vendors. The challenges of MRO linked inventory management could be aided by Industry 4.0 technologies (Chen et al., 2019) like the internet of things (IoT) and big data analytics, to name a few. Studies on vendor selection techniques have proven to be a success in the supply side of inventory management as corroborated by researchers (Sumrit,2020) et al., The procurement policies of Indian steel mills vary in their strategy towards managing their supply chains, and managing their total cost of operations (TCO).

Hurkens et al. (2006) have mentioned the strategic applications of TCO in purchasing, leading to supply base rationalization and an increase in quality of purchases. Running a VMI program in the supply chain has also been advantageous in controlling the Bullwhip effects. (Disney and Towel, 2003)

1.1 Importance of Supply Chain for Steel Industry
By definition, a supply chain involves all business activities of research, development, manufacturing, materials management, packaging, logistics and marketing. While the demand for steel in the country is on the rise, the projected demand is expected to be up by 16.7 % (Indian Steel Association through Press Trust of India Dec, 28th 2021 release). Historical challenges are higher input cost and lack of visibility (Xiong & Helo, 2008) and the more recent ones of supply chain disruptions owing to the pandemic and humanitarian crisis. Amongst various benefits, effective supply chains benefits could be derived by maximizing the value of supplier relationships and minimizing input cost.

A steel mill typically procures inputs in the form of commodities (iron ore, coal, dolomite, limestones etc), it also retains high-value capital assets, which are mostly supplied by technology providers and original equipment manufacturers (OEMs)

While the Steel industry needs to balance its acts between its inventories and production, the nature of manufacturing in steel follows a split or V-shaped bill of material, where the raw material itself diversifies to various types of iron and steel products. Based on the market demands, all the mills and finishing lines need to

be operating continuously, and a machine failure and a subsequent downtime can severely impact the targeted production rate and profitability.

Steel Mills are a Business to Business(B2B) kind of commercial model principally operating with national and global contracts with vendors through a purchase procurement procedural plan. Price negotiations, inspections, delivery schedules with lead time, logistic cost, inventory and inventory carrying cost are important metrics of material management.

With the advent of globalization, the Indian Steel industry had to adopt to new procedures in its procurement and sourcing techniques; while the global economy had its ups and downs, the steel demands fluctuated in unison. According to research (Sahay et al.,2006), this was a time to look into how Indian industries, both MSMEs and large, once had to rejig their process and procedures. Most Indian industries, in general, had no written or documented policy on implementing supply chain concepts, and more so, the concept of implementing VMI in the first course. Vendor Managed Inventory (VMI) deals with continuous replenishment of buyer's inventory through a written down contract agreement between the buyer and the seller or trading partners (Angulo et al., 2004). The concept was actually initiated by a partnership between Wal-Mart and Proctor and Gamble (Waller et al.,1999). The success of VMI implementation (Malhotra et al., 2017) let other big corporates incorporate VMI in their supply chains. Glaxo-Smith Kline(Danese,2004), Electrolux India (DeToni and Zamolo(2005), Nestle and Tesco(Watson,2005), Boeing and Alcoa (Micheau,2005) to name a few. Therefore, a VMI shifts the customer's role of managing inventory to extending inventory and rental space to the supplier (Simchi-Levi et al.,2003, Mishra and Raghunathan,2004). As already researched, VMI offers a competitive advantage as it results in higher product availability and service levels, with low inventory monitoring from buyers ends along with low ordering cost (Waller et al.,1999; Achable et al.,2000). The advantages gained by suppliers are reduced bullwhip effect (Lee et al., 1997b; Disney and Towill,2003) with improved replenishment and improved synchronization (Waller et al.,1999, Chetinkaya and Lee,2000)

These benefits help all parties involved, a hallmark of healthy, lean manufacturing strategy.

- Provides consistent scheduling
- Shortens lead times
- Controls costs
- Optimizes equipment set-up
- Supports repeatable quality standards
- Streamlines process planning
- Contributes to company's lean initiatives
- Produces reliable forecasting, measurement, and reporting
- VMI insulates from Market Fluctuations

While most VMI programs have met with major success, research work was also carried out by (Aviv 2002, Ovalle and Marquez,2003; Angulo et al.,2004; Yao et al.,2007) on places where it met with failures. The research work on the reason for failures was extracted out of their reports and tabulated with two main findings:

(1) The sales and material stock data were inaccurately shared for lack of inadequate information technology

(2) The incorrect data on demand forecasting leading to back-end pressures.

VMI Challenges in the Indian Steel Industry
The steel producers are faced with a complexity of problems in steel manufacturing. Some of the key challenges have been to source cheaper raw materials, fluctuating market demands, and global price competition. Some of the major challenges to the growth of the steel industry has been identified by Xiong and Helo (2016)

(1) Increasing input cost of raw materials

(2) Lack of visibility across supply chains

(3) Market demand fluctuations

(4) Resistance to change in cost investments like information and communication technology (ICT) and other information enablers

Lack of clear SCM implementation policies, including cost control through SCM initiatives, vendor development, and technology upgrade of any additional expense to be incurred towards VMI implementation, in procurement procedural aspects are viewed as cost increase/drivers. A clear-cut policy prevents organizations from avoiding supply chain partnerships and adopting concepts like VMI.

REVIEW OF PREVIOUS STUDIES

The issue of IT incorporation, as identified by studies of Jharkaria and Shanker (2005), has not been an easy task owning to varied IT capabilities of business partners, cost of changes and concerns of standardization, threats of security encroachment and lack of technical understanding have been some major impediments towards the incorporation of IT in VMI adoption. Researchers like (Barratt 2004) have indicated the difficulty faced on account of collaboration, indicating too much focus on technology, failure of understanding what, when, and whom to collaborate, and the basic level of trust and dependency have been impediments to a fruitful implementation of VMI.

Researchers Smaros and Holmstrom (2000) have indicated the advantages of implementing Radio-frequency Identification (RFID) as a very successful technology for VMI business despite the higher cost. Similarly, DeToni and Zamalo (2005) have researched the benefits of VMI in Electrolux, Italy. Literature reviews have thus revealed the success of VMI implementation in various industries. The new Globalization for India has brought in new sets of challenges both for product and service delivery, and it is now furthermore critical to adopt new supply chain strategies, to remain globally competitive and efficient. Some of the major drivers to an efficient supply chain are instant customer feedback, industrial and investment trends, technology innovation, competition and shrinkage of product life-cycle.

The use of information sharing Dimentew et al. (2016) is yet another important input in integrating the supply chain in the Steel industry, which has enabled steel mills to synchronize the value chain deeper into operational coordination. Products like SAP and other IT enabled solution products have enhanced operational performance levels.

1.2 OBJECTIVES OF RESEARCH

The Research was Undertaken with the following Purpose:

1. To study the vendor and supply chain strategies of three top steel manufacturers in India.

2. To examine the Vendor Managed Inventory as the right fit for the steel industry in cost savings.

According to Hoffman & Belin (2011), freeing up working capital (WC) can benefit both buyers and sellers. With this very objective should the buyer design a plan to have its supply chain curved out with a focus on savings in working capital which is the current difference of current liabilities and current asset value in positive.

1.3 RESEARCH HYPOTHESIS. FIG- 1.0

The VMI in the supply chain plays a vital role in industry cost control, considering the importance and wide impacts of maintenance, repair, and operations (MRO) supplies (Chen et al., 2019). Inventory efficiencies can be leveraged using the strategies, thereby delivering cost savings. Factors finally considered are information quality, information sharing and communication system and supply chain performance through effective use of VMI.

1. **Hypothesis H01** is about Information Quality INFOQUAL having a positive impact on Information Sharing INFOSHARE.

2. **Hypothesis H02** is about Information Sharing INFOSHARE having a positive impact on Communication System COMMUSYS.

3. **Hypothesis H03** is about Communication System COMMUSYS positively impacting Supply Chain Performance SCPERF.

4. **Hypothesis H04** is about Supply Chain Performance SCPERF positively impacting Perceived Cost-Benefit COSTBENEFIT.
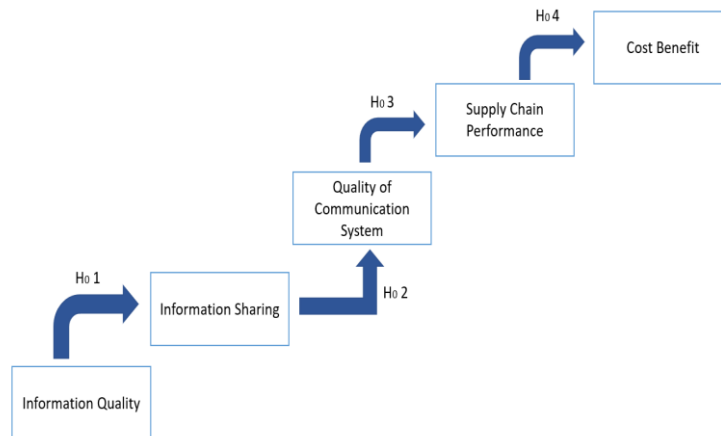
Fig-1.0

1.4 **Maintenance, Repair and Operations/Overhaul (MRO) Supplies in a Steel Mill**

The asset-intensive Steel industry depends heavily on electrical and mechanical types of equipment along with consumables in their production processes. The MRO are inventory items that support production operations but do not form a part of the final product. Limble CMMS, a US-based software company, finds approximately 50 % of prolonged unscheduled downtime occurring due to lack of spare parts or stock-outs in heavy asset and manufacturing industries. Research by Zhu et al. (2019) has found substantial cost reductions by having a maintenance plan for MRO components. Manufacturers carry huge inventories to save on downtime due to the very unpredictable nature of spares and irregular lead times. Chen et al. (2019) is optimistic about the role of emerging technologies Industry 4.0 comprising of Big Data Analytics, Machine Learning (ML) and Internet of Things (IoT) in enabling manufacturing industries to prognose about equipment failures and maintenance need versus MRO spare components planning.

With a focus on MRO inventories, the benefits gained using IT solutions are:

- Ensuring leaner inventories and carrying cost of components in stores.

- Improved forecasting of equipment spares on a timely basis with live updates about the different metrics like the cost of components and price trends utilizing sensors and IOT.

- Improved supplier and vendor selections by way of data knowledge and information of MRO inventory-related focus yielding more informed decision making while planning for appropriate vendor and vendor relationships based on a collaborative approach.

The average spending on MRO inventory by industries averages around 5 % of their overall supply chain cost (Limble CMMS blog reference to Peerless Research Group)

1.5 Risk Mitigation in Vendor Managed Inventory (VMI):

In today's business context, a company's success relies heavily on its suppliers and their relationships. Companies need to manage this relationship with their suppliers or vendors, measure them and deepen their relationships. The relationship could be more distinct with the term collaboration. According to Schroder and Powell in an article in Ivy Business Journal, July/Aug (2012) mentioned, supplier proliferation occurs when most companies chase their goal of incremental sales and cost improvements but do incur certain costs.

It is important for Steel companies to manage their vendors such that the services rendered and products offered by them are in line with the service and product requirements of the manufacturer. Steel as an industry needs to think beyond product cost while creating more efficiency by effectively managing their vendors or business partners in their value chain. This calls for segmenting suppliers (product and services) Adopting the strategy of supplier segmentation (A.T. Kearney Analysis)

What is essential in today's scenario are the business objectives of the corporate level percolating down to individual functional units. In other words, business objectives have to be commonly understood at the manufacturing and procurement levels of the organization. This, in turn, should reflect in vendor selection based on segmentation criteria based on the vendor's capabilities with respect to the companies' objectives and requirements.

Vendor Engagement in the steel industry directly challenges the requirement of material on one side and the demand for high quality, low inventory and lower cost of production (Stevens,1999). While research has revealed many different techniques on vendor selection, major consolidation has taken place by steel companies (Park et al., 2012). The business environment is country-specific and therefore calls for specific evaluation criteria based on the product needs. According to Kar (2015), "Reinvestigating vendor selection criteria in iron and steel industry," an attempt has been made to identify and estimate important criteria by Delphi study of domain experts along with AHP techniques has been undertaken to accommodate the diverse requirements of purchase while achieving a "consensus."

However, while vendor selection is important, the steel mill complexity and asset diversity call for a large inventory base. Traditionally, Indian steel mill vendors do not have access to production and market demand forecasts. Steel companies have multiple suppliers conducting business with. However, the value of the business can be obtained only when the business needs best meet with the best fitting supplier's capabilities. The management of assets can be best done with people, groups or companies that clearly specialize in their products and services for specific asset management.

1.6 **Vendor Risk Mitigation**
The last decade has been an eventful kind as many companies had to face supply chain disruptions, leading to various production and profit loss. In the centre of things was the inability of companies to have a robust supply chain, especially addressing vendor risk management. The reasons identified by McKinsey & Company report (2019) are:

- Lack of transparency in the supply base.
- The intimidating scope and scale of risk.
- Proprietary data restrictions with Tier 1 and Tier 2 suppliers supply chains.

Suppliers' risk management is critical to Vendor Managed Inventory and therefore calls for a structured way to address known risk while improving the organization's strength for inevitable unknown risk to avoid a future problem. The seven most important supply chain risks identified are:

- Inaccurate internal need analysis.
- Poor Vendor Selection
- Disorganized Vendor Management
- Non-compliance and crude contract management
- Error-prone manual processing
- Delays in procurement
- Human talent shortcomings.

Known Risk
These are the risks that are identifiable and can be measured. Suppliers' credentials such as their financial strength, ability to deliver, internet cyber security risk can be extremely damaging to the organization. It is integral for organizations to form risk management teams while creating frameworks that can define risk metrics while rigorously tracking and monitoring the risk metrics.

Managing Known Risk Would Involve
1. Identifying and documenting risk
2. Build a supply chain risk management framework
3. Monitor risk
4. Periodically review supply chain risk

Unknown Risk
These are risk which is difficult to foresee and predict and quantify. According to the McKinsey research team, unknown risk mitigation can be achieved through creating strong defences and building a risk-aware culture.

Building defences involves incorporating risk covered terms and conditions to workers' training for exigency and risk awareness culture while, building a strong response to unknown risk upsurge. Abrupt risk should be immediately highlighted and brought to the notice of the management team and workers. Thus, acknowledging a given risk event should be discussed and resolved with the collective thought process.

There needs to be transparency in recognizing and mitigating a risk occurrence at any given process level. Employee empowerment toward risk mitigation should be present. Thus, risk mitigation can be done by robust plans and procedures with employee empowerment towards mitigation.

1.6 Vendor Selection in Supply Chain Process of a Steel Plant

In the modern era, global steel companies are faced with this unique threat of producing high-quality steel at a low cost. Every part of the value addition calls for production planning, procurement, stores and logistics management for delivering high-quality products for enhanced customer satisfaction. Newer norms, including technology upgrades, increasing customer demands, disruptive supply chains, global warming and sustainability, have pushed the manufacturers into rethinking their supply chains (Imeri et al.,2015). To maintain higher qualities with a low cost of production, companies prefer selecting their suppliers to reduce their purchase costs (Mukherjee and Kar,2013). Based on the research (Weber, Current, Benton,1991), the raw material and component costs carry around 70% of the manufacturing cost. While suppliers have been acknowledged as the best intangible asset of any business organization (Chris I.Bell, Haynes,2010) Selection of suppliers is a strategic decision. Lee et al. (2001) and Kumara et al. (2003) have emphasized that vendor selection is critical for supply chain effectiveness and efficiency. This, in turn, would impact lowering cost improving quality and flexibility. An attempt has been made to identify and estimate the relative importance of critical vendor selection criteria for the steel industry. Though a huge variety of literature is available for highlighting vendor selection (Ho et al., 2010) along with evaluation (Weber et al., 1991), Most of the commonly used criteria on vendor selection deals with attributes according to the literature available (Kar. A,.2015).Table-1

Table 1: Vendor Selection Criteria's

Product Quality	Delivery Reliability	Guarantees and Warranties
Exporting Status	Packaging Capability	Intellectual Property rights
Product Pricing	Product capability	Technical Capability
Management Capability	Vendor Reputation	Financial Position
Labour Relations	Service Quality Experience	Past Business Records
Reciprocal arrangements	Cultural fitment	Communication Barriers
Inventory Positions	Electronic Data Exchange	Value-added Productivity
Geographical Distance	Foreign Exchange Rates	Trade Tariffs
Acceptable Parts Per Million	Service design	Order Acknowledgement
Trade Restriction	Buyers Commitments	E-Transaction Capabilities
Documentation	Design Capabilities	Supply Variety
Rejection Rate During Inspection	Rupee Value of Performance	Purchase Order Stability
Lead Time	Indirect Costs	Response Flexibility
Innovation	Facility Planning	Safety Adherence
Domain Experience	Exporting Status	Conflict Resolution Systems
Customs Duties	Product Line Diversity	Intimacy of Relationships
Quality Management	IT Standards	Cost Reduction Capabilities
Electrical Capacity	Judgement	Response Time
Total Cost of Acquisition	Risk Perception	Certification and standards
Research and Development	Organisational Culture	Availability of Parts
Sub-Component Pricing	Regulatory Compliance	Self-Audits
Rejection from Customers	Educational Level of Personnel	Receiving Inspection
Billing Accuracy	Cost Reduction Performance	Indirect Cost
Data Administration	Improvement Commitment	Procedural Compliance
Service Quality Credence	Vendors Commitments	Skill Levels of Staff

While vendor selection is important, the steel mill complexity and asset diversity call for a large inventory base. Traditionally, Indian steel mill vendors do not have access to production and market demand forecasts. Steel companies have multiple suppliers conducting business with. However, the value of the business can be obtained only when the business needs best meet with the best fitting supplier's capabilities. The management of assets can be best done with people, groups or companies that clearly specialize in their products and services for specific asset management.

1.7 **RESEARCH METHODOLOGY**
In order to evaluate the efficacy of VMI in the steel industry, a survey form was designed to extract the enablers by way of literature reviews, supply chain blogs, industry consultants' views and research papers. About 32 enablers of various functions related to VMI have been inducted into the questionnaire. The front end of the questionnaire has questions beginning from the name of the executive, information on the organization, e-mail ids. The questionnaire has a 5-point evaluation scale ranging from (1) very negative and (5) very positive. The survey was disbursed through e-mails and WhatsApp to about 270 known industry people of major steel plants across India between November 2020 and February 2021 while assuring the secrecy of their identity and confidentiality of the organization, as there was a high-pressure element of sensitivity in industry data. By and large Indian industry discourage their employees from sharing industry information by way of confidentiality as observed by self and also, researchers like Nagabhushana and Shah (1990)

1.8 **FACTOR ANALYSIS**
Factor analysis was used to remove the redundant (highly correlated) variables from the survey data and reduce the number of variables into a definite number of dimensions. The application was made using SPSS 19.0. The factor analysis is performed using the principal component extraction method with varimax rotation. In the application, the number of variables is reduced from 32 to 17 based on their factor-loading score. The sorted rotated values of factor loading with a minimum value of 0.7 or more are considered.

1.8 **HYPOTHETICAL SEM FRAMEWORK**
The VMI in the supply chain plays a vital role in industry cost control, considering the importance and wide impacts of maintenance, repair, and operations (MRO) supplies (Chen et al., 2019). Inventory efficiencies can be leveraged using the strategies, thereby delivering cost savings. Factors finally considered are information quality, information sharing, communication system and supply chain performance through effective use of VMI. The hypothesis considered are as below-mentioned through structural equation model (SEM) Fig-1.2

1.9 **TEST METHOD**
The inner and outer models are created by dragging them one by one from the indicators tab of the smart PLS-SEM software. The measurement scale is of "reflective" kind where the arrows point outward from the latent variables on account of high correlation and interchangeability. The default arrow scheme in the smart PLS-SEM is of a reflective kind instead of a "formative" one
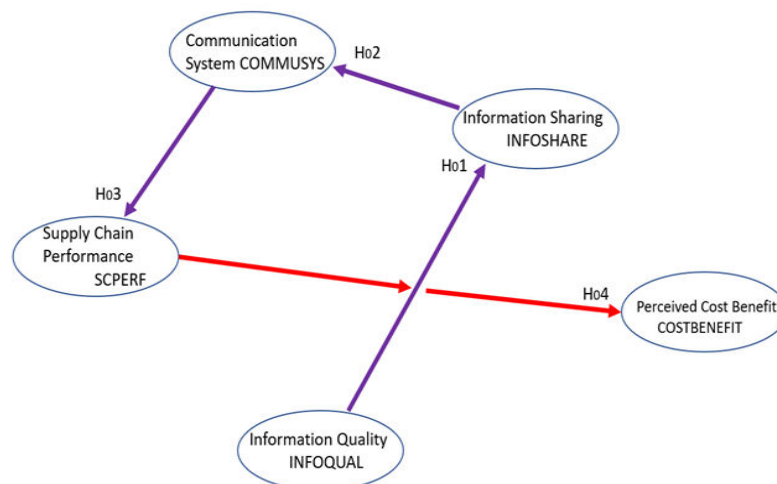
Fig: 1.2

The observed variables are the measurable indicators for a corresponding latent variable. Table: 2

Table.2: Indicator variables

Variables(V)	Description	Latent Variable	Supporting Literature
21	The implementation of VMI is indeed an excellent idea	SCPERF	Kauremaa,Smaros and Holmstrom(2009)
22	VMI has more advantages than disadvantages	SCPERF	Despal, Gupta and Tewari (2012)
27	VMI helps to improve customer responsiveness	SCPERF	Wenbo(2013)
28	VMI helps to improve flexibility in the supply chain	SCPERF	Xiong & Helo(2008)

29	VMI helps to improve customer service levels	SCPERF	Oliveira (2017)
31	VMI can help to reduce the bullwhip effect in the supply chain	SCPERF	Disney & Towill(2003) , Almeida et al.,(2015)
8	Accurate information is provided by the organization	INFOQUAL	Cachon & Fisher (1997)
9	Complete information is provided by the organization	INFOQUAL	Dutta and Roy (2003)
10	Adequate information is provided by the organization	INFOQUAL	Li & Lin (2006)
11	Reliable information is provided by the organization	INFOQUAL	Spiliotopoulou,Donahue & Gurbuz(2016)
1	The communication system used by the organization for VMI is compatible with existing IT systems.	COMMUSYS	Wenbo(2013)
3	Organization related information can readily be entered into the supplier's systems.	COMMUSYS	Wang,Lin & Lin(2006)
12	The information on-demand changes are shared with the supplier	INFOSHARE	Lofti,Mukhtar,Sahran & Zadeh(2013)
13	The organization and supplier exchange information on a frequent basis to enable both to perform better	INFOSHARE	Kamalapur, Lyth & Houshyar(2013)
24	VMI can help to reduce the transportation costs	COSTBENFIT	Soltany,Sayadi,Monjezi and Hayati(2013)
25	VMI can help to reduce administration costs	COSTBENFIT	Pettersson and Segerstedt (2012)
26	VMI can help to reduce materials handling costs	COSTBENFIT	Viera et al. (2011)

The path modelling preliminary observations are.

R- Square

Table 3:

	R Square	R Square Adjusted
Comm_SYS	0.376	0.350
Cost_BENFT	0.472	0.450
Info_SHR	0.327	0.299
SC_PERF	0.331	0.303

Endogenous Variable Variance:

- The coefficient of determination R^2 for the endogenous target variable is 0.472 for the Cost_BENFT latent variable. This indicates that SC_PERF contributes to 47.2% of the variance in Cost_BENFT

- R^2Info_Qual contributes value 32.7% of the variance to Info_SHR

- Info_SHR

- R^2contributes value 37.6% of the variance towards Comm_SYS

- R^2Comm_SYS contribute a value of 33.1% of the variance towards SC_PERF.

Inner Model Path Coefficient Sizes and Significance: Table 4

- The inner model suggests that SC_PERF has the strongest effect on Cost_BENFT(0.687)

- This is followed by Comm_SYS(0.575), Info_SHR(0.613) and Info_Qual(0.572)

- All the hypothesized path relationships between Info_Qual to Cost_BENFT are statistically significant while following a path supporting a prediction towards the hypothesis modelling.

Path Coefficient

Table 4:

	Comm_SYS	Cost_BENFT	Info_Qual	Info_SHR	SC_PERF
Comm_SYS					0.575

Cost_BENFT					
Info_Qual				0.572	
Info_SHR	0.613				
SC_PERF		0.687			

Outer Model Loadings: Table 5

A stable estimation is targeted by using the algorithm to converge before reaching the set final iteration value of 300. The algorithm converged after just six iterations confirming a good estimation.

Table 5:

	V1	V10	V11	V12	V13	V21	V22	V24	V25	V26	V27	V28	V29	V3	V31	V8	V9
Iteration 0	0.529	0.268	0.268	0.534	0.534	0.185	0.185	0.352	0.352	0.352	0.185	0.185	0.185	0.529	0.185	0.268	0.268
Iteration 1	0.526	0.273	0.211	0.523	0.545	0.203	0.172	0.404	0.337	0.317	0.189	0.155	0.175	0.533	0.217	0.314	0.273
Iteration 2	0.525	0.272	0.211	0.524	0.545	0.203	0.172	0.405	0.335	0.318	0.190	0.155	0.174	0.534	0.217	0.314	0.274
Iteration 3	0.525	0.272	0.211	0.524	0.545	0.203	0.172	0.405	0.335	0.318	0.190	0.155	0.174	0.534	0.217	0.314	0.274
Iteration 4	0.525	0.272	0.211	0.524	0.545	0.203	0.172	0.405	0.335	0.318	0.190	0.155	0.174	0.534	0.217	0.314	0.274
Iteration 5	0.525	0.272	0.211	0.524	0.545	0.203	0.172	0.405	0.335	0.318	0.190	0.155	0.174	0.534	0.217	0.314	0.274
Iteration 6	0.525	0.272	0.211	0.524	0.545	0.203	0.172	0.405	0.335	0.318	0.190	0.155	0.174	0.534	0.217	0.314	0.274

Result Summary for Reflective Outer Models: Table 6

Table 6: Outer Loadings:

VARIABLES	Comm_SYS	Cost_BENFT	Info_Qual	Info_SHR	SC_PERF
V1	0.944				
V10			0.932		
V11			0.932		
V12				0.933	
V13				0.938	
V21					0.937
V22					0.919
V24		0.951			
V25		0.930			
V26		0.955			
V27					0.917
V28					0.885
V29					0.868
V3	0.946				
V31					0.873
V8			0.937		
V9			0.934		

Construct Reliability and Validity: Table 7

Table 7:

Factors	Cronbach's Alpha	Rho_A	Composite Reliability	Average Variance Extracted (Ave)
Comm_SYS	0.879	0.880	0.943	0.892
Cost_BENFT	0.941	0.957	0.962	0.894
Info_Qual	0.951	0.966	0.965	0.872
Info_SHR	0.858	0.859	0.934	0.876
SC_PERF	0.953	0.960	0.962	0.810

Discriminant Validity Table:

Table 8: Furnell-Larker Criterion

	Comm_SYS	Cost_BENFT	Info_Qual	Info_SHR	SC_PERF
Comm_SYS	0.945				
Cost_BENFT	0.585	0.946			
Info_Qual	0.600	0.598	0.934		
Info_SHR	0.613	0.419	0.572	0.936	
SC_PERF	0.575	0.687	0.541	0.450	0.900

2.0 DISCUSSION AND OUTCOMES

Reliability is about the consistency of a measure, while validity is about the accuracy of a measure. Observing the Indicator Reliability above reveals that all factors satisfy Cronbach's Alpha value (Cronbach's alpha is a measure of internal consistency indicating how closely related a set of items are as a group, a value greater than 0.7 is considered acceptable). The Composite Reliability, another method measuring the internal consistency with a recommended reliability of a construct greater than 0.60 (Bagozzi and Yi, 1988: Hair et al., 2012), confirms the high level of internal consistency and reliability amongst all the five reflective latent variables. The rho_A function calculates the rho_A reliability indices for each construct. A rho_A value between Cronbach's alpha and composite reliability is a good indication of reliability.

The extent to which responses on a test exhibit a strong relationship with responses on the concept or the convergent validity, each of the latent variable's Average Variance Extracted (AVE) value indicates a value greater than the minimum threshold of 0.5, thus confirming the convergent validity.

On the contrary, the degree to which a test diverges from (or does not correlate with) other measures or latent variables in a conceptual construct is measured by a term called discriminant validity. As suggested by Fornell and Larker (1981), the square root of AVE of each of the latent variables can be used to establish discriminant validity if this value is larger than other correlation values among the latent variables as depicted in Table-8. The tables are created using the AVE values of the Construct Validity table above in a diagonal table. This establishes the discriminant validity of each of the latent variables with the highest value of each of the latent values placed in the column and compared with other lower values of the other latent variables. i.e., Info_Qual value of 0.934 is higher than Info_SHR and SC_PERF (0.572 & 0.541), indicating that the discriminant validity is well established. Fig- 1.3

Fig.13:
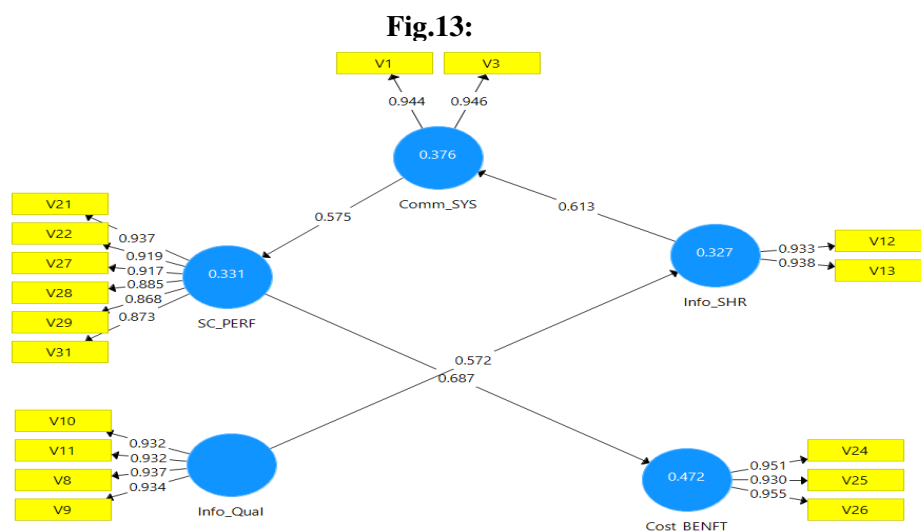
2.1 CONCLUSION

Considering various challenges faced by the Steel industry, i.e., unpredictable break down frequencies, the delivery performance of vendors and suppliers, incompatibility with IT systems does lead to a manufacturing performance concurring to financial losses in terms of down-time cost, replacement costs and high inventory cost, all leading up to the erosion of monetary gains. The lost opportunities could have repercussions on customer satisfaction and supply obligations, financial losses, higher quality costs with increased Days of Sale (DOS) which is the inverse of inventory turnover. Supplier or vendor collaboration does help the manufacturing organizations to take advantage of the vendor's expertise of their respective domain, creating a win-win kind of business situation where the total cost of operations become more transparent.

2.2 RECOMMENDATION FOR FUTURE RESEARCH

While the research indicates the benefits that an Indian Steel industry could gain by having a well-established network of IT-based maintenance and inventory communication systems, vendor selection and consolidation; it is equally important to have systems and practices for strategic updates on customer demands, economic environment, national and international trade practices and policies governing raw material and availability of MRO kind of inventories. Future research studies could indicate these impacts and the policy direction towards more robust supply chain practices. It would also be valuable to research techniques towards evaluating customer demands of the steel market while integrating it through operation material and maintenance planning. Operational and vendor cost benefits could also be researched further.

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OPTIMIZATION OF BUS BODY TO REDUCE AERODYNAMIC DRAG USING CFD ANALYSIS

ATUL PATEL AND RAM BANSAL

ABSTRACT

Buses are the major transportation mode among the common mass all over the world. In today's times hike in price of fuel is carefully observed and regarding to current strict government norms and regulation, buses are on down track of efficiency and fuel economy. Aerodynamically redesigned bus body and fuel efficient bus body may improve its fuel economy. To gain better economy and better performance, it is required to redesign a bus with least drag resistance.

Fuel consumption is significantly affected by the Forces like drag & lift, weight, side forces and thrust acts on a vehicle when moving on road. Reduction of drag forces improves the fuel utilization. This research aims to lower the coefficient of drag which upgraded the fuel economy and further saves our environment as well.

The CAD design of Bus will be done on Creo 4.0 and the same will be used for analysis in ANSYS-FLUENT. The analysis will do for finding out drag coefficient at different boundary conditions. This study insists an efficient numerical model based on the computational fluid dynamics approach.

Keywords: Aerodynamic, Drag, Ansys-fluent, Creo, lift.

1. INTRODUCTION

Buses are the major mode of mass transportation all over the world, despite of the rail network. Buses have low efficiency and consume more fuel for a mile, thus to decrease the consumption of fuel for buses, improvement in the aerodynamics behavior of bus shapes will add some values. It becomes necessary to design a vehicle (bus) for better aerodynamics shape, as it is relating to the fuel consumption and running cost, which further this is the main parameter for ours to purchase the vehicle. More closely the reduction of coefficient of drag becomes the major challenge of the automotive industries. For same power output, decreased in overall resistance to motion, vehicle provides higher speed or use lower power for same speed [5].

Improved aerodynamics behavior forms a body shape that increases the downward force (the negative lift) and reduces the force (the drag forces) that resists the forward motion. To rise the fuel efficiency, the bus body design should be aerodynamically efficient (less drag force). In a moving vehicle, the engine power is utilizing to overcome resistance, which is the sum of gradient resistance, rolling resistance and aerodynamic resistance. At lower speed, rolling resistance leads the aerodynamic resistance. While at higher speed, drag force (Aerodynamic resistance) is more than 3/4th of total resistance, because the drag force is directly proportional to square of speed. Hence the maximum engine power is wasted to overcome the drag force (aerodynamic resistance) and the engine load largely increases which further increases the rate of fuel consumption.

1.1 Importance of Buses in Mass Transportation

By moving people more economically and efficiently, public transport produces considerably less air pollution per passenger kilometer than a car with a single user. Buses emit 10% less nitrogen oxides and 20% less Carbon mono oxide per passenger kilometer than a vehicle (car/ bikes) with a single user as well as it provides more fuel economy per passenger kilometer, which put up an overall drop in the amount of energy required for the transportation. Bus transportation can carry many people in very least space than individual cars and bike, which in turn decreases air pollution from idling vehicle and helps passenger and rider to avoid the stress that comes from daily riding/driving in traffic congested areas [11].

1.2 Aerodynamic Drag

Aerodynamic drag force is a force that opposes the motion of an object inside any fluid, here air. The aerodynamic drag of any shape is graded by a number (dimensionless) is called as the drag coefficient or the coefficient of drag (Cd).

Drag force against the moving object is given by,

Drag Force (D) = $C_d \frac{\rho A V^2}{2}$ _____ (1)

Where,

A = Frontal Projected Area

V =Vehicle velocity with respect to Fluid velocity

ρ = Fluid Density

From the equation no (1) it is clearly shown that, aerodynamic drag force depends on the drag co-efficient (Cd) and frontal projected area (A) of a vehicle. Reduction in the values of projected area and drag coefficient will directly decrease drag force exerted on the vehicle.

2. AERODYNAMIC BEHAVIOR OF BUSES
Bus is a commercial passenger vehicle which is generally in cubical shape. Shape like cubical have experience more resistance to move forward on the road. The drag force depends on the relative velocity of the air. So at low speed we can neglect the effect of drag over other resistance but as the velocity increases, the effect of drag is considerable.

2.1 Resistance on bus body while Running on the Road
Generally, there are three major resistances that opposes the vehicle motion. So the vehicle has to do some extra work to overcome this force and accelerate it.

These Are-
Rolling Resistance: Produces from the road surface and tire interface

Grade Resistance: Produces due to the slope of the road

Aerodynamic Resistance: Produces due to resistance offered by the Air Flow against vehicle motion.

2.2 Effects of Resistance Forces on the Economy and Performance
These resistances forces reduce the economy of vehicle because automobile engine has to do more extra work to overcome these forces and hence more fuel is used for per kilometer run and economy becomes degraded. Similarly, performance of engine also degraded when these forces encountered the vehicle motion, so either to maintain same performance more power is needed or for same power it will provide less performance.

2.3 Aerodynamic Forces and its Types
Aerodynamic force is that force which is caused by motion of the vehicle. As the vehicle moves the aerodynamic force opposes the vehicle. And its magnitude is proportional to square of the velocity. So at low speed it is less significant but it is significant at higher speed (above 35km/h).

We can categories the aerodynamic drag into these types-

2.3.1. Profile Drag/ Form Drag: It is due to its shape, splines and curve of the body

2.3.2. Induced Drag/Lift Drag: It is due to the difference of pressure of above and under body.

2.3.3. Skin Friction Drag: It generates because of the roughness and smoothness of the body material. More rough body produce high skin friction drag and vice versa.

2.3.4. Interference Drag: The fittings attached to the body (antenna, side mirror etc.) creates extra force comes under the interference drag.

2.3.5. Cooling and Ventilation Drag: The air passes through the engine and AC system radiator also create a drag force is called cooling and ventilation drag.

The profile of the vehicle is the principle component of the aerodynamic drag and it contributes 60 % of the total drag force. So my area of interest is to reduce the profile drag by making some modification in the body.

3. COMPLEX AIR FLOW OVER BUS BODY

3.1 Study of Flow over any Solid Body
Ideally the surface of an object is streamlined for an ideal fluid flow having no boundary layers. Bernoulli's equation can be used to for a streamlined flow to determine pressure distribution for known velocity distribution. If boundary layers are present, things are more complex, since the external flow responds to the edge of the boundary layer and the pressure on the surface is imposed from the edge of the boundary layer. If the boundary layer separates from the surface, it gets even more complex. So to determine the velocity distribution and pressure distribution in such real cases here we are using Computer aided Engineering.

3.2 Complex Flow over bus Body

Please refer figure 1. **Region A:** Below figure shows the flow of air over the bus. In the beginning of flow, at front and middle most portion (Mention as A), the velocity is nearly zero and the pressure is very high hence this part provides more drag.

Region B: At top of the bus the velocity of the layer just near the surface of body is stick with surface. Similarly, adjacent layer slips one another and the velocity is gradually increases as we go perpendicular away from top and became equal to the free stream velocity and this region is called boundary layer. This boundary layer when separate from any surface creates eddy, which are also a cause of drag.

Region C: The region C is backside of bus bounded by the layers from top, bottom, right side, and left side, meets and merge according to their behavior. This region is a low pressure region and pulls the bus body to rearward and hence it also contributes in drag. Large volume of this region, produce more vacuum and vice versa.
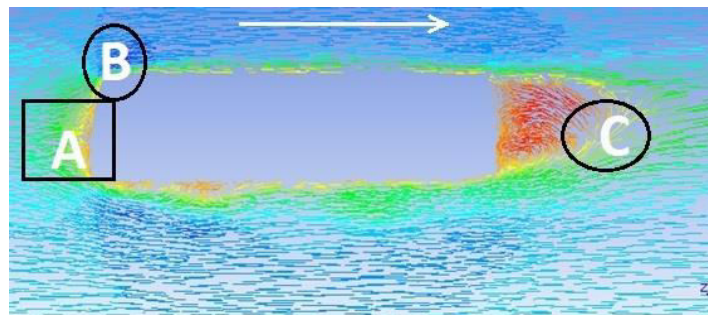
Figure 1: Flow over Bus Body

3.3 Boundary Layer Separation and Back Body Vacuum Generation

It is concept to study the parameter of fluid flow dominated by the viscosity and so the fluid flow over the surface is divided into two areas separated by a boundary called boundary layer. Region inside the boundary layer is dominated by the viscosity and this region is responsible for majority of the drag experienced by the body and second region which is outside the boundary layer provide very less drag due to the insignificant effect of viscosity.

Boundary layer is that region over the body where the velocity gradient (change in velocity with respect to length (height) is exist. This region when detached from the body it creates vacuum and push the body against the motion

Back body vacuum: the region behind the bus where the layers of fluid flow from top, bottom and sides of body meets not exact the back of bus but leave some black space where the pressure is below atmosphere. This blank space is also the main cause of drag production.

4. LITERATURE REVIEW

Chandrashekhar R Jadhav and Rashmi P Chorage use four to five modification in the Volvo B11R to reduce the coefficient of drag from 0.62 (existing model) to 0.41 (modified model). They modify the Front face, Side wall, Rear body, Under body and Roof of Volvo B11R [1].

Mandar Gophane, Gauri Salvi, Gandhi Pratik Pradeep and Dr. Ravi. Kpresents the comparative study on three bus models by carrying out CFD simulations. Aerodynamically shaping the windscreen, rounding off the sharp corners, using best diffuser angle and lowering the floor panel height leads to reduction of drag and lift for the modified models. Drag co-efficient is found to get reduced from 0.9 for the standard bus to 0.6 for the concept bus [5].

N. GovindhaRasu, A M Renil and S.J. Sunil presents 6 models for the CFD analysis. For the CFD analysis they use Ansys fluent software. Models are analysed at about 100 km/h, 75 km/h & 50 km/h. At 100 km/h, Coefficient of drag reduces from 0.73 to 0.49 [2].

A. Muthuvel and MK Murthi reduced the drag force about 30-40% by making modification in top part, side body and side rear body and also calculate the fuel consumption which also reduced 8 to 35% [7].

Research of Yogendra Kumar Vishwakarma shows that the modification in the exterior design of car body may lead to improvement in the aerodynamic behaviour. And these modifications reduce the coefficient of drag Cd which effects the fuel consumption. By these modifications the coefficient of drag is reduced by approximately 2.18% [8].

Based on this research of V. Naveen Kumar on the aerodynamic flow around a car, second spoiler of the car stood best among the three cases of car based on results obtained in terms of Drag coefficient and it is about 0.329. Lift coefficient is 0.106 [4].

4.1 OUTCOME OF LITERATURE REVIEW

The research aim is to enhance the performance of the automobile by optimizing the body profile and adding some devices i.e. by making the vehicle body for better aerodynamic characteristics. They used one of the CAD software for making the CAD model of actual bus and also the modifications on the body have done in same. ANSYS FLUENT were used for analysis of base model and the modified model. They used two or three modifications on base model of the bus and compare the results related to the performance.

4.2 Modifications that Lead to Decrease the Drag Force

Modification that reduces the tendency of the flow separation and back body vacuum generation is very helpful to decrease the drag force. These are the modifications which we are using to overcome the boundary layer separation and back body vacuum.

Tapered top from front to rear

Using of Spoiler

Inclined and curved windscreen.

4.3 Base Model Dimensions

Table 1 shows the standard Bus dimensions according to the guidelines of Urban Bus Specification under the Ministry of Housing and Urban Affairs [9].

5. METHODOLOGY

5.1 Modeling of bus in CAD

Here we use one base model and four modified model of base model. For the modeling of the same we use well-known CAD software Creo 4.0. These CAD models are modeled by using "Style tool" of part modeling.

5.2 Simulation of CAD Model

After the modeling of all the models, CFD analysis will be done with the help of CAE software ANSYS-FLUENT. The analysis will give the coefficient of drag of all models for different-different velocities.

Table 1: Standard Bus Dimensions [9]

| S.No.	Dimensions	Value
1	Maximum Length	12 meters
2	Maximum Width	2.6 meters
3	Floor Height	400-600 mm
4	Approach Angle	8 degree
5	Departure Angle	8 degree
6	Passenger Compartment Internal Height (minimum)	1900mm
7	Overall height (minimum)	2300mm
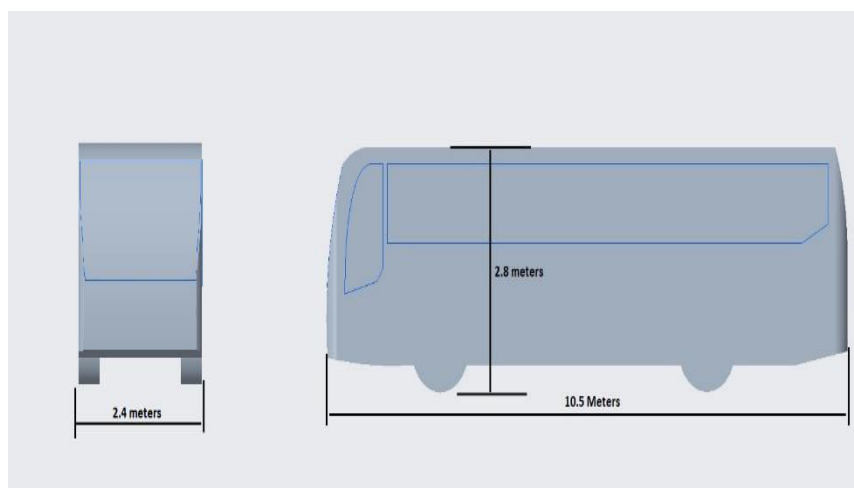
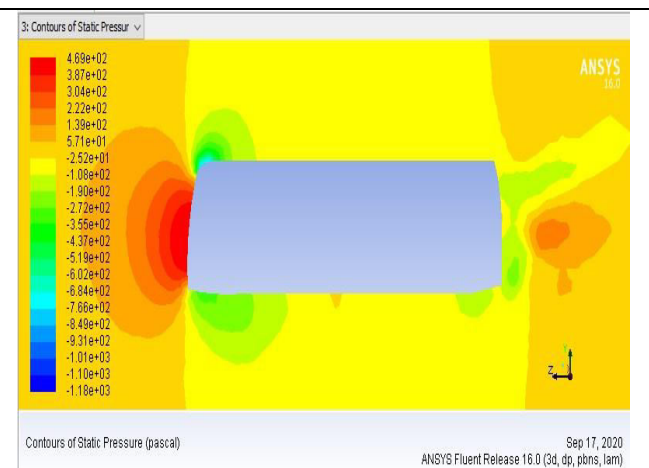**Figure 2:** Our base model dimension taking consideration of above guidelines of MOHUA
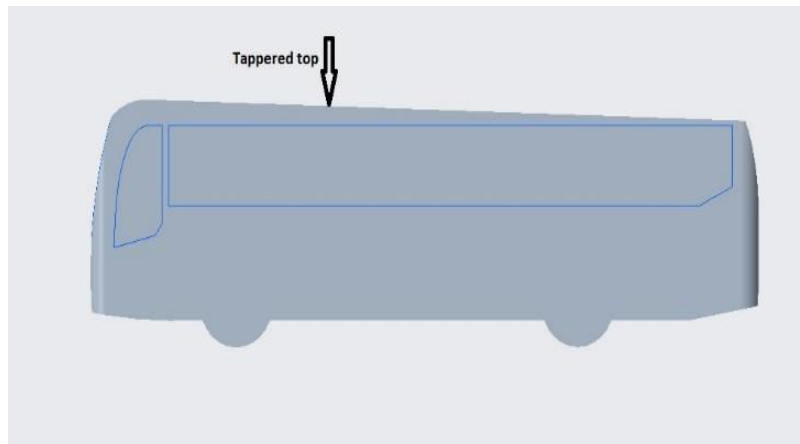
Figure 3: Tapered top Bus

6. RESULTS

The below figures shows the aerodynamic behavior of base modal analyzed at 100km/hr. From the CFD analysis the coefficient drag is 0.68. The extreme red parts in front of windscreen shows the maximum pressure of magnitude 469 Pa where the velocity is minimum of magnitude (0.5 to 1.9) m/s. The pressure at the back is -190 Pa (Vacuum).
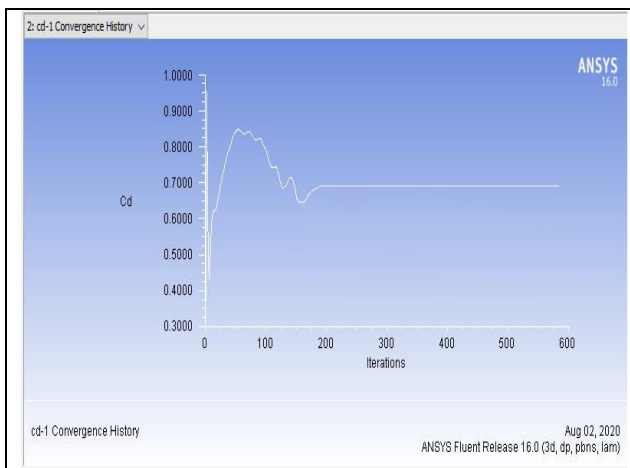
|	
Figure 4: Coefficient of drag of base model tested at 100km/hr	**Figure 5:** Pressure distribution over base model @100km/hr
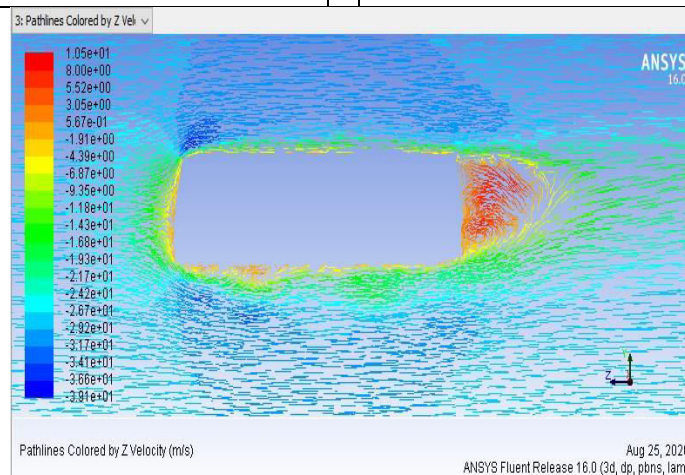
Figure 6: Velocity Path lines over base model @100km/hr**.**

There are three taper in top surface of bus 1/50, 1/40 and 1/30. From the CFD analysis the coefficient of drag for 1/40 taper is least and equal to 0.46. The back pressure for 1/50, 1/40 and 1/30 taper is -77.3 Pa, -49.6 Pa and -74.7 Pa respectively. And maximum pressure is 478 Pa, 471 Pa and 474 Pa respectively. The table below shows the relative analysis data of base model with modified model.
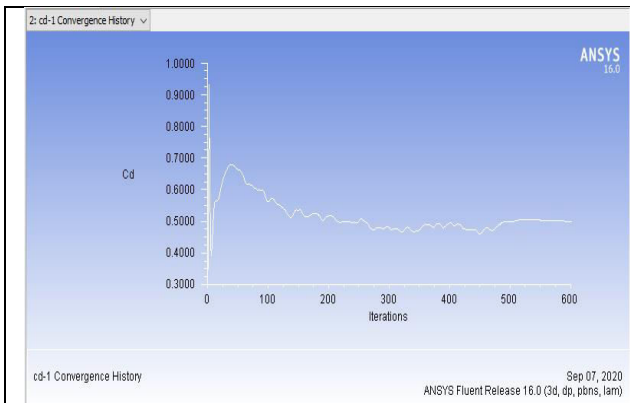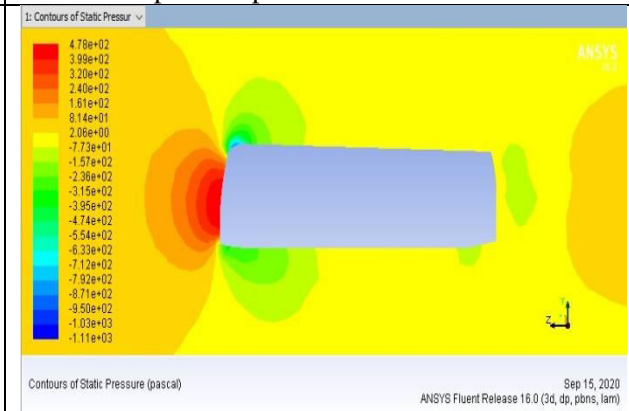
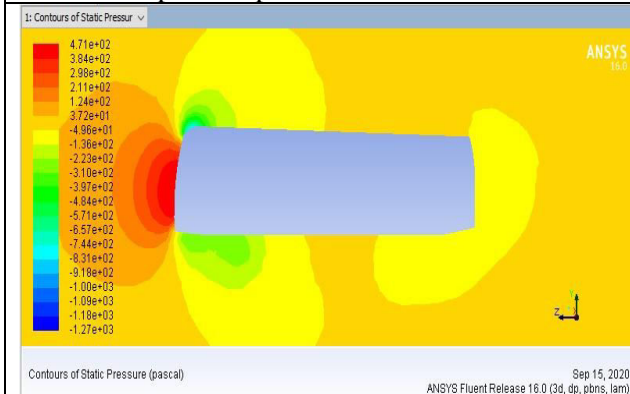**Figure 7:** Coefficient of drag of bus having 1/50 taper in top surface @100km/h.
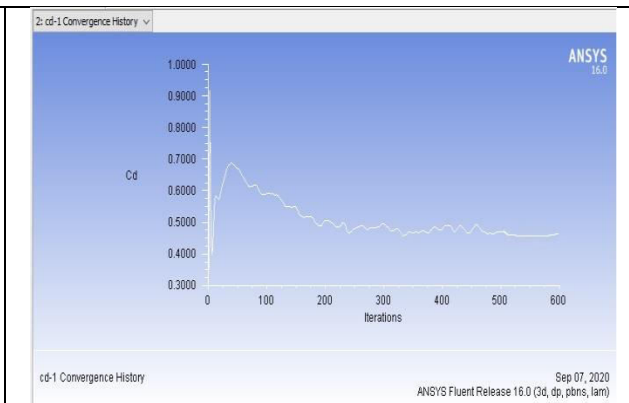
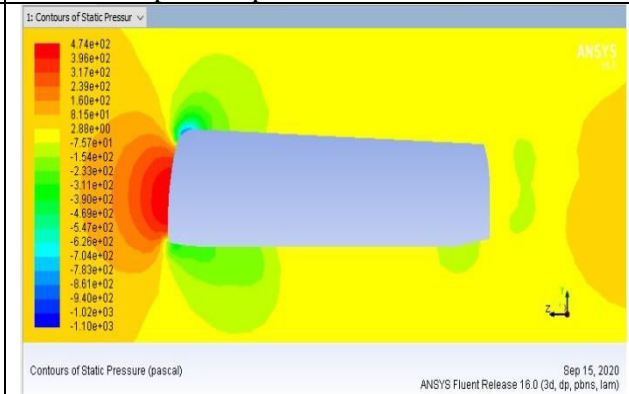**Figure 8:** Coefficient of drag of bus having 1/40 taper in top surface @100km/hr.
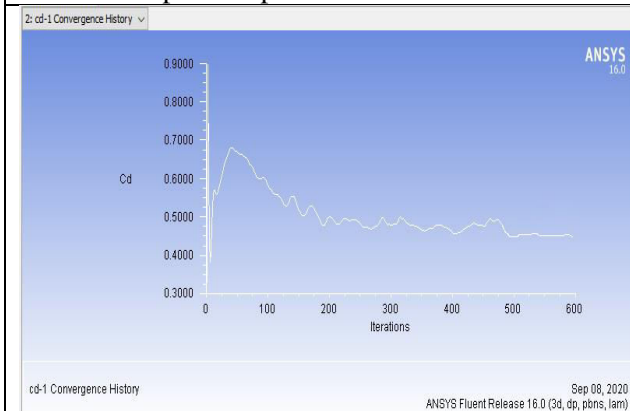
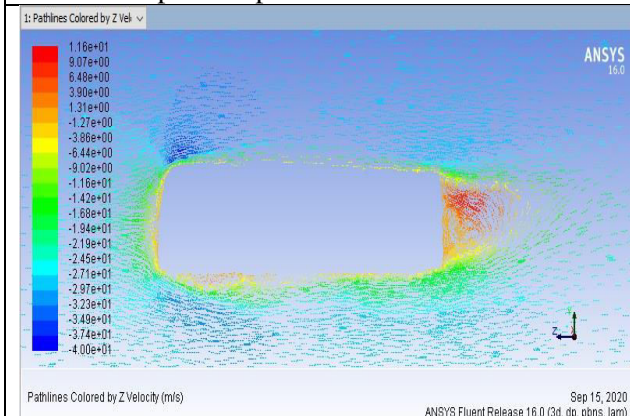**Figure 9:** Coefficient of drag of bus having 1/30 taper in top surface @100km/hr.

Figure 10: Pressure Contour of bus having 1/50 taper in top surface @100km/hr.
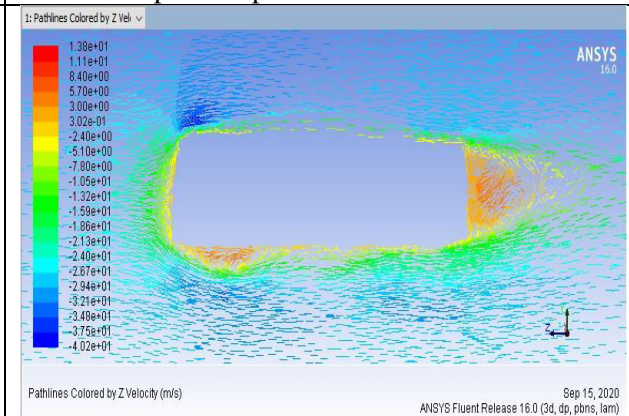

Figure 11: Pressure Contour of bus having 1/40 taper in top surface @100km/hr.

Figure 12: Pressure Contour of bus having 1/30 taper in top surface @100km/hr.

Figure 13: Velocity path lines of bus body having 1/50 taper in top surface @100km/hr.

Figure 14: Velocity path lines of bus body having 1/40 taper in top surface @100km/hr.

Table 2: Relative analysis between base model and tapered model

S.No	Bus Body	Max Pressure (Pa)	Back Pressure (Pa)	Cd	% reduction in Cd
1	Base Model	+469	-108	0.68	0
2	Taper 1/50	+478	-77.3	0.52	23.52
3	Taper 1/40	+471	-49.8	0.46	32.35
4	Taper 1/30	+474	-74.7	0.48	29.41

7. CONCLUSION

Among the all three modifications made in the top of the bus body, 1/40 taper is best body shape which provide drag coefficient about 0.46 and reduces it up to 32.35%. The main reason for this reduction is the low vacuum (-49.8 Pa) back side of the bus.

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SYSTEMATIC APPROACH TO FIND EFFECT OF CLOCK SKEW IN THE PERFORMANCE OF PHYSICAL CMOS DESIGN IN DEEP SUBMICRON TECHNOLOGIES

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ABSTRACT
The Clock distribution has become an increasingly challenging problem for VLSI designs, consuming an increasing fraction of resources such as wiring, power, and design time. Clock skew is mainly because of static mismatches in the clock. We can define the clock as the variations in the arrival time of clock transition in an integrated circuit. They can dramatically affect the system wide performance and reliability. In this paper, we analyse the effect and impact of positive skewed circuitry on the performance of physical CMOS design in deep submicron technologies. The physical design is implemented and simulated in Microwind EDA tool in CMOS 45 nm technology with BSIM 4 MOS modelling. The VDD for simulation is 1V. The physical design simulation shows delay of 0.102 nsec between the clock arrival with the same clock source at different instances and that is of significantly 2.198 nsec between two different output instances of synchronous circuit.

Keywords: Clock skew, Clock distribution, physical design, BSIM 4 MOS Modelling, etc.

I. INTRODUCTION

In modem VLSI circuit, a clock distribution network may drive thousands of registers, active and passive components in a chip with a very small size, creating a large capacitive load that must be efficiently sourced. In addition to this, every transition of the clock signal when changes it also changes the state of every capacitive node within the network of clock distribution, in contrast with the switching activity in combinational logic blocks, where the change of logic state is dependent on the logic function. The current submicron technologies demand the low power application design with respect to size reduction of the device [1]. Power consumption is the most important term that the designer needs to think while developing the logic [2]. Primarily power dissipation in the digital circuits are dynamic power and short circuit power. Hence the dynamic power dissipation is reduced by lowering the clock frequency and power supply or the capacitive load of the clock distribution. But by lowering the clock frequency, will lowers down the speed of the processor. With the same, lowering the power supply will also affects the current strength of the devices. So, the clock reaching time for the circuits used can be designed in such manner that the clock will reach at the same instances to the respective circuits in order to lower down the power utilization [1] [3].

Because of clock skew, a circuit may get failure [4], that is a race around condition may occur which is independent of clock frequency. Advancements in chip fabrication technology improve chip size. It not only improves compactness in logic gates but also increases the operating frequency. Due to this, clock skew is an important factor to ensure the correct functioning of VLSI chips. But increase in clock frequency in a digital system makes it critical to reduce clock skew.

Therefore, we need to understand the skewed arises in the synchronous circuits because of the different instances of the clock arrival so that we can develop the mitigation techniques in order to lower down the clock delays. For designing Integrated circuits, It is important that set up and hold time parameters must satisfy timing requirements. Delay calculation is depending upon propagation delay and clock. The function of the clock distribution network is to maintain the flow of data signals along similar data paths.
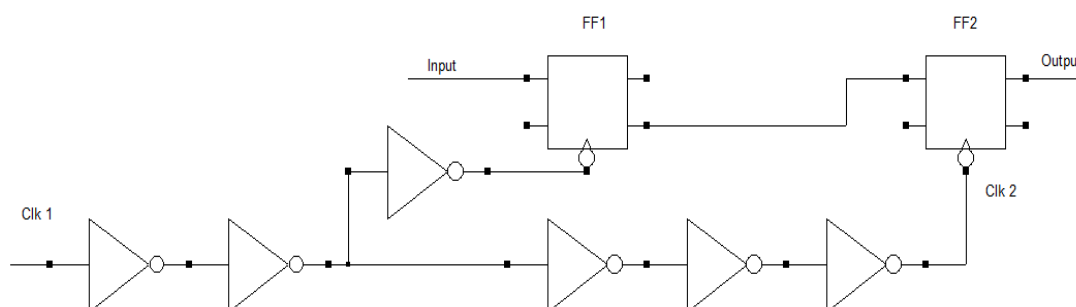
Figure 1: Clock Skew concept

The figure 1 shows the concept of the clock skew. The clock "Clk" is applied to the FF1 through some buffers. Depending on this clock, the output of FF1 is appeared. The same clock "Clk" is applied to the FF2 but through many inverter buffered stages. The effect of doing this will affect the final output of the system as clock is not reaching at the same instance to the adjacent FF2. This arrival of the clock at the FF2 is delayed in comparison with the instance of appearance on the FF1. That will affect the overall behavior of the system. If we considered millions of the transistor n the single chip, the instances delays will be significant and the overall circuit behavior will be affected.
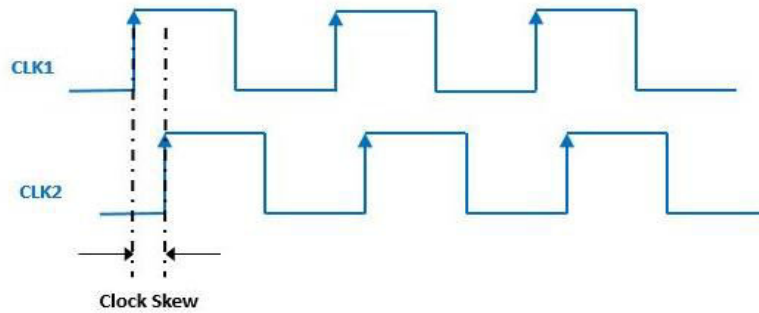

Figure 2: Clock skew

Figure 2 shows the positive edge of both the clock signal (Clk 1 and Clk 2) has some time delay even when there is the same clock source. These delays can add the significant variations in the final output of a system.

To understand clock skew better, many theoretical backgrounds are provided which explains how clock distribution network interact with different data paths. The desired considerations are associated to accomplish low power consumption, minimum layout area [7]. These target specifications become very difficult to achieve due to the continuous down scaling of silicon CMOS technologies [10]. As processors frequencies are continuously increasing in the multi-GHz space, the clock skew becomes one of the main factors that affects the reliability of systems and the constrain improvement of clock frequencies [4]. S. L. Bangare et al [12-13] have worked in similar to machine learning issues. N. Shelke et al. [14] and S. Gupta et al. [15] have worked for LRA DNN and other methods. This work presents the effect of skewed circuitry on the data at the arrival and at the final data element. This paper proposed a physical design of Flop-flops with clock skew addition using CMOS 45nm technology with BSIM 4 MOS modelling technique considering low power and the lower delays. The proposed physical design is simulated to Monte Carlo simulations and rise and fall delay variations for random variables. The analysis is repeated 10 times and the effect of the same is varied on the systems delays is verified. This analysis will show the behavior of proposed Clock skew to more robust.

II. Clock Skew
In the synchronous circuit, if the clock signal arrives at a different time at two different registers, a clock skew is generated. Many factors like different wire interconnect length, capacitive coupling, material defects, change in temperature, and variation in clock input capacitances causes clock skew, which becomes more critical when clock frequency increases.[5][6]

In a digital system, a clock signal is used as a time reference to synchronize different parts of the system. Hence the clock is very important for synchronous operation. As the word synchronous itself indicate that clock must be in sync .With this time reference, data can move with the system so that we can calculate the system delay

Figure 3 shows the proposed circuit without inserting the skew. The skewed circuitry is nothing but the trail of inverter / buffers added between the clock of the first FF1 and FF2.
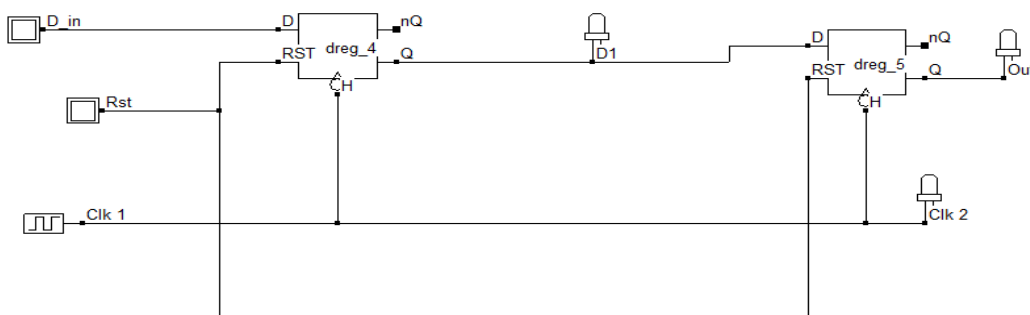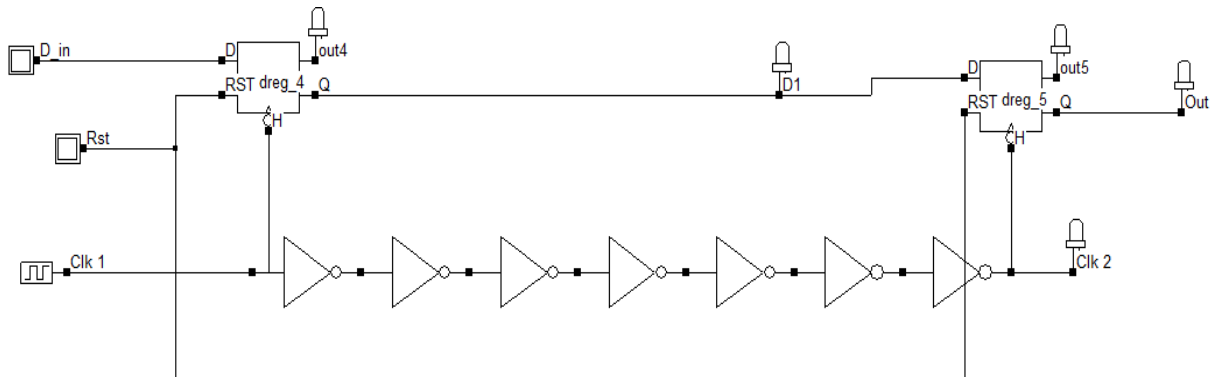

**Figure 3:** Schematic design of circuit without skew

Below circuit in figure 4, illustrates the problem of clock skew, where a large delay in clock has been inserted to study the effect of clock skew. The inverters are used for delay insertion and ensures that clock would arrive late than the data at flip-flop. In the circuit designs, the inverter trail inserted timing skew because of which the clock signal sent from the clock circuit arrives at different time instances at different components.

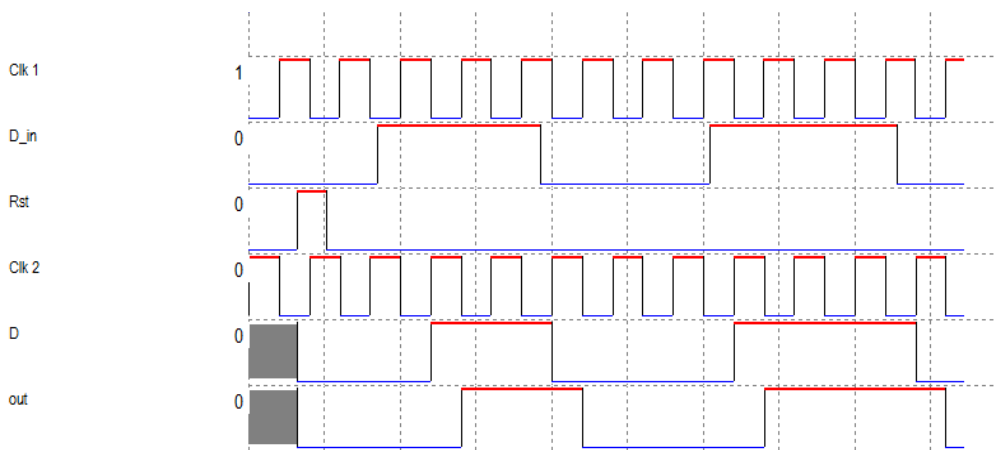**Figure 4:** Schematic design of circuit with skew inserted

III. RESULT AND DISCUSSSION

The proposed designs are simulated using DSCH software using CMOS 45nm technology with voltage as 1V as shown in figure 5.
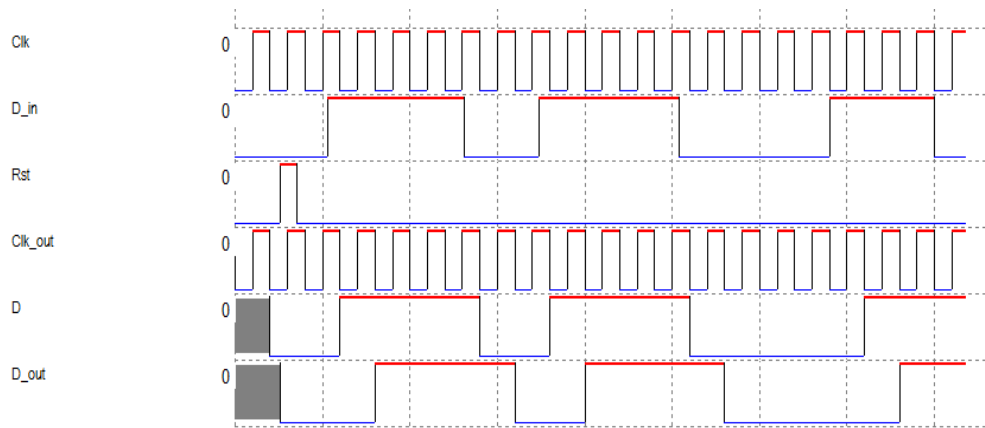
Figure 5: Digital simulation for design without skew

In figure 6, we have implemented skewed circuit which shows the delays in the two clocks.

Figure 6: Digital simulation for design with skew inserted

The physical layout of the proposed circuit with timing skewed is simulated with BSIM4 MOS modelling technique considering 300 MOS parameters as shown in figure 7. The data input "Din" is a normal data clock assigned. "Clk1" and "Clk 2" are the two clocks at the same interval and from the same source. "D1" is output of FF1 and "Out" is the final output for "FF2".
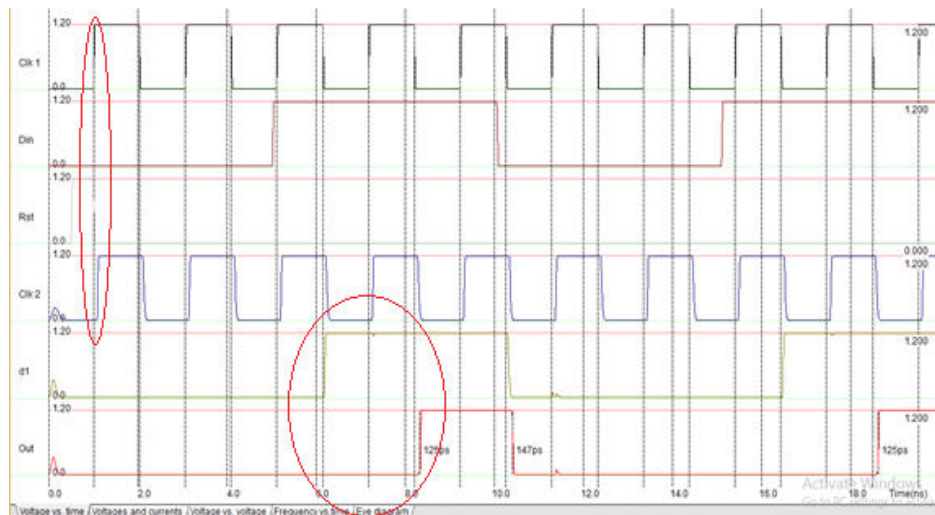
Figure 7: Transient analysis showing the effect of Clock skew on output (With Skew added)

Due to clock skew, the same Din input is stored in both FFs in same clock edge. From the simulation graph, it is clear that the clock 1 and clock 2 are arises at two different instances thought the clock source for both the clocks is same. It affects the output instance and the final Out is delayed as compared to the first output across FF1. On the same design, we have performed Monte Carlo analysis. The Monte Carlo analysis is carried out through the variation of Width (W) and Length (L) for each one of the 10 feasible solutions over many runs. The outcome of the Monte Carlo simulations is employed to compute the mean and the standard deviation of the objective function value. Monte Carlo analysis is performed on the design. The analysis is repeated 10 times and the effect of the same is varied on the rise and fall delays of the circuit is verified. Simulation result is shown in figure 8. The rise delays ranges between 0.137 to 0.155 nsec and that of fall delays ranges in between 0.137 to 0.170 nsec which shows the
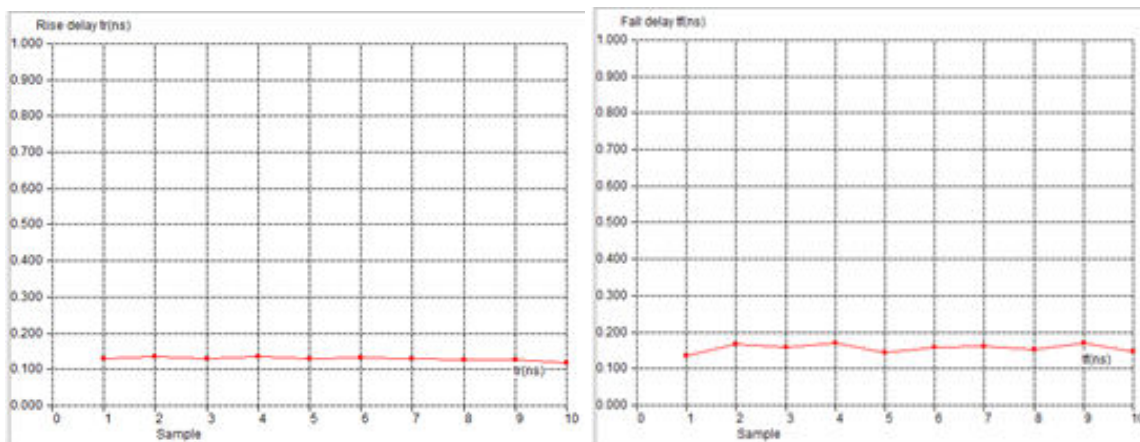
Figure 8: Monte Carlo analysis for proposed design with respect to rise and fall delay

IV. CONCLUSION

VLSI/UVLSI based synchronous systems require the efficient synthesis of clock distribution networks in order to obtain higher clock frequencies, reduction in power consumption and elimination of race conditions. Here, we have analysed the impact of clock skew on the circuit behaviour for understanding the final output of the system. The proposed circuit with addition of timing skew provides the delays of 0.102nsec between the clock instances and that is of 2.198nsec between the output instances. The overall power consumption of the proposed circuit is 46.061uW and physical Surface are is 187.6µm2. The Monte Carlo analysis is performed on the design provides the robust nature of proposed design.

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SOME EQUALITIES ON EINSTEIN OPERATIONS OF PYTHAGOREAN FUZZY MATRICES

M. RAMAKRISHNAN AND S. SRIRAM

ABSTRACT

In this paper, we discuss algebraic properties which are used to solve Some Equalities on Einstein operations of Pythagorean Fuzzy matrices and their basic operations. We define their algebraic properties with some Existing operations in detail. Also, we prove some new results associated with the standard Pythagorean fuzzy implication. Finally, we introduce new relations which are related to some Equalities Einstein operations of Pythagorean Fuzzy matrices are established and with numerical examples.

Keywords: Fuzzy Matrix, Intuitionistic fuzzy Matrix, Pythagorean Fuzzy Matrix, Einstein operations of Pythagorean Fuzzy Matrix.

1. INTRODUCTION

The fuzzy set concept was introduced by zadeh [17] analysed membership degree. The fuzzy matrix was introduced by Thomason [13], who gave a detailed explanation about the convergence of powers of the fuzzy matrix. As an extended concept of fuzzy set, the intuitionistic fuzzy set **(IFS)** was discussed, membership degree and non-membership degree was developed by Atanassov [1,2]. Pal established Intuitionistic Fuzzy Matrices **(IFMs)** [12] and generated min-max, max-min, a solved equality between IFMs [4,7,8]. Sriram established a lot of original works in the Intuitionistic Fuzzy Matrices [3,5,6,9]. Yager [14,15,16] developed the Pythagorean fuzzy set **(PFS)**. The Pythagorean fuzzy set satisfies the condition that the square sum of its membership and non-membership degree. Silambarasan and Sriram [11] presented Pythagorean fuzzy matrices **(PFM)** and developed algebraic operations for Pythagorean fuzzy matrices. Also they determined Some Equalities on Einstein operators for the Pythagorean fuzzy matrix and proved their algebraic properties.

2. PRELIMINARIES

In 2018, Silambarasan and Sriram [11] defined Pythagorean Fuzzy matrix and its basic properties.

Definition 2.1 [11]: A Pythagorean fuzzy matrix is a pair $A = (\langle u_{lm\mu}, u_{lm\nu} \rangle)$ of non negative real numbers $u_{lm\mu}, u_{lm\nu} \in [0,1]$ satisfying $0 \leq u_{lm\mu}^2 + u_{lm\nu}^2 \leq 1$, for all l, m.

Definition 2.2 [11]: Given two Pythagorean Fuzzy matrices U and V of same size, the algebraic operations are defined as follows:

$(i)\ U \vee V = (\langle \max(u_{lm\mu}, v_{lm\mu}), \min(u_{lm\nu}, v_{lm\nu}) \rangle)$

$(ii)\ U \wedge V = (\langle \min(u_{lm\mu}, v_{lm\mu}), \max(u_{lm\nu}, v_{lm\nu}) \rangle)$

$(iii)\ U^C = (u_{lm\nu}, u_{lm\mu})$

$$(iv)\ U \oplus_E V = \left(\langle \sqrt{u_{lm\mu}^2 + v_{lm\mu}^2 - u_{lm\mu}^2 v_{lm\mu}^2}, u_{lm\nu} v_{lm\nu} \rangle \right)$$

$(v)\ U \otimes_E V = \left(\langle u_{lm\mu} v_{lm\mu}, \sqrt{u_{lm\nu}^2 + v_{lm\nu}^2 - u_{lm\nu}^2 v_{lm\nu}^2} \rangle \right)$

$(vi)\ U \geq V$ If and only if $u_{lm\mu} \geq v_{lm\mu}$, and $u_{lm\nu} \leq v_{lm\nu}$

Where $+, -$ and $\cdot$ are real numbers addition, subtraction and multiplication respectively.

Definition 2.3 [10]:
Let $U = (\langle u_{lm\mu}, u_{lm\nu} \rangle)$ and $V = (\langle v_{lm\mu}, v_{lm\nu} \rangle)$ be two Einstein Operations on Pythagorean Fuzzy Matrices **(EPFMs)** of same size, then,

$$(i)\ U \oplus_E V = \left(\langle \sqrt{\frac{(u_{lm\mu})^2 + (v_{lm\mu})^2}{1 + (u_{lm\mu})^2 (v_{lm\mu})^2}}, \frac{u_{lm\nu} v_{lm\nu}}{\sqrt{1 + (1 - (u_{lm\nu})^2)(1 - (v_{lm\nu})^2)}} \rangle \right)$$

$(ii)\ U \otimes_E V = \left(\langle \dfrac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}, \sqrt{\dfrac{(u_{lm\nu})^2 + (v_{lm\nu})^2}{1 + (u_{lm\nu})^2 (v_{lm\nu})^2}} \rangle \right)$

They are called Einstein sum and Einstein product.

Some Basic Algebraic Properties on Einstein Operations of Pythagorean Fuzzy Matrix:
In this section, we develop the Einstein operations on Pythagorean fuzzy matrices based and analyze some desirable properties.

Theorem 3.1:
Let $U = \left(\langle u_{lm\mu}, u_{lm\nu} \rangle \right)$ and $V = \left(\langle v_{lm\mu}, v_{lm\nu} \rangle \right)$ be two **PFMs** of same size, then $U \oplus_E V \geq U \otimes_E V$.

Proof:
We know that, $\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right) \geq 2\left(u_{lm\mu}^2 v_{lm\mu}^2 \right)$

$= \left(u_{lm\mu}^2 v_{lm\mu}^2 \right) + \left(u_{lm\mu}^2 v_{lm\mu}^2 \right)$

$\geq \left(u_{lm\mu}^2 v_{lm\mu}^2 \right) + \left(u_{lm\mu}^2 v_{lm\mu}^2 \right)^2$

$= \left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)\left(u_{lm\mu}^2 v_{lm\mu}^2 \right)$

$\dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)} \geq \left(u_{lm\mu}^2 v_{lm\mu}^2 \right)$

$\sqrt{\dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)}} \geq \sqrt{u_{lm\mu} u_{lm\nu}} \geq u_{lm\mu} v_{lm\mu}$

Also, $u_{lm\mu} u_{lm\nu} \geq \dfrac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}$

$\sqrt{\dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)}} \geq \sqrt{u_{lm\mu} u_{lm\nu}} \geq \dfrac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}$

$\sqrt{\dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)}} \geq \dfrac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}$

Similarly we can prove $\dfrac{u_{lm\nu} v_{lm\nu}}{\sqrt{1 + (1 - (u_{lm\nu})^2)(1 - (v_{lm\nu})^2)}} \leq \sqrt{\dfrac{(u_{lm\nu})^2 + (v_{lm\nu})^2}{1 + (u_{lm\nu})^2 (v_{lm\nu})^2}}$

Thus, $U \oplus_E V \geq U \otimes_E V$.

Theorem 3.2:
Let $U = \left(\langle u_{lm\mu}, u_{lm\nu} \rangle \right)$ and $V = \left(\langle v_{lm\mu}, v_{lm\nu} \rangle \right)$ be two **PFMs** of same size, then $U \otimes_E V \leq U @_E V \leq U \oplus_E V$.

Proof:
We know that, $\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right) \leq 2$

$\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right) \leq 2\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)$

$\dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{2} \leq \dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)}$

$\dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{2} \leq \sqrt{\dfrac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \leq \dfrac{\left(u_{lm\mu}^2 + v_{lm\mu}^2 \right)}{\left(1 + u_{lm\mu}^2 v_{lm\mu}^2 \right)} \leq \sqrt{\dfrac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}$

$$\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \leq \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}$$

Since, $\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \geq \sqrt{u_{lm\mu} v_{lm\mu}}$ **and** $\sqrt{u_{lm\mu} v_{lm\mu}} \geq \frac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}$

Also, $\frac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}} \leq \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \leq \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}$

Example 3.3
Let U and V be two **PFMs** of same size, for $x = \{x, y, z\}$. Then,

$$\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}} \geq \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \geq \sqrt{u_{lm\mu} v_{lm\mu}} \geq \frac{\sqrt{2}\, u_{lm\mu} v_{lm\mu}}{\sqrt{u_{lm\mu}^2 + v_{lm\mu}^2}} \geq \frac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}$$

Suppose,

$$U = \begin{bmatrix} p(0.7,0.4) & q(0.9,0.6) \\ r(0.5,0.4) & s(0.8,0.5) \end{bmatrix} \text{ and } V = \begin{bmatrix} p(0.8,0.1) & q(0.6,0.5) \\ r(0.9,0.3) & s(0.6,0.4) \end{bmatrix}$$

we   have,

$$0.927486617 \geq 0.751664818 \geq 0.748331477 \geq 0.745012917 \geq 0.514737191$$
$$0.411981109 \geq 0.291547594 \geq 0.2 \geq 0.137198868 \geq 0.029555933$$
$$0.951763208 \geq 0.764852927 \geq 0.734846922 \geq 0.706018086 \geq 0.509887962$$
$$0.748086243 \geq 0.552268050 \geq 0.547722557 \geq 0.543214476 \geq 0.246598481$$
$$0.938880653 \geq 0.728010988 \geq 0.670820393 \geq 0.618122537 \geq 0.421002242$$
$$0.496438419 \geq 0.353553391 \geq 0.346410161 \geq 0.339411255 \geq 0.090340548$$
$$0.901523057 \geq 0.707106781 \geq 0.692820323 \geq 0.678822509 \geq 0.432731067$$
$$0.627877989 \geq 0.452769257 \geq 0.447213595 \geq 0.441726104 \geq 0.15665209$$

Theorem 3.4:
Let $U = \left(\langle u_{lm\mu}, u_{lmv}\rangle\right)$ and $V = \left(\langle v_{lm\mu}, v_{lmv}\rangle\right)$ be two **PFMs** of same size, then

$(i)(U^C)^C = U$

$$(ii)U^C \oplus_E V^C = (U \otimes_E V)^C$$

$(iii)U^C \otimes_E V^C = (U \oplus_E V)^C$

$(iv)U^C \vee V^C = (U \wedge V)^C$

$(v)U^C \wedge V^C = (U \vee V)^C$

$(vi)(U \vee V) \oplus_E (U \wedge V) = (U \oplus_E V)$

$(vii)(U \vee V) \otimes_E (U \wedge V) = (U \otimes_E V)$

Proof:
(ii) **L.H.S** $= U^C \oplus_E V^C$

$$= \left(\sqrt{\frac{(u_{lmv})^2 + (v_{lmv})^2}{1 + (u_{lmv})^2(v_{lmv})^2}}, \frac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}\right) = (U \otimes_E V)^C = \textbf{R.H.S}$$

(iv) **L.H.S** $= U^C \vee V^C = \left(\max(u_{lmv}, v_{lmv}), \min(u_{lm\mu}, v_{lm\mu})\right) = (U \wedge V)^C = \textbf{R.H.S}$

$(\boldsymbol{vi})$ **L. H. S** $= (U \vee V) \oplus_E (U \wedge V)$

$$= \left(\sqrt{\frac{\max\left((u_{lm\mu})^2, (v_{lm\mu})^2\right) + \min\left((u_{lm\mu})^2, (v_{lm\mu})^2\right)}{1 + \max\left((u_{lm\mu})^2, (v_{lm\mu})^2\right) \min\left((u_{lm\mu})^2, (v_{lm\mu})^2\right)}}, \frac{\min(u_{lmv}, v_{lmv}) \max(u_{lmv}, v_{lmv})}{\sqrt{1 + (1 - (\min((u_{lmv})^2, (v_{lmv})^2)))(1 - (\max((u_{lmv})^2, (v_{lmv})^2)))}} \right)$$

$$= \left(\sqrt{\frac{(u_{lm\mu})^2 + (v_{lm\mu})^2}{1 + (u_{lm\mu})^2 (v_{lm\mu})^2}}, \frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (v_{lmv})^2)}} \right) = (U \oplus_E V) = \textbf{R. H. S}$$

Thus $(ii), (iv), (vi)$ holds.

$(i), (iii), (v), (vi)$. It can be proved similarly.

Example 3.5

Let U and V be two **PFMs** of same size, for $x = \{x, y, z\}$. Suppose,

$$U = \begin{bmatrix} p(0.7,0.4) & q(0.9,0.6) \\ r(0.5,0.4) & s(0.8,0.5) \end{bmatrix} \text{ and } V = \begin{bmatrix} p(0.8,0.1) & q(0.6,0.5) \\ r(0.9,0.3) & s(0.6,0.4) \end{bmatrix}$$

$$(U \vee V) = \begin{bmatrix} p(0.8,0.1) & q(0.9,0.5) \\ r(0.9,0.3) & s(0.8,0.4) \end{bmatrix} \text{ and } (U \wedge V) = \begin{bmatrix} p(0.7,0.4) & q(0.6,0.6) \\ r(0.5,0.4) & s(0.6,0.4) \end{bmatrix}$$

Then we have,

$$(U \oplus_E V) = \begin{bmatrix} p(0.927486617,0.029555933) & q(0.951763208,0.246598481) \\ r(0.938880653,0.090340548) & s(0.901523057,0.15665209) \end{bmatrix} = (V \oplus_E U)$$
$$= (U \wedge V) \oplus_S (U \vee V)$$

$$(U \otimes_E V) = \begin{bmatrix} p(0.514737191,0.411981109) & q(0.509887962,0.748086243) \\ r(0.421002242,0.496438419) & s(0.432731067,0.627877989) \end{bmatrix} = (V \otimes_E U)$$
$$= (U \wedge V) \otimes_E (U \vee V)$$

$$(U^C \oplus_S V^C) = \begin{bmatrix} p(0.411981109,0.514737191) & q(0.748086243,0.509887962) \\ r(0.496438419,0.421002242) & s(0.627877989,0.432731067) \end{bmatrix} = (U \otimes_E V)^C$$

$$(U^C \otimes_E V^C) = \begin{bmatrix} p(0.029555933,0.927486617) & q(0.246598481,0.951763208) \\ r(0.090340548,0.938880653) & s(0.15665209,0.901523057) \end{bmatrix} = (U \oplus_E V)^C$$

$$(U^C \vee V^C) = \begin{bmatrix} p(0.4,0.7) & q(0.6,0.6) \\ r(0.4,0.5) & s(0.5,0.6) \end{bmatrix} = (U \wedge V)^C,$$

$$(U^C \wedge V^C) = \begin{bmatrix} x(0.1,0.8) & y(0.5,0.9) \\ z(0.3,0.9) & s(0.4,0.8) \end{bmatrix} = (U \vee V)^C \text{ and}$$

$$U = \begin{bmatrix} x(0.7,0.4) & y(0.9,0.6) \\ z(0.5,0.4) & s(0.8,0.5) \end{bmatrix} = (U^C)^C$$

Theorem 3.6:

Let U and V be two **PFMs** of same size, then

$$(\boldsymbol{i}) \ U \oplus_E (V \wedge W) = (U \oplus_E V) \wedge (U \oplus_E W)$$

$(\boldsymbol{ii}) \ U \oplus_E (V \vee W) = (U \oplus_E V) \vee (U \oplus_E W)$

$(\boldsymbol{iii}) \ U \otimes_E (V \wedge W) = (U \otimes_E V) \wedge (U \otimes_E W)$

$(\boldsymbol{iv}) \ U \otimes_E (V \vee W) = (U \otimes_E V) \vee (U \otimes_E W)$

$(\boldsymbol{v}) (U \vee V) \oplus_E W = (U \oplus_E W) \vee (V \oplus_E W)$

$(\boldsymbol{vi}) (U \wedge V) \oplus_E W = (U \oplus_E W) \wedge (V \oplus_E W)$

$(\boldsymbol{vii}) (U \wedge V) \otimes_E W = (U \otimes_E W) \wedge (V \otimes_E W)$

$(\boldsymbol{viii}) (U \vee V) \otimes_E W = (U \otimes_E W) \vee (V \otimes_E W)$

$(\boldsymbol{ix}) (U \vee V) \wedge W = (U \wedge W) \vee (V \wedge W)$

$(\boldsymbol{x}) (U \wedge V) \vee W = (U \vee W) \wedge (V \vee W)$

Proof:

$(\boldsymbol{i})$**L. H. S** $= U \oplus_E (V \wedge W)$

$= (u_{lm\mu}, u_{lmv}) \oplus_E \big(\min(v_{lm\mu}, w_{lm\mu}), \max(v_{lmv}, w_{lmv}) \big)$

$$= \left(\sqrt{\frac{(u_{lm\mu})^2 + (\min(v_{lm\mu}, w_{lm\mu}))^2}{1 + (u_{lm\mu})^2 (\min(v_{lm\mu}, w_{lm\mu}))^2}}, \frac{u_{lmv} \max(v_{lmv}, w_{lmv})}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (\max(v_{lmv}, w_{lmv}))^2)}} \right)$$

$$= \left(\begin{array}{c} \min\left(\sqrt{\frac{(u_{lm\mu})^2 + (v_{lm\mu})^2}{1 + (u_{lm\mu})^2 (v_{lm\mu})^2}}, \frac{(u_{lm\mu})^2 + (w_{lm\mu})^2}{1 + (u_{lm\mu})^2 (w_{lm\mu})^2} \right), \\ \max\left(\frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (v_{lmv})^2)}}, \frac{u_{lmv} w_{lmv}}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (w_{lmv})^2)}} \right) \end{array} \right)$$

$$= \left(\begin{array}{c} \min\left(\sqrt{\frac{(u_{lm\mu})^2 + (v_{lm\mu})^2}{1 + (u_{lm\mu})^2 (v_{lm\mu})^2}}, \sqrt{\frac{(u_{lm\mu})^2 + (w_{lm\mu})^2}{1 + (u_{lm\mu})^2 (w_{lm\mu})^2}} \right), \\ \max\left(\frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (v_{lmv})^2)}}, \frac{u_{lmv} w_{lmv}}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (w_{lmv})^2)}} \right) \end{array} \right)$$

$= (U \oplus_E V) \wedge (U \oplus_E W) = $ **R. H. S**

$(\boldsymbol{iii})$**L. H. S** $= U \otimes_E (V \wedge W)$

$= (u_{lm\mu}, u_{lmv}) \otimes_E \big(\min(v_{lm\mu}, w_{lm\mu}), \max(v_{lmv}, w_{lmv}) \big)$

$$= \left(\frac{u_{lm\mu} \min(v_{lm\mu}, w_{lm\mu})}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (\min(v_{lm\mu}, w_{lm\mu}))^2\right)}}, \sqrt{\frac{(u_{lmv})^2 + (\max(v_{lmv}, w_{lmv}))^2}{1 + (u_{lmv})^2 (\max(v_{lmv}, w_{lmv}))^2}} \right)$$

$$= \left(\begin{array}{c} \min\left(\frac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}, \frac{u_{lm\mu} w_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (w_{lm\mu})^2\right)}} \right), \\ \max\left(\sqrt{\frac{(u_{lmv})^2 + (v_{lmv})^2}{1 + (u_{lmv})^2 (v_{lmv})^2}}, \frac{(u_{lmv})^2 + (w_{lmv})^2}{1 + (u_{lmv})^2 (w_{lmv})^2} \right) \end{array} \right)$$

$$= \left(\begin{array}{c} \min\left(\frac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (v_{lm\mu})^2\right)}}, \frac{u_{lm\mu} w_{lm\mu}}{\sqrt{1 + \left(1 - (u_{lm\mu})^2\right)\left(1 - (w_{lm\mu})^2\right)}} \right), \\ \max\left(\sqrt{\frac{(u_{lmv})^2 + (v_{lmv})^2}{1 + (u_{lmv})^2 (v_{lmv})^2}}, \sqrt{\frac{(u_{lmv})^2 + (w_{lmv})^2}{1 + (u_{lmv})^2 (w_{lmv})^2}} \right) \end{array} \right)$$

$= (U \otimes_E V) \wedge (U \otimes_E W) = $ **R. H. S**

$(\boldsymbol{v})$L. H. S $= (U \vee V) \oplus_E W$

$= \left(\max(u_{lm\mu}, v_{lm\mu}), \min(u_{lmv}, v_{lmv})\right) \oplus_E \left(w_{lm\mu}, w_{lmv}\right)$

$= \left(\max\left(\sqrt{\dfrac{\left((u_{lm\mu})^2, (v_{lm\mu})^2\right) + (w_{lm\mu})^2}{1 + \left((u_{lm\mu})^2, (v_{lm\mu})^2\right)(w_{lm\mu})^2}},\right), \min\left(\dfrac{(u_{lmv}, v_{lmv})w_{lmv}}{\sqrt{1 + (1 - ((u_{lmv})^2, (v_{lmv})^2))(1 - (w_{lmv})^2)}}\right)\right)$

$= \left(\begin{array}{c} \max\left(\sqrt{\dfrac{(u_{lm\mu})^2 + (w_{lm\mu})^2}{1 + (u_{lm\mu})^2(w_{lm\mu})^2}}, \sqrt{\dfrac{(v_{lm\mu})^2 + (w_{lm\mu})^2}{1 + (v_{lm\mu})^2(w_{lm\mu})^2}}\right), \\ \min\left(\dfrac{u_{lmv}w_{lmv}}{\sqrt{1 + (1 - (u_{lmv})^2)(1 - (w_{lmv})^2)}}, \dfrac{v_{lmv}w_{lmv}}{\sqrt{1 + (1 - (v_{lmv})^2)(1 - (v_{lmv})^2)}}\right) \end{array}\right)$

$= (U \oplus_E W) \vee (V \oplus_E W) =$ **R. H. S**

$(\boldsymbol{vii})$L. H. S $= (U \wedge V) \otimes_E W$

$= \left(\min(u_{lm\mu}, v_{lm\mu}), \max(u_{lmv}, v_{lmv})\right) \otimes_E \left(w_{lm\mu}, w_{lmv}\right)$

$= \left(\begin{array}{c} \min\left(\dfrac{(u_{lm\mu}w_{lm\mu}, v_{lm\mu}w_{lm\mu})}{\sqrt{1 + \left((1 - (u_{lm\mu})^2)(1 - (w_{lm\mu})^2), (1 - (v_{lm\mu})^2)(1 - (w_{lm\mu})^2)\right)}}\right), \\ \max\left(\sqrt{\dfrac{((u_{lmv})^2, (v_{lmv})^2) + (w_{lmv})^2}{1 + ((u_{lmv})^2, (v_{lmv})^2)(w_{lmv})^2}}\right) \end{array}\right).$

$= \left(\begin{array}{c} \min\left(\dfrac{u_{lm\mu}w_{lm\mu}}{\sqrt{1 + (1 - (u_{lm\mu})^2)(1 - (w_{lm\mu})^2)}}, \dfrac{v_{lm\mu}w_{lm\mu}}{\sqrt{1 + (1 - (v_{lm\mu})^2)(1 - (w_{lm\mu})^2)}}\right), \\ \max\left(\sqrt{\dfrac{(u_{lmv})^2 + (w_{lmv})^2}{1 + (u_{lmv})^2(w_{lmv})^2}}, \sqrt{\dfrac{(v_{lmv})^2 + (w_{lmv})^2}{1 + (v_{lmv})^2(w_{lmv})^2}}\right) \end{array}\right)$

$= (U \otimes_E W) \wedge (V \otimes_E W) =$ **R. H. S**

$(\boldsymbol{ix})$L. H. S $= (U \vee V) \wedge W$

$= \left(\min\left(\max\left((u_{lm\mu}, w_{lm\mu}), (v_{lm\mu}, w_{lm\mu})\right)\right), \max(\min((u_{lmv}, w_{lmv}), (v_{lmv}, w_{lmv})))\right)$

$= \left((\max(\min(u_{lm\mu}, w_{lm\mu}), \min(v_{lm\mu}, w_{lm\mu})))(\min(\max(u_{lmv}, w_{lmv}), \max(v_{lmv}, w_{lmv})))\right)$

$= \left(\min(u_{lm\mu}, w_{lm\mu}), \max(u_{lmv}, w_{lmv})\right) \vee \left(\min(v_{lm\mu}, w_{lm\mu}), \max(v_{lmv}, w_{lmv})\right)$

$= (U \wedge W) \vee (V \wedge W) =$ **R. H. S**

Thus $(i), (iii), (v), (vii), (ix)$ holds.

$(ii), (iv), (vi), (viii), (x)$ It can be proved similarly.

Example 3.7
Let U and V be two **PFMs** of same size, for $x = \{x, y, z\}$. Suppose,

$U = \begin{bmatrix} p(0.7,0.4) & q(0.9,0.6) \\ r(0.5,0.4) & s(0.8,0.5) \end{bmatrix}, V = \begin{bmatrix} p(0.8,0.1) & q(0.6,0.5) \\ r(0.9,0.3) & s(0.6,0.4) \end{bmatrix}$ and $W = \begin{bmatrix} p(0.6,0.3) & q(0.8,0.7) \\ r(0.2,0.5) & s(0.7,0.9) \end{bmatrix}$

We have,

(i) $U \oplus_E (V \wedge W) = (U \oplus_E V) \wedge (U \oplus_E W)$

$$= \begin{bmatrix} p(0.850025501, 0.090340548) & q(0.957763208, 0.364680073) \\ r(0.535843925, 0.15665209) & s(0.901523057, 0.421002242) \end{bmatrix}$$

(ii) $U \oplus_E (V \vee W) = (U \oplus_E V) \vee (U \oplus_E W)$

$$= \begin{bmatrix} p(0.927486617, 0.029555933) & q(0.977216752, 0.246598481) \\ r(0.938880653, 0.090340548) & s(0.927486617, 0.15665209) \end{bmatrix}$$

(iii) $U \otimes_E (V \wedge W) = (U \otimes_E V) \wedge (U \otimes_E W)$

$$= \begin{bmatrix} p(0.364680073, 0.496438419) & q(0.509887962, 0.850025501) \\ r(0.076249285, 0.627877989) & s(0.432731067, 0.938880653) \end{bmatrix}$$

(iv) $U \otimes_E (V \vee W) = (U \otimes_E V) \vee (U \otimes_E W)$

$$= \begin{bmatrix} p(0.514737191, 0.411981109) & q(0.696571267, 0.748086243) \\ r(0.421002242, 0.496438419) & s(0.514737191, 0.627877989) \end{bmatrix}$$

(v)$(U \vee V) \oplus_E W = (U \oplus_E W) \vee (V \oplus_E W)$

$$= \begin{bmatrix} p(0.901523057, 0.021759134) & q(0.977216752, 0.297670278) \\ r(0.907372191, 0.115641501) & s(0.927486617, 0.334309253) \end{bmatrix}$$

(vi)$(U \wedge V) \oplus_E W = (U \oplus_E W) \wedge (V \oplus_E W)$

$$= \begin{bmatrix} p(0.850025501, 0.090340548) & q(0.901523057, 0.246598481) \\ r(0.907372191, 0.115641501) & s(0.850025001, 0.421002242) \end{bmatrix}$$

(vii)$(U \wedge V) \otimes_E W = (U \otimes_E W) \wedge (V \otimes_E W)$

$$= \begin{bmatrix} p(0.364680073, 0.496438419) & q(0.432731067, 0.850025501) \\ r(0.076249285, 0.627877989) & s(0.514737191, 0.926666632) \end{bmatrix}$$

($viii$)$(U \vee V) \otimes_E W = (U \otimes_E W) \vee (V \otimes_E W)$

$$= \begin{bmatrix} p(0.432731067, 0.316085559) & q(0.696571267, 0.811937658) \\ r(0.165535175, 0.57664403) & s(0.3646800730, 0.938880653) \end{bmatrix}$$

(ix)$(U \vee V) \wedge W = (U \wedge W) \vee (V \wedge W) = \begin{bmatrix} p(0.6, 0.3) & q(0.8, 0.7) \\ r(0.2, 0.5) & s(0.7, 0.9) \end{bmatrix}$

(x)$(U \wedge V) \vee W = (U \vee W) \wedge (V \vee W) = \begin{bmatrix} p(0.7, 0.3) & q(0.8, 0.6) \\ r(0.5, 0.4) & s(0.7, 0.5) \end{bmatrix}$

4. EXISTING OPERATIONS FOR PYTHAGOREAN FUZZY MATRIX

Silambarasan and Sriram [11] presented the Existing operators of Pythagorean Fuzzy matrices and studied their properties with respect to the algebraic operations. In this section, we study the algebraic properties of Existing operators with respect to the Einstein operations.

Definition: 4.1 [11]

Let $U = (\langle u_{lm\mu}, u_{lm\nu} \rangle)$ and $V = (\langle v_{lm\mu}, v_{lm\nu} \rangle)$ be two PEFMs of same size, then

$$(U @_E V) = \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}}, \sqrt{\frac{u_{lm\nu}^2 + v_{lm\nu}^2}{2}} \right)$$

Definition: 4.2 [11]

New operations for PFMs:

Let $U = (\langle u_{lm\mu}, u_{lm\nu} \rangle)$ and $V = (\langle v_{lm\mu}, v_{lm\nu} \rangle)$ be two PEFMs of same size, then

(i) $U \rightarrow_E V = (\max(u_{lm\nu}, v_{lm\mu}), \min(u_{lm\mu}, v_{lm\nu}))$

(ii) $U \$_E V = (\sqrt{u_{lm\mu} v_{lm\mu}}, \sqrt{u_{lm\nu} v_{lm\nu}})$

(iii) $U \#_E V = \left(\dfrac{\sqrt{2} u_{lm\mu} v_{lm\mu}}{\sqrt{u_{lm\mu}^2 + v_{lm\mu}^2}}, \dfrac{\sqrt{2} u_{lm\nu} v_{lm\nu}}{\sqrt{u_{lm\nu}^2 + v_{lm\nu}^2}} \right)$

If $u_{lm\mu} = v_{lm\mu} = 0$, then, $\frac{u_{lm\mu}v_{lm\mu}}{u_{lm\mu}+v_{lm\mu}} = 0$ and

If $u_{lm\nu} = v_{lm\nu} = 0$, then, $\frac{u_{lm\nu}v_{lm\nu}}{u_{lm\nu}+v_{lm\nu}} = 0$.

Theorem: 4.3

For U and V be two **PFMs** of same size, then

$(i)(U \to_\mathrm{E} V^C)^C \oplus_E (U^C \to_\mathrm{E} V) = (U \oplus_E V)$

$(ii)(U \to_\mathrm{E} V^C)^C \otimes_E (U^C \to_\mathrm{E} \mathcal{V}) = (U \otimes_E V)$

$(iii)(U \to_\mathrm{E} V^C)^C @_\mathrm{E}(U^C \to_\mathrm{E} V) = (U@_\mathrm{E}V)$

$(iv)(U \to_\mathrm{E} V^C)^C \$_\mathrm{E}(U^C \to_\mathrm{E} V) = (U\$_\mathrm{E}V)$

$(v)(U \to_\mathrm{E} V^C)^C \#_\mathrm{E}(U^C \to_\mathrm{E} V) = (U\#_\mathrm{E}V)$

Proof:
Let,

$(U \to_\mathrm{E} V^C) = \left(\max(u_{lm\nu}, v_{lm\nu}), \min(u_{lm\mu}, v_{lm\mu})\right)$

$(U \to_\mathrm{E} V^C)^C = \left(\min(u_{lm\mu}, v_{lm\mu}), \max(u_{lm\nu}, v_{lm\nu})\right)$

$(U^C \to_\mathrm{E} V) = \left(\max(u_{lm\mu}, v_{lm\mu}), \min(u_{lm\nu}, v_{lm\nu})\right)$

(i)**L. H. S** $= (U \to_\mathrm{E} V^C)^C \oplus_E (U^C \to_\mathrm{E} V) =$

$$= \left(\sqrt{\frac{\min(u_{lm\mu}^2, v_{lm\mu}^2) + \max(u_{lm\mu}^2, v_{lm\mu}^2)}{1 + \min(u_{lm\mu}^2, v_{lm\mu}^2)\max(u_{lm\mu}^2, v_{lm\mu}^2)}}, \frac{\max(u_{lm\nu}, v_{lm\nu})\min(u_{lm\nu}, v_{lm\nu})}{\sqrt{1 + (1 - \max(u_{lm\mu}^2, v_{lm\mu}^2))(1 - \min(u_{lm\mu}^2, v_{lm\mu}^2))}} \right)$$

$$= \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \frac{u_{lm\nu}v_{lm\nu}}{\sqrt{1 + (1 - u_{lm\nu}^2)(1 - v_{lm\nu}^2)}} \right) = (U \oplus_E V) = \textbf{R. H. S}$$

(ii)**L. H. S** $= (U \to_\mathrm{E} V^C)^C \otimes_E (U^C \to_\mathrm{E} \mathcal{V})$

$$= \left(\frac{\min(u_{lm\mu}, v_{lm\mu})\max(u_{lm\mu}, v_{lm\mu})}{\sqrt{1 + (1 - \min(u_{lm\mu}^2, v_{lm\mu}^2))(1 - \max(u_{lm\mu}^2, v_{lm\mu}^2))}}, \sqrt{\frac{\max(u_{lm\nu}^2, v_{lm\nu}^2) + \min(u_{lm\nu}^2, v_{lm\nu}^2)}{1 + \max(u_{lm\nu}^2, v_{lm\nu}^2)\min(u_{lm\nu}^2, v_{lm\nu}^2)}} \right)$$

$$= \left(\frac{u_{lm\mu}v_{lm\mu}}{\sqrt{1 + (1 - u_{lm\mu}^2)(1 - v_{lm\mu}^2)}}, \sqrt{\frac{u_{lm\nu}^2 + v_{lm\nu}^2}{1 + u_{lm\nu}^2 v_{lm\nu}^2}} \right)$$

$= (U \otimes_E V) = \textbf{R. H. S}$

Thus $(i), (ii)$ holds.

$(iii), (iv), (v)$ It can be proved similarly.

Example 4.4

Let U and V be two **PFMs** of same size, for $x = \{x, y, z\}$. Suppose,

$(U \to V^C)^C = \begin{bmatrix} p(0.7,0.4) & q(0.6,0.6) \\ r(0.5,0.4) & s(0.6,0.5) \end{bmatrix}$ and $(U^C \to V) = \begin{bmatrix} p(0.8,0.1) & q(0.9,0.5) \\ r(0.9,0.3) & r(0.8,0.4) \end{bmatrix}$

Now,

$(U \rightarrow_E V^C)^C \oplus_E (U^C \rightarrow_E V) = (U \oplus_E V)$

$$= \begin{bmatrix} p(0.927486617, 0.029555933) & q(0.951763208, 0.246598481) \\ r(0.938880653, 0.090340548) & s(0.901523057, 0.15665209) \end{bmatrix}$$

$(U \rightarrow_E V^C)^C \otimes_E (U^C \rightarrow_E V) = (U \otimes_E V)$

$$= \begin{bmatrix} p(0.514737191, 0.411981109) & q(0.509887962, 0.748086243) \\ r(0.421002242, 0.496438419) & s(0.901523057, 0.15665209) \end{bmatrix}$$

$(U \rightarrow_E V^C)^C @_E (U^C \rightarrow_E V) = (U @_E V)$

$$= \begin{bmatrix} p(0.751664818, 0.291547594) & q(0.764852927, 0.552268050) \\ r(0.728010988, 0.35355339) & s(0.707106781, 0.452769256) \end{bmatrix}$$

$(U \rightarrow_E V^C)^C \$_E (U^C \rightarrow_E V) = (U \$_E V) = \begin{bmatrix} p(0.748331477, 0.2) & q(0.734846922, 0.547722557) \\ r(0.670820393, 0.346410161) & s(0.692820323, 0.447213595) \end{bmatrix}$

$(U \rightarrow_E V^C)^C \#_E (U^C \rightarrow_E V) = (U \#_E V) = \begin{bmatrix} p(0.745012917, 0.137198868) & q(0.706018086, 0.543214476) \\ r(0.618122537, 0.339411255) & s(0.678822509, 0.441726104) \end{bmatrix}$

Theorem 4.5

For U and V be two **PFMs** of same size, then

$(i)(V \rightarrow_E U) \oplus_E (U \rightarrow_E V)^C = (U \oplus_E V^C)$

$(ii)(V \rightarrow_E U) \otimes_E (U \rightarrow_E V)^C = (U \otimes_E V^C)$

$(iii)(V \rightarrow_E U) @_E (U \rightarrow_E V)^C = (U @_E V^C)$

$(iv)(V \rightarrow_E U) \$_E (U \rightarrow_E V)^C = (U \$_E V^C)$

$(v)(V \rightarrow_E U) \#_E (U \rightarrow_E V)^C = (U \#_E V^C)$

Proof:
Let,

$(V \rightarrow_E U) = \left(\max(v_{lmv}, u_{lm\mu}), \min(v_{lm\mu}, u_{lmv}) \right)$

$(U \rightarrow_E V) = \left(\max(u_{lmv}, v_{lm\mu}), \min(u_{lm\mu}, v_{lmv}) \right)$

$(U \rightarrow_E V)^C = \left(\min(u_{lm\mu}, v_{lmv}), \max(u_{lmv}, v_{lm\mu}) \right)$

(i) **L. H. S** $= (V \rightarrow_E U) \oplus_E (U \rightarrow_E V)^C$

$= \left(\max(v_{lmv}, u_{lm\mu}), \min(v_{lm\mu}, u_{lmv}) \right) \oplus_E \left(\min(u_{lm\mu}, v_{lmv}), \max(u_{lmv}, v_{lm\mu}) \right)$

$$= \left(\sqrt{\frac{\max(v_{lmv}^2, u_{lm\mu}^2) + \min(u_{lm\mu}^2, v_{lmv}^2)}{1 + \max(v_{lmv}^2, u_{lm\mu}^2)\min(u_{lm\mu}^2, v_{lmv}^2)}}, \frac{\min(v_{lm\mu}, u_{lmv})\max(u_{lmv}, v_{lm\mu})}{\sqrt{1 + (1 - \min(v_{lm\mu}^2, u_{lmv}^2))(1 - \max(u_{lmv}^2, v_{lm\mu}^2))}} \right)$$

$$= \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lmv}^2}{1 + u_{lm\mu}^2 v_{lmv}^2}}, \frac{u_{lmv} v_{lm\mu}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lm\mu}^2)}} \right)$$

$= (U \oplus_E V^C) = $ **R. H. S**

(ii) **L. H. S** $= (V \rightarrow_E U) \otimes_E (U \rightarrow_E V)^C$

$= \left(\max(v_{lmv}, u_{lm\mu}), \min(v_{lm\mu}, u_{lmv}) \right) \otimes_E \left(\min(u_{lm\mu}, v_{lmv}), \max(u_{lmv}, v_{lm\mu}) \right)$

$$= \left(\frac{\max(v_{lmv}, u_{lm\mu})\min(u_{lm\mu}, v_{lmv})}{\sqrt{1 + (1 - \max(v_{lmv}^2, u_{lm\mu}^2))(1 - \min(u_{lm\mu}^2, v_{lmv}^2))}}, \sqrt{\frac{\min(v_{lm\mu}^2, u_{lmv}^2) + \max(u_{lmv}^2, v_{lm\mu}^2)}{1 + \min(v_{lm\mu}^2, u_{lmv}^2)\max(u_{lmv}^2, v_{lm\mu}^2)}} \right)$$

$$= \left(\sqrt{\frac{u_{lm\mu} + v_{lm\nu}}{1 + u_{lm\mu}^2 v_{lm\nu}^2}}, \frac{u_{lm\nu}^2 v_{lm\mu}^2}{\sqrt{1 + (1 - u_{lm\nu}^2)(1 - v_{lm\mu}^2)}} \right)$$

$$= (U \otimes_E V^C) = \mathbf{R.H.S}$$

Thus $(i), (ii)$ holds.

$(iii), (iv), (v)$ It can be proved similarly.

Example 4.6

Let U and V be two **PFMs** of same size, for $x = \{x, y, z\}$. Suppose,

$$(V \to_E U) = \begin{bmatrix} p(0.7,0.4) & q(0.9,0.6) \\ r(0.5,0.4) & r(0.8,0.5) \end{bmatrix} and \ (U \to_E V)^C = \begin{bmatrix} p(0.8,0.1) & q(0.6,0.5) \\ r(0.9,0.3) & s(0.4,0.6) \end{bmatrix}$$

Then we have,

$(V \to_E U) \oplus_E (U \to_E V)^C = (U \oplus_E V^C)$
$$= \begin{bmatrix} p(0.70538071,0.280399854) & q(0.938880653,0.303217704) \\ r(0.57664403,0.334309253) & s(0.851874054,0.246598481) \end{bmatrix}$$

$(V \to_E U) \otimes_E (U \to_E V)^C = (U \otimes_E V^C) = \begin{bmatrix} p(0.057061635,0.851874054) & q(0.421002242,0.798369443) \\ r(0.115641501,0.926666632) & s(0.280399854,0.748086243) \end{bmatrix}$

$(V \to_E U) @_E (U \to_E V)^C = (U @_E V^C) = \begin{bmatrix} p(0.5,0.632455532) & q(0.728010988,0.6) \\ r(0.412310562,0.696419413) & s(0.632455532,0.55226805) \end{bmatrix}$

$(V \to_E U) \$_E (U \to_E V)^C = (U \$_E V^C) = \begin{bmatrix} p(0.264575131,0.565685424) & q(0.670820393,0.6) \\ r(0.387298334,0.6) & s(0.565685424,0.547722557) \end{bmatrix}$

$(V \to_E U) \#_E (U \to_E V)^C = (U \#_E V^C) = \begin{bmatrix} p(0.14,0.505964425) & q(0.618122537,0.6) \\ r(0.363803437,0.516929874) & s(0.505964425,0.543214476) \end{bmatrix}$

Theorem 4.7

For U and V be two **PFMs** of same size, then

$(i) \left((U \oplus_E V) \to_E (U@_E V)^C \right)^C = \left((U@_E V) \to_E (U \oplus_E V)^C \right)^C = (U@_E V)$

$(ii) \left((U \otimes_E V) \to_E (U@_E V)^C \right)^C = \left((U@_E V) \to_E (U \otimes_E V)^C \right)^C = (U \otimes_E V)$

$(iii) \left((U \oplus_E V) \to_E (U\#_E V)^C \right)^C = \left((U\#_E V) \to_E (U \oplus_E V)^C \right)^C = (U\#_E V)$

$(iv) \left((U \otimes_E V) \to_E (U\#_E V)^C \right)^C = \left((U\#_E V) \to_E (U \otimes_E V)^C \right)^C = (U \otimes_E V)$

$(v) \left((U \oplus_E V) \to_E (U\$_E V)^C \right)^C = \left((U\$_E V) \to_E (U \oplus_E V)^C \right)^C = (U\$_E V)$

$(vi) \left((U \otimes_E V) \to_E (U\$_E V)^C \right)^C = \left((U\$_E V) \to_E (U \otimes_E V)^C \right)^C = (U \otimes_E V)$

$(vii) \left((U \oplus_E V) \to_E (U \otimes_E V)^C \right)^C = \left((U \otimes_E V) \to_E (U \oplus_E V)^C \right)^C = (U \otimes_E V)$

Proof:

(i)**L.H.S** $= \left((U \oplus_E V) \to_E (U@_E V)^C \right)^C$

$$= \left(\max \left(\frac{u_{lm\nu} v_{lm\nu}}{\sqrt{1 + (1 - u_{lm\nu}^2)(1 - v_{lm\nu}^2)}}, \sqrt{\frac{u_{lm\nu}^2 + v_{lm\nu}^2}{2}} \right), \min \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \right) \right)^C$$

$$= \left(\min \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \right), \max \left(\frac{u_{lm\nu} v_{lm\nu}}{\sqrt{1 + (1 - u_{lm\nu}^2)(1 - v_{lm\nu}^2)}}, \sqrt{\frac{u_{lm\nu}^2 + v_{lm\nu}^2}{2}} \right) \right)$$

$$= \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}}, \sqrt{\frac{u_{lmv}^2 + v_{lmv}^2}{2}} \right) = (U@_E V) = \left((U@_E V) \to_E (U \oplus_E V)^C \right)^C = \textbf{R.H.S}$$

(iii)**L.H.S** $= \left((U \oplus_E V) \to_E (U\#_E V)^C \right)^C$

$$= \left(\max\left(\frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}}, \frac{\sqrt{2} u_{lmv} v_{lmv}}{\sqrt{u_{lmv}^2 + v_{lmv}^2}} \right), \min\left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \frac{\sqrt{2} u_{lm\mu} v_{lm\mu}}{\sqrt{u_{lm\mu}^2 + v_{lm\mu}^2}} \right) \right)^C$$

$$= \left(\min\left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \frac{\sqrt{2} u_{lm\mu} v_{lm\mu}}{\sqrt{u_{lm\mu}^2 + v_{lm\mu}^2}} \right), \max\left(\frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}}, \frac{\sqrt{2} u_{lmv} v_{lmv}}{\sqrt{u_{lmv}^2 + v_{lmv}^2}} \right) \right)$$

$$= \left(\frac{\sqrt{2} u_{lm\mu} v_{lm\mu}}{\sqrt{u_{lm\mu}^2 + v_{lm\mu}^2}}, \frac{\sqrt{2} u_{lmv} v_{lmv}}{\sqrt{u_{lmv}^2 + v_{lmv}^2}} \right) = (U\#_E V) = \left((U\#_E V) \to_E (U \oplus_E V)^C \right)^C = \textbf{R.H.S}$$

(v)**L.H.S** $= \left((U \oplus_E V) \to_E (U\$_E V)^C \right)^C$

$$= \left(\max\left(\frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}}, \sqrt{u_{lmv} v_{lmv}} \right), \min\left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \sqrt{u_{lm\mu} v_{lm\mu}} \right) \right)^C$$

$$= \left(\min\left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \sqrt{u_{lm\mu} v_{lm\mu}} \right), \max\left(\frac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}}, \sqrt{u_{lmv} v_{lmv}} \right) \right)$$

$$= \left(\sqrt{u_{lm\mu} v_{lm\mu}}, \sqrt{u_{lmv} v_{lmv}} \right) = \left((U\$_E V) \to_E (U \oplus_E V)^C \right)^C = (U\$_E V) = \textbf{R.H.S}$$

(vii)**L.H.S** $= \left((U \oplus_E V) \to_E (U\otimes_E V)^C \right)^C$

$$= \left(\begin{array}{c} \max\left(\dfrac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}}, \sqrt{\dfrac{u_{lmv}^2 + v_{lmv}^2}{1 + u_{lmv}^2 v_{lmv}^2}} \right), \\[2em] \min\left(\sqrt{\dfrac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \dfrac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + (1 - u_{lm\mu}^2)(1 - v_{lm\mu}^2)}} \right) \end{array} \right)^C$$

$$= \left(\begin{array}{c} \min\left(\sqrt{\dfrac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \dfrac{u_{lm\mu} v_{lm\mu}}{\sqrt{1 + (1 - u_{lm\mu}^2)(1 - v_{lm\mu}^2)}} \right), \\[2em] \max\left(\dfrac{u_{lmv} v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}}, \sqrt{\dfrac{u_{lmv}^2 + v_{lmv}^2}{1 + u_{lmv}^2 v_{lmv}^2}} \right) \end{array} \right)$$

$$= \left(\frac{u_{lm\mu}v_{lm\mu}}{\sqrt{1 + (1 - u_{lm\mu}^2)(1 - v_{lm\mu}^2)}}, \sqrt{\frac{u_{lmv}^2 + v_{lmv}^2}{1 + u_{lmv}^2 v_{lmv}^2}} \right)$$

$$= \left((U \otimes_E V) \rightarrow_E (U \oplus_E V)^C \right)^C = (U \otimes_E V) = \mathbf{R.H.S}$$

Thus $(i), (iii), (v), (vii)$ holds.

$(iii), (iv), (vi)$ It can be proved similarly.

Theorem 4.8:
For U and V be two **PFMs** of same size, then

$(i) \left((U \otimes_E V)^C \rightarrow_E (U \oplus_E V) \right) = \left((U \oplus_E V)^C \rightarrow_E (U \otimes_E V) \right) = (U \oplus_E V)$

$(ii) \left((U \oplus_E V)^C \rightarrow_E (U@_E V) \right) = \left((U@_E V)^C \rightarrow_E (U \oplus_E V) \right) = (U \oplus_E V)$

$(iii) \left((U \otimes_E V)^C \rightarrow_E (U@_E V) \right) = \left((U@_E V)^C \rightarrow_E (U \otimes_E V) \right) = (U@_E V)$

$(iv) \left((U \oplus_E V)^C \rightarrow_E (U\#_E V) \right) = \left((U\#_E V)^C \rightarrow_E (U \oplus_E V) \right) = (U \oplus_E V)$

$(v) \left((U \otimes_E V)^C \rightarrow_E (U\#_E V) \right) = \left((U\#_E V)^C \rightarrow_E (U \otimes_E V) \right) = (U\#_E V)$

$(vi) \left((U \oplus_E V)^C \rightarrow_E (U\$_E V) \right) = \left((U\$_E V)^C \rightarrow_E (U \oplus_E V) \right) = (U \oplus_E V)$

$(vii) \left((U \otimes_E V)^C \rightarrow_E (U\$_E V) \right) = \left((U\$_E\$ V)^C \rightarrow_E (U \otimes_E V) \right) = (U\$_E V)$

Proof:
(i)**L.H.S** $= \left((U \otimes_E V)^C \rightarrow_E (U \oplus_E V) \right)$

$$= \left(\begin{array}{l} \max\left(\frac{u_{lm\mu}v_{lm\mu}}{\sqrt{1 + (1 - u_{lm\mu}^2)(1 - v_{lm\mu}^2)}}, \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}} \right), \\ \min\left(\sqrt{\frac{u_{lmv}^2 + v_{lmv}^2}{1 + u_{lmv}^2 v_{lmv}^2}}, \frac{u_{lmv}v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}} \right) \end{array} \right)$$

$$= \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{1 + u_{lm\mu}^2 v_{lm\mu}^2}}, \frac{u_{lmv}v_{lmv}}{\sqrt{1 + (1 - u_{lmv}^2)(1 - v_{lmv}^2)}} \right)$$

$= (U \oplus_E V) = \left((U \oplus_E V)^C \rightarrow_E (U \otimes_E V) \right) = \mathbf{R.H.S}$

(iii)**L.H.S** $= \left((U \otimes_E V)^C \rightarrow_E (U@_E V) \right)$

$$= \left(\max\left(\frac{u_{lm\mu}v_{lm\mu}}{\sqrt{1 + (1 - u_{lm\mu}^2)(1 - v_{lm\mu}^2)}}, \sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}} \right), \min\left(\sqrt{\frac{u_{lmv}^2 + v_{lmv}^2}{1 + u_{lmv}^2 v_{lmv}^2}}, \sqrt{\frac{u_{lmv}^2 + v_{lmv}^2}{2}} \right) \right)$$

$$= \left(\sqrt{\frac{u_{lm\mu}^2 + v_{lm\mu}^2}{2}}, \sqrt{\frac{u_{lmv}^2 + v_{lmv}^2}{2}} \right)$$

$= (U@_E V) = \left((U@_E V)^C \rightarrow_E (U \otimes_E V) \right) = \mathbf{R.H.S}$

(v) **L.H.S** $= \left((U \otimes_E V)^C \rightarrow_E (U\#_E V) \right)$

$$= \left(\max\left(\frac{u_{lm\mu}v_{lm\mu}}{\sqrt{1+(1-u_{lm\mu}^2)(1-v_{lm\mu}^2)}}, \frac{\sqrt{2}u_{lm\mu}v_{lm\mu}}{\sqrt{u_{lm\mu}^2+v_{lm\mu}^2}} \right), \min\left(\sqrt{\frac{u_{lmv}^2+v_{lmv}^2}{1+u_{lmv}^2 v_{lmv}^2}}, \frac{\sqrt{2}u_{lmv}v_{lmv}}{\sqrt{u_{lmv}^2+v_{lmv}^2}} \right) \right)$$

$$= \left(\frac{\sqrt{2}u_{lm\mu}v_{lm\mu}}{\sqrt{u_{lm\mu}^2+v_{lm\mu}^2}}, \frac{\sqrt{2}u_{lmv}v_{lmv}}{\sqrt{u_{lmv}^2+v_{lmv}^2}} \right) = (U\#_{\mathrm{E}}V) = \left((U\#_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = \mathbf{R.H.S}$$

(vii) **L.H.S** $= \left((U\otimes_E V)^C \to_{\mathrm{E}} (U\$_{\mathrm{E}}V) \right)$

$$= \left(\max\left(\frac{u_{lm\mu}v_{lm\mu}}{\sqrt{1+(1-u_{lm\mu}^2)(1-v_{lm\mu}^2)}}, \sqrt{u_{lm\mu}v_{lm\mu}} \right), \min\left(\sqrt{\frac{u_{lmv}^2+v_{lmv}^2}{1+u_{lmv}^2 v_{lmv}^2}}, \sqrt{u_{lmv}v_{lmv}} \right) \right)$$

$$= \left(\sqrt{u_{lm\mu}v_{lm\mu}}, \sqrt{u_{lmv}v_{lmv}} \right) = (U\$_{\mathrm{E}}V) = \left((U\$_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = \mathbf{R.H.S}$$

Thus $(i),(iii),(v),(vii)$ holds.

$(iii),(iv),(vi)$ It can be proved similarly.

Lemma 4.9

For U and V be two **PFMs** of same size, then

$(i)\left((U\oplus_E V) \to_{\mathrm{E}} (U@_{\mathrm{E}}V)^C \right)^C = \left((U@_{\mathrm{E}}V) \to_{\mathrm{E}} (U\oplus_E V)^C \right)^C = \left((U\otimes_E V)^C \to_{\mathrm{E}} (U@_{\mathrm{E}}V) \right)$
$\qquad = \left((U@_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = (U@_{\mathrm{E}}V)$

$(ii)\left((U\oplus_E V)^C \to_{\mathrm{E}} (U@_{\mathrm{E}}V) \right) = \left((U@_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\oplus_E V) \right) = \left((U\oplus_E V)^C \to_{\mathrm{E}} (U\#_{\mathrm{E}}V) \right)$
$\qquad = \left((U\#_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\oplus_E V) \right) = \left((U\oplus_E V)^C \to_{\mathrm{E}} (U\$_{\mathrm{E}}V) \right) = \left((U\$_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\oplus_E V) \right)$
$\qquad = \left((U\otimes_E V)^C \to_{\mathrm{E}} (U\oplus_E V) \right) = \left((U\oplus_E V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = (U\oplus_E V)$

$(iii)\left((U\otimes_E V) \to_{\mathrm{E}} (U@_{\mathrm{E}}V)^C \right)^C = \left((U@_{\mathrm{E}}V) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C = \left((U\otimes_E V) \to_{\mathrm{E}} (\mathcal{U}\#_{\mathrm{E}}\mathcal{V})^C \right)^C$
$\qquad = \left((\mathcal{U}\#_{\mathrm{E}}\mathcal{V}) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C = \left((U\otimes_E V) \to_{\mathrm{E}} (U\$_{\mathrm{E}}V)^C \right)^C = \left((U\$_{\mathrm{E}}V) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C$
$\qquad = \left((U\oplus_E V) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C = \left((U\otimes_E V) \to_{\mathrm{E}} (U\oplus_E V)^C \right)^C = (U\otimes_E V)$

$(iv)\left((U\oplus_E V) \to_{\mathrm{E}} (U\#_{\mathrm{E}}V)^C \right)^C = \left((U\#_{\mathrm{E}}V) \to_{\mathrm{E}} (U\oplus_E V)^C \right)^C = \left((U\otimes_E V)^C \to_{\mathrm{E}} (U\#_{\mathrm{E}}V) \right)$
$\qquad = \left((U\#_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = (U\#_{\mathrm{E}}V)$

$(v)\left((U\oplus_E V) \to_{\mathrm{E}} (U\$_{\mathrm{E}}V)^C \right)^C = \left((U\$_{\mathrm{E}}V) \to_{\mathrm{E}} (U\oplus_E V)^C \right)^C = \left((U\otimes_E V)^C \to_{\mathrm{E}} (U\$_{\mathrm{E}}V) \right)$
$\qquad = \left((U\$_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = (U\$_{\mathrm{E}}V)$

Example 4.10:

Let U and V be two **PFMs** of same size, for $x = \{x,y,z\}$. Suppose,

$(i)\left((U\oplus_E V)^C \to_{\mathrm{E}} (U@_{\mathrm{E}}V) \right) = \left((U@_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\oplus_E V) \right) = \left((U\oplus_E V)^C \to_{\mathrm{E}} (U\#_{\mathrm{E}}V) \right)$
$\qquad = \left((U\#_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\oplus_E V) \right) = \left((U\oplus_E V)^C \to_{\mathrm{E}} (U\$_{\mathrm{E}}V) \right) = \left((U\$_{\mathrm{E}}V)^C \to_{\mathrm{E}} (U\oplus_E V) \right)$
$\qquad = \left((U\otimes_E V)^C \to_{\mathrm{E}} (U\oplus_E V) \right) = \left((U\oplus_E V)^C \to_{\mathrm{E}} (U\otimes_E V) \right) = (U\oplus_E V)$

$$= \begin{bmatrix} p(0.927486617, 0.029555933) & q(0.951763208, 0.246598481) \\ r(0.938880653, 0.090340548) & s(0.901523057, 0.15665209) \end{bmatrix}$$

$(ii)\left((U\otimes_E V) \to_{\mathrm{E}} (U@_{\mathrm{E}}V)^C \right)^C = \left((U@_{\mathrm{E}}V) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C = \left((U\otimes_E V) \to_{\mathrm{E}} (\mathcal{U}\#_{\mathrm{E}}\mathcal{V})^C \right)^C$
$\qquad = \left((\mathcal{U}\#_{\mathrm{E}}\mathcal{V}) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C = \left((U\otimes_E V) \to_{\mathrm{E}} (U\$_{\mathrm{E}}V)^C \right)^C = \left((U\$_{\mathrm{E}}V) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C$
$\qquad = \left((U\oplus_E V) \to_{\mathrm{E}} (U\otimes_E V)^C \right)^C = \left((U\otimes_E V) \to_{\mathrm{E}} (U\oplus_E V)^C \right)^C = (U\otimes_E V)$

$$== \begin{bmatrix} p(0.514737191, 0.411981109) & q(0.509887962, 0.748086243) \\ r(0.421002242, 0.496438419) & s(0.901523057, 0.15665209) \end{bmatrix}$$

$(iii)\left((U \oplus_E V) \to_E (U@_E V)^C\right)^C = \left((U@_E V) \to_E (U \oplus_E V)^C\right)^C = \left((U \otimes_E V)^C \to_E (U@_E V)\right)$

$= \left((U@_E V)^C \to_E (U \otimes_E V)\right) = (U@_E V)$

$= \begin{bmatrix} p(0.751664818, 0.291547594) & q(0.764852927, 0.552268050) \\ r(0.728010988, 0.35355339) & s(0.707106781, 0.452769256) \end{bmatrix}$

$(iv)\left((U \oplus_E V) \to_E (U\$_E V)^C\right)^C = \left((U\$_E V) \to_E (U \oplus_E V)^C\right)^C = \left((U \otimes_E V)^C \to_E (U\$_E V)\right)$

$= \left((U\$_E V)^C \to_E (U \otimes_E V)\right) = (U\$_E V)$

$= \begin{bmatrix} p(0.748331477, 0.2) & q(0.734846922, 0.547722557) \\ r(0.670820393, 0.346410161) & s(0.692820323, 0.447213595) \end{bmatrix}$

$(v)\left((U \oplus_E V) \to_E (U\#_E V)^C\right)^C = \left((U\#_E V) \to_E (U \oplus_E V)^C\right)^C = \left((U \otimes_E V)^C \to_E (U\#_E V)\right)$

$= \left((U\#_E V)^C \to_E (U \otimes_E V)\right) = (U\#_E V)$

$= \begin{bmatrix} p(0.745012917, 0.137198868) & q(0.706018086, 0.543214476) \\ r(0.618122537, 0.339411255) & s(0.678822509, 0.441726104) \end{bmatrix}$

5. CONCLUSION

In this paper, we discussed algebraic properties, these properties will be very useful to solve equalities on Einstein operations of Pythagorean Fuzzy matrices. From the result of algebraic properties, we can easily find some existing operations in detail. This paper developed some new results which are associated with the standard Pythagorean fuzzy implication. Finally, we proved new relations which relate to Pythagorean Fuzzy matrices. These relations will help to solve some equalities on Einstein operations of Pythagorean Fuzzy matrices are established with suitable numerical examples

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A STUDY ON IMPACT OF CASE STUDIES ON LEARNER'S PERSPECTIVE UNDERSTANDING

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ABSTRACT
The Indian education system mainly follows the lecture style of delivery from the pre-primary to the graduate level. Therefore the case based approach is fairly unknown to Indian students. Recently, case pedagogy has rapidly replaced the mode of lecturing in higher education institutes in India, particularly in business management colleges. Case-based pedagogy is a valuable tool for applying management principles and ideas to organizational contexts. We conducted a survey of respondents regarding their perspective of understanding of concepts using a case study as teaching pedagogy.

Keywords: Case study, Teaching Pedagogy, Management

INTRODUCTION
From its inception as a systematic research discipline in the early 19th century, management education underwent numerous shifts in its design of content, curriculums, and pedagogy. Over the years, the case teaching approach has been a prevalent method of teaching in Business Schools, especially in the western world where it was popularized by the Harvard Business School (Harling & Akridge, 1998). Analysing real-world cases has since become a standard teaching method in industry, law and management studies.

A case study is a research method in the social and life sciences that involves an up-to-date, profound and detailed examination of a specific case. A case study in industry, for example, may study the approach of a particular company. Typically, the case clearly defines as a specific situation, reflects on decisions and issues related to this decision, and is organised so that the reader is invited to play the role of a decision-maker in the case, to take the decision (Harling & Akridge, 1998); (Antill, 2007).

Case studies are useful teaching tools, particularly for MBA students, as they (1) provide students with an understanding of the functioning of the organisations, and (2) provide them with the chance to develop real problems solutions in business environments. Case studies also allow students to apply their training and experience to the corporate problems or challenges presented in cases.

LITERATURE REVIEW
As future managers and leaders, our students need to develop the ability to predict and react linearly, analytically and also creatively and intuitively to organizational problems and business problems. In short, both analytical and creative thinking skills need to be developed.

When management educators rethink the traditional view of this pedagogy, case method instruction has the potential to build all sets of skills. For many years, the faculty has believed that the case approach is ideally suited over teaching students how to recognize and overcome business problems by finding and analyzing the data from their respective situation.

The case method has proven to be particularly useful for this task, as cases provide a framework for interpreting expertise in the field of study and adapting the information to practical situations. The case method improves the students ' ability to reason by encouraging them to perform analysis, participate in an exploratory debate, and consider "best possible" instead of "right/wrong" solution. The case approach encourages professional skills growth (Harling & Akridge, 1998).

(Barnes, Christensen, & Hansen, 1994) When students and teachers interact using a case study pedagogy method, the students' ability to solve problems increase. The way they communicate with one another will come easier and their decisions will be more accurate if the students work with a non-fictive company. The impact that case study teaching has differs from person to person. Something that can be seen in this research is that teaching method which includes case studies is more effective than those that include traditional methods. What most of the authors are saying is that by using the case study method, the students hunger to learn and seek more information will increase. Because of a better understanding, their self-confidence will increase as long as they are guided in the right direction.

(Nath, 2005) describes the different types of case studies used in the academic field. She has also highlighted how these case studies are different and the impact they have on learners. From this paper, we come to know how the case study teaching method helps in bridging the gap between practical and theoretical world.

(Bonney, 2015) In his article he mentions that the teaching method of case study increases student performance and understanding of learning gains by stating that case studies help to improve student learning, whatever the origin of the case study. Students are better able to understand the practical aspects which the teacher wants to direct towards them. This also leads to better performance in the examinations.

(Dupuis & Persky, 2008) In the last few decades, there has been a growing interest in the use of active learning methods that involve learners in the learning process rather than being passive observers. Student-centred instruction and active learning methods such as case studies, problem-solving, and guided instruction, give students opportunities to connect new information to their own experiences and provide them with models for applying new knowledge which prepares them for similar situations in real-life after they graduate. In particular, case studies that use real-life narratives to explore the content of specific topic areas have been a popular means of engaging students in active learning in the classroom. One of the essential criteria of the case-study method is a group or teamwork because learners share information while working together. (Hilburn, Towhidnejad, Nangia, & Shen, 2006) explained that the case study method is particularly valuable for improving problem-based learning, which requires both self-directed and teamwork skills.

In addition to building strategic, decision-making, leadership and collaboration skills for students (Leenders, Erskine, & Mauffette-Leenders, 2001), The case study particularly seeks to improve the problem-solving skills of students, since it best fits three forms of learning goals – cognitive, affective and functional (Mesny, 2013). The students engage in active learning exercises like critical thinking, discussions and brainstorming in problem-solving case studies individually. All these practices need to be undertaken by students in their own curriculum instead of passively listening to lectures, taking notes, memorizing ideas and completing specified skills assessments.

(O'Sullivan & Copper, 2003) talks about the use of case studies in the field of marketing education. In this case study, the author recognises the problem of effectiveness of marketing tools and theories to explain the concepts to the students. The author proposes that case studies must be used and should be customised on regular intervals to keep them relevant with the students.

(Caldwell, Weishar, & William^Glezen, 1996) investigated the effect of cooperative learning techniques on introductory accounting students' perceptions of accounting. Collaborative learning is a formal type of small group study that is based on interdependence, responsibility, social skills and community interaction, where students work together to achieve a common goal.

(Tootoonchi, Lyons, & Hagen, 2002) examined MBA students' attitude about how teaching methodologies and instructor characteristics affect their learning. Participants favour the use of real world example in class significantly, accompanied by open classroom discussion as the methods that most positively affect their knowledge. The learners further show that the most important characteristics of the teachers which can support their learning include: communication skills, understanding of the subject, general behaviour, honesty and general temperament.

(Popil, 2011) observed that critical thinking ability was enhanced in students when case studies were implemented as a teaching method. Based on his experimental results and an increase in student performance, (Mayo, 2004) concluded that case-based instruction promotes critical thinking.

(Yadav, Megan, Shaver, Meckl, & Firebaug, 2014) observed that the conceptual understanding of learners was substantially enhanced when they learned from case-based instruction, as compared with traditional teaching methods. They also noted that the teaching method of case study helps the learners become more involved and connected to the real world.

RESEARCH METHODOLOGY
- **Sample Size** – The study is conducted with the help of 129 respondents who have minimum work experience of 1 year.

- **Data Collection Instrument** – The structured questionnaire is used as an instrument.

- **Data Collection Method** – Non-probabilistic sampling is used for the study. Variables used in this study are Independent (Attitude, Practice) and Dependent (Overall satisfaction / Practice).

OBJECTIVES

- To study the impact of of case study on leraner's perspective understanding

- To study the relationship between attitude and practice of usage of case study on overall satuisfaction of the respondents understanding of concepts

ANALYSIS

As the statement for the scale is coming from various research papers, we went for reliability study with the help of Cronbach's Alfa. After getting the satisfactory value (Alpha=0.8) we have checked the unidimensionality of the construct. After the construct, the impact of the case study on learners perspective understanding was analysed.

HYPOTHESIS

H_{o1}: There is no significant impact of the case study on the understanding of Leraner 's perspective

Ha_1: There is a significant impact of the case study on the understanding of Leraner 's perspective

H_{o2}: There is no significant relationship between repsondents attitude and overall satisfaction of usage of case study

Ha_2: There is a significant relationship between repsondents attitude and overall satisfaction of usage of case study

H_{o3}: There is no significant relationship between the practice of usage of the case study and the overall satisfaction

Ha_3: There is a significant relationship between the practice of usage of the case study and the overall satisfaction

DATA ANALYSIS & FINDINGS:

Demograhics

Age group	Sub Groups	Frequency	Percentage
	18-22	23	17.8%
	23-27	69	53.5%
	28-32	46	35.6%
	32 and above	1	0.7%
Gender	Male	80	62%
	Female	49	38%
Educational Qualification	HSC	3	2.3%
	Graduate	46	35.6%
	Post graduate	78	60.5%
	PhD	2	1.6%
Work Experience	1-2 years	41	31.8%
	2-5 years	71	55%
	5-10 years	17	13.2%

Inferential Analysis:

Correlations		Satisfaction	Attitude	Practices
Satisfaction	Pearson Correlation	1	.255**	.237**
	Sig. (2-tailed)		.003	.007
	N	129	129	129
Attitude	Pearson Correlation	.255**	1	.801**
	Sig. (2-tailed)	.003		.000
	N	129	129	129
Practices	Pearson Correlation	.237**	.801**	1
	Sig. (2-tailed)	.007	.000	
	N	129	129	129
. Correlation is significant at the 0.01 level (2-tailed).				

Interpretation:

1. Above results indicate that correlation value between satisfaction and attitude is 0.255. The corresponding p-value is 0.003. It is less than 0.05. Therefore correlation is positive and significant.

2. Above results indicate that correlation value between satisfaction and practices is 0.237. The corresponding p-value is 0.007. It is less than 0.05. Therefore correlation is positive and significant.

Conclusion:

1. There is a high impact of attitude on satisfaction.

2. There is a high impact of practices on satisfaction.

For findings of hypothesis, regression is applied. Results of the regression model are as follows.

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	**Regression**	5806.451	2	2903.225	4.602	.012[b]
	Residual	79492.820	126	630.895		
	Total	85299.271	128			
a. Dependent Variable: Satisfaction						
b. Predictors: (Constant), Practices, Attitude						

Above results indicate that calculated p-value is 0.012. It is less than 0.05. Therefore the impact of independent variables is significant. The conclusion is the Regression model is fit for analysis.

To develop the regression model following table is obtained.

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	**(Constant)**	30.958	10.564		2.930	.004
	Attitude	.286	.224	.184	1.276	.204
	Practices	.135	.217	.090	.623	.534
a. Dependent Variable: Satisfaction						

Above table indicate that constant value =   30.958

Coefficient of Attitude   =   0.286

Coefficient of Practices   =   0.135

Therefore, Regression equation is as follows

Satisfaction = 30.958 + 0.286 *Attitude + 0.135 * Practices

FINDINGS, & CONCLUSION

There is a high impact of attitude on satisfaction. There is a high impact of practices on satisfaction.

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GROWING INTER-RELATIONSHIP BETWEEN URBAN AND RURAL SETTINGS

DR. RISHU TOMAR

ABSTRACT

Modern day policymaking has all it takes to accommodate diverse interests of people and work for the marginalized sections of India, hitherto been neglected, with proactive use of new and emerging technologies like AI, Machine Learning, Quantum Computing, Internet of Things and Nanotechnology along with empiricism and strong computational abilities. We have set bigger targets of growth like to become $5 trillion economy by 2025 and $10 trillion economy by 2030. Not only the financial growth indicators power our efforts towards sustainable development but effective climate targets of achieving carbon neutrality by 2070 and fulfilling Sustainable Development Goals (SDGs) by 2030, too, ignite our research and development processes. In 21st century India, thanks to geopolitics and domestic credentials, our position has improved a lot over the time due to strategic leverage and bargaining power. It doesn't materialize automatically, however, conscious and risky steps have been taken in the past with well calculated options in order to influence strategic global policymaking.

Keywords: Growth, Development, Vibrant Democracy, Sustainable Development Goals, Strategic Leverage

VISION

We are in 75th year of Indian independence with vibrant democracy, strong market credentials and effective macro economic indicators. To reach on this platform has required a lot of effort from all the stakeholders involved in the development of nation. It has often been said in the circles that without a certain vision, all the paths we take don't lead us to destinies. Indian story has been quite mixed, if, to judge by the programs initiated for the welfare and the path of implementation. It's not that we complain of the efforts taken in the last 75 years but critical analysis do provide a lot of answers for the future mistakes to mitigate and improve.

In 21st century India, thanks to geopolitics and domestic credentials, our position has improved a lot over the time due to strategic leverage and bargaining power. It doesn't materialize automatically, however, conscious and risky steps have been taken in the past with well calculated options in order to influence strategic global policymaking. And, it goes without saying that *international leverage has given us additional push at the domestic level to further strong agendas and policies.*

Modern day policymaking has all it takes to accommodate diverse interests of people and work for the marginalized sections of India, hitherto been neglected, with proactive use of ***new and emerging technologies like AI, Machine Learning, Quantum Computing, Internet of Things and Nanotechnology*** along with empiricism and strong computational abilities. We have set bigger targets of growth like to become $5 trillion economy by 2025 and $10 trillion economy by 2030. Not only the financial growth indicators power our efforts towards sustainable development but effective climate targets of achieving ***carbon neutrality*** by 2070 and fulfilling ***Sustainable Development Goals (SDGs)*** by 2030, too, ignite our research and development processes.

IMPLEMENTATION

India's success story demands ***accommodating interests of diverse sections of people, empirical based policy making, sustainable development, optimal utilization of resources, enabling participative democracy*** and ***ensuring democratic credentials*** in this age of radical polarization and populism. To streamline all the motives is to define specific indicators to work upon and one of them is strong, effective, efficient and workable ***urban-rural*** setting relationship.

Several issues range in both the settings, however, interlinkages between technology, demand of the markets, demographic growth and experience provide us with hope to transform individual aspects into unison for nation's development. We have all the required resources to complement greater urgency to growth and development in order to cater to the new age demands of people and demography. Issues like migration, sanitation, employment, avenues of opportunity and safety and security; they define the inherent mindset of the people living in both the settings. What we need to understand here is the inevitability of their collective potential for vision of India and in resolving differences between both of them.

CHARACTERISTICS

As stated above, implementation measures involve different characteristics emanating out of social, political, economic, technological, cultural and scientific aspects. To sustainably grow and ensure strengthening relationship between urban and rural settings is to first outline the provision of change and work towards capacity building, finessing innate potential and ensuring desired results.

Socially, urban centers have taken over the cues of rural settings in enabling majority of the population from rural areas to migrate towards cities in search of better livelihood opportunities and a decent standard of life. Push and Pull migration happening in this particular context doesn't explain the full story because there's lack of opportunities back home and exploitative tendencies at rural levels which defines this temporary, or sometimes, permanent, shift of population. However big the vision India had set for itself, Gandhi's words of **ensuring atmanirbharta at local level** and **enabling participative governance** are only going to provide adequate solutions and support Rurban relationship.

Technologically, rural settings, these days, thanks to increasing mobile and internet penetration, has kind of matched urban centers. Despite support of Information and Communication Technologies (ICT) along with ITeS in cities, rural settings are doing their bit to match up to the standards set by cities in providing electronic solutions to people. E-commerce, delivery of services, education, health and consulting mechanisms; all have been enjoyed by the virtual place, giving push to equality in services and opportunities to the people of rural settings.

Lack of awareness and access to the effective technologies are problems which governments, centre, state and local, are working upon to ease the pressure and ensure availability and accessibility. There's been an issue of internet pricing and spurious costs of e-services spiraling up the ante and robbing the people of rural areas with equal opportunities to grow and sustain their lives with empowerment and quality of life.

Politically, the levers of power have been decentralized by constitutional means and statutory aspects, thus giving rise to decentralization and greater participation in political processes of rural people. That has given them the scope and scale to not only interact with confidence but also transform their lives for good. Increased linkages between rural and urban settings enable people in both the categories to explore each other's ways of life to adapt and adopt sustainable practices for future.

Dexterity of isolation and particularism, hitherto practiced and perceived to be the norm between both the lifestyles, now find difficulty to materialize due to increased globalization and sharing of ideas.

Culturally, there has been an increase in the socio-politico-economic interaction between both the settings, giving rise to greater acceptance and cooperation. The social media and electronic convergence has played a pivotal role in connecting the dots between people of both settings to realize the gravity of the situation and work towards collaborative and sustainable development.

FUTURE

It is imperative upon all the stakeholders involved in the process of furthering integration and inter-relationship between urban and rural settings to continue the process and up the ante to streamline the errors in order to facilitate solution oriented approach. Greater and wise use of technology with decent rules and guidelines in the ambit of democracy is going to guide the real potential of demographic dividend of India.

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OPTIMAL MATERIAL FLOW ANALYSIS FOR SOLID WASTE MANAGEMENT: A GOAL PROGRAMMING APPROACH

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ABSTRACT

The present study attempts to assess the risk associated with various waste management activities in relative terms and presents multi-objective transportation problem by using goal programming based multi time step optimal material flow analysis model to achieve satisfaction of multiple objectives of economy and health and environmental risk. The model selects various treatment and disposal facilities from a given set and allocates optimum quantities of waste to them along chosen transportation routes, depending on different priorities to cost and risk. An illustrated hypothetical example of municipal solid waste management is presented to demonstrate the usefulness of the proposed formulation.

Keywords: Municipal solid waste, goal programming, integrated waste management, transportation problem, multi-objective optimization, optimal material flow

1. INTRODUCTION

Municipal Solid Waste Management (MSWM) is getting increased attention at national and local levels. The specific goals of each community for implementing MSWM plans depend on site-specific conditions and issues. For instance, a community facing a landfill space crisis may set a goal to reduce the amount of waste sent to landfill disposal and may consider source reduction, waste diversion through recycling, and volume reduction alternatives such as converting waste to energy. The most appropriate choice, however, is often not clear. E.g. if the market prices of recyclable materials are low, then a recycling program may not be as economical as one of the other options. To add complexity to this problem, landfill space may be very limited, making recycling an attractive option regardless of low market prices for recyclable materials. Each step-in waste management (collection, recycling, treatment, disposal) could be accomplished through different technological options, and an overall MSWM overall strategy should include in most cases at least one technological option for each step. Decision makers are then faced with a problem of multiple dimensions: they need to select from multiple technological options to manage municipal waste from the generation point to the final disposal point to create an overall strategy, and they must evaluate each overall strategy for the competing objectives of cost effectiveness and environmental impact reduction. Given the large number of available options for MSWM and the interrelationships among these options, identifying MSWM strategies that satisfy economic or environmental objectives is a complex task. Simulation of MSWM is used in this work to help the decision makers with the screening and identification of MSWM strategies Eric Solano (2012).

Various deterministic multi-objective programming models have been applied for planning solid waste management systems. Thus, objective of this paper is to present goal programming based optimal material flow analysis (OMFA) model addressing multiple goals of cost, waste flow and requirement of facility centers P. K. Ahluwalia et al. (2007).

However, the organization of the present paper is as, introduction and review of literature is given in the first and second section respectively, followed by that methodology, notations, assumptions are discussed in section three. In fourth section model formulation is explained, model application with numerical application is given in fifth section. Then results and discussion is described in sixth section. Finally, conclusions are explained in seventh section.

2. REVIEW OF LITERATURE

2.1 Optimization Analysis Related to Waste Management

Zografos et al. (1989) suggested a multi-objective formulation of hazardous waste routing problem using goal programming approach to address population at risk, risk imposed to special population categories, travel time and property damages.

Zografos et al. (1990) proposed a combined location-routing model examining trade-offs between hazardous waste transportation and disposal risks, routing risk and travel time.

Chang et al. (1996) analyzed the potential conflict between environmental and economic goals using multi-objective, mixed integer programming technique, and evaluated sustainable strategies for waste management in

a metropolitan region. The information incorporated into the optimization objectives included economic impacts, characterized by operational income and cost for waste management, air quality impacts from discharges of target pollutants due to waste incineration, noise impacts from various types of facilities operation, and traffic flow increments by garbage truck fleets.

Giannikos (1998) presented a goal programming model for locating disposal and treatment centers and routing hazardous wastes through an underlying transportation network. Four objectives were considered: (1) minimization of total operating cost, (2) minimization of total perceived risk, (3) minimization of maximum individual risk, and (4) minimization of maximum individual disutility.

Nema et al. (1999) proposed a model based on multi-objective integer programming approach to suggest optimal configuration of waste management facilities. Utility function approach was used to address multiple objectives of cost and environmental risk.

Sharma et al. (2007) presented a mixed integer linear programming model with a single objective of minimization of cost, aimed at facilitating better leasing and logistics decisions (including end-of-life disposal options), from the perspective of an electronic equipment leasing company.

On the basis of all the above literature review we are trying to apply an effective goal programming approach for optimal solid waste material flow analysis.

2.2 Data Uncertainty in Waste Management

The success of a planning critically depends on the accuracy of parameters. The parameter values are likely to deviate from estimated ones during implementation of planning. In an optimization model the uncertainty can be incorporated using grey technique, fuzzy systems and/or stochastic modeling. A number of researchers have applied these techniques to consider the effect of uncertainty in the integrated solid waste management (ISWM) models.

Grey programming has been widely used by researchers to incorporate uncertainty in ISWM (e.g., Huang et al. (1994); Huang et al. (1995a, 1995b); Huang et al. (1997); Huang et al. (2005)). The output of grey programming method/ technique is within upper and lower bounds and does not reflect the distribution of output within these bounds.

Fuzzy techniques have also been used for addressing the uncertainties due to human impreciseness. Various decision support models have addressed uncertainty in the input parameters using fuzzy techniques. A combination of grey programming with fuzzy linear programming has been used by Chang et al. (1997). Chang et al. (1997) applied fuzzy goal programming for considering the impreciseness of the decision maker's preferences associated with multiple goals.

Stochastic modeling is another way for addressing uncertainty and is dependent on the probability range of parameter values. Abundance of stochastic uncertainty within any solid waste management system renders many optimization approaches relatively unsuitable for practical implementation purposes, since they provide no effective mechanism for directly incorporating system uncertainties into their solution construction (Coyle (1973); Brown et al. (1974); Liebman (1975); Gottinger (1986); Tchobanoglous et al. (1993); MacDonald (1996)). Consequently, Monte Carlo simulation methods Kalos (1986) have been used in attempts to circumvent these uncertainty shortcomings (Bodner et al. (1970); Openshaw et al. (1985); Baetz (1990); Wang et al. (1994)). Monte Carlo simulation has been stated as one of the most effective quantification method for uncertainties and variability among the environmental system analysis tools available La Grega et al. (1994). The method makes all the parameters vary at random in a given range. The randomly selected values from all the parameter are inserted as parameter input. Model calculations produce output values reflecting the combined parameter uncertainties. Although, it does not provide a formal mechanism for producing best solutions, simulation contributes an effective means for comparing stochastic system performance.

2.3. Need for the Present Study

Management of waste has significant issues of health and risk associated with it. Although several studies have addressed the issue of risk during the management of hazardous waste, they have not been specifically implemented to waste categories. Also, waste has significant reuse and the dilemma to either send it to a reuse facility (which will make it reappear in future years as waste) or recover the recyclables by sending it to processing facilities can only be resolved by a multi-time step model. It is to be noted that the multi-time step model should consider the reappearance of the waste after its secondary or tertiary uses. Also, there is a need to simultaneously address uncertainty in waste generation quantities while analyzing the tradeoffs between cost and associated risks.

3. METHODOLOGY

Goal programming based optimal material flow analysis model performed for municipal solid waste management. The proposed model can be applied to any regional network of source nodes; processing / recycling / treatment facilities, reuse facilities and disposal facilities. The model considers varying quantities of waste generation in various time steps. The waste going for reuse in a certain time step is again analyzed in future time steps depending upon the assumed / known reuse time range for that particular waste type. This feature of the model is particularly useful for waste streams such as MSW, E-wastes, hazardous waste etc. Because, while analyzing the tradeoffs between various management options (reuse, recycle and land filling) for a single time step, it may seem beneficial to reuse as much as possible. However if we take into account its reappearance as waste in future, it may not be the most optimum option from economic point of view, as cost of land filling would increase with each time step not to mention the constraint of availability of landfill space. The selection of various facilities and allocation of waste to these facilities is decided keeping in mind the achievement of a certain objective over all the time steps Eric Solano (2012).

3.1 NOTATIONS

1) *i = 1; 2; 3; 4* for waste to energy (WTE), composting (C), recycling (R) and landfill (l) facility respectively;

2) *Sorting points / segregation N = 1, 2, 3, 4.*

3.2 Assumptions

1) Three-time steps are considered for the present study viz. each time step of being four months.

2) Four facilities are considered as composting facility, a material recycling facility and WTE and landfill facility for the residues from all the facilities.

3) All facilities are operated 365 days per year.

4) Each waste can either go to recycling or composting or waste to energy facilities or can go to either of the disposal (with residue from all stated facilities) facilities.

5) Due to changes in MSW generation rates in different time periods, it is demonstrated that waste generation and different costs are increasing order.

4. MODEL FORMULATION

The proposed model has been formulated using goal programming approach. The decision variables in this mathematical formulation are: i) waste quantities traveling on a set of transportation routes; ii) decision variables for location of a set of facilities; and iii) the quantities being processed/stored/disposed at various facilities.

The distinguishing feature of GP is that the goals (targets that the decision-maker would ideally like to achieve for each goal) are satisfied in ordinal sequence. i.e., the solution of the GP problem involves achieving some higher goals first, before the lower order goals are considered. Since it is not possible to achieve every goal to extent desired by the decision-maker, attempts are made to achieve a 'satisfactory' level of all his goals rather than optimum solution for a single goal. In GP, instead of trying to minimize or maximize the objective function directly as in linear programming, the deviations from established goals within the given set of constraints are minimized. The deviational variables ate represented in two dimensions, both positive and negative deviations from each goal and sub goal. The objective function then becomes the minimization of a sum of these deviations based on the relative importance within the preemptive priority structure assigned to each deviation.

5. MODEL APPLICATION

With *m* goals, the general goal programming model

$$Minimize\ Z = \sum_{i=1}^{m} \sum_{r=1}^{k} P_r(w_i^- d_i^- + w_i^+ d_i^+) \quad (5.1)$$

Subject to the constraints

$$\sum_{j=1}^{n} a_{ij} x_j + d_i^- - d_i^+ = b_i; \quad i = 1, 2, \dots, m \quad (5.2)$$

And $x_j, \ d_i^-, \ d_i^+ \geq 0$

Where x_j represents a decision variable which is under the control of the decision-maker, whereas ranking coefficient P_r; weights w_i; matrix of coefficient, a_{ij} and the constant, b_i are not under the direct control of decision-maker. d_i^-, and d_i^+ are deviational variables representing the amount of under and over-achievement of ith goal, respectively.

5.1 Multi- OBJECTIVE Transportation Problems

The basic transportation problem (TP) was originally developed by Hitchcock in 1941 Hitchcock (1941). Efficient methods for finding solution were developed, primarily by Dantzig in 1951 Dantzig (1951) and then by Charnes, Cooper and Henderson in 1953 Charnes A. et al. (1953). In real life situations, the TP usually involves multiple, conflicting and unequal objective functions. This type of problems is called multi-objective transportation problem (MOTP). The mathematical model of MOTP can be stated as follows: Osuji et al. (2014).

$$min\, Z^k(x) = \sum_{i=1}^{m}\sum_{j=1}^{n} C_{ij}^k x_{ij}, \quad (5.3)$$

Subject to

$$\sum_{j=i}^{n} x_{ij} = a_{i,}\ i = 1,2,\dots,n \qquad (5.4)$$

$$\sum_{i=1}^{m} x_{ij=}b_{j}; \quad j = 1,2,\dots,m \qquad (5.5)$$

$$x_{ij} \geq 0, \qquad i = 1,2,\dots\dots,m;\ j = 1,2,\dots\dots,n;\ k = 1,2,\dots\dots,k$$

Where $Z^k(x) = \{Z^1(x), Z^2(x), \dots\dots, Z^k(x)\}$ is a vector of k objective functions, the superscript on both $Z^k(x)$ and C_{ij}^k are used to identify the number of objective functions *(k = 1,2,.....,k),* and m and n are the number of sources and destinations respectively.

$$a_i > 0 \quad \forall\, i, \qquad b_j > 0 \quad \forall\, j, \qquad C_{ij}^k \geq 0\ \forall\, i,j$$

And

$$\sum_{i=1}^{m} a_i = \sum_{j=1}^{n} b_j$$

5.2 Numerical Application

A hypothetical waste management system is considered wherein a manager / city authority is responsible for allocation waste flows from four segregation (sorting) points, to four treatment facilities. An existing landfill, recycling, composting and waste to energy facilities are available to serve the municipal solid waste management disposal needs. The relevant information is given in the table no. 1. The upper left corner in each cell gives the amount of waste (in ton) transported on the corresponding route and lower left corner in each cell gives the unit transportation cost per unit on that route. During the planning period, manager is unable to meet whole demand of facility centers. However, city authority has to trying to fulfill demand of all processing / facility centers within time i.e. reliability of demand of the each facility from its sorting points, minimize the total transportation cost and minimize the total transportation of wastes. The transportation cost and wastes to be transported from i^{th} source to j^{th} destination are given in the following table.

Table No. 1: The transportation cost and wastes to be transported from i^{th} source to j^{th} destination

Destination→ Nodes / Sources ↓	L	R	C	WTE	Supply
N_1	240 (x_{11}) 140	290 (x_{12}) 210	180 (x_{13}) 180	230 (x_{14}) 130	420
N_2	330 (x_{21}) 240	200 (x_{22}) 130	290 (x_{23}) 210	320 (x_{24}) 230	480
N_3	210 (x_{31}) 120	420 (x_{32}) 300	120 (x_{33}) 90	200 (x_{34}) 110	360

	250	300	190	240	
N₄	(x₄₁) 130	(x₄₂) 220	(x₄₃) 190	(x₄₄) 140	600
Demand	260	444	520	640	1860

Let P be the priority level of goal. Here we assume that P1, P2 and P3 are the priority levels of the goals. X_{ij} be the amount to be transported from i^{th} supplier to j^{th} destination.

P1: Demand of all facility centers must be satisfied i.e. reliability in transportation.

P2: Minimize the total transportation cost.

P3: Minimize the total transportation waste.

Let;

$$d_i^+ = over\ achievement\ of\ the\ goals\ or\ constaints\ in\ the\ i^{th} equation$$

$$d_i^- = under\ achievement\ of\ the\ goals\ or\ constaints\ in\ the\ i^{th} equation$$

MOTP with multi dimensional goal programming model, first we have to formulate the model constraints on the basis of our goals.

P1: City authority has determined that demand of all facility centers must be satisfied within time i.e. reliability of the each facility from his sorting point is meet.

$$240x_{11} + 330x_{21} + 210x_{31} + 250x_{41} + d_1^- - d_1^+ = 260 \qquad\qquad (5.6)$$
$$290x_{12} + 200x_{22} + 420x_{32} + 300x_{42} + d_2^- - d_2^+ = 440 \qquad\qquad (5.7)$$
$$180x_{13} + 290x_{23} + 120x_{33} + 190x_{43} + d_3^- - d_3^+ = 520 \qquad\qquad (5.8)$$
$$230x_{14} + 320x_{24} + 200x_{34} + 240x_{44} + d_4^- - d_4^+ = 640 \qquad\qquad (5.9)$$

P2: Minimize the total transportation cost

$$\sum x_{ij}c_{ij} + d_5^- - d_5^+ = 0; \quad for\ i,j$$

i.e.

$$140x_{11} + 210x_{12} + 180x_{13} + 130x_{14} + 240x_{21} + 130x_{22} + 210x_{23} + 230x_{24} + 120x_{31} + 300x_{32}$$
$$+ 90x_{33} + 110x_{34} + 130x_{41} + 220x_{42} + 190x_{43} + 140x_{44}$$

$$+d_5^- - d_5^+ = 0 \qquad\qquad (5.10)$$

P3: Minimize the total transportation waste.

$$\sum x_{ij}t_{ij} + d_6^- - d_6^+ = 0; \ for\ i,j$$

i.e.

$$240x_{11} + 290x_{12} + 180x_{13} + 230x_{14} + 330x_{21} + 200x_{22} + 290x_{23} + 320x_{24}$$

$$+210x_{31} + 420x_{32} + 120x_{33} + 200x_{34} + 250x_{41} + 300x_{42} + 190x_{43} + 240x_{44} + d_6^- - d_6^+ = 0 \quad (5.11)$$

Hence, MOTP with multi dimensional goal programming model given as follows,

$$Minimize\ Z = P_1(d_1^- + d_2^- + d_3^- + d_4^-) + P_2 d_5^+ + P_3 d_6^+$$

Subject to;

$$240x_{11} + 330x_{21} + 210x_{31} + 250x_{41} + d_1^- - d_1^+ = 260$$
$$290x_{12} + 200x_{22} + 420x_{32} + 300x_{42} + d_2^- - d_2^+ = 440$$
$$180x_{13} + 290x_{23} + 120x_{33} + 190x_{43} + d_3^- - d_3^+ = 520$$
$$230x_{14} + 320x_{24} + 200x_{34} + 240x_{44} + d_4^- - d_4^+ = 640$$

$$140x_{11} + 210x_{12} + 180x_{13} + 130x_{14} + 240x_{21} + 130x_{22} + 210x_{23} + 230x_{24} + 120x_{31} + 300x_{32}$$
$$+ 90x_{33} + 110x_{34} + 130x_{41} + 220x_{42} + 190x_{43} + 140x_{44} + d_5^- - d_5^+ = 0$$

$$240x_{11} + 290x_{12} + 180x_{13} + 230x_{14} + 330x_{21} + 200x_{22} + 290x_{23} + 320x_{24} + 210x_{31} + 420x_{32}$$
$$+ 120x_{33} + 200x_{34} + 250x_{41} + 300x_{42} + 190x_{43} + 240x_{44} + d_6^- - d_6^+ = 0$$

$$x_{ij}, c_{ij}, t_{ij}, d_i^-, \qquad d_i^+ \geq 0$$

6. RESULTS AND DISCUSSION

Z= {260, 440, 520, 640, 0, 0}, these are the values of D1M, D2M, D3M, D4M, D5P and D6P respectively. From this result, we have to say that in priority level 1 or goal 1 demand of facility L, R, C and WTE cannot be achieved because value of D1M is 260, D2M is 440, D3M is 520 and D4M is 640 i.e. in priority 1 or goal 1 only no one facility has satisfy his whole demand. So then we say that sorting point has cannot be supply to its facility center in time. Hence goal 1 cannot be achieved. Priority 2 and 3 are related to transportation cost and wastes transportation. We see that, D5P and D6P are zero that means these goals are achieved.

7. CONCLUSIONS

In this paper we solved multi-dimensions MOTP by using goal programming. It shows that the transportation cost and waste transportation can be minimized effectively whereas the demand of the facility cannot satisfy. The solution of the numerical example is illustrated by using LINGO 17.0 software.

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ELECTROCHEMICAL SENSORS FOR ENVIRONMENTAL MONITORING

P. D. GAIKWAD

ABSTRACT
Electrochemical sensing devices have a major impact upon the monitoring of priority pollutants by allowing the instrument to be taken to the sample (rather than the traditional way of bringing the sample to the laboratory). Such devices can perform automated chemical analyses in complex matrices and provide rapid, reliable and inexpensive measurements of a variety of inorganic and organic pollutants. exciting electrochemical research, this many important advances in electrochemical sensor design and development for environmental monitoring purposes.

Keywords: Conducting Polymer, electrochemical method UV Spectroscopy, FTIR and SEM

INTRODUCTION

Traditional environmental monitoring approaches are based upon discrete sampling methods followed by laboratory analysis. These approaches do not improve our understanding of the natural processes governing chemical species behavior, their transport and bioavailability, discrete sampling methods and analyses are expensive, time consuming and do not provide the high-resolution data needed to truly study chemical species dynamics in aquatic systems [1-4]. Electrochemical sensors represent an important subclass of chemical sensors in which an electrode is used as the transduction element and power requirements of on-site environmental monitoring[5-7].Characteristics of electrochemical sensing systems include high sensitivity and selectivity, a wide linear range, minimal space and power requirements, and low-cost instrumentation .Electrochemical devices have been used for several decades for field monitoring of a variety of water quality parameters (e.g. conductivity, dissolved oxygen or pH). These have led to a wider range of environmental applications. This paper critically examines the role electrochemical sensors play in current environmental monitoring efforts.

Polyaniline can be synthesized by both chemical and electrochemical oxidative polymerization [8-9]. Polyaniline exists in four main oxidation states viz. (i) Leucoemeraldine base, (ii) Emeraldine base (iii) Emeraldine salt and (iv) Pernigraniline, Schemati representations for which are shown in the Fig 1.

Leucoemeraldine

Emeraldine base

Emeraldine salt
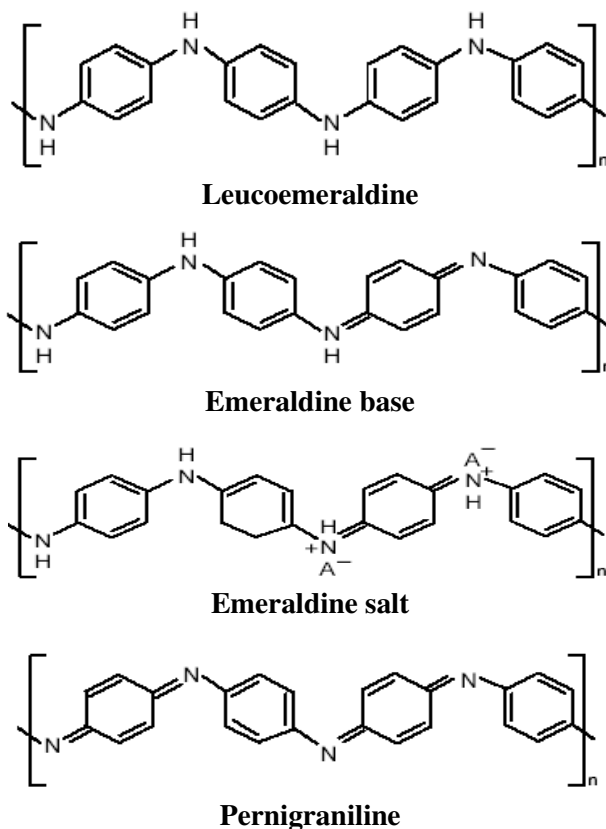
Pernigraniline
Figure 1: Various oxidation states of Polyaniline

PRINCIPLES

Electroanalytical sensors are concerned with the interplay between electricity namely the measurements of electrical quantities, such as current, potential or charge and their relationship to chemical parameters. Most of the electrochemical devices used for environmental monitoring fall within three categories and ultimately depend upon the specific analyte, nature of the sample matrix and the sensitivity and selectivity requirements [10].

PHYSICAL METHODS

The physical technique shows the preparation and characterization of thin films of PANI at ambient temperature by electrodeposition methods.

Table 1: Modes of electrodeposition.

Mode of Electrodeposition	Difference
Galvanostatic	Deposition by applying a constant current between the counter and working electrodes
Potentiodynamic	Electrode potential is varied using a stable reference electrode, and the current flow is measured between the working and counter electrode
Potentiostatic	Potentiostatic Deposition by applying a constant potential between working and counter electrodes

SYNTHESIS OF PANI-HCL MATRIX

All the chemical used in the investigation were analytical reagent grade   The electro polymerization of aniline was carried out by Galvanostatic technique. The Polyaniline Matrix was synthesized from an aqueous solution of distilled water containing 0.2 M aniline and 1 M of Hydrochloric acid (HCl).

RESULT AND DISCUSSION

Galvanostatic Studies of Pani- HCL Matrix
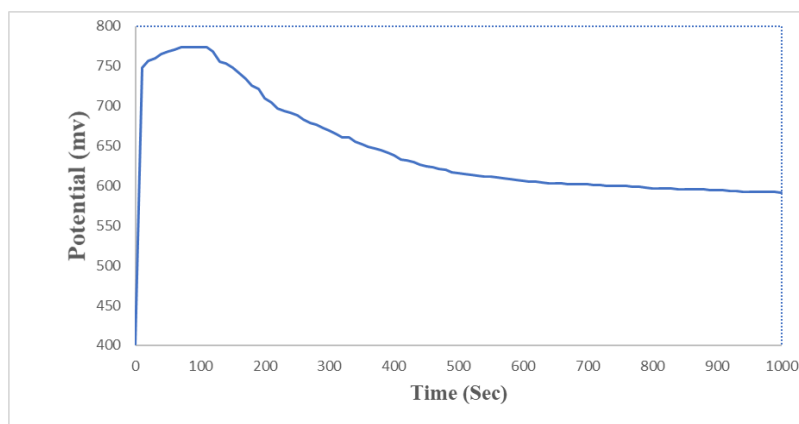
Fig.2: Potential-time curves obtained synthesis of polyaniline Matrix

The PANI-HCl Matrix was synthesized on ITO coated glass from 0.2 M concentration of aniline and 1.0 M of HCl at 1.0 pH and temp 27 °C. After this, potential remain constant suggesting that building up of the film proceeds according to the same reaction along the full thickness of the polymer as shown in Figure 2.
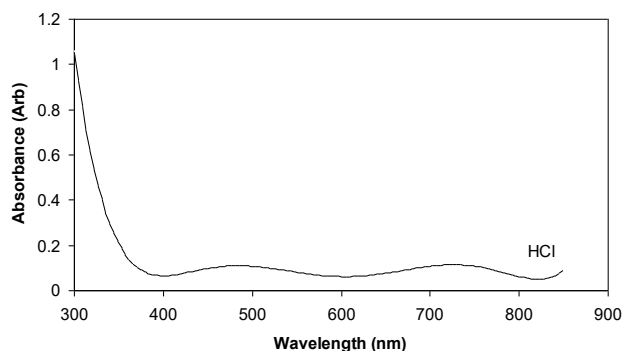
Fig.3: UV-visible spectra of PANI-HCl.

A green colored matrix showed two absorption peaks for PANI-HCl . The peak at 475 nm is because of π-π^* transition and a broad peak at 750 nm is due to formation of Emeraldine salt corresponds to the conducting phase for PANI-HCl matrix.
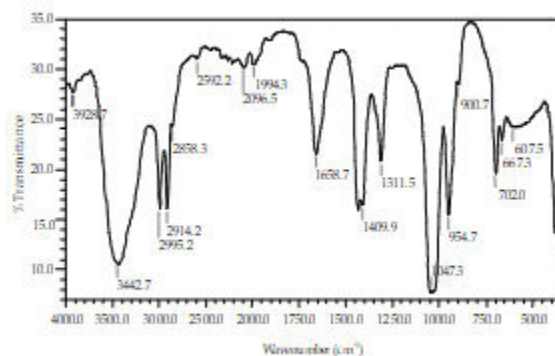
Fig. 4: FTIR spectra of PANI-HCl.

The peak at 3442.7 cm^{-1} corresponding to N-H starching. The peak at 2995.2 cm^{-1} is due to C-H stretching and similarly the C-N stretching is observed at 1311.5 cm^{-1}. Thus, the FTIR spectral results confirm the structure of polyaniline.
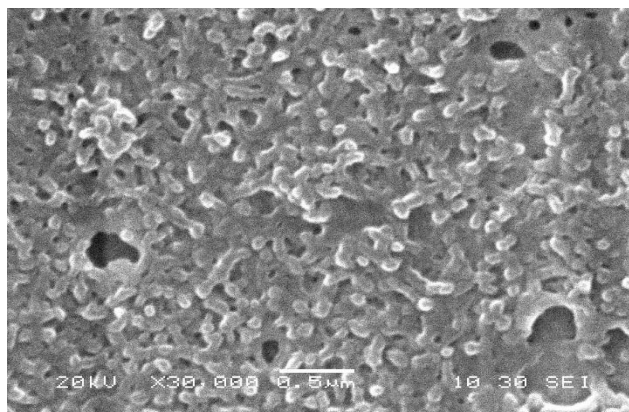
Figure 5: SEM micrograph of PANI-HCl matrix synthesized at 1.0 pH, 0.2 M aniline, 1.0 M HCl T=27 °C.

The SEM micrograph for synthesized PANI film with optimized process parameters is shown in Fig 5. It is fibrillar like structure good porosity,

CONCLUSIONS
The synthesized Polyaniline nanostructure matrix electrode can improve the sensitivity and reproducibility of electrochemical method in detection of Heavy Metal ions for Environmental Monitoring development in nanodevices.

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WATER QUALITY MONITORING

The need to accurately monitor water quality continues to grow due to the ever-increasing demand for fresh, clean water all over the world. water-quality sensing to provide real-time information to complement traditional laboratory analysis. The data from these sensor measurements should be made public to ensure transparency and to keep citizens informed appropriately.

Table 11-5: Common Sensor Approaches Used for Chemical Water Quality Analysis

Characteristic	Description	Sensor
Dissolve Oxygen Adequate dissolved oxygen (O2	Adequate dissolved oxygen (O2) is necessary for good water quality. The main factor contributing to changes in dissolved oxygen levels is the build-up of organic wastes. Low levels of dissolved oxygen maybe indicative of microorganisms in the water consuming oxygen as they decompose sewage, urban and agricultural runoff, and discharge from food-processing plants	Electrochemical Amperometric Galvanic Gas Optical Biosensor
pH	The pH of a water sample relates to the concentration of hydrogen ions. Drinking water has a pH range of 6.5 to 9.5. Extreme pH values can indicate chemical spills, treatment plant issues, or problems with the supply pipe network.	Electrometric Potentiometric Optical
Heavy Metals	Common heavy metals, such as cadmium (Cd), copper (CU), mercury (Hg), and lead (Pb), in water have been linked to a variety of health risks, including reduced growth and development, cancer, organ damage, nervous system damage, and, in extreme cases, death. Young children are particularly susceptible to the toxic effects of heavy metals.	Electrochemical ISE ISFET Optical

Table 11-4: Sensor-Based Physical Water Quality Analysis

Characteristic	Description	Sensor
Conductivity	Measurement of the capacity of water to conduct an electrical current. Conductivity is a function of the concentrations and types of dissolved solids, such as metals, inorganics, and organics. Changes in conductivity can result from discharges into the water. Sewage, for example, raises conductivity due the presence of chloride, phosphate, and nitrate. In contrast, an oil spill may cause a drop in conductivity due to thepresence of organic compounds.	Conductivity Electrode

DISCUSSIONS AND CONCLUSIONS

Environmental monitoring is a necessary component of environmental science and policy design et al., 2007). In order to achieve valuable results from environmental monitoring activities, it is necessary to adhere to sampling processes that are supported by the traditional scientific method (Artiola et al., 2004), and any

effective monitoring program must include focused and relevant questions, appropriate research designs, high quality data collection and management, and careful analysis and interpretation of the results (Lovett et al., 2007).

CONCLUSIONS

The combination of modern electrochemical techniques in miniaturization allows r effective process would further facilitate environmental monitoring efforts. refinement and commercialization advances will play major roles in large scale efforts to address today's environmental monitoring needs.

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DELIBERATING STRUCTURAL, OPTICAL AND SPECTROSCOPIC PROPERTIES OF NOVEL BARIUM TITANATE ZINC FERRITE NANOCOMPOSITE SYNTHESIZED USING LOW TEMPERATURE TECHNIQUES

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ABSTRACT

Low temperature synthesizing technique (<500ºC) is employed for synthesizing novel Barium Titanate -Zinc ferrite nano composites, where the particle size is controllable. Two different ratios of hard and soft site composites (BTO-ZFO 80:20, BTO-ZFO 70:30) are synthesized and characterized to study their unique structural, morphological, spectroscopic and optical properties. The structural refinement studies using XRD data showed 46 % of hard phase (anorthic structure) and 54% of soft phase (Cubic Structure) for BTO-ZFO 80:20 and similarly 76% of hard phase and 24% of soft phase in the BTO-ZFO 70:30 composite respectively. The SEM and EDAX are used to identify smaller particles of 6 nm using histogram and their sample purity. Spectroscopic studies were carried out using FTIR where the formation of nanocomposites and their respective tetrahedral and octahedral phases were confirmed. The band gap energy is calculated using Tauc's plot and it is found to be 2.7757 eV, thus being a potential candidate for photovoltaic (PV) applications and other opto-electric devices.

Keywords: Barium Titanate, Zinc ferrite, Nanocomposite, Low Temperature, spectroscopic properties, Bandgap Energy, Coprecipitation, Physical Mixing.

INTRODUCTION

Multifunctional materials have brought greater interest to researchers for the last decade. Materials like Multiferroics and ferroics have the possibility of opening enormous applications in the field of magneto-electric materials, which can have two parallel properties at the same time. Such properties can exceed the traditional use of magneto-electric materials. These applications include the scope of controlling magnetic phase by electric fields to magnetically controlled ferroelectrics. A large number of theoretical, experimental and application-oriented publications were done in these multifunctional materials in the past years. Multiferroics was also listed as the only one in top ten "Areas to study" in the field of Material Science in the upcoming years. In 1994 according to Schmid, Multiferroics are the materials that have two or more primary properties of ferroics at the same time. Today such materials have expanded their properties by including materials having simultaneous magnetic, electric and elastic properties such as ferroelectric, Ferromagnetic and Ferro elastic. Composite materials in recent years are also used for advanced electronic devices [1], [2]. These composites have magneto-electric coupling, which is the ability to control the magnetic phase under the influence of an electric field and vice versa [3]. In the case of Multiferroics composite, the material has one phase of Ferroelectric and another phase of Ferromagnetic behavior. Such materials can also be termed as Magneto-electric Multiferroics. It is to be noted that when two different phases coexist with each other as multiferroics, there is a dilution between the electric and magnetic phases.

In recent periods different types of Multiferroic composites are reported based on their stable chemical equilibrium, compatible grains, high piezoelectric coefficient, high ME signal, high resistivity and high Magneto strictive coefficient [1]–[8]. It is to be noted that the preparation techniques play a significant role in achieving the desired properties of the final composite material. Though the future will need more such types of composite materials, there are some problems in synthesizing such multiferroics which need to be solved [4]. Besides research, multiferroics have potential applications as novel electronic memory devices, transducers, actuators, capacitive filters or inductive filters for telecommunication, magnetic field sensors, electric-write magnetic-read memory devices etc. [9]–[16]. Nano ferrites or nano-multiferroics have various applications in areas like novel storage devices, Nano-electric generators, ferro-fluids, microwave devices, antennas, magnetic refrigerators, heterogeneous catalysts, targeted drug delivery and as repulsion-suspension in levitated railway systems [16]–[18].

Among various ferroelectrics like Lead Titanate, Lead zirconium titanate, Barium Titanate, Rochelle salt etc, Barium titanate is used widely due to its less toxicity compared to lead based materials. These materials have high energy storage properties and are environmentally friendly in nature. It is believed that Barium titanate based ceramics can not only improve the electric energy storage performance but also be used in high level advance applications including advanced pulsed power capacitors, High electron mobility transistors, flexible

polymer dye sensitized solar cell, photodetectors, tunable microwave devices, mid-infrared electro optical waveguide modulators etc. [19]–[23]. More recently a biomechanical energy harvesting device has been fabricated by Hangzhou et al, using a pair of multiferroic laminates of high magneto-electro strictive properties [17]. With Barium titanate composite blended with PDMS (polydimethylsiloxane), Hajra et al constructed a hybrid nano-generator device that can generate a maximum electrical output of 320 V and 12μA [18]. Even though there are numerous research on Barium Titanate nanoparticles and zinc ferrite nanoparticles, there are no studies related to Barium Titanate – Zinc Ferrite composites. Thus, a novel research is carried out to synthesize BTO-ZFO nanocomposites at low temperature (<500°C). In order to study their unique optical and spectroscopic properties, BTO-ZFO nano composites of two different ratios, 80-20 and 70-30 respectively are deliberated in this paper.

Preparation of Hard Site Material
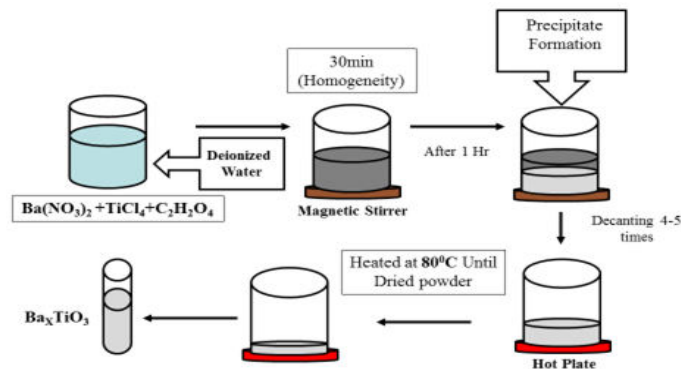
Figure 1: Synthesis of Barium Titanate by co-precipitation Method.

The composite material consists of two particles. One is the hard phase and another one is the soft phase in terms of its Ferro properties. The idea is to prepare a nanocomposite with barium titanate on the hard site and Nickel ferrite on the soft side. For the preparation of barium titanate particles the coprecipitation method is employed. At first a stoichiometric amount of Barium Chloride, Titanium tetrachloride and Oxalic acid are dissolved in deionized water which is magnetically stirred for 30 minutes to obtain homogeneous mixing. The solution is then left to settle down to form precipitate and the decanting process is carried out several times. And later the precipitate is heated on a hot plate at 80-degree Celsius to form powdered barium titanate particles. It is to be noted that if the solution is heated above 80°C oxalic acid undergoes decomposition and the solution may turn black which is not BTO. The particles are later crushed in motor pistol and then collected

Preparation of Soft Site Material

For synthesis of Zinc ferrite Nitrate method is used where stochiometric amount of Zinc nitrate, ferric nitrate and Citric acid is dissolved in deionized water and heated in a hot plate at 80^{0}C for 1 hour. Here Citric acid acts as a Chelating agent preventing precipitation of metal oxides (Chelating agents are chemical compounds that bonds & react with metal ions to form a stable, water-soluble complex). The solution is left to cooldown at room temperature and then dried in hot air oven at 100^{0}C to form fluffy mass. Then the powder is placed in muffle furnace and heated at 300^{0}C for 1 hour. This will make Nitrates of highly reactive metals to decompose thermally to form metal nitrite and oxygen gas when heated. The Nitrates of moderately reactive metals will produce brown fumes of nitrogen dioxide gas when heated, as well as the metal oxide and oxygen gas. Thus, forming Zinc ferrite particles.
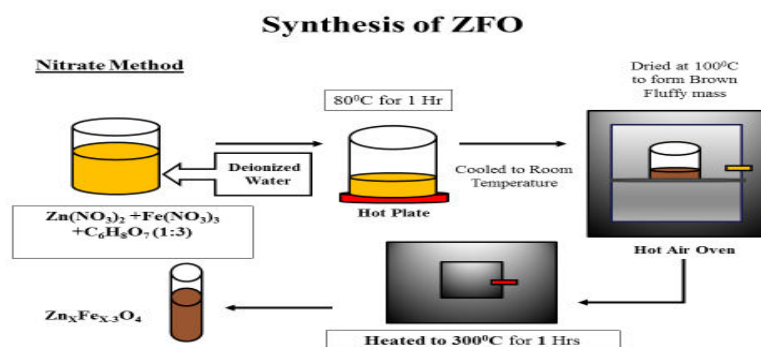
Figure 2: Synthesis of Zinc Ferrite by Nitrate Method.

Preparation of Nanocomposite Material

For preparation of nanocomposites, a physical mixing route is employed. 80 and 70% weight ratio of as-prepared barium titanate are mixed with 20 and 30% weight ratio of as-prepared zinc ferrite particles which are grinded for 1 hour by using motor and pistol. Thus, the composites are taken in two different ratios of 80:20 and 70:30 respectively and are named as BTO-ZFO 80-20 and BTO-ZFO 70-30. These two sample powders are further given for characterization.

Experimental Techniques

The following characterization is done over the prepared nanocomposites. The Structural analysis of the samples were determined using an X-ray diffractometer (3rd generation Empyrean, Malvern Panalytical) with Cu Kα (λ=1.540598 Å) radiation. Fourier transform infrared (Shimadzhu, IR affinity 1A) spectra were recorded on a spectrometer in the range of 4000-400 cm-1 in order to confirm formation Spinel and M-type hexaferrite metal-oxygen bond. Particle size distribution and morphology analysis was performed using Scanning Electron Microscopy (SEM) Jeol JSM 6390model equipped with EDX for elemental analysis. The optical properties of the nanocomposite were analyzed within the range of 200 to 800nm using UV-2400PC Series with slit width 1.0nm and light source of wavelength 360 nm. From the UV analysis the bandgap energy was calculated using tauc's plot.

RESULTS AND DISCUSSIONS

Structural Analysis
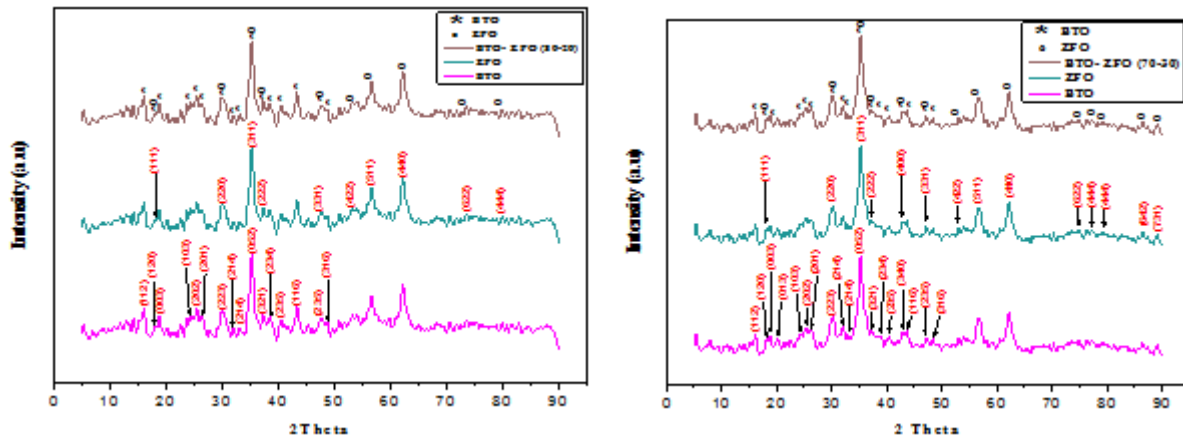
Figure 3: XRD patterns for BTO-ZFO 80-20 and 70-30 respectively.

Further to find the average crystallite size of the prepared nanocomposite, Scherrer's equation is used considering the diffraction peaks of higher intensities for BTO and Highest peak (311) for ZFO.

The structural analyses of all the prepared samples are carried out using XRD. All peaks are indexed in accordance with JCPDS card no. Lattice Parameter a match with the JCPDS: 40-0405 for BTO & JCPDS: 87-1231 for ZFO. Except b & γ all other lattice parameters increases with increase in the soft site content. The intensity of the peak increases with increase in the hard site content. Compared with BTO-ZFO 70-30 sample, sharper and new peaks are observed in BTO-ZFO 80-20 composite. This means that new peaks are found with high concentration of the hard site materials.

By substituting K=0.9 in the equation, D= k*λ/ (β*Cosθ), the resultant values are tabulated in table 2 where a smaller crystalline size of 1.16nm and 1.19 nm are observed in BTO-ZFO 80-20 and BTO-ZFO 70-30 nanocomposites respectively.

Table 1: Lattice parameter and cell volume for BTO-ZFO 80-20 and BTO-ZFO 70-30.

(JCPDS:40-0405) for BTO (JCPDS: 87-1231) for ZFO	a	b	c	α	β	γ	Cell Vol.
Standard Value (BTO)	7.471	14.08	14.344	89.94	79.43	84.45	1476.20
Standard Value (ZFO)	8.424	-	-	90	90	90	597.97
Calculated Value BTO-ZFO 80-20							
BTO	7.34746	14.43465	13.10272	95.1469	75.052	85.928	1330.76
ZFO	8.423791	-	-	90	90	90	597.8

Calculated Value BTO-ZFO 70-30							
BTO	7.45893	14.16915	13.3248	93.6073	77.193	85.825	1365.05
ZFO	8.442294	-	-	90	90	90	601.7

In comparison, it is seen that the average crystalline size for BTO - ZFO increases with the increase in soft site concentration. The structural refinement studies using XRD data showed 46 % of hard phase (anorthic structure) and 54% of soft phase (Cubic Structure) for BTO-ZFO 80:20 and similarly 76% of hard phase and 24% of soft phase in the BTO-ZFO 70:30 composite respectively.

Table 2: Average crystalline size of BTO-ZFO nanocomposite calculated using Scherrer's equation.

		Peaks Taken	Range of Particles (nm)		Average size (nm)	Phase Coexistence (%)	
			From	To		BTO	ZFO
BTO ZFO	80-20	Diffraction peaks of Higher intensities	1.64	14.73	7.04	58.63	41.37
	70-30		1.19	8.59	6.01	91.89773	8.102269

MORPHOLOGICAL ANALYSIS

The typical SEM micrograph and particle size distribution with histogram of BTO-ZFO samples are shown in figures below. Spherical microstructure has been observed from the SEM micrograph. It is very interesting that the grain sizes are uniformly distributed throughout the sample. All the samples have similar particle distribution (As shown below). The grain sizes obtained from SEM are larger than the crystallite size calculated from the XRD analysis. It divulges the multiple crystallites or agglomerations in a single particle and form grains, which are separated by crystallographic grain boundaries inside the grains. A similar difference between crystallite size (obtained from XRD analysis) and grain size (obtained from SEM analysis) has been reported by another research group [1]. It is the typical nature of oxide materials. It is a limitation of the XRD technique.
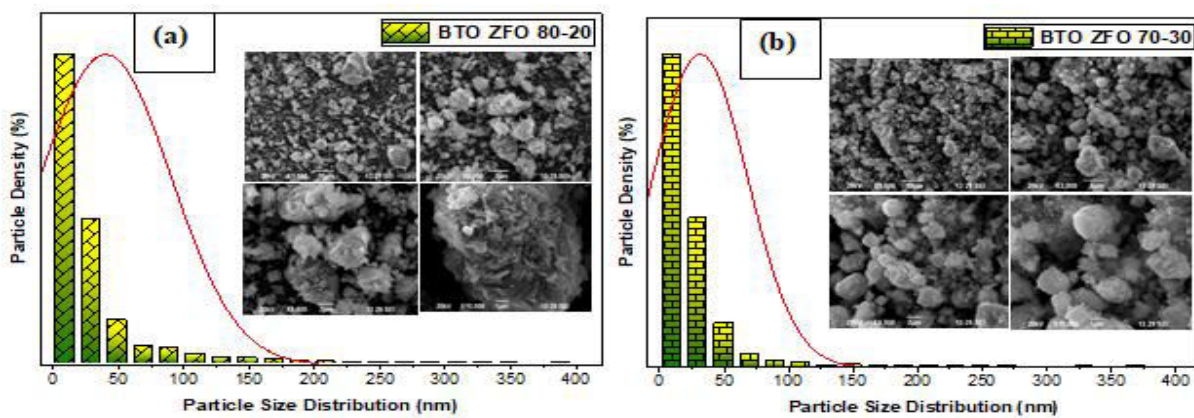
Figure 4: Typical SEM micrograph and particle size distribution with histogram of (a) BTO-ZFO 80-20 and (b) BTO-ZFO 70-30 nanocomposite.

The EDAX analysis was performed on the surface of the samples. The EDX spectrum (shown below) reveals the presence of Ba, Ti, Zn, Fe and O elements in $BaTiO_3$-$ZnFe_2O_4$ in 80-20 and 70-30 samples respectively.
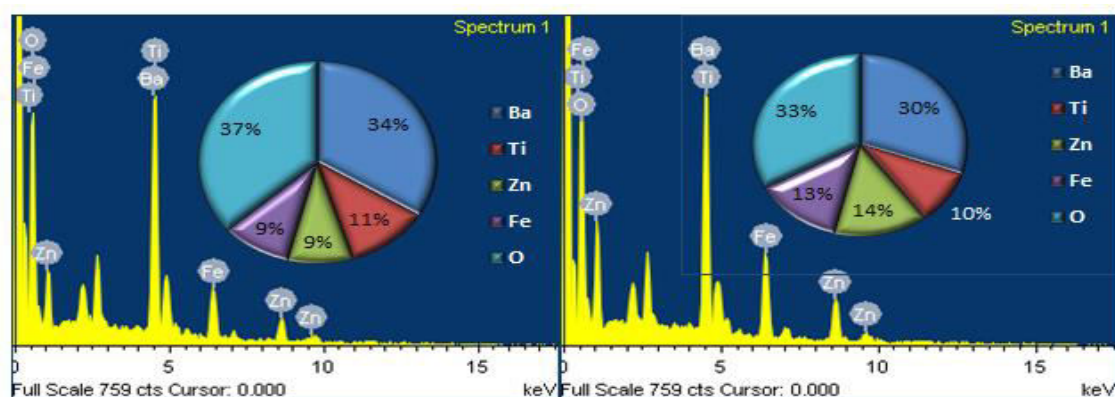
Figure 5: EDAX analysis for BTO-NFO revealing the presence of elements along with weight %.

Sample	Element	80-20			70-30		
		Apparent Concentration	Weight %	Atomic %	Apparent Concentration	Weight %	Atomic %
BTO-ZFO	Ba	7.83	33.84	8.02	8.04	30.26	7.53
	Ti	2.73	11.36	7.72	2.62	9.48	6.76
	Zn	2.00	8.78	4.37	3.71	14.14	7.39
	Fe	2.14	9.46	5.51	3.48	13.24	8.10
	O	9.36	36.56	74.38	9.96	32.88	70.22
Total		100.00			100.00		

Table 3: Quantitative data extracted from the EDX spectra of BTO-ZFO Nanocomposite.

The quantitative data extracted from the EDX spectra are enlisted in table below and, it confirmed that no element/s (impurity) is/are present in the sample other than Ba, Ti, Zn, Fe and O.

SPECTROSCOPIC ANALYSIS

The FTIR spectrum of BTO-ZFO shows strong bands as seen in the figure 6. IR spectrum of $Zn\,Fe_2O_4$ shows two strong bands. The band v_1 was found in the range 543- 544 cm^{-1} due to tetrahedral complexes and band V2 in the range 423- 424 cm^{-1}, due to octahedral complexes. The difference in the two strong bands v1 and V2 could be related to difference in Fe^{3+}-O^{2-} distances for A and B sites. 791 &764 is related to Fe-O bonds. Tetrahedral Complexes with high wave number in 603cm^{-1} confirms formation of composites. It is evident that these bands vary slightly on increasing the hard/soft content ratio, which could be due to coupling of the hard and soft phases in the nanocomposites. A characteristic band of Zn-O is observed at 681 cm-1. There is also a Strong C-Cl stretching halo compound at 852 cm-1 that is due to the chlorine presence in precursors. The band at 2347 represents C-O stretching vibration this is due to the presence of atmospheric Carbon-dioxide during experimentation. In order to avoid this in future it is notable that the sample must be placed under compressed air or nitrogen surrounding during FTIR Analysis. At 1677, O-H bending serves as an evidence for successful formation of ferrite nanoparticles.

Absorption (cm^{-1})	Functional Group
455-510	M-O$_{octa}$
541-563	M-O$_{tetra}$
563	Characteristic Zn-O bending
738	Ti-O-Ti bridges in the central ring of clusters.
764 & 791	Fe-O stretching
896	Ba-O Stretching
1651	O-H bending
2312 & 2350	Strong O=C=O stretching
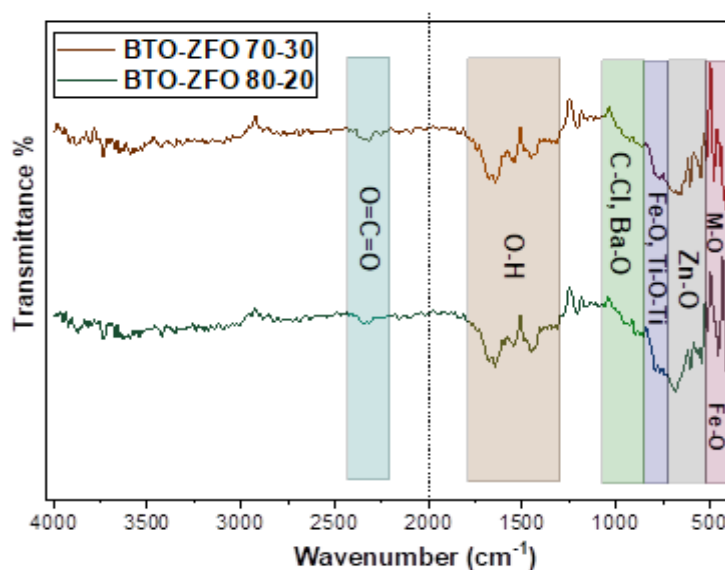
Figure 6: FTIR Graph of BTO-ZFO 80-20 and BTO-ZFO 70-30

OPTICAL ANALYSIS

The optical properties of both nanocomposites were analyzed within the range of 200 to 800nm using UV-2400 PC Series analyzer. The width of the slit is measured to be 1.0nm with an emitting light source of 360 nm wavelength.
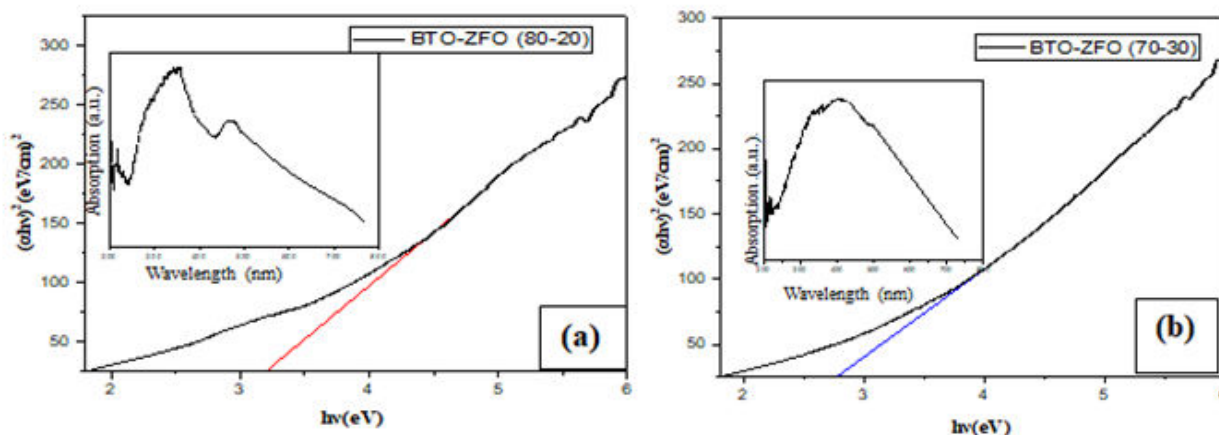
Figure 7: Absorption vs wavelength with Tauc's plot for (a) BTO-NFO 80-20, (b) BTO-NFO 70-30.

The absorption graph is plotted for both the samples along with Tauc's plot. Normally, a Tauc's plot indicates the ordinate quantity $(\alpha h\nu)1/2$ and the photon energy $h\nu$ on the abscissa. This derivation of the linear region gives the optical energy band gap of the sample. Thus, on calculating it is found that the band gap for BTO-ZFO 80-20 is 3.1971 eV and the band gap energy for BTO-ZFO 70-30 is 2.7757 eV. It is observed that the band gap for BTO-ZFO 80-20 is more than BTO-ZFO 70-30. Thus, the bandgap energy increases with the increase in the hard site concentration. This may be due to the atomic radius of BTO which is larger when compared to ZFO or; when concentration decreases the number of molecules decreases and thus overlapping of atomic orbital are lesser which leads to the formation of narrow conduction and valence bands. Now as the widths of the bands are smaller, the band gap energy between the bands is larger. Thus, the increased band gap energy may be due to the increased concentration of hard site material.

CONCLUSION

A novel low temperature cost effective simple technique was employed to successfully synthesize novel pure Barium Titanate - Zinc ferrite nanocomposites. Since both preparation methods have control over their particle size, smaller particles of 6 nm can be synthesized for various nano applications. The main aim of this work is to analyze the Spectroscopic and Optical bandwidth of the nanocomposites for photovoltaic and novel optical applications. Based on the results, the composites have better Structural, morphological and optical properties compared to other oxide-based nanocomposites. It is important to note that such optical behavior is observed at just 0.1 % concentrations on both hard and soft sites of the nanocomposite.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENT

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INVESTIGATING OPTICAL PROPERTIES OF NOVEL HETEROSTRUCTURE ALUMINIUM DOPED BARIUM HEXAFERRITE (AlBAM) COBALT ZINC FERRITE (CZFO) NANOCOMPOSITE

ALLWIN SUDHAKARA, ASHWIN SUDHAKARA AND E. SIVASENTHI[*]

ABSTRACT
The novel heterostructure $(Al_{0.5}Ba_{0.5}Fe_{12}O_{19})_{1-x}/ (Co_{0.6}Zn_{0.4}Fe_2O_4)_x$ with X= 0.1, 0.2 have been synthesized by using the ball mill technique. Further characterization is done using XRD, SEM, EDAX, FTIR and UV analysis. The XRD Analysis revealed successful hexagonal and spinel formation in the synthesized heterostructure composite. The cell volume and lattice parameter are calculated with the JCPDS card data. The cell volume, lattice a and c decrease with increase in the hard site concentration. Similarly, the average crystalline size calculated by Scherrer's equation also showed decrease in size of the crystal with increase in AlBaM concentration. Comparison between crystalline size and particle size is done using SEM studies. Form UV analysis the band gap energy is found using Tauc's Plot which is 2.563eV for AlBaM-CZFO 80-20 and 2.285eV for AlBaM-CZFO 90-10 respectively.

Keywords: Doped Barium Hexaferrite, Cobalt Zinc Ferrite, Sol-gel Citrate, Sol-gel Auto combustion, Ball milling, Bandgap Energy.

1. INTRODUCTION
Nano Magnetic composites have various uses in the field of hard disk, supercapacitors, media recording, microwave absorbing, permanent magnets, and refrigeration magnets [1]. Generally, nanocomposites are made by joining two materials with dissimilar geometric arrangements (0-3,2-2,1-3 types) using appropriate synthesis method [2], [3]. Among them the 0-3 type nanocomposite is greatly utilized due to its simple synthesis process and less reaction time [4]. Mainly the M-Type Barium hexaferrite has attained maximum attention due to its high magnetic property [5]. The cobalt ferrite attains ferrimagnetic nature when doped with transition metals [5], [6]. Similarly, many scientists have done numerous studies in electrical, dielectric, optical and magnetic properties of barium hexaferrite nanocomposites [6]–[16]. Yet to the best of the author's knowledge none have synthesized Aluminium doped barium hexaferrite nanocomposite material. Recently our group studied the optical properties of BTO and Barium hexaferrite based nanocomposites. Among them the copper doped barium hexaferrite with cobalt zinc ferrite composite. The study of band gap energy from Tau's plot using UV analysis revealed maximum band gap of 2.8456 eV which increases with the soft site concentration [17], [18].

In the present study, AlBaM-CZFO is prepared using ball milling technique in which individual hard and soft sites were prepared using sol-gel auto combustion and sol-gel citrate method respectively. XRD is used to find the formation of hexagonal and spinel structure in the synthesized heterostructure. The cell volume and lattice parameter are calculated with the help of JCPDS card data. Similarly, the average crystalline size was calculated by Scherrer's equation. Comparison between the size of the crystal and particle is done using particle size distribution obtained from SEM analysis. The optical bandgap of novel heterostructure Aluminium doped barium hexaferrite cobalt zinc ferrite nanocomposite (AlBaM-CZFO) were studied using Tauc's plot from UV analysis.

2. SYNTHESIS

2.1. Preparation of Hard Site Material
The Aluminium -substituted barium ferrite particles were prepared using the sol-gel auto combustion method (figure 1). Where, stoichiometric amounts of nitrates of barium, ferric and aluminium were dissolved in deionized water followed by the addition of citric acid. The pH value is maintained to 7 using ammonia solution. The solution was heated upto 80 °C in a hot plate until a viscous gel formed. Then the temperature was increased to 100 °C to form brittle powder. Finally, this precursor powder was calcined at 850 °C in muffle furnace for 1 h to get the final aluminium doped barium hexaferrite particles.
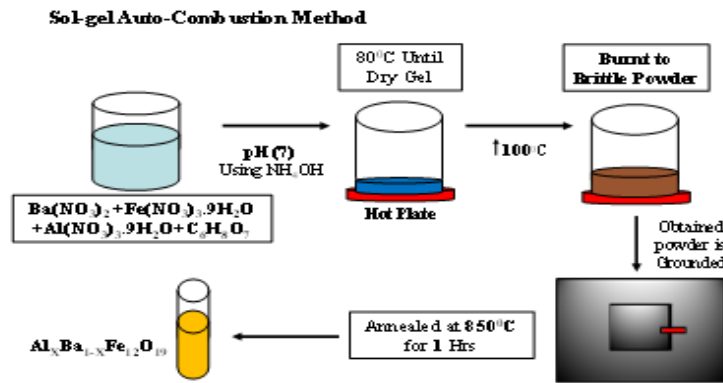
Figure 1: Synthesis of Aluminium doped $BaFe_{12}O_{19}$ (AlBaM).

2.2. Preparation of Soft Site Material

Cobalt Zinc ferrite nanoparticles were prepared by auto-combustion synthesis (figure2). Where Under fierce stirring, the nitrates of Zinc, Cobalt and Ferric are mixed in stoichiometric amounts. The ratio of citric acid to the metal nitrates is 1:1. The mixture is kept under constant stirring and temperature is gradually increased until a viscous gel form. Later the solution is kept under fierce stirring and the temperature is increased to 75°C until the solution evaporated to dryness. Finally, the dried precursors were ground with mortar and pestle and was annealed at 800 °C for 5 h to get the desired Cobalt Zinc ferrite nanoparticles.
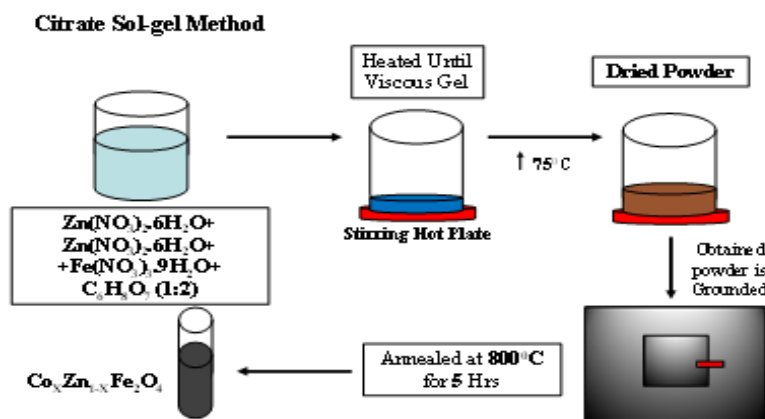
Figure 2: Synthesis of Cobalt doped Zinc Ferrite (CZFO) by Citrate Sol-Gel Method.

2.3. Preparation of nanocomposite material

The hard site AlBaM is combined together with the soft site CZFO at different weight ratios $[(Al_{0.5}Ba_{0.5}Fe_{12}O_{19})_{1-x}/(Co_{0.6}Zn_{0.4} Fe_2O_4)_x]$ with X=0.1,0.2 with the help of planetary ball milling technique. These are denoted as AlBaM-CZFO90-10 and AlBaM-CZFO 80-20 respectively. The prepared nanocomposites are sintered at 800^0C for 3 hours before sending them for further characterization studies (figure 3).
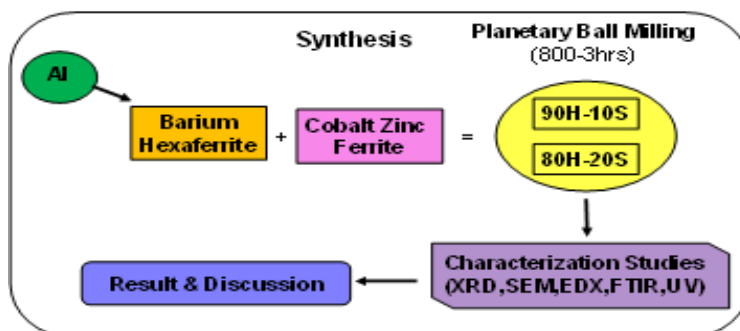
Figure 3. Synthesis of Nanocomposite AlBaM-CZFO.

3. EXPERIMENTAL TECHNIQUES

The following characterization is done over the prepared nanocomposites. The Structural analysis were determined using XRD (3rd generation Empyrean, Malvern Panalytical) with Cu Kα (λ=1.540598 Å) radiation.

FTIR (Shimadzhu, IR affinity 1A) spectra were analyzed within 4000-400 cm-1 range to confirm Spinel and M-type hexaferrite metal-oxygen bond. Particle size distribution & morphology was studied using SEM Jeol JSM 6390model with EDX for composition analysis. The optical properties of the nanocomposite were analyzed within 200 to 800nm using UV-2400PC Series with slit width 1.0nm and light source of wavelength 360 nm. From the UV analysis the bandgap energy was calculated using tauc's plot.

3.1. XRD Analysis

The structural analysis of all the prepared samples are carried out using XRD. All peaks are indexed in accordance with JCPDS card number 71-1376 and 88-2152 for AlBaM and CZFO respectively. The formation of hexagonal structure with space group of P63/mmc for AlBaM and cubic structure with Fd-3m space group for CZFO respectively were confirmed. The cell volume and lattice parameter a and c for all the prepared samples are calculated and it matches with the standard JCPDS card data.
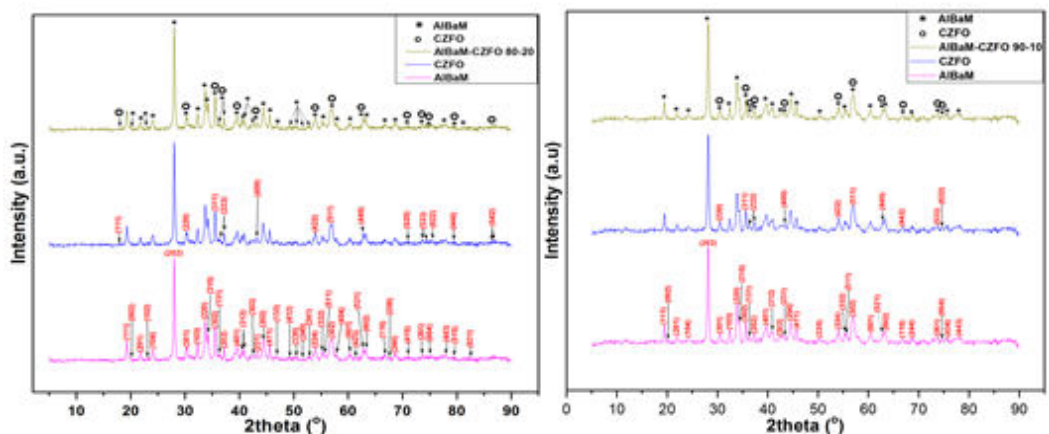
Figure 4: XRD patterns for AlBaM-CZFO 80-20 and 90-10 respectively.

The figure 4 represents the XRD peaks for AlBaM-CZFO 80-20 and 90-10 respectively. The lattice parameter and cell volume are measured and presented in table 1 below, which shows that the values of a, c and cell volume decreases with increase in the concentration of AlBaM.

Table 1: Lattice parameter and cell volume for AlBaM CZFO 80-20 and AlBaM CZFO 90-10.

(JCPDS:71-1376) for AlBaM (JCPDS: 88-2152) for CZFO	a	c	Cell Volume (V)
Standard Value (AlBaM)	10.81	8.707	881.1515
Standard Value (CZFO)	8.396	=	591.8577
Calculated Value AlBaM CZFO 80-20			
AlBaM(002)	-	8.819576	907.5546
AlBaM (310)	10.90052	-	
CZFO (311)	8.37097	=	586.5801
Calculated Value AlBaM CZFO 90-10			
AlBaM(002)	-	8.81524	902.4974
AlBaM(310)	10.87278	-	
CZFO (311)	8.325643	=	577.103

The average crystalline size is measured using Scherrer's equation (as shown in the table 2). Where to calculate the average size for AlBaM-CZFO the peaks (202),(220),(310),(302),(206),(302) is used by substituting K=0.89. here we can clearly see that for AlBaM-CZFO, the crystalline size decreases with increase in hard site concentration.

Table 2: Average crystalline size of AlBaM-CZFO nanocomposite calculated using Scherrer's equation.

Sample	Conc. H-S	Peaks Taken	Range of particles (nm) From	Range of particles (nm) To	Average size (nm)	Inference
AlBaM CZFO	**80-20**	(202), (220), (310), (302), (206), (302)	12.23	31.65	22.31	Decreases with increase in hard site
	90-10		12.08	26.63	19.94	

3.2. Morphological Analysis

The SEM image and histogram of particle size are shown in figures 5. The surface of the sample appears to be having dense microstructure with good crystal nature of uniform distribution which is joined together due to agglomeration. The size of the grain calculated from the SEM image shows higher values than the size of the crystal calculated using XRD. This may be due to agglomeration with in the particles in the sample.
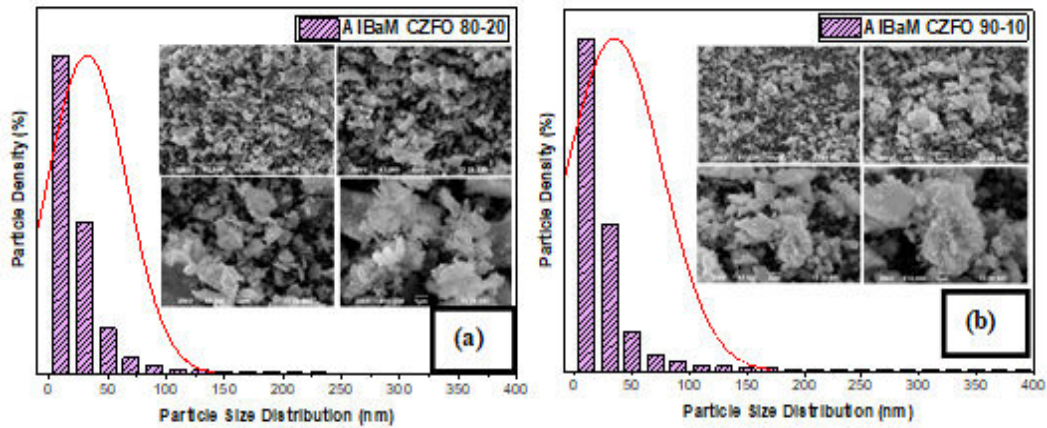
Figure 5: Typical SEM image with histogram of size of the particles of AlBaM-CZFO nanocomposite.

The EDAX analysis was performed on the surface of all the samples (table 3). The EDX spectrum (shown as in figure 6) reveals the presence of Aluminium, Barium, Cobalt, Zinc, Fe and Oxygen elements in AlBaM CZFO 90-10 and 80-20 samples respectively, and it confirmed that no element/s (impurity) is/are present in the sample other than Al, Ba, Co, Zn, Fe and O.
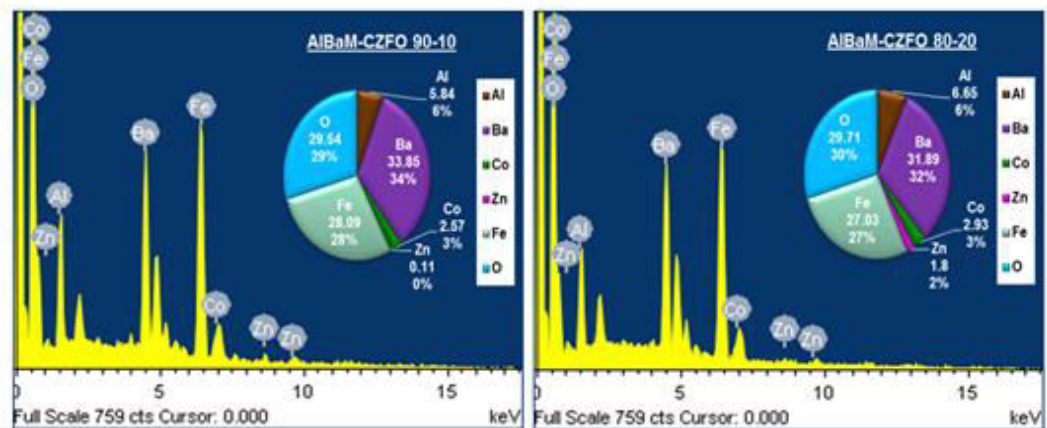
Figure 6: EDAX analysis for AlBaM-CZFO revealing the existence of Al, Ba, Co, Zn, Fe & O elements along with weight %.

Table 3: Quantitative data extracted from the EDX spectra of AlBaM-CZFO Nanocomposite.

Sample	Element	90-10			80-20		
		Apparent Concentration	Weight %	Atomic %	Apparent Concentration	Weight %	Atomic %
AlBaM-CZFO	Al	1.03	5.84	7.57	1.28	6.65	8.50
	Ba	10.28	33.85	8.62	10.54	31.89	8.02
	Co	0.76	2.57	1.53	0.95	2.93	1.71
	Zn	0.03	0.11	0.06	0.58	1.80	0.95
	Fe	8.35	28.09	17.60	8.79	27.03	16.71
	O	15.41	29.54	64.62	16.67	29.71	64.10
Total		100.00			100.00		

3.3. FTIR Analysis

The FTIR spectrum of AlBaM-CZFO is shown in figure 7 along with absorption table (table 4). The band V_1 was found between 522- 601cm^{-1} which is due to tetrahedral Zn^{2+} ion stretching complexes. The band V_2

between 408-460 cm^{-1} is due to octahedral complexes which correspond to the presence of Fe–O stretching vibrations confirming the presence of M–O stretching band in ferrites metal-oxygen bonds and are attributed to the formation of hexaferrite structure. The observation of these bands for the samples confirms the ferrite structure in the prepared nanocomposites. It is obvious that these bands vary to some extent on increasing the ratio of hard/soft content, which could be due to coupling of both the phases in the composites. The difference in the V_1 and V_2 bands could be related to the difference in Fe^{3+}-O^{2-} distances for A and B sites. the peaks 543 cm represents the characteristic peaks of Cobalt Zinc Ferrite and the peak 596 represent Al–O bending vibrations in the tetrahedral sheet. The band V_3 from 650 to 740 corresponds to the characteristic absorption of Fe-O bond which confirms Fe-O stretching modes. The band at 856 cm-1 is assigned to divalent octahedral metal ion–oxygen ion complexes which represent Ba–O stretching. The band at 1433 represents O-H bending which further provides an evidence for the formation of M- type ferrite nanoparticles.
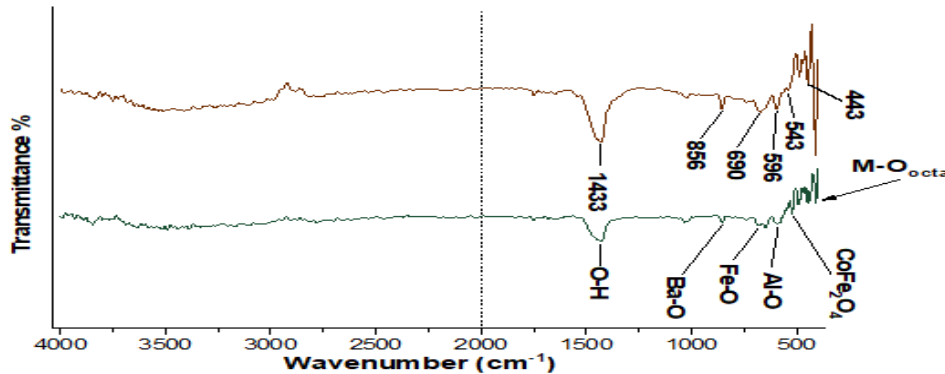
Figure 7: FTIR Graph of AlBaM-CZFO 90-10 and AlBaM-CZFO 80-20

Table 4: FTIR Table for the prepared nanocomposite.

Absorption (cm^{-1})	Functional Group
V2 (408-460)	Fe-O Stretching confirming M-O$_{octa}$
V1 (522-601)	M-O$_{tetra}$
543	Characteristic peak of $CoFe_2O_4$
596	Al-O bending
V3 (650-740)	Characteristic peak of Fe-O
856	Ba-O Stretching
1433	O-H deformation, Evidence for M-Ferrite nanoparticles formation

3.4. Optical Analysis

The optical properties of the nanocomposite were analyzed within 200 to 800nm using UV-2400PC Series with slit width 1.0nm and light source of wavelength 360 nm. From the UV analysis the bandgap energy was calculated using tauc's plot as shown in figure 8. It is found that the bandgap for AlBaM-CZFO 90-10 (2.2854eV) is lesser than AlBaM-CZFO 80-20 (2.5632eV). Thus, the bandgap energy Increases with the decrease in the hard site concentration.
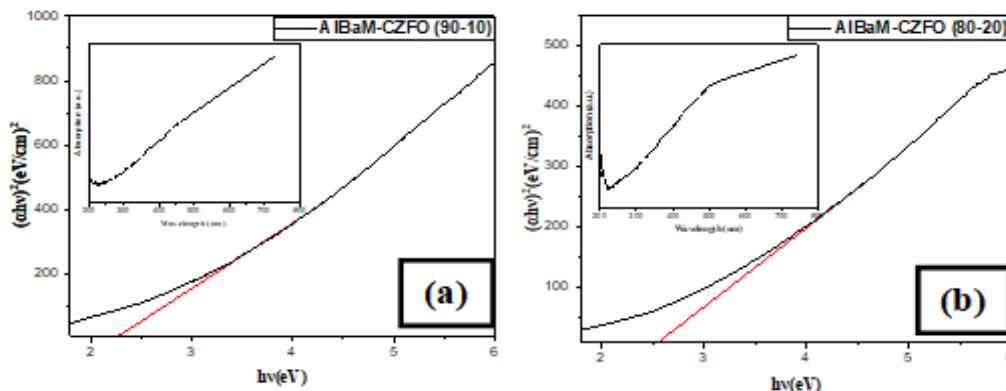
Figure 8: Absorption vs wavelength with Tauc's plot for (a) AlBaM-CZFO 90-10 and (b) AlBaM-CZFO 80-20 respectively.

4. CONCLUSION

A novel nanocomposite of Al doped barium hexaferrite/ Cobalt zinc ferrite is successfully synthesized using Planetary ball milling technique. Generally, the optical parameters in nanocomposites are greatly affected via synthesis, temperature, and the concentration of AlBaM and CZFO sites. The XRD Analysis revealed successful hexagonal and spinel formation in the synthesized heterostructure composite. The cell volume, and the lattice a and c are calculated with JCPDS card data. The cell volume, lattice a and c decrease with increase in the hard site concentration. Similarly, the average crystalline size calculated by Scherrer's equation also showed decrease in size of the crystal with AlBaM concentration. The SEM and histogram of particle distribution are investigated showing good crystalline nature with dense microstructure. It is interesting to find a uniform distribution in grain size within the sample. From the EDAX spectrum confirms the purity of the prepared sample. The presence of band V_1, V_2 and V_3 in FTIR analysis confirmed the formation of both Metal-Oxide bonds and hexagonal structure in the prepared sample. The study of band gap energy from Tau's plot using UV analysis revealed maximum band 2.2854eV for AlBaM-CZFO 90-10 nanocomposite which decreases with the soft site concentration. These novel results are amazing and unique according to the Author point of view.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ACKNOWLEDGEMENT

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RANDOM FOREST AND K-NEAREST NEIGHBOR BASED MODEL TO PREDICT ROAD ACCIDENT RATE IN VARIOUS STATES OF INDIA

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ABSTRACT
Road accidents are one of the biggest causes of death in India, with an accident being recorded every four minutes. It is therefore the need of the hour to study the causes of road accidents in India across the various States and Union Territories in the country in order to develop effective measures to reduce the incidence of road accidents. It would also be of further use to develop a predictive model for road accidents in India. In this study, several accident-causing factors were identified and data mining techniques used to classify road accidents State-wise as also cause-wise. A model has been developed to predict the future accident rates in the States of India with respect to the accident-causing factors identified. As far as the authors are aware, no such study encompassing a predictive model has been conducted for all the States of India.

Keywords: Predictive Model; Road Accidents; Data Mining models.

1. INTRODUCTION
Accidents have become daily happenings, with data suggesting that road traffic injuries constitute the ninth leading cause of death in India [1]. There are several reasons for road accidents, like bad roads, violation of traffic rules, bad weather conditions, drunken driving and driver negligence. Whenever a road accident occurs, various types of damage take place, such as injury or death to human beings or animals or damage to infrastructure.

According to the statistics provided by the Ministry of Road Transport and Highways, Government of India, around 4.89 lakhs road accidents have been reported in the year 2014, claiming about 1.40 lakh lives and causing injury to more than 4.93 lakh people [2].

In this work, we study the incidence of road accidents in the various States of India and analyze several contributing factors. Based on this study, a model is proposed that predicts the accident rate in the various States of India based on causal factors. A classification model is presented that classifies the States of India in accordance with the rate of accidents.

This work also provides predictive information regarding accidents. A model is proposed here that would help predict the number of accidents that could possibly occur, cause-wise, in the forthcoming year in the various States of India. Dataset for the years 2014, 2015 and 2016 has been taken and results predicted for the year 2017. These data sets have been used for the purpose of perusing the correctness of the model, analyzing the results of the prediction and hence show that the model developed can be applied to predict road accidents of any upcoming year based on the previous year data.

This could provide crucial information to the Government for developing targeted strategies and effective road safety programs for prevention of these road accidents, and also try to reduce the number of accidents and hence the loss of life and property. The classification model mentioned above could also provide useful information to the governmental and other agencies to try to reduce or eliminate the causes of road accidents.

2. RELATED WORK
Liling Li, Sharad Shrestha, Gongzhu Hu [4] carried out an analysis of road traffic fatal accidents and studied the relationship between fatality rate and other attributes including manner of collision, weather, surface condition, light condition and drunk driver. Association rules were discovered by Apriori algorithm, classification model was built by Naive Bayes classifier and clusters were formed by simple K-means clustering algorithm. Certain safety driving suggestions were made based on statistics, association rules, classification model and the clusters obtained.

Ayushi Jain, Garima Ahuja, Anuranjana, Deepti [5] in their analysis of road accidents in India, created a model that not only smoothens out the heterogeneity of the data by grouping similar objects together to find the accident prone areas in the country with respect to different accident-factors, but also helps determine the association between these factors and casualties.

Gagandeep Kaur, Er. Harpreet Kaur [6] proposed a methodology to analyze road traffic accidents and modeled accident and incident data gathered from traffic data and data related to construction sectors. Prajakta S. et al [7], in their work have presented a survey of road accident analysis methods in data mining and have used a self-organization map (SOM) to find a number of patterns to analyse the road accident data.

3. DATASET COLLECTION AND PREPROCESSING

The dataset used in this work is taken from the data published by the Government of India in its portal, data.gov.in. (Last accessed July 2019). These datasets provide great details with respect to the road accidents that have happened over the years in all States of India.

The datasets collected (29 States and 7 Union Territories, as on 5 august 2019) has data with a total of 48 attributes such as total accidents, number of persons killed, number of persons injured, age of the driver, location type, road type, and weather conditions.

The data was first cleaned to make sure that there are no missing values in the data set. As a second step, data transformation of attributes was carried out to transform categorical values such as States, types of weather conditions, road types, traffic signal types, location and age of the driver. All the categorical values were replaced with numerical values manually. As a third step, data reduction was done by selecting a limited number of attributes. The attributes selected for this work are:

- Road type: Surfaced road, metaled road, kutcha road, dry road, wet road, good surfaced road, loose surfaced road, muddy road, speed breaker.

- Traffic controls: Traffic light signals, stop signs, police controlled, flashing signal, uncontrolled.

- Age limit: 14 years & below, 15-24 years, 25-64 years, 65 years & above

- Weather condition: Fine, mist/fog, cloudy, light rain, heavy rain, flooding of slipways, hail/sleet, storm wind, dust storm, very hot, very cold.

- Location: Near school, near village, near factory, religious place, recreation place, bazaar, office complex, hospital, residential area, open area, bus stop, petrol pump.

As a fourth step in the preprocessing stage, data discretization was done, which is used in the classification model. Data were discretized using a discretized operator to convert numerical values to nominal values.

4. METHODOLOGY

The prediction techniques of KNN (K-Nearest Neighbors) and Random Forest [3][8] have been used in this work to predict the future road accidents rate for each State of India. The total accident rate for each accident–factor for all the States has been predicted. Also presented is an analysis of both the prediction models.

5. PREDICTION MODELS DEVELOPED

5.1 Using K-Nearest Neighbor Algorithm

We normalize the data and apply the K-Nearest Neighbor Algorithm using K = 5. Different metrics such as the Euclidean distance are used to calculate the distance between the test data set and the training data set. Due to the fact that distances often depend on absolute values, it is recommended to normalize data before training and applying the K-Nearest Neighbor algorithm. The value of K was set to 5, from which the nearest k value is calculated based on the distance, and the result is sorted. The higher mean value is predicted as the total accident rate for the next year for all the States separately.

Total accident with accident – factors namely road type, weather condition, location, junction type, traffic signal are calculated. Fig 1. depicts the number of road accidents by considering weather conditions as one of the factors. The data shown in the figure, for the year 2014, 2015 and 2016 is the actual data set (number of road accidents) taken from data.gov.in. The total number of road accidents in 2017 has been predicted using the K-Nearest Neighbor algorithm. The same can be predicted using other factors such as road type, location etc.
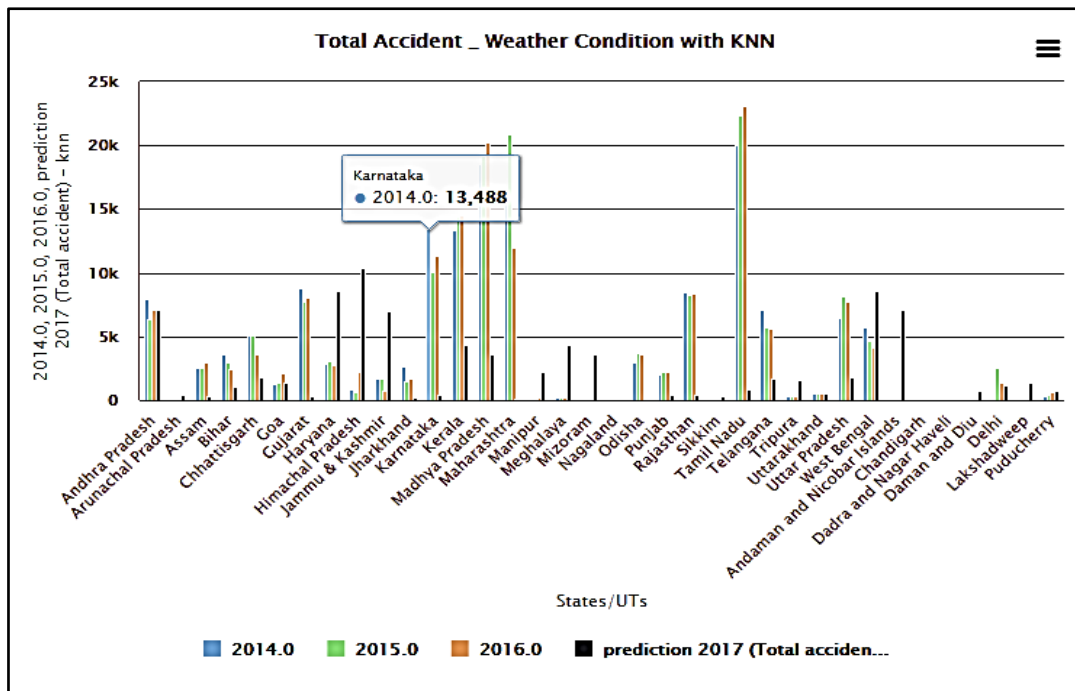
Fig.1: Actual and predicted values using K- Nearest Neighbor

5.2 Using Random Forest Algorithm

Random forest is an efficient algorithm that produces most accurate results. Each tree in the random forest learns from a random sample of the training observation. The samples are tested multiple times in the entire tree. The algorithm predicts new data by aggregating the prediction of N trees.
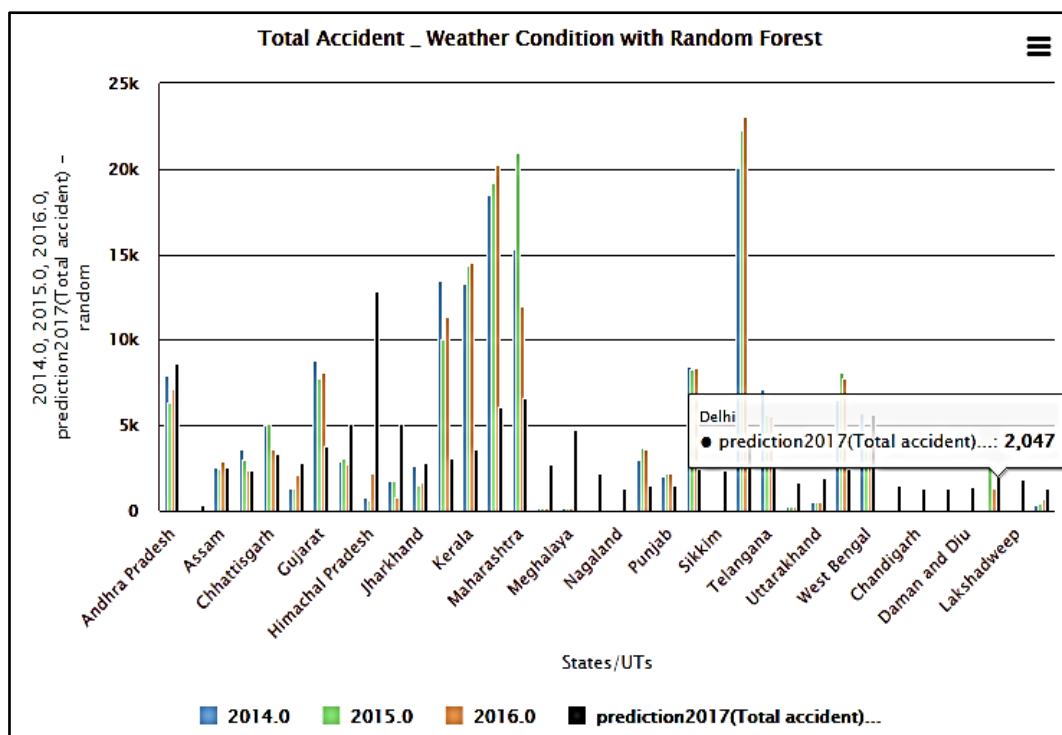

Fig.2: The actual and the predicted values using Random Forest

In this paper, the random forest algorithm is used to predict the road accident rate of the upcoming year. The tree is taken from the sample training data repeatedly, so that data point has equal probability. Number of trees is set to 100 and the criterion measure used is least square method. This method is used to approximate the solution, and has enabled prepruning. Based on this, the total accident rate is predicted for all the States. Fig (2) shows the actual (years 2014, 2015 and 2016) and predicted values (year 2017) of road accidents using random forest classifiers by taking weather conditions as a factor for prediction. Fig (3) compares the predicted results of KNN and Random forest models.
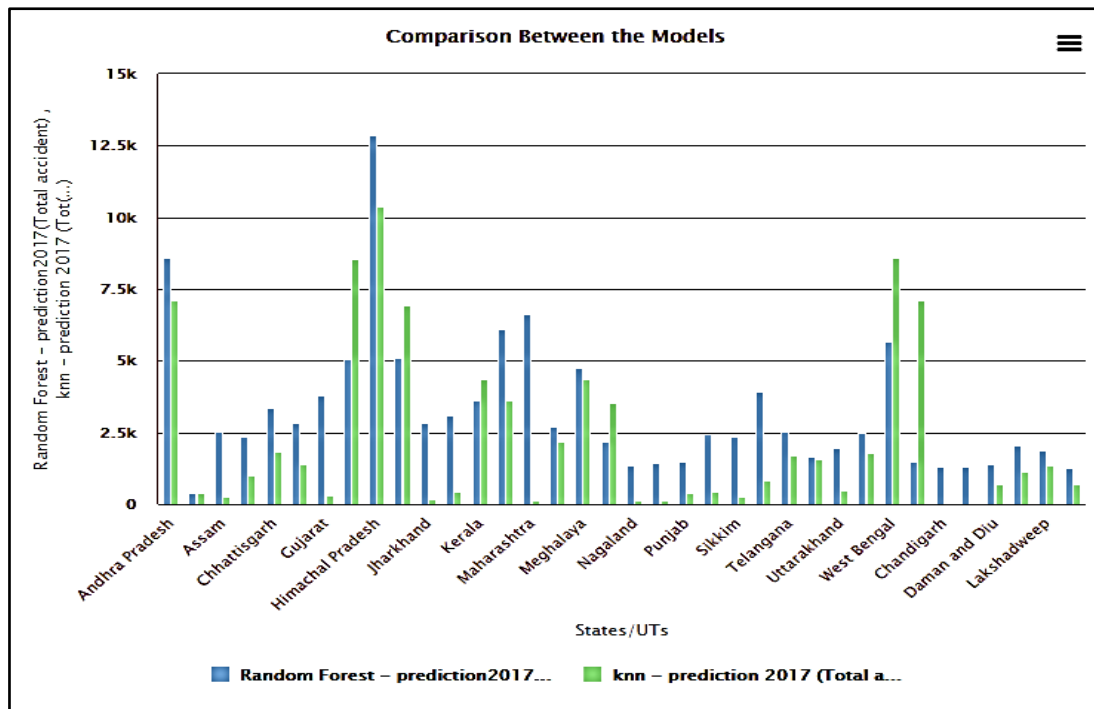
Fig.3: Comparison of KNN and Random forest models

Table 1: Performance based on traffic signal violation

Performance Key Parameter (Traffic Signal Violation)	Random Forest	K-Nearest Neighbor
Absolute Error	470.815	543.917
Normalized Absolute Error	0.216	0.223
Root Mean Squared Error	763.133	952.518

Table 2: Performance based on road type

Performance Key Parameter (Road Type)	Random Forest	K-Nearest Neighbor
Absolute Error	498.976	514.771
Normalized Absolute Error	0.379	0.369
Root Mean Squared Error	877.078	988.622

Table 3: Performance based on Weather Condition

Performance Key Parameter (Weather Condition)	Random Forest	K-Nearest Neighbor
Absolute Error	348.464	385.147
Normalized Absolute Error	0.247	0.250
Root Mean Squared Error	802.073	967.457

Table 4: Performance based on age of the driver

Performance Key Parameter (Age of the driver)	Random Forest	K-Nearest Neighbor
Absolute Error	885.023	903.788
Normalized Absolute Error	0.851	0.818
Root Mean Squared Error	1410.831	1412.081

Table 5: Performance based on location type

Performance Key Parameter (location type)	Random Forest	K-Nearest Neighbor
Absolute Error	268.419	260.852
Normalized Absolute Error	0.305	0.347
Root Mean Squared Error	529.469	519.470

The Performance vector shows the difference in the performance of both the models. This is done by calculating the Root Mean Square Error (RMSE) of both the models with the same set of data.

The results showing the comparison between using Random forest algorithm and K-Nearest Neighbor, according to different performance key parameters is tabulated below (Table 1 – Table 5). On comparing, we find that the Random Forest model has shown better performance, by producing least values for all the performance key factors such as RMSE, absolute error (AE) and normalized absolute error (NAE).

5.3 Applying the Random Forest Algorithm for Classification

Classification is a data mining function that assigns items in a collection to target categories or classes. It is the process of finding a model that describes and distinguishes data, classes, model and concept. Different Algorithms are used to build a classifier by making the model learn using the training set available.

A model is constructed using the Random Forest algorithm. This model is used to predict class labels. The constructed model is tested using the test data and thereby the accuracy of the classification rules is estimated. Random Forest grows many classification trees. To classify a new object from an input vector, we have to put the input vector down each of the trees in the forest. Each tree gives a classification, and we say the tree "votes" for that class. The forest chooses the classification having the most votes (over all the trees in the forest). Gain ratio is set as criteria to build a random forest tree. Gain ratio, a variant of information gain, adjusts the information gain for each attribute to allow the breadth and uniformity of the attribute values.

Gain Ratio (A) = Gain (A) / SplitInfo (A)

Table 6: Accuracy of the classification for different attributes

Attributes	Accuracy
Location Types	76.38%
Traffic Signal Violation	81.36%
Road Types	72.38%
Weather Condition	80.86%
Age Limit	81.26%

Using this classification method, we identify whether the predicted accident rate for the year 2017 has increased or decreased compared to the previous year. Depending on the result, the accident rate will be classified as low-accident, moderate – accident, high-accident respectively. Based on this classification rate we can judge how many accidents have taken place in all the States of India. Table 6 shows the accuracy of the classification for the different attributes.

6. ANALYSIS AND RESULTS

A prediction model has been used to find the accident rate for the upcoming year and the classification model has been used to find the increase and decrease in the accident rates.
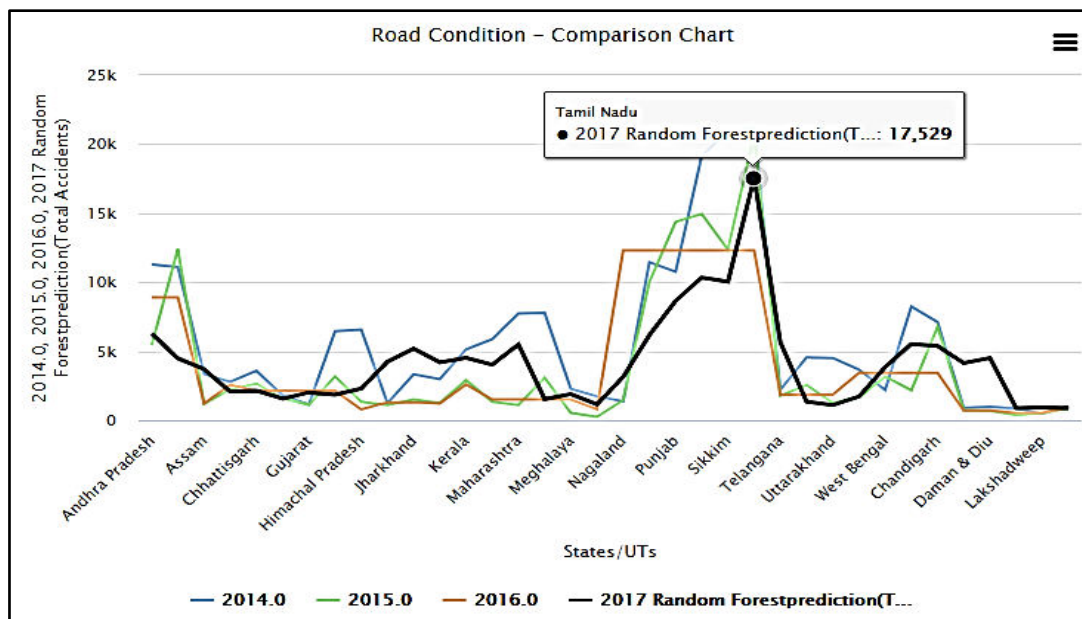
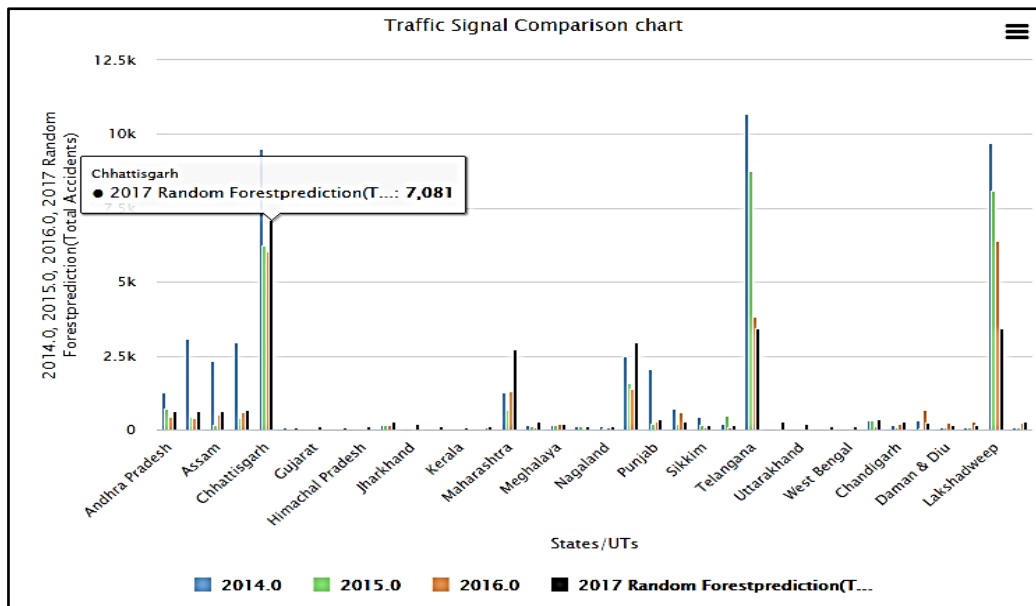**Fig 4:** Total accidents State-wise based on road-type

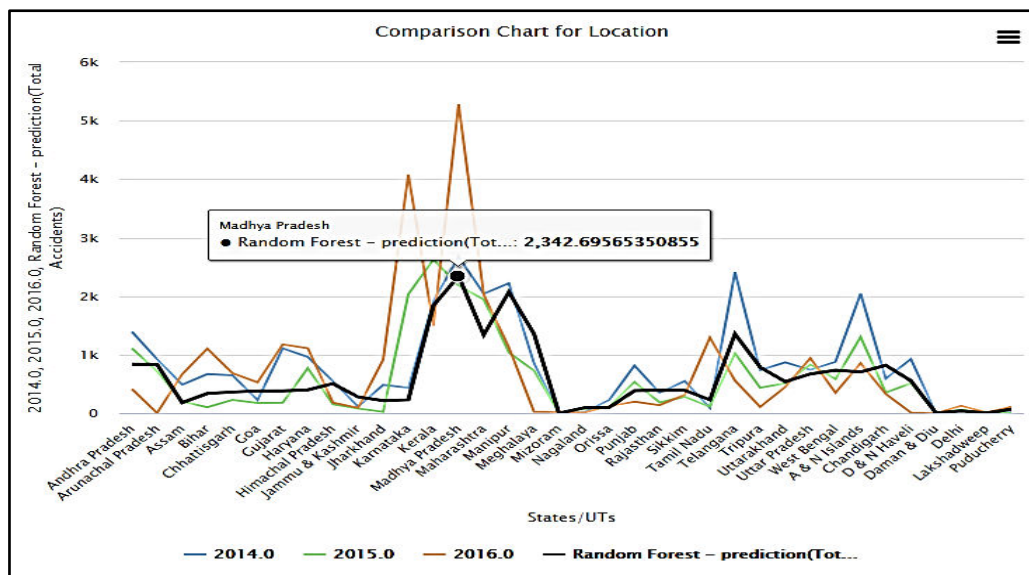**Fig 5:** Total accidents State-wise based on traffic signal violation

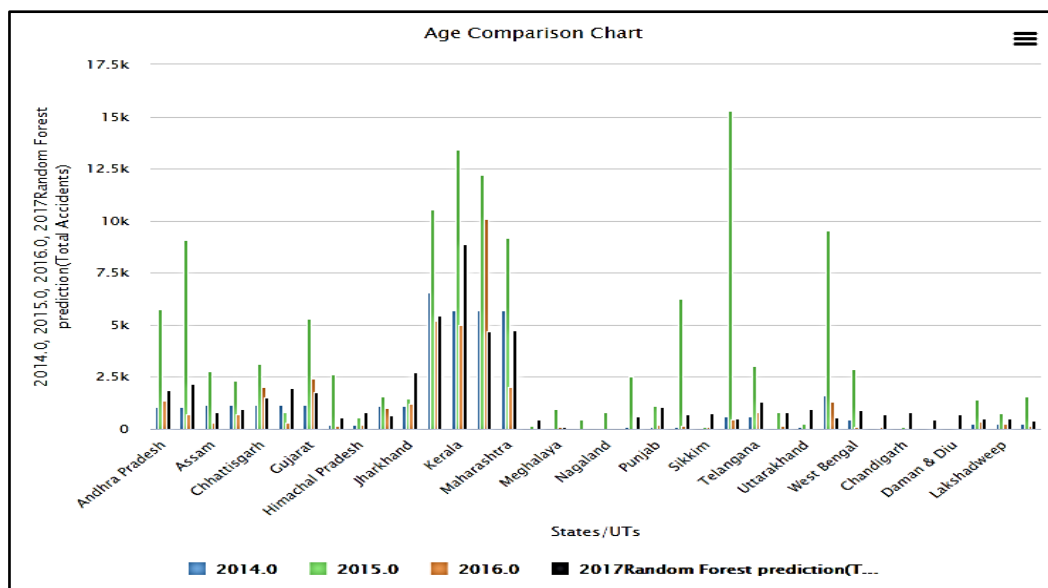**Fig 6:** Total accidents State-wise based on type of location

Fig 7: Total accidents State-wise based on age of driver

The prediction results based on different accident factors have been discussed below.

1. **Road Type:** Highest number of accidents is predicted in Tamil Nadu. Fig 4 shows the total accidents State wise based on road type.

2. **Traffic Signals Types:** Highest number of accidents is predicted in Chhattisgarh. The result is shown in Fig 6.

3. **Location Types:** Fig 6 shows the total accidents based on type of location. Madhya Pradesh is prone to increased accidents in the predicted year.

4. **Age of the Driver:** As per the prediction, Kerala shows the highest number of accidents. Fig 7. shows the total accidents based on the age of the driver.

5. **Weather Conditions:** Himachal Pradesh is prone to more accidents as per the result shown earlier in Fig 2.

7. CONCLUSION

This work has used data recorded in the archives of the Government of India, to predict and classify the road accident rate in 29 States and 7 Union Territories across India based on the factors - road condition, weather condition, location type, age of the driver and traffic signal violation.

K-Nearest neighbor and Random Forest models are used to build the predictive model. This work shows the differences in the predicted total road accidents rates calculated using K-Nearest neighbor and Random Forest algorithm, for all the States of India. The performance of the model is calculated using the root mean square error as a metric for comparison and the results are tabulated. It is found that Random forest gives better result with minimum root mean square error and the same algorithm is used to classify the accident rate in various States as low, moderate and high.

Road accidents can be avoided or reduced by following the traffic rules, by having a control over the speed and by following all safety measures. In future, the model developed can be further extended by adding driver responsibility as a cause and the possible accident rate in specific regions of a given State can be predicted.

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INVESTIGATION ON GROWTH, STRUCTRUAL, VIBRATIONAL, NMR, THERMAL, LINEAR NAD NON LINEAAR OPTICAL, AND PHOTOLUMINISVENCE EFFICACY OF CHARGE TRANSFER CRYSTAL - L VALINIUM HYDROGEN MALEATE

R. SELVI AND DR. R. S. SUNDARARAJAN

ABSTRACT

L –Valininium Hydrogen Maleate (LVHM) crystal is grown by solvent vaporation method at room temperature. The grown crystal is subjected to single crystal X- ray diffraction, powder X-ray diffraction, FTIR, UV-Vis- NIR, Photoluminescence, TGA/DTA and SHG studies. The single crystal X-Ray diffraction study reveals that the grown crystal belongs to monoclinic system with P_{21} space group. The functional groups presented in the grown crystal have been identified using FTIR analysis and are confirmed by NMR study. The UV-Vis spectral analysis shows that the title compound has good optical transmittance in the entire UV-Vis region starting from 290 nm. The photoluminescence study gives blue emission peak. From the TGA study the thermal stability is observed and the TGA/DTA analysis reveals the melting point of the crystal is found to be 140˚C. The second harmonic generation efficiency of the of the grown crystal is 3.4 times that of KDP.

Keywords: FTIR, Second harmonic generation, photoluminescence, NLO, X- ray diffraction etc.

INTRODUCTION

In recent days, Organic nonlinear optical (NLO) materials bring much attention due to their high nonlinear coefficient, stability in physical and chemical properties and rapid response to electro -optic effect. They have already been used in various aspects, such as optical switches, optical communications, optical data storage, high frequency electro-optic modulation, different frequency conversion, broad band terahertz wave generation and detection etc., [1], [2]. Organic crystals are expected to have comparatively higher nonlinear optical properties due to the presence of delocalized π- electrons conjugate system, connecting donor and acceptor group, responsible for improved asymmetric polarizability [3].

Owing to the presence of asymmetrical carbon atom and the formation of complexes having non-centro symmetric space groups are prominent characteristics of amino acid crystals as far as NLO properties concerned [4]. The grown LVHM crystal also crystallized in Monoclinic system with non- Centro symmetric P_{21} space group. The crystallographically non-Centro symmetric (NCS) materials is of current interest and attracted the researchers due to the fact that such compounds may show interesting physical properties e.g., non-linear second harmonic generation, Ferro electricity etc. [5]. Various amino acid based Maleate crystals are reported, which are promising material for NLO applications [6 -10].

L- Valine is a branched chain amino acid, which has aliphatic non-polar side chain which retains both   primary carboxyl and primary amino group. The carboxylate acid group donates its proton to the amino group L-. So in the formation of the crystal, amino acid exists as zwitterions, which forms hydrogen bonds in the form of N–H+ –O–C, which are very strong bonds. Hydrogen bonds are used in the generation of non-Centro symmetric structures, which is a precondition for an effective NLO material [11]. Maleic acid is a linear four Carbon molecule with Carboxylate group on both ends and a double bond between the central carbon atoms. The anhydride of Maleic acid is a cyclic molecule containing five atoms.   Maleic acid basically dicarboxylic acid attracted the researcher's attention due to its large π conjugation [12]. In the present study we focus L Valinium Hydrogen Maleate which consists of Valinium ($C_5H_{11}NO_2^+$)   as the cation and Maleate($C_4H_2O_4^{-2}$) as anion. The crystal structure DFT calculations of L Valinium Hydrogen Maleate was reported by Denis Rychkov,**.** (2016)[13]. In the present work L Valinium Hydrogen Maleate crystals (LVHM) were grown by slow evaporation technique with deionized water as Solvent. The grown crystals are analyzed using FTIR, UV- Vis-NIR, ^{13}C, ^1H NMR, Photoluminescence, Single crystal XRD, Powder X- ray diffraction and TGA/ DTA and SHG analyses.

Crystal Growth Technique

The L – Valinium Hydrogen Maleate crystals are grown by solvent evaporation technique. The solutions of initial materials L-Valine ($C_5H_{11}NO_2$) and Maleic acid($C_4H_6O_5$) are prepared in 1:1 ratio with deionized water as solvent .The prepared solution was kept at room temperature in a vibration free and dust free environment. After 40 days tiny transparent colourless crystals of LVHM are harvested. The Molecular packing diagram and photograph of grown the crystal is shown in fig 1 and 2. The grown crystal consists of Valinium as the cation

and Maleate as the anion. The amino group of L- Valinium cation and the Maleate anion is held together by intermolecular hydrogen bond. In molecule containing N-H, O- H bonds have large difference in electro negativity between H atom and N or O atom leads to highly polar covalent bond. The electronegativity value of Hydrogen is 2, while the Oxygen is 3.5, because of these vast difference H atom bears a large partial positive charge and the electro negativity of N atom is 3.0 which bears a potential negative charge. Hence H atom in one molecule is electrostatically attracted to N O or F atom in another molecule. This electronegativity of H atom on N atom makes the protonation and results ($NH_3^{+)}$) in the grown crystal. This has been proved by the presence of NH_3^+ vibrations in NMR and FTIR spectrum.

The chemical scheme of the grown crystal is as follows

L -Valine   **Maleic acid**   **L Valinium Hydrogen Maleate**
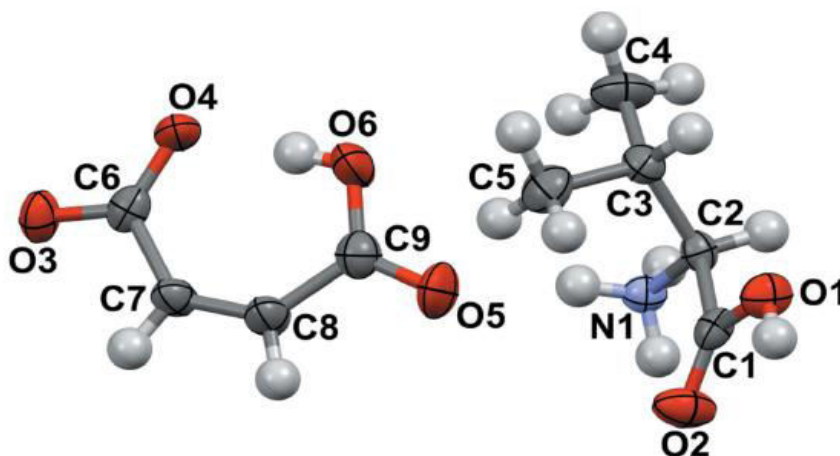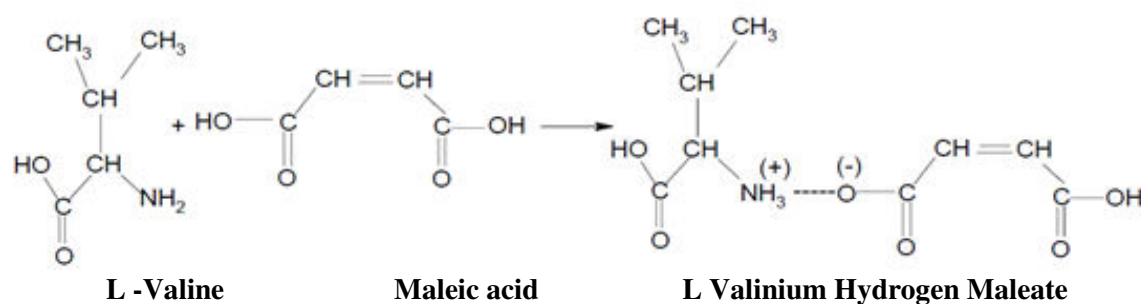
Fig. 1: ORTEP of LVHM (as adaopted from ref. [13]).
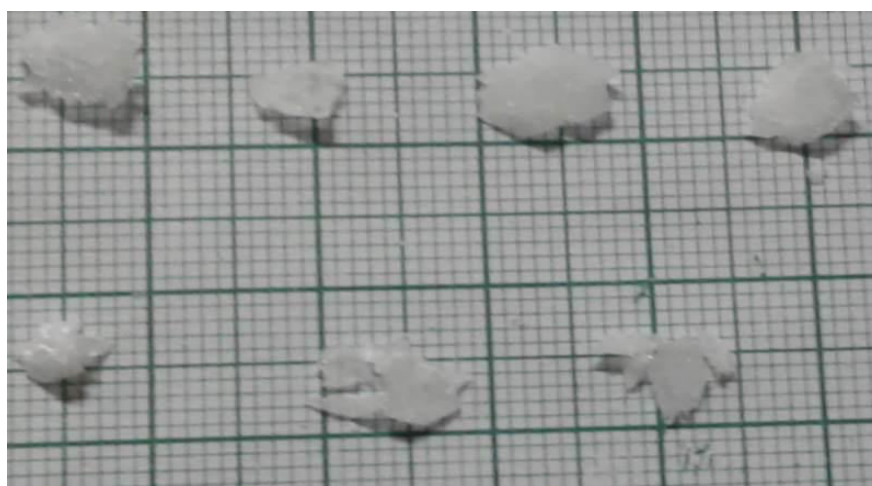
Fig. 2: Crystals of LVHM (as grown)

RESULTS AND DISCUSSION

The grown crystal of LVM is diffracted by ENRAF- NONIOUS CAD4 single crystal X-ray diffractometer with MoKα radiations and the results are tabulated in table 1. From the crystal data, it is confirmed that the crystal belongs to Monoclinic system with P $_{21}$ space group. The space group P $_{21}$ allows the maximum possible contribution of molecular nonlinearity (38%) while the P $_{2121}$ groups allows only minimum (19%) [14]. The grown crystal LVHM also belongs to efficient P_{21} symmetry group.
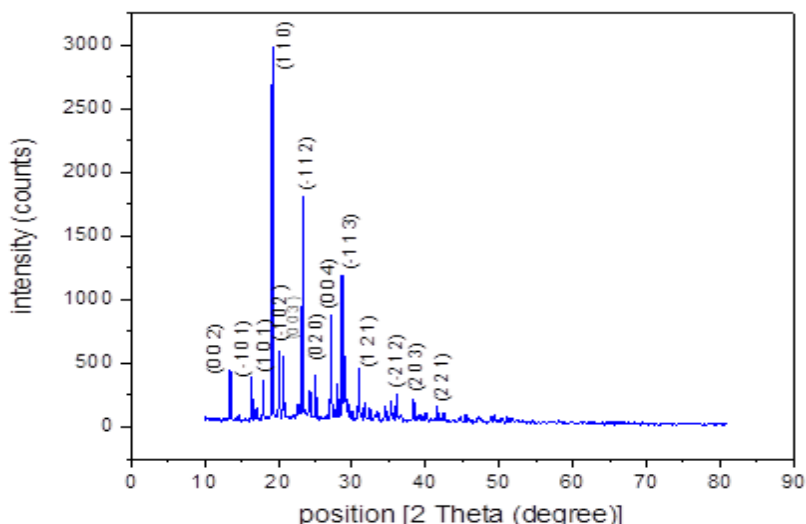
Fig.3: Powder X- ray diffraction pattern of LVHM

Table.1: Single crystal X- ray diffraction data

L- Valine Kauzo Troll etal.., (1969)	Maleic acid James M.N.G etal ., (1974)	L- Valinium Hydrogen Maleate present work
a = 9.71 A°	a = 7.473 A°	a =5.72 A°
b = 5.27 A °	b = 10.098 A°	b = 7.00 A°
c = 12.06 A	γ = 7.627 A°	c = 12.93A°
α = 90°	α = 90°	α = 90°
β = 90.0+2°	β = 123.529°	β = 92.49°
γ = 90°	γ = 90°	γ = 90°
Volume = 617.2A°3	Volume = 478.92A°3	Volume = 513 A°3
Space group : P21	Space group : P21/c	Space group : P21
Crystal system : Monoclinic	Crystal system : Monoclinic	Crystal system : Monoclinic

Powder X-Ray diffraction Study

The grown crystal is crushed into powder and diffracted with XPERT PRO X- ray diffractometer using CUkα radiations. The well-defined sharp peaks reveal the crystalline nature of the title compound. The recorded X – ray diffraction pattern is displayed in fig. 3. By using the unit cell values taken from single crystal XRD, the powder diffraction patterns of the crystals have been indexed using the software package INDX. By using the lattice parameters values taken from single crystal XRD, powder XRD diffraction patterns of the crystals have been indexed by the software package Indx , using the simulated hkl values and d spacing values lattice parameters are calculated with the help of program Unit Cell. The calculated values of lattice parameters values are in agreement with the parameters obtained from the Single Crystal X-ray diffraction study.

FTIR analysis

The powdered sample of the grown crystal is subjected to FTIR analysis using Perkin Elmer Spectrometer using KBr pellet technique in the range 4000 – 400 cm^{-1}.The functional groups presente in the grown crystal are analyzed using FTIR spectrum . The recorded spectrum is displayed in fig. 4. The prominent peak assignments are presented in table.2 and the assignments are in agreement with references [13-15].

Amine Groups: The amino group (NH_2) of Valine molecule in the title crystal is protonated by accepting proton in Carboxyl group of Maleic acid and produces NH_3^+ ion in the LVHM crystal. This protonation is confirmed by the peaks at 3350 cm^{-1}, 3079cm^{-1}, 1624cm^{-1}, 1514cm^{-1}, 1208cm^{-1}. The peaks at 3350 cm^{-1} ,3082 cm^{-1} show the symmetric and asymmetric stretching vibrations of (NH_3^+) ion respectively and the peaks at 1624 cm^{-1}, 1514 cm^{-1} are demonstrated the asymmetric and symmetric deformation of (NH_3^+) ions and the peak at 1240 cm^{-1} exhibits the rocking of (NH_3^+) ions.

Methyl Groups: Methyl groups are usually represented as electron donating substituents in the aromatic ring system [14]. The asymmetric and symmetric stretching vibrations of methyl groups are observed at 2731 cm^{-1} and 2638 cm$^{-1,}$ The peak at 982 cm^{-1} is attributed to rocking of CH_3 molecules.

Carboxyl Groups: Carboxylic acid exists usually in dimeric form with very strong hydrogen bridges between the carbonyl and hydroxyl groups of the two molecules. In the recorded FTIR spectrum, O–H plane deformation and torsional vibrations are observed at $1282 cm^{-1}$ and $804 cm^{-1}$ respectively. The carbonyl stretch C=O of a carboxylic acid appears as an intense band from 1760-$1690 cm^{-1}$. In the present study also C =O vibrations observed at $1715 cm^{-1}$, which is in agreement with reference [14]. The peak at $616 cm^{-1}$ and $435 cm^{-1}$ are attributed to COO^- bending vibrations and wagging of COO^- molecules.
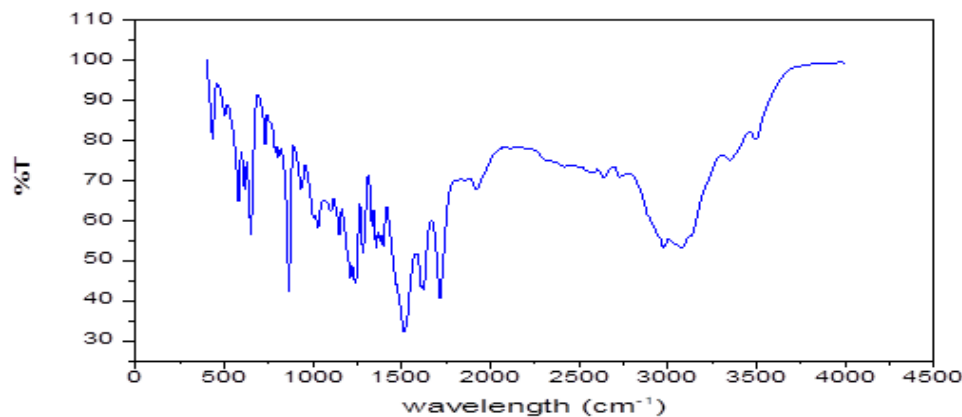
Fig. 4: FTIR spectrum of LVHM crystal.

Table. 2: FTIR Assignments of LVHM

Peaks observed in Reference works cm⁻¹	Peaks observed in the present work cm⁻¹	Assignments
3467 [20]	3494	Hydrogen bonding
3444 [14]	3350	NH_3^+ asymmetric stretching vibrations
3082 [14]	3079	NH_3^+ symmetric stretching vibrations
2976 [15]	2973	asymmetric stretching of C –H in CH_3 group
2882 [15]	2638	symmetric stretching of C –H in CH_3 group
2580 [13]	2578	combination bands of NH_3^+ and CH_3 group
1635 [14]	1624	NH_3^+ asymmetric deformation
1718 [14]	1715	C = O stretching vibrations
1508 [15]	1514	NH_3^+ symmetric deformation
1396 [15]	1396	COO^- symmetric stretching
1271 [15]	1282	OH in plane deformation
1208 [13]	1240	rocking of NH_3^+
1140 [15]	1148	C – C stretching
1178 [15]	1191	C – C stretching
1028 [15]	1020	C – C stretching
1001 [13]	1009	C – C stretching
949 [15]	982	rocking of CH_3
860 [14]	865	C – C – N symmetric stretching
787 [14]	788	C – H out of plane deformation
824 [13]	804	OH torsional vibrations
740 [14]	731	C – C- C ring breathing
664 [15]	651	C – H out of plane bending
619 [13]	616	COO^- bending
583 [13]	580	in plane deformation of COO^-
543 [13]	503	wagging of COO^-
428 [15]	435	rocking of COO^-

^{1}H NMR and ^{13}C NMR Studies

Nuclear Magnetic resonance (NMR) studies on crystalline samples provide structural and crystallographic information. [16]. ^{1}H and NMR ^{13}C NMR spectrum of LAM was recorded in D_2O solution and Tetra methyl saline is used as an internal reference at room temperature. The spectrum was recorded at 500 MHZ BRUKER AVANCE III spectrometer. The recorded resonance peaks are depicted in fig.5a and 5b.

In the ^{1}H NMR spectrum , the quartet peaks at 0.88ppm are attributed to methyl (CH_3) of the amino acid. L-Valine contains two methyl (CH_3) groups which lie in the same moiety; hence it produces a single peak with four lines as followed by (n+1) rule. The mulitiplet centered at2.149 is attributed to C-H of L Valine. Another peak of CH is observed as doublet at 3.671ppm. Two singlets observed at 6.193 ppm and 6.654ppm is attributed to vinyl hydrogen of Maleic acid. The above assignments are in agreement with the reported data [17].The protonation of NH_2 of L Valine with OH of Maleic acid is depicted by the peak at 7.828 ppm. This up field peak indicates the presence of (NH_3) in the grown crystal, This is in agreement with the reference [18].

In the ^{13}C NMR, the triplet centered at 17.279ppm is attributed to carboxylic group carbon atom of the L Valine and the doublet at 134.131 ppm and the doublet at 134.131 ppm is assigned to C = C of Maleic acid. Resonance vibrations of CH of L Valine are observed at 59.08ppm and 29.011 ppm. The peaks observed at 17.527ppm and 16.772ppm is attributed to the carbon atom present in methyl group (CH_3) of L Valine. Thus NMR analysis ensures the protonation, hydrogen bond influence and ascertains the formation of LVHM molecule and additionally validates the FT-IR observations.

Table 4:^{13}C NMR spectral assignments of LVHM

Chemical shift (ppm)	Number of peaks	Assignments
0.88, 0.874 ,0.855, 0.841	quartert	CH_3 of L Valine
2.286, 2.121	doublet	CH Of L Valine
3.671, 3.662	doublet	CH Of L Valine
4.70	inglet	D_2O(Solvent peak)
6.193	singlet	Vinylic Hydrogen of Maleic acid
6.654	singlet	Vinylic Hydrogen of Maleic acid
7.828	singlet	NH_3 (due to protonation of L Valine and Maleic acid)

Table 3: ^{1}HNMR spectral assignments of LVHM.

Chemical shift (ppm)	Number of peaks	Assignment
172.486, 170.279, 168.65	Triplet	COOH of L Valine
134.101,131.104	doublet	C = C in Maleic acid
59.008	singlet	CH of L Valine
29.011	singlet	CH of L Valine
17.527, 16.772	doublet	CH3 of L Valine
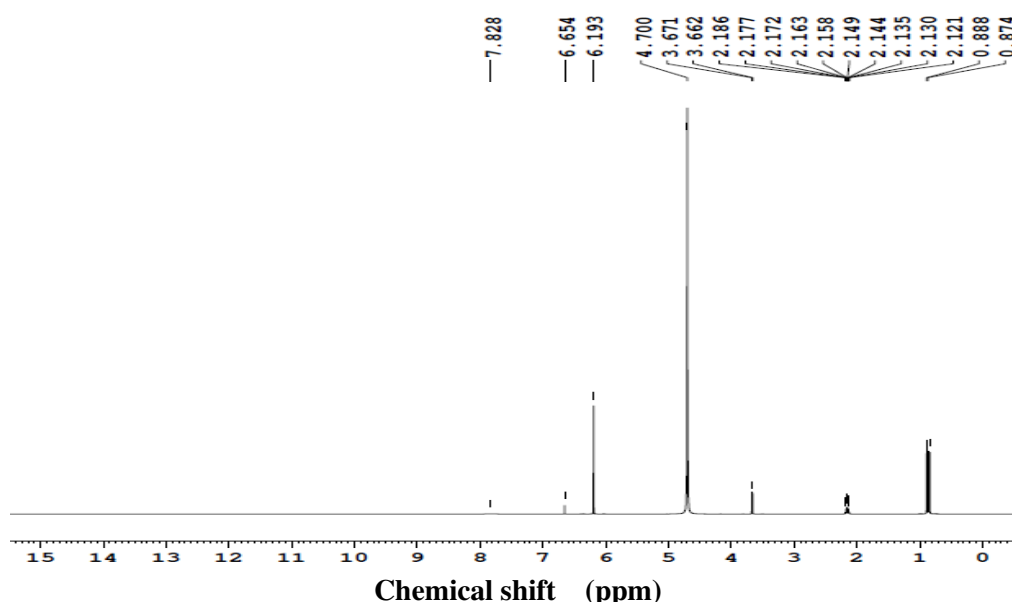
Chemical shift (ppm)
Fig 5a: ^{1}H NMR spectrum of LVHM

Chemical shift   (ppm)
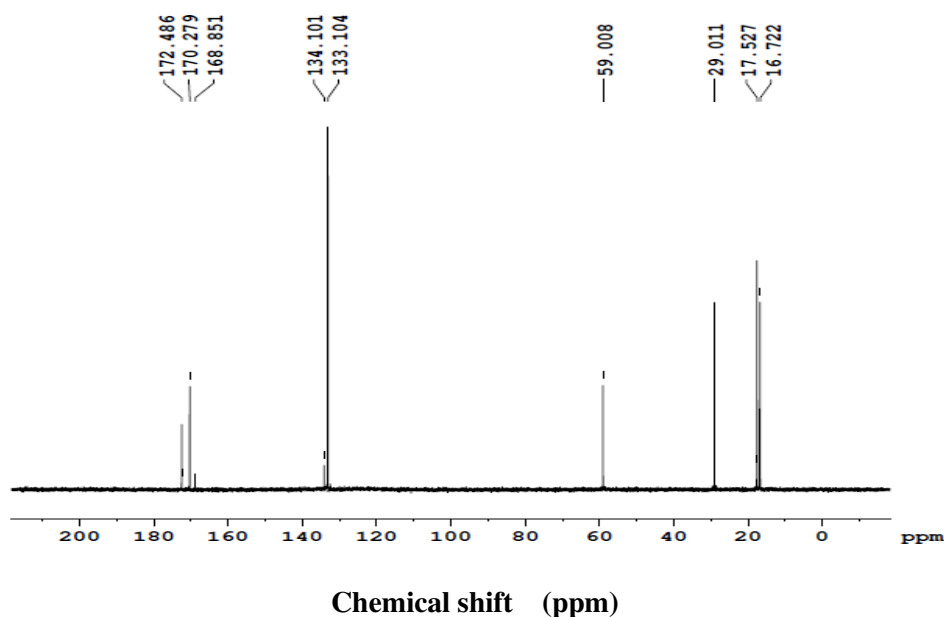**Fig. 5b:** ^{13}C NMR spectrum of LVHM

UV –Vis –NIR Spectral Study

The Optical linear transmittance spectrum of LVHM is studied using Elmer UV-Vis-NIR spectrometer. The absorbance and transmittance spectra are   recorded in the range (200 - 1100 nm). The recorded spectra are shown in fig 6a and 6b. From the transmittance spectrum the lower cut-off wavelength is observed at 290 nm. Hence the title compound forms the transmission window from 290 to 1100 nm. Because of this significant range the grown crystal can be used generate third harmonic frequency for Nd:YAG laser of fundamental wavelength 1064 nm. [19]. The optical band gap energy of LAHM crystal is estimated using the fundamental relation as described in [20].The Eenergy band gap value is given by

$E_{g} = 1240/ \lambda$ eV

The calculate energy band gap value is 4.2758 eV. This low energy gap reveals the biological activity of the molecule as well as explains the charge transfer conjugation occurs within in the molecule [20]. The conjugation may occurs between (π $\pi*$) transition.
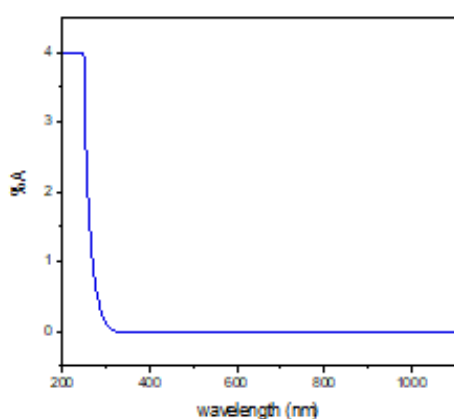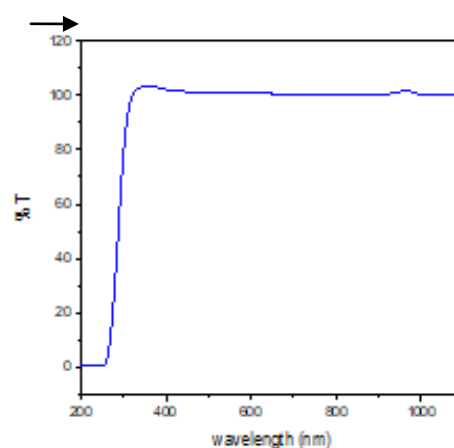

Fig 6: a   Fig 6: b

Photoluminescence Study

Photoluminescence is the significant feature that helps to examine the impurity level and transitions of electrons to different energy states in the given material by tracing trajectory of electrons during photo relaxation. The electron transits to sector boundaries, solvent inclusions, growth band gap, slip band grain boundaries, dislocations, vacancies, cracks, stacking etc., [21]. The PL spectrum of the in powdered sample is recorded using Varian Cary Eclipse Spectrophotometer in the wavelength range 340nm- 600nm at the scan rate of

600nm/minutes with an excitation wavelength of 290 nm (lower cut-off wavelength as observed in UV-Vis analysis). The recorded spectrum is shown in fig.7. The sharp emission peak at 409 nm corresponds to near blue emission of the visible spectrum. Hence this material can be used as a suitable material for blue LED applications. After 409 nm the intensity is gradually decreased due to the presence of hydrogen bond in the crystal lattice [20].
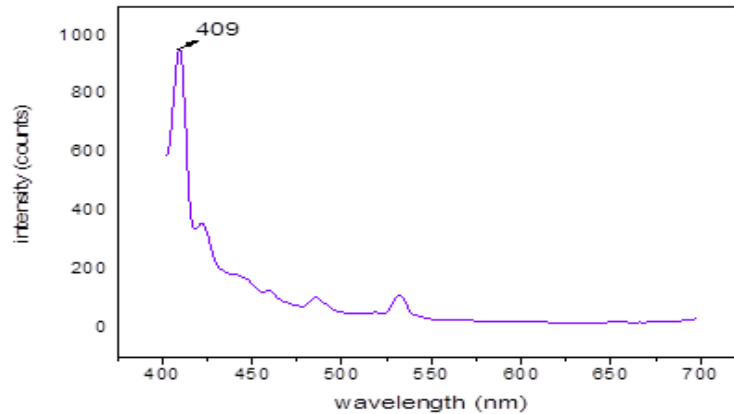

Fig.7: Photoluminescence spectrum of LVHM

THERMAL ANALYSIS

TG/DTA curves of LVHM are presented in fig.8 . From the TG curve of LVHM undergoes single stage decomposition and we can see that the initial decomposition begins approximately at $140°C$. Below $100°C$ there is no decomposition takes place , hence there is no water of crystal ionization observed in the grown crystal. From DTA curve we observe that there is a sharp endothermic peak and there is a steep fall in the mass in TG curve reveals that the grown crystal is undergoing change of state from solid to liquid phase. After heating above $140°C$, the the volataile su substances like NH_3, CH_2 are liberated from the crystal ,which is confirmed by the subsequent exothermic peaks observed in the DTA curve. Thus from thermal analyses, it is conclued that the crystal can be utilized for device applications in the field of optoelectronics and photonics up to $140°C$ Hence the melting point of LVM crystal is observed to be $140°C$ which is very low as compared to the melting point of pure L- Valine $295°C$[15]. Hence due to Hydrogen bonding of L- Valine with Maleic acid reduces the melting point of the grown crystal but this may increase the NLO property of the system.
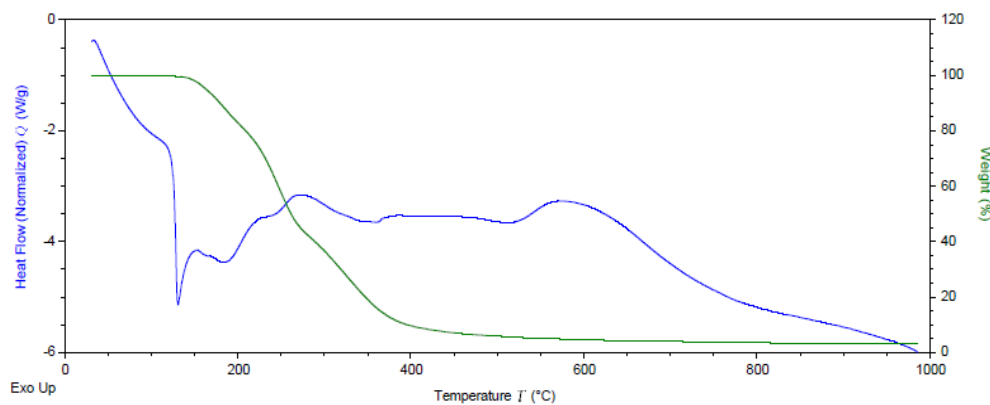

Fig: TG/DTA trace of LVHM

NLO Study

When a light wave of frequency (ω) passes through a noncentrosymmetric crystal, the electric field E (ω) associated with the wave induces polarization P (2ω) at twice the incident frequency. This interaction is given by the relation [22]

$$P_j(2\omega) = \varepsilon_0 \, d_{ijk}(2\omega) \, E_j(\omega)E_k(\omega)$$

Where dij_k is second harmonic coefficient. This polarization phenomenon of laser light t is known as Second harmonic generation (SHG). The SHG efficiency is usually measured using Powder technique developed by Kurtz and Perry [23]. The Q-Switched high energy ND: YAG laser (QUANTA Ray model lab 170-10) is used

to measure the SHG efficiency of the sample. The powdered sample packed in a micro capillary tube is mounted in the path of the laser beam of energy 0 .70 mj and and of wavelength 1064nm at the repetition rate of 10Hz with the pulse width of 6 ns. The output is measured using energy meter (EPM 2000). SHG efficiency was calculated by the ratio of signal energy of the LVHM sample to that of KDPsignal energy for the same input power.The SHG Efficiency of the grown LVHM is found to be 3.4 times higher than that of KDP.

CONCLUSION

L-Valinuniun Hydrogen Maleate crystals are grown by Solvent evaporation technique at room temperature. .The single crystal XRD analysis establishes that, LAHM crystallizes in the monoclinic crystal system with space group P_{21}. The indexed Powder XRD pattern shows the crystalline nature of the grown sample. FTIR and NMR Spectral studies confirm the protonation amine of L-Valine with the Carboxylic group of Maleic acid. The UV cut-off wavelength of the LVHM crystal is 290 nm and shows a wide range of transmission between 290 and 1100nm. The photoluminescence study gives the blue emission in the visible region.

As expected, LVHM crystal exhibit higher second order nonlinear efficiency. The effect of intermolecular charge transfer interactions through hydrogen bonds is responsible for the NLO activity of LVHM crystal. Hence, the crystal can be used in the optoelectronic and photonic applications

ACKNOWLEDGMENT

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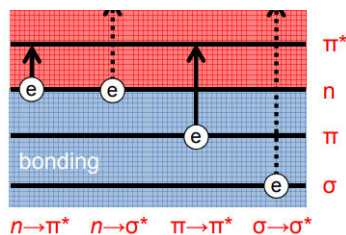
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CSR DURING THE PANDEMIC-AN INDIAN PERSPECTIVE ON OPPORTUNITIES AND CHALLENGES

CS DR. JIGARRUPANI

ABSTRACT
All over the world the business was affected and the profitability also affected severely during the pandemic. This results in stagnation of CSR activities by the companies. India's CSR expenditure declined considerably from INR 18,655 crore in FY19 to INR 17,885 crore in FY20. Nevertheless, corporate have engaged in a number of philanthropic CSR activities in response to the need of the situation which are really commendable. During the second wave of covid-19 the Ministry of Corporate Affairs announced the companies use CSR funds for "creating health infrastructure for Covid-19 care, establishment of medical oxygen and storage plants, manufacturing and supply of oxygen concentrators, ventilators, cylinders and othermedical equipment for countering Covid-19". Also CSR funds utilised for 'makeshift hospitals and temporary covid care facilities'. The COVID-19 pandemic has been a very challenging period for Indians and the global community. During these times, CSR has attained a new level of providing effective aid to various stakeholders in the process of achieving sustainable development. An important lesson this pandemic has taught us is that all stakeholders need to come together to fight the inequities and fix the fault lines of the society. In this regard, CSR interventions have served as appropriate models of providing aid to the most vulnerable sections and communities.

Keywords: Corporate Social Responsibilities (CSR), Stakeholders Challenges

INTRODUCTION

In 2014, India had become the first country to legally mandate CSR. Corporate Social Responsibility (CSR) is a self-interest activity of a company to focus on the importance given to the society in terms of economic conscious and environmental conscious. Apart from a company earning profit for its wellbeing, something must be given back to community. As an ethical activity of business CSR improves the goodwill of the company in the society. CSR should mandatory and be an integrated part of the business, so the stake holders of the company realize the survival of the company in the society. CSR improves the customer perception, attracts and retains employees, improves the brand among investors. Business entity can undertake CSR activity in the form of giving environmental importance, becoming a philanthropist by donating money for social causes, charities, local community programs, by having fair employee practice in the work place and volunteering ourselves in local community program. As a beginner in business may not have enough financial backups, but well established firm can contribute a least minimum amount to the society.

Importance of CSR in Pandemic

According to Section 135 of Companies (CSR) Rules, 2014 and Schedule VII of Companies Act 2013:

"Every company with a net worth of Rs 500 crore or more or turnover of Rs 1,000 crore or more or net profit of Rs 5 crore or more during the immediate preceding financial year, must have a CSR committee and spend at least 2 per cent of average net profits earned during three immediate preceding financial years to CSR activities."

But this was not possible during the pandemic since the corporate undergone financial crises. So the Government of India motivated the companies to provide social support in the areas listed under the following items of Schedule VII:

Innovative CSR Models during Post Pandemic

The covid19 pandemic erased the development opportunities that were expected for the next decade. The individuals with low education, fever resources, money were burdened in the pandemic era. During the pandemic the Indian government imposed to lockdown all the unnecessary activities including physical business operations. The entire world expected the business firms jointly with the government step to solve the societal problems.

REVIEW OF LITERATURE

PujiHandayati, (2020) discussed CSR challenges in the area of food and beverages company at Malang. The economic and social challenges before and after the pandemic were considered. The results shows some companies CSR quality were increased during pandemic by adding quantity to their CSR activities in the form of providing healthy food, maintaining environment and product cleanliness, employees health improvement, providing mask to customer and employees and providing vitamins to customer and public.

Yanqin Wu and Wenzhong Zhu (2021), discuss CSR engagement in social mediahelp DiDi a Chinese brand. The result shows there is positive relationship between the CSR engagement of DiDionwechat, customer-company identification, behavioral intention and e-word-of-mouth intention of customer. The study highlights the CSR engagement in the critical period and business innovation strategies.

Appel Mahmud, Donghong Ding (2021) discuss the responses of the companies towards the stakeholders namely employees, customer, communities and society. The study was conducted with contemporary sources from the press release, newsletters, and details from stakeholders from 25 corporations with 100 respondents. The results shows the companies are showing stewardship relationship with the employees, customers and the society. **Hakseung Shin, Abhinav Sharma, Juan Luis Nicolau, Juhyun Kang (2021)** adopts mixed-methods approach to study the hotel CSR activities towards multiple stakeholders during the pandemic. The hotels provided accommodations facilities to the health workers, changes in the market value of the hotels, customers booking behaviour were considered as the CSR activities by the hotels during the pandemic. it also added hotel CSR activities for strategic philanthropy would benefit society in the current scenario, but how these activities benefit hotel stakeholders.

Soyeon Kim (2022) discusses the CSR activities by the Korean global firms during the pandemic. Major global firms Samsung Electronics, LG Electronics, and Hyundai Motors were analysed and shows the CSR were conducted in prompt and systematic way during the pandemic condition. They focused on the main CSR activities which were closely related to their business. They created value to the business and also society contributing to create values.

Archie B. Carroll (2021) saysemployees, consumers and communities were mostly affected in the pandemic. Many companies were striving to reset their CSR thinking and try to meet the expectation from the public. The study says companies need to inhabit the strategic-integrated-deep end of continuum to deal with Covid-19. Also the transformations may affect the stakeholders.

PoojaaGokarna, Bala Krishnamoorthy (2021) says the pandemic offered opportunities for the companies to connect with the society. India is the first to mandate CSR activities legally in the entire world. CSR is not

merely donating to the public; it is part of the business where company contribute to the social good. Massive support the PM cares fund, health and sanitation facilities like PPE kits, medicine, ventilators, Corporates engage them in R&D activities to identify vaccine, providing food and sanitation to health workers, Making programs digitally, identifying the funds are properly utilized, Crowd funding to rise funds from the public. The study can be extended in quantitative basis for further outcomes.

IzaGigauri (2021), says through a semi-structured interview was framed to identify the CSR activities during pandemic. The strategic CSR practices during pandemic to overcome the challenges faced by the countries and corporate.

Hongwei Hea, Lloyd Harris (2020) says the pandemic offers great opportunity for business to shift to genuine and contribute to urgent global social and environmental challenges. The study says pandemic influence in the CSR, consumer ethics, and marketing of the companies. A great change in the consumer ethical decision, shifting consumers more social responsible. Social marketing concept was emerged and more responsible business orientation.

AlessiaPatuelli (2021) considers the large Italian firms for the study on Twitter. They say using an entropy based null model, identifies a network of accounts. At the centre of the network focused on environmental sustainability, digital innovation and safety. Firms ownership does not influence the CSR but hostages and stakeholders engagement relatively small in some communities.

Impact of Pandemic on CSR

Covid 19 was considered as global problem by the World Health Organisation (WHO). Usage of mask, hand sanitizer and social distancing physically was great hindrance for the CSR activities. Prolonged lockdowns increased the economic problems among the public. Undoubtedly, COVID-19 pandemic has disparate impacts on the society, generally hurting lower income individuals playing as the ostensibly 'essential' workers more, which have further widened the inequality spectrum. Despite being widely applauded, such workers have also often been exposed to infection because of lack of necessary protection and remain poorly paid and economically vulnerable. It has clearly challenged a number of existing CSR assumptions, concepts, and practices.

Companies Contribution during Pandemic

Reliance industries contributed its Jamnagar oil refinery to produce oxygen and supply free to mostly affected states. Radio Kaitan company a well known producer of vodka produce sanitizers. Amazon delivery oxygen equipments to all corners of the world through leveraged its logistics capacity. CISCO and AWS supported digital education to all corners of India. The government is implementing the Public-Private-Philanthropic partnership models to ensure efficient welfare delivery. The PPP models proved large companies leveraged their efforts to support employees and communities of our country. Maruti Suzuki ltd train the skilled workers through Industrial Training Institutes, Amazon spent corers in global and local logistics through mission Vayu 2021. The MSME sectors were less focussed during the pandemic and most of the employees were affected in the pandemic. This was not accountable since large number of MSME workers all around our country. There was no proper quantitative data about the situation of MSME during pandemic. Emergency Credit Line Guarantee Scheme (ECLGS) for MSMEs, concentrate on formal enterprises running under loans at a prescribed date.

Table: Showing Contributions made by various companies in the BFSI sector in India during COVID-19 times:

	Company	Action
1	Aadhar Housing Finance Ltd.	Donated 28,810 three-ply masks, 10,239 hand sanitisers, 112 hand gloves, 3 carbide nozzles to frontline staff in hospitals and police stations Provided 1,200 kg rice, 2,140 ration kits and 167,000 meals to migrant labourers and families Contributed Rs 50 lakh to PM CARES Donated Rs 350,000 to the Bandra Holy Family Hospital for the treatment of COVID-19 patients
2	Arohan Financial Services Ltd.	25,000 ration kits were distributed Organised health camps to create awareness on women's welfare Promotion of local arts and craft Funded a non-profit for relief to victims of human-trafficking

		Under Arohan's WASH initiatives, partnered 'Friends of Women's World Banking' to providing loans for better sanitation
3	JM Financial Home Loans Ltd.	Contributed Rs 15 crore to PM CARES Contributed Rs 15 crore to support healthcare assistance to counter the pandemic
4	India first Life Insurance Co. Ltd.	Contributed to PM CARES
5	IIFL Securities Ltd.	Contributed Rs 5 crore to PM CARES Donated Rs 20 lakh to hospitals and non-profits to provide protective gears to frontline staff and food to migrant labourers
6	DCB Bank Ltd	Set up a Rs 1 crore fund for COVID-19
7	Bharat Financial Inclusion Ltd.	Contributed Rs 1 crore to PM CARES Helped state governments in Jharkhand, Madhya Pradesh and Karnataka to access essential medical equipment (testing kits, PPEs, other sanitation requirements) and train frontline health workers in protecting themselves against the virus
8	Bajaj Finserv	Contributed Rs 10.15 crore to PM CARES
9	Indiabulls	Pledged Rs 21 crores to PM CARES Fund
10	AU Small Finance Bank	Pledged Rs 5 crore (Contributed Rs 2 crore to PM CARES, Rs 51 lakh each to Delhi and Maharashtra Chief Minister relief funds and provided the Rajasthan government a testing facility in Bhilwara)
11	India Infrastructure Finance Co. Ltd.	Contributed Rs 25 crore towards PM CARES
12	General Insurance Corp.	Donated Rs 22.69 crore to PM CARES
13	DBS Bank India	Committed 2 million meals to the pandemic-affected To provide ventilators, medical supplies and equipment and sponsor free-testing for the deprived
14	Kotak Mahindra Bank	Pledged Rs 60 crore (Rs 25 crore to PM CARES; Rs 10 crore to Maharashtra CM Relief Fund)
15	HDFC Bank	Committed Rs 150 crore to PM CARES
16	Life Insurance Corp. of India	Pledged Rs 105 crore to PM CARES
17	ICICI Bank	Pledged Rs 80 crore to PM CARES Committed Rs 20 crore to state governments, hospitals, CISF and police forces for protective equipment Provided 2.13 lakh surgical masks, 40,000 N95 masks, 20,000 litres of sanitisers, 16,000 gloves, 5,300 PPE suits, 2,600 protective eye gear and equipment (50 thermal scanners, 3 non-invasive category ventilators) to states and hospitals
18	Max Life India	Launched initiative to gather one lakh social-isolation pledges Donated sanitisers, masks and food Donated Rs 5 crore for COVID-19 testing Provided for daily needs of construction labourers and other under-privileged people
19	Magma Fincorp Ltd.	Pledged Rs 5 crore to PM CARES Provided ration and food to 5,600 families
20	Hero Fincorp Ltd.	Pledged Rs 100 crore for COVID-19 relief, half of that to PM CARES

Source: Knowledge Report CSR during Covid19: Experience and Learning's- TERI

CSR Challenges during Pandemic

The assessment of pandemic impact on CSR is robust to various sensitivity tests and cross-sectional analysis. It was understood that business roundtable firms did not outperform during the crisis. However, the following key issues were assessed to understand the impact of COVID-19 pandemic on CSR:

- The areas where CSR has been challenged by pandemic should be identified. These are stakeholders, societal risk, supply chain responsibility, and the political economy of CSR. After identification, it is important to propose measures to realign future CSR research to tackle them.

- The second key issue is that of societal risk and uncertainty. Remarkably, there has been scant attention paid in the CSR literature to pandemics and similar global societal risks. However, COVID 19 has highlighted the role of business as a source of such risks and as an actor that is highly exposed to such new risks and needs to play a role in addressing them.

- The third area of challenge in CSR research concerns the issue of responsibility in supply chains. Interruption in demand for medical products like personal protective equipment and ventilators, as well as shortages caused by stockpiling, have demonstrated the fragility of some of our global supply chains, during lockdowns that have severely disrupted the production. In addition, low-wage workers in these supply chains have clearly borne a great deal of brunt of these shocks with many workers left without pay, employment, or social protections. Supplier factories also faced with cancelled orders, delayed payments, and demands for deep discounting in industries relying on low-cost sourcing, such as the global garment industry.

- This leads to the next challenge wherein COVID 19 has exposed the new political economy of CSR. COVID 19 has recentred governments as the key actors in tackling grand challenges rather than being seen as increasingly ineffective in this space, as they are often portrayed in the CSR literature. Also, it is clear that the social responsibility of companies in the pandemic has been to act along with governments (and other actors) to deal with the pandemic not only by voluntary and charitable good deeds but also by employing and safeguarding workers, producing socially useful products, and protecting their respective stakeholders. This will aid in explaining the core purpose of a firm and the role it should play in society.

CSR Opportunities during Pandemic

The impact assessment study also suggested that the increase in the management solutions in the wake of the pandemic crisis will increase the importance of the economic, social, and environmental dimensions in CSR. The following are the specific observations:

- It is indicated that the value of CSR in the hospitality sector depends on its nature and environmental contexts. Definite theoretical and practical implications were provided.

- The effects of CSR on employees' psychological capital remain unclear. This research examined different effects of CSR on self-efficacy, hope, resilience, and optimism. Based on a survey of 430 employees in tourism in China, the results showed that CSR had positive impacts on employees' self-efficacy, hope, resilience, and optimism through the satisfaction of employees with corporate COVID-19 responses.

- CSR policies in response to COVID-19 are created by organizations but are implemented by individual employees. The manner in which employees perceive and react to CSR actions determines CSR's implementation and success.

- It is found that the pandemic-induced drop in stock prices was milder among firms with (i) stronger pre-2020 finances (more cash, less debt, and larger profits), (ii) less exposure to COVID-19 through global supply chains and customer locations, (iii) more CSR activities, and (iv) less entrenched executives. Furthermore, the stock prices of firms with greater hedge fund ownership performed worse and those of firms with larger non-financial corporate ownership performed better.

- The findings suggest that donation appeals featuring warmth-focused messages combined with handwritten typeface and competence-focused messages combined with machine written typeface can maximize donation intention and brand loyalty. Furthermore, results from the moderated mediation analyses indicate that brand trust is the psychological mechanism underlying these effects.

- CSR is now presented as a comprehensive business strategy, arising mainly from performance considerations and stakeholder pressure.

- The focus has shifted from the pre-planned framework of CSR to activities related to fight against COVID-19, which would reap indirect benefits from the operating segment in which companies operate.

- It has become apparent that the focus has been somewhat one sided in nature, with the bulk of attention going to the corporate processes, motives, and outcomes of such efforts .

CONCLUSION

CSR is a business cycle that for the resources taken from the society, the gains are transferred back to the society itself. The government efforts to do the CSR activities during pandemic were remarkable that lot of freedom were given to support the society. To support the society the companies should identify sustained projects for the sustainable growth. Proper information was required to select the sustainable projects. Pan India projects identification requires proper channels to provide proper information. It is necessary to ensure the CSR efforts have multiplier effect on social, economic and environmental background. Finally the pandemic creates lot of opportunities for new area of business, though there was lot of challenges for the business, Government and the stakeholders.

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STRUCTURAL AND RAMAN STUDIES OF INORGANIC-ORGANIC CERAMICS: THEORETICAL CRYSTALLOGRAPHIC ANALYSIS

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ABSTRACT

The biocompatibility of inorganic-organic hybrid ceramics is very important in materials science and to study the role of structural behaviour of ceramic materials, a series of ten ceramic derivatives have been undertaken to analyse their XRD data for spectroscopic predictions. The Crystallographic Information File (CIF) data obtained from International Union of Crystallography (IUCr) depicts that these ten ceramic materials exist in four crystal systems i.e. monoclinic, orthorhombic, tetragonal and trigonal. The ceramic materials, C1 [$Na_4Ni_7(AsO_4)_6$] and C4 [$2C_7H_8N_4OH_2O$] exist in monoclinic crystal system with space groups C 2/m and C 2/c respectively, C2 [$Nd_3BSi_2O_{10}$], C3 [$Sr(ClO_4)_2$] and C5[$Ca(ClO_4)_2$] exist in orthorhombic crystal system having P_{bca} space group, C10 [$Ba(ClO_4)_2$] in orthorhombic crystal system with F_{ddd} space group, C6 [$Ca_{0.84}Sr_{0.16}MoO_4$] in tetragonal crystem system having space group I4$_1$/a and three ceramic materials, C7 [$Cd_3Ge_2As_4$], C8 [$SrGa_4As_4$] and C9 [Cd_3TeO_6] exist in trigonal crystal system with space groups R-3, P3$_2$21 and R-3:H, respectively. The spectral active modes of IR and Raman spectra tensors were calculated which shows that Raman-active modes for orthorhombic C2 [$Nd_3BSi_2O_{10}$], C3 [$Sr(ClO_4)_2$] and C5[$Ca(ClO_4)_2$] (Pbca) were ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$), ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$) and ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$), respectively while orthorhombic C10 [$Ba(ClO_4)_2$] (F_{ddd}) were ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$). Raman-active modes for trigonal C7 [$Cd_3Ge_2As_4$], C8 [$SrGa_4As_4$] and C9 [Cd_3TeO_6] (R-3) were ($\Gamma_{acoustic}= A + {}^1E + {}^2E$), (P3$_2$21) were ($\Gamma_{acoustic}= A_2 + E$) and (R-3:H) were ($\Gamma_{acoustic} = A + {}^1E + {}^2E$). The Raman-active modes for monoclinic C1 [$Na_4Ni_7(AsO_4)_6$] and C4 [$2C_7H_8N_4OH_2O$] (C 2/m) were ($\Gamma_{acoustic} = A_u+2B_u$) and (C 2/c) were ($\Gamma_{acoustic} = A_u+2B_u$) respectively while tetragonal C6 [$Ca_{0.84}Sr_{0.16}MoO_4$] having space group (I4$_1$/a) were ($\Gamma_{acoustic} = A_u + {}^1E_u + {}^2E_u$).

Keywords: Ceramic Hybrids, Structural data, Raman Active Modes, Raman Tensors, etc.

1. INTRODUCTION

Ceramics are natural/synthetic inorganic, non-metallic, polycrystalline materials. The biocompatibility of inorganic-organic hybrid ceramics is quite significant in terms of fixation of various hybrid materials hard and soft tissues [1]. A variety of organic moiety can be employed in the synthesis of hybrids with silica. The ceramic hybrids as well as their composites have attracted great attention as effective hybrid bio-polymeric sorbents due to high sorption capacity, cost effectiveness, renewability and high stability [2]. The stability of ceramic based hybrids in harsh solvents and conditions of industrial process streams is due to the sturdy and inert architecture of the ceramic, while the organic functionalization is responsible for surface and pore properties of the membrane and hence its performance [3].

The inorganic-organic hybrid ceramics are known as ormocers and are of considerable importance in new class of composite materials through their novel properties that exist with the combination of organic polymers with inorganic material. Structural diversity of hybrid cermics attracted attention of the scientific world over the last decade. The durability of ceramic materials can be increased by combining the organic polymers with the inorganic materials so they have multifunctional applications in different areas such as adsorption, photochemical, catalysis and magnetism. Organic– inorganic hybrid materials synthesized at room temperature by a sol–gel method are particularly attractive for obtaining micro-optical elements, optical coatings as well as sorbents as they combine some typical properties of organic (elasticity organic functionalities, flexibility, ductility, tightness and chemical inertness) and inorganic (hardness, thermal and chemical stability, transparency and a large refractive index) constituents [4-6]. If the inorganic species is silica, derivatives are formed by the sol–gel process and the change from base to acid catalysis makes a large difference because base catalysis leads to a more particle-like microstructure while acid catalysis leads to a polymer-like microstructure. In this process small molecules are used as precursors (alkoxysilanes, metal alkoxides as well as metal halides in organic solvents) for the formation of cross-linked materials.

Preparation of organic–inorganic hybrid materials is one of the most attractive fields of sol–gel chemistry. Such materials have attracted much attention from material scientists and chemists in recent years due to the possibility of combination at the nanosize level of inorganic and organic or even bioactive components in a

single hybrid composite. The mechanism of metal adsorption on the silica–chitosan derivatives involves electrostatic interactions (ion-exchange), metal chelation (coordination) and ion pair formation. Several parameters influence this reaction. These are ionic charge of the adsorbent, solution pH and the chemistry of the metal ion (ionic charge, ability to be hydrolysed and form). Heavy metal ion removal has attracted a considerable attention for beneficial water usage due to their long-term environmental toxicity as well as short-term public health damage. The design and synthesis of organic–inorganic hybrid materials have developed over the last two decades as chemists and materials engineers paid their attention to these materials. In the synthetic process of organic–inorganic hybrid materials, the organic components usually act as templates for directing the connectivity and arrangement of inorganic building blocks. Specifically, according to the size and scale of inorganic building blocks, these organic–inorganic hybrid materials can be divided into molecular scale and nanoscale organic–inorganic hybrid materials [7]. Looking upon the structural diversity of ceramic materials, we had selected a series of ceramic material to study their structural properties from X-ray crystallographic data and also to correlate their spectroscopic predictions [8].

2. EXPERIMENTAL

The X-ray crystal data of a selected series of ceramic based hybrid materials were obtained from the International Union of Crystallography, U.K. to analyze the relationship between the two different materials which were synergistically clubbed together to form a single hybrid ceramic material as motivated by the industrial applications of these types of hybrids. The standard archive data file in CIF format has been used to fed as input file in DIAMOND software [9] to analyse the structural data such as cell parameters a, b, c and α, β, γ, crystal systems and space groups, crystal structure, unit cell packing, weak interactions, dihedral angles, etc. The crystal data parameters of all the ten ceramic materials were presented in table 1.

Table.1: Crystal structure data for ceramic materials

Code	IUPAC Name	Chemical Formula	Cell Parameters Å O°	Crystal System & Space Group	Structure Refinement Factor
C1 [10]	Synthesis and crystal structure of $Na_4Ni_7(AsO_4)_6$	$Na_4Ni_7(AsO_4)_6$	a= 14.538 (1) b=14.505 (1) c=10.612(8) α= γ= 90 β=118.299(2)	Monoclinic C 2/m	0.0391
C2 [11]	Synthesis and crystal structure of a neodymium borosilicate $Nd_3BSi_2O_{10}$	$Nd_3BSi_2O_{10}$	a= 9.789(2) b=7.108(1) c=23.089(4) α= β=γ= 90	Orthorhombic Pbca	----
C3 [12]	Crystal structure of strontium perchlorate anhydrate $Sr(ClO_4)_2$ from laboratory powder X-ray diffraction data	$Sr(ClO_4)_2$	a= 14.182(1) b=9.789(1) c=9.376(1) α= β=γ= 90	Orthorhombic Pbca	----
C4 [13]	Crystal structure of 4-formylpyridine semicarbazone hemihydrates	$2C_7H_8N_4OH_2O$	a=25.064(1) b=5.372(3) c=13.012(7) α= β=γ= 90	Monoclinic C 2/c	0.029
C5 [14]	Crystal structure of calcium perchlorate anhydrate, $Ca(ClO_4)_2$ from laboratory powder X-ray diffraction data	$Ca(ClO_4)_2$	a= 13.751(8) b=9.509(5) c=9.062(5) α= β=γ= 90	Orthorhombic Pbca	----

C6 [15]	Synthesis and crystal structure of a mixed alkaline-earth powellite $Ca_{0.84}Sr_{0.16}MoO_4$	$Ca_{0.84}Sr_{0.16}MoO_4$	a= 5.259(1) b=5.259(1) c=11.549(4) $\alpha= \beta=\gamma= 90$	Tetragonal, $I4_1/a$	0.131
C7 [16]	Crystal structure and chemistry of tricadmium digermanium tetraarsenide, $Cd_3Ge_2As_4$	$Cd_3Ge_2As_4$	a= 7.375(1) b=7.375(1) c=27.415(5) $\alpha= \beta=\gamma= 90$	Trigonal R-3	0.062
C8 [17]	strontium tetra-arsenido tetra-gallate(II,III)	$SrGa_4As_4$	a= 6.361(1) b=6.361(1) c=16.579(2) $\alpha= \beta= 90$ $\gamma=120$	Trigonal $P3_221$	0.034
C9 [18]	Tricadmium orthotellurate(VI)	Cd_3TeO_6	a= 9.162(2) b=9.162(2) c=11.074(3) $\alpha= \beta= 90$ $\gamma=120$	Trigonal R-3:H	0.033
C10 [19]	Crystal structure of barium perchlorate anhydrate $Ba(ClO_4)_2$ from laboratory X-ray powder data	$Ba(ClO_4)_2$	a= 14.304(9) b=11.688(7) c=7.286(4) $\alpha= \beta= \gamma= 90$	Orthorhombic F_{ddd}	-----

The 3D ellipsoid pattern of the ceramic material $2C_7H_8N_4OH_2O$ presents the crystal structural representation bonded through C-H...π weak interaction as presented in figure 1.
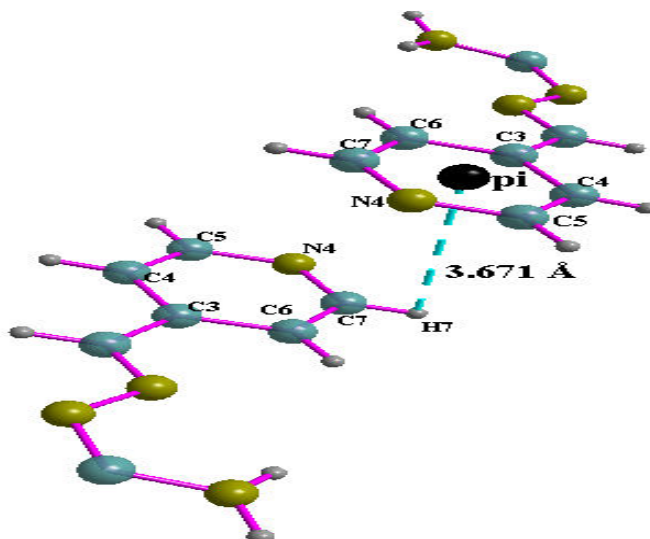
Figure 1: 3D structural view of the ceramic material [$2C_7H_8N_4OH_2O$].

The IR spectra and Raman scattering tensors were calculated through the spectral active modes of the Bilbao Crystallographic Server which calculates the symmetry-adapted form of tensor properties for any magnetic or non-magnetic point group or space group as presented in table 2. The tensor is chosen from a list of known tensor properties gathered from the scientific literature or, alternatively, the user can also build a tensor that possesses an arbitrary intrinsic symmetry. Four different tensor types are considered: equilibrium, transport, optical and nonlinear optical susceptibility tensors. The Raman and Hyper-Raman spectra tensors consists of IR tensors in any orientation, polarization selection rules for Raman and Hyper-Raman scattering processes, IR and Raman activity under a symmetry break for a given structure, correlation of point groups under the influence of an electric and magnetic fields.

3. RESULTS AND DISCUSSION

The CIF data obtained from International Union of Crystallography (IUCr) depicts that C1 crystal structure has been refined upto 0.0391 with 38754 reflections and C4 has R-factor 0.029 with 5941 reflections. The value of R-factor in case of C6, C7, C8 and C9 are 0.131, 0.062, 0.034 and 0.033 with 6597, 20756, 9912 and 6637 reflections respectively. The structural parameters of the remaining compounds [C2, C3, C5 and C10] were determined from powder XRD data. These ten ceramic materials exist in four crystal systems i.e. monoclinic, orthorhombic, tetragonal and trigonal. The powder XRD data shows that the three ceramic materials i.e. C2 [$Nd_3BSi_2O_{10}$], C3 [$Sr(ClO_4)_2$] and C5[$Ca(ClO_4)_2$] exist in P_{bca} space group and C10 [$Ba(ClO_4)_2$] in F_{ddd} of orthorhombic crystal system. The single crystal XRD data presents that the two ceramic materials i.e. C1 [$Na_4Ni_7(AsO_4)_6$] and C4 [$2C_7H_8N_4OH_2O$] exist in monoclinic space group C 2/m and C 2/c, respectively whereas the ceramic derivative C6 adopts the tetragonal space group $I4_1/a$. Three ceramic materials coded as C7 [$Cd_3Ge_2As_4$], C8 [$SrGa_4As_4$] and C9 [Cd_3TeO_6] exists in trigonal space group R-3, $P3_221$ and R-3:H, respectively.

The spectral active modes of IR and Raman spectra tensors in SAM structural utility tool of Bilbao crystallographic server [20, 21] were studied by using the lattice parameters and the fractional co-ordinates. The comparison of these types of crystal structures of the selected series of ceramic based compounds through theoretically structural model shows [22] that these types of materials have the promising results for spectroscopic applications [23, 24]. The ceramic materials C2, C3 and C5 has Wyckoff positions WP3 [4a, 4b, 8c] whereas C8 has WP3 [3a, 3b, 6c]. The Wyckoff position for C7 and C9 are WP2 [1a, 3b] and [3a, 9b] but for C4 and C6 the Wyckoff positions areWP6 [16f, 4a, 4b, 8c, 8d, 8e] as presented in detail in Table 2. Raman-active modes for orthorhombic C2 [$Nd_3BSi_2O_{10}$], C3 [$Sr(ClO_4)_2$] and C5[$Ca(ClO_4)_2$] (Pbca) were ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$), ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$) and ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$) respectively while C10 [$Ba(ClO_4)_2$] (F_{ddd}) were ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$).Raman-active modes for trigonal C7 [$Cd_3Ge_2As_4$], C8 [$SrGa_4As_4$] and C9 [Cd_3TeO_6] (R-3) were ($\Gamma_{acoustic}= A + {}^1E + {}^2E$), ($P3_221$) were ($\Gamma_{acoustic}= A_2 + E$) and (R-3:H) were ($\Gamma_{acoustic} = A + {}^1E + {}^2E$). The Raman-active modes for monoclinic C1 [$Na_4Ni_7(AsO_4)_6$] and C4 [$2C_7H_8N_4OH_2O$] (C 2/m) were ($\Gamma_{acoustic} = A_u+2B_u$) and (C 2/c) were ($\Gamma_{acoustic} = A_u+2B_u$) respectively while C6 [$Ca_{0.84}Sr_{0.16}MoO_4$] (I_{41}/a) were ($\Gamma_{acoustic} = A_u + {}^1E_u + {}^2E_u$).

Table.2: Summary of IR, Raman and Hyper Raman Tensors calculated in ceramic based materials.

Compound	Active Mode Equation	Wyckoff Position	Infra-Red	Raman	Hyper Raman
C1	($\Gamma_{acoustic} = A_u+2B_u$)	WP10=[2a,2b,2c,2d,4e,4f,4g,4h,4i,8j]	A_u=1 A_u=3 B_u=2 B_u=3	A_g=1 A_g=2 A_g=3 B_g=1 B_g=2 B_{2g}=3	A_u=1 A_u=3 B_u=2 B_u=3
C2	($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$)	WP3=[4a,4b, 8c]	B_{1u}=3 B_{2u}=3 B_{3u}=3	A_g=3 B_{1g}=3 B_{2g}=3 B_{3g}=3	A_u=3 B_{1u}=3 B_{2u}=3 B_{3u}=3
C3	($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$)	WP3=[4a,4b, 8c]	B_{1u}=3 B_{2u}=3 B_{3u}=3	A_g=3 B_{1g}=3 B_{2g}=3 B_{3g}=3	A_u=3 B_{1u}=3 B_{2u}=3 B_{3u}=3
C4	($\Gamma_{acoustic} = A_u+2B_u$)	WP6=[4a,4b, 4c, 4d, 4e, 8f]	A_u=1 A_u=3 B_u=2 B_u=3	A_g=1 A_g=3 B_g=2 B_g=3	A_u=1 A_u=3 B_u=2 B_u=3
C5	($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$)	WP3=[4a,4b, 8c]	B_{1u}=3 B_{2u}=3 B_{3u}=3	A_g=3 B_{1g}=3 B_{2g}=3 B_{3g}=3	A_u=3 B_{1u}=3 B_{2u}=3 B_{3u}=3
C6	($\Gamma_{acoustic} = A_u + {}^1E_u + {}^2E_u$)	WP6=[16f,4a,4b,8c,8d,8e]	A_u=1 A_u=3 ${}^1E_u$=1	A_g=1 A_g=3 B_g=1	A_u=1 A_u=3 B_u=1

Compound Symbol	Mechanical Representation	Wyckoff Position			
			$^1E_u=2$ $^1E_u=3$ $^2E_u=1$ $^2E_u=2$ $^2E_u=3$	$B_g=3$ $^1E_g=1$ $^1E_g=2$ $^1E_g=3$ $^2E_g=1$ $^2E_g=2$ $^2E_g=3$	$B_u=3$ $^1E_u=1$ $^1E_u=2$ $^1E_u=3$ $^2E_g=1$ $^2E_g=2$ $^2E_g=3$
C7	$(\Gamma_{acoustic}= A + {}^1E + {}^2E)$	WP2=[1a,3b]	A=1 A=3 $^1E=1$ $^1E=3$ $^2E=1$ $^2E=3$	A=1 A=3 $^1E=1$ $^1E=3$ $^2E=1$ $^2E=3$	A=1 A=3 $^1E=1$ $^1E=3$ $^2E=1$ $^2E=3$
C8	$(\Gamma_{acoustic}= A_2 + E)$	WP3=[3a,3b,6c]	$A_2=2$ $A_2=3$ E=3 E=6	$A_1=1$ $A_1=3$ E=3 E=6	$A_1=1$ $A_1=3$ $A_2=2$ $A_2=3$ E=3 E=6
C9	$(\Gamma_{acoustic} = A + {}^1E + {}^2E)$	WP2=[3a,9b]	A=1 A=3 $^1E=1$ $^1E=3$ $^2E=1$ $^2E=3$	A=1 A=3 $^1E=1$ $^1E=3$ $^2E=1$ $^2E=3$	A=1 A=3 $^1E=1$ $^1E=3$ $^2E=1$ $^2E=3$
C10	$(\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u})$	WP8=[16c,16d,16e, 16f, 16g, 32h, 8a, 8b]	$B_{1u}=1$ $B_{1u}=2$ $B_{1u}=3$ $B_{2u}=1$ $B_{2u}=2$ $B_{2u}=3$ $B_{3u}=1$ $B_{3u}=2$ $B_{3u}=3$	$A_g=1$ $A_g=3$ $B_{1g}=1$ $B_{1g}=2$ $B_{1g}=3$ $B_{2g}=1$ $B_{2g}=2$ $B_{2g}=3$ $B_{3g}=1$ $B_{3g}=2$ $B_{3g}=3$	$A_u=1$ $A_u=3$ $B_{1u}=1$ $B_{1u}=2$ $B_{1u}=3$ $B_{2u}=1$ $B_{2u}=2$ $B_{2u}=3$ $B_{3u}=1$ $B_{3u}=2$ $B_{3u}=3$

The mechanical representation for every individual Wyckoff position, IR active modes and Raman active modes for series of ten selected ceramic based hybrid materials are presented in table 3.

Table.3: Mechanical representation of selected ceramic materials.

Compound Symbol	Wyckoff Position	Mechanical Representation	Infra-Red Active Modes	Raman Active Modes
C1	2a	$M = A_u+2B_u$	A_u, B_u	None
	2b	$M = A_u+2B_u$	A_u, B_u	None
	2c	$M = A_u+2B_u$	A_u, B_u	None
	2d	$M = A_u+2B_u$	A_u, B_u	None
	4e	$M = 3A_u+3B_u$	A_u, B_u	None
	4f	$M = 3A_u+3B_u$	A_u, B_u	None
	4g	$M = A_g+A_u+2B_g+2B_u$	A_u, B_u	A_g, B_g
	4h	$M = A_g+A_u+2B_g+2B_u$	A_u, B_u	A_g, B_g
	4i	$M = 2A_g+A_u+B_g+2B_u$	A_u, B_u	A_g, B_g
	8j	$M = 3A_g+3A_u+3B_g+3B_u$	A_u, B_u	A_g, B_g
C2, C3, C5	4a	$M = 3A_u+3B_{1u}+3B_{2u}+3B_{3u}$)	B_{1u}, B_{2u}, B_{3u}	None
	4b	$M = 3A_u+3B_{1u}+3B_{2u}+3B_{3u}$	B_{1u}, B_{2u}, B_{3u}	None
	8c	$M = 3A_g+3A_u+3B_{1g}+3B_{1u}+3B_{2g}+3B_{2u}+3B_{3g}+3$	B_{1u}, B_{2u}, B_{3u}	$A_g, B_{1g}, B_{2g}, B_{3g}$

Code	Site			
		B_{3u}		
C4	4a	$M = 3A_u+3B_u$	A_u, B_u	None
	4b	$M = 3A_u+3B_u$	A_u, B_u	None
	4c	$M = 3A_u+3B_u$	A_u, B_u	None
	4d	$M = 3A_u+3B_u$	A_u, B_u	None
	4e	$M = A_g+A_u+2B_g+2B_u$	A_u, B_u	A_g, B_g
	8f	$M = 3A_g+3A_u+3B_g+3B_u$	A_u, B_u	A_g, B_g
C6	16f	$M = 3A_g+3A_u+3B_g+3B_u+3\,^1E_g+3\,^1E_u+3\,^2E_g+3\,^2E_u$	$A_u, {}^1E_u, {}^2E_u$	$A_g, B_g, {}^1E_g, {}^2E_g$
	4a	$M = A_u+B_g+{}^1E_g+{}^1E_u+{}^2E_g+{}^2E_u$	$A_u, {}^1E_u, {}^2E_u$	$B_g, {}^1E_g, {}^2E_g$
	4b	$M = A_u+B_g+{}^1E_g+{}^1E_u+{}^2E_g+{}^2E_u$	$A_u, {}^1E_u, {}^2E_u$	$B_g, {}^1E_g, {}^2E_g$
	8c	$M = 3A_u+3B_u+3\,^1E_u+3\,^2E_u$	$A_u, {}^1E_u, {}^2E_u$	None
	8d	$M = 3A_u+3B_u+3\,^1E_u+3\,^2E_u$	$A_u, {}^1E_u, {}^2E_u$	None
	8e	$M = A_g+A_u+B_g+B_u+2\,^1E_g+2\,^1E_u+2\,^2E_g+2\,^2E_u$	$A_u, {}^1E_u, {}^2E_u$	$A_g, B_g, {}^1E_g, {}^2E_g$
C7	1a	$M = A+{}^1E+{}^2E$	$A, {}^1E, {}^2E$	$A, {}^1E, {}^2E$
	3b	$M = 3A+3\,^1E+3\,^2E$	$A, {}^1E, {}^2E$	$A, {}^1E, {}^2E$
C8	3a	$M = A_1+2A_2+3E$	A_2, E	A_1, E
	3b	$M = A_1+2A_2+3E$	A_2, E	A_1, E
	6c	$M = 3A_1+3A_2+6E$	A_2, E	A_1, E
C9	3a	$M = A+{}^1E+{}^2E$	$A, {}^1E, {}^2E$	$A, {}^1E, {}^2E$
	9b	$M = 3A+3\,^1E+3\,^2E$	$A, {}^1E, {}^2E$	$A, {}^1E, {}^2E$
C10	16c	$M = 3A_u+3B_{1u}+3B_{2u}+3B_{3u}$	B_{1u}, B_{2u}, B_{3u}	None
	16d	$M = 3A_u+3B_{1u}+3B_{2u}+3B_{3u}$	B_{1u}, B_{2u}, B_{3u}	None
	16e	$M = A_g+A_u+2B_{1g}+2B_{1u}+2B_{2g}+2B_{2u}+B_{3g}+B_{3u}$	B_{1u}, B_{2u}, B_{3u}	$A_g, B_{1g}, B_{2g}, B_{3g}$
	16f	$M = A_g+A_u+2B_{1g}+2B_{1u}+B_{2g}+B_{2u}+2B_{3g}+2B_{3u}$	B_{1u}, B_{2u}, B_{3u}	$A_g, B_{1g}, B_{2g}, B_{3g}$
	16g	$M = A_g+A_u+B_{1g}+B_{1u}+2B_{2g}+2B_{2u}+2B_{3g}+2B_{3u}$	B_{1u}, B_{2u}, B_{3u}	$A_g, B_{1g}, B_{2g}, B_{3g}$
	32h	$M = 3A_g+3A_u+3B_{1g}+3B_{1u}+3B_{2g}+3B_{2u}+3B_{3g}+3B_{3u}$	B_{1u}, B_{2u}, B_{3u}	$A_g, B_{1g}, B_{2g}, B_{3g}$
	8a	$M = B_{1g}+B_{1u}+B_{2g}+B_{2u}+B_{3g}+B_{3u}$	B_{1u}, B_{2u}, B_{3u}	B_{1g}, B_{2g}, B_{3g}
	8b	$M = B_{1g}+B_{1u}+B_{2g}+B_{2u}+B_{3g}+B_{3u}$		B_{1g}, B_{2g}, B_{3g}

From the selected series of ceramic based hybrid materials we have analyzed that most of them are in "Flat sheet" crystal morphology with whitish crystalline colour, the size of the crystals are different for every cif-file, the temperature upto which the material is heated are described as 150K for material C7, 293K for C1, C6 and C8, 295K for C2 and C5 whereas for C4 and C9 temperature is 296K also for C3 and C10 it is 298K. Volume of the crystal and θ_{min} & θ_{max} is also represented in table 4.

Table.4: Crystal structure and size of selected ceramic materials.

Code	μ mm^{-1}	Crystal Colour	Crystal Size (mm)	Temp. (K)	Volume (Å^3)	Atomic No. (Z)	θ_{max} (°)	θ_{min} (°)
C1	16.76	Irregular, Brown	0.07 X 0.06 X 0.04	293	1970.3(3)	4	33.3	2.1
C2	-	Flat sheet, Blue white	25 X 25	295	1606.4(5)	8	90	14.5
C3	-	Flat sheet, white	24.9 X 24.9	298	1301.7(2)	8	129.9	10.0
C4	0.11	Block, Clear light colourless	0.82 X 0.27 X 0.20	296	1627.8(2)	4	27.1	1.8
C5	-	Flat sheet, white	24.9 X 24.9	295	1184.8(1)	8	139.9	5.0
C6	7.92	Irregular, light white	0.05 X 0.05 X 0.03	293	319.5(1)	4	36.5	4.3

C7	29.36	Triangular prism, black	0.07 X 0.07 X 0.03	150	1291.3(5)	6	42.4	2.2
C8	37.42	Block, black	0.10 X 0.05 X 0.05	293	581.1(2)	3	27.9	3.7
C9	17.06	Spherical, colourless	0.08 X 0.08 X 0.08 X 0.08 (radius)	296	805.1(4)	6	46.8	3.2
C10	-	Flat sheet, white	20 X20	298	1218.1(1)	8	129.6	14.9

4. CONCLUSIONS

A series of ten ceramic materials were selected to analyse their structural and spectroscopic correlations. The XRD data of the selected materials concludes that these ten ceramic materials exist in four crystal systems i.e. monoclinic, orthorhombic, tetragonal and trigonal. Two ceramic materials, C1 and C4 exist in monoclinic space groups C 2/m and C 2/c respectively; three materials C2, C3 and C5 exist in orthorhombic space group P_{bca}, C10 in orthorhombic F_{ddd}, C6 in tetragonal $I4_1/a$ and three ceramic materials, C7, C8 and C9 exist in trigonal space groups R-3, $P3_221$ and R-3:H, respectively. The spectral active modes of IR and Raman spectra tensors were calculated which shows that Raman-active modes for orthorhombic C2 $[Nd_3BSi_2O_{10}]$, C3 $[Sr(ClO_4)_2]$ and C5$[Ca(ClO_4)_2]$ (Pbca) were ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$), ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$) and ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$), respectively while C10 $[Ba(ClO_4)_2]$ (F_{ddd}) were ($\Gamma_{acoustic} = B_{1u} + B_{2u} + B_{3u}$). Raman-active modes for trigonal C7 $[Cd_3Ge_2As_4]$, C8 $[SrGa_4As_4]$ and C9 $[Cd_3TeO_6]$ having space groups (R-3) were ($\Gamma_{acoustic}= A + {}^1E + {}^2E$), ($P3_221$) were ($\Gamma_{acoustic}= A_2 + E$) and (R-3:H) were ($\Gamma_{acoustic} = A + {}^1E + {}^2E$) respectively. The Raman-active modes for monoclinic C1 $[Na_4Ni_7(AsO_4)_6]$ and C4 $[2C_7H_8N_4OH_2O]$ (C 2/m) were ($\Gamma_{acoustic} = A_u+2B_u$) and (C 2/c) were ($\Gamma_{acoustic} = A_u+2B_u$) respectively while C6 $[Ca_{0.84}Sr_{0.16}MoO_4]$ ($I4_1/a$) were ($\Gamma_{acoustic} = A_u + {}^1E_u + {}^2E_u$). Hence, the ORMOCERs (organically modified ceramics) are inorganic-organic composites on a molecular or nano level having structural framework which can be chemically linked to the inorganic backbone or act as an interpenetrating network. Ceramic hybrids have wide range of properties from thermoplastic materials (e.g. sealings) to brittle coatings (hard coatings). Their thermal stability and low conductivities lead to the development of dielectric coatings for electronic applications.

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COMBATING FAKE NEWS USING INTELLIGENT SYSTEMS

JASPREET KAUR AND HARPREET SINGH

ABSTRACT
News is no longer limited to television. In fact, the news world is presently dominated by Social media and has given rise to the sharing of falsified information. Fake information is used to harm the reputation of an individual, persons or organization; to spread false information about a product; to play with social or religious sentiments for political gains or to negatively impact citizens. The after effect of fake news is that it corrodes the reliance of public on social media and poses a major challenge for people fighting misinformation. Recently, intelligent systems have been employed to fight this phenomenon. The present study summarizes some useful features, resources (reference datasets for fake news detection) and intelligent methods (Linguistic Cue, Network Analysis, Naïve Bayes, SVM, Decision Tree, Random Forest, Semantic Analysis, Sentiment Analysis, Machine Learning, Deep learning, AI etc.) to mine, analyze and detect fake news. In addition, some major challenges and possible gaps in the current state of knowledge to detect fake news have also been highlighted to motivate future research in this regard.

Keywords: Fake News, Social Media, Machine Learning, Intelligent Systems

1. INTRODUCTION

The importance of news cannot be undermined in the life of an individual and many ways to disseminate news have been evolved over the time. Recently a wide interest has been created in using social media platforms which has given a niche to some forces that tend to distribute false information for their own political, economic and social benefits. This chapter particularly aims to introduce various types of Fake news their features, social impact and various methods to detect it including the Machine Learning and other intelligent methods. Section one of this chapter gives an overview of News, its importance, types of News media, transition of news media from print to electronic to social media and then explains the concept of false and malicious information.

1.1. News and its Importance

News updates the knowledge and information on the readers. It portrays the real situation of the world whether it is education, sports, entertainment, economics, politics or societal issues etc. News is broadcasted via social media, television, radio, newspapers and magazines etc. It informs and enlightens the individuals, develops analytical thinking and protects them in case of exigencies.[1] Various aspects of news can be summarized as follows: -

1.1.   1. News Informs the Spectators:- News provide information to general public about daily happenings whether it be politics, sports, weather prediction, international affairs, education etc. News encompass every important issue that public has right to know. It not only informs and educates public but also guides them about outcomes of the events and influences them to take the action in the correct direction.[2] It raises voice for justice. In addition to this, news also intimate public about new launch of car, mobiles, home appliances etc. Moreover, information about new government schemes as well as any change in the existing schemer is also stated in news.[3]

1.1.2.   News Upskills the Reader: By reading newspapers, individuals get new perspective of life and leave their old bad habits. They learn lessons for life and become able to understand convoluted issues. It enablesreaders to emulate habits of personalities they like. Moreover, news enhances the skills of readers and listeners and they can spot genuine and distorted events.

1.1.3.   News Intensifies Citizen Involvement: News enhances the civil involvement of persons who either read from newspapers and social media etc. who listens news on TV or radio. The reader can share the new updates with other people and help in developing responsible citizens. They become able to understand which news and news media is biased and which is unbiased. They will become able to select appropriate media with

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[1]http://hour-news.net/importance-of-news-hours-in-your-life/

[2]https://www.sociologygroup.com/purpose-news-functions-journalism/

[3]http://gupshups.org/importance-of-newspaper/

their critical thinking and objectivity. It also paves way to associate with amazing people and astonishing events.

1.1.4. News as a Source of Inspiration:When one reads about other people's success stories, it acts as a source of motivation and one try to apply those ideas in ones business as well by modifying these as per the need and try to learn from the mistakes of others. Readers can also guide their friends and relatives.

1.1.5. News Influences Mood: Success stories, joyful and fortunate events happening all over the world make the reader or listener contended while bad news spoil the mood of an individual. But it is not necessary to go through the full details of the bad events. But one should be aware of the happenings all over the world because these events work as the medicine for the reader and listener.

1.1.6. News Reduces Memory Loss: In the old age people often face the problem of the Alzheimer's. But people, who are in the habit of reading or listening news, often correlate various past events. So, these stimuli decelerate crumble brain.[1]

1.1.7. News Acts a Teaching Tool: In the teenage, when children do not behave sensibly and disrespect their parents, at that time news acts as a medium to teach them. Parents can highlight the news giving good lessons or lessons of life for their children and ask them to read. News works in a constructive manner and they start behaving sensibly and act obediently. News also sharpens the skills of kids and familiarizes them with the most intricate and mysterious issues in an amazing way.Newspapers also act as teaching tool for adults who have not completed their almamater. News refines narrative and raconteur techniques as well as language adroitness of reader and listener, news amplifies creativity.[1]

1.1.8. News Provides Information about Vacancies: In newspapers, there is a separate column for vacancies. Moreover, on social media, news about vacancies are also posted, if one has subscribed recruitment channel one gets updated. Job seekers can get information and can apply for the same. In addition to this, house wives can also earn by working from home. There are various posts on social media, they can contact the employer and   can work and earn.[3]

1.2. Various Types of News Media

News broadens the perspective of readers and aggrandizes their knowledge.[2] But it is not possible for public at large to collect all information about the happenings of the world by themselves so they rely on news media. News media means mass media that delivers information news to the public at large.[3] Its significance and sustainability confides on spectators because if public or spectator would not value news media, it would lose its commercial worth.There are various types of news media (Figure 1) like print media (newspapers, magazines, handouts etc.), broadcasting media (television, radio) and internet (social networks, online forums, podcasts etc.).
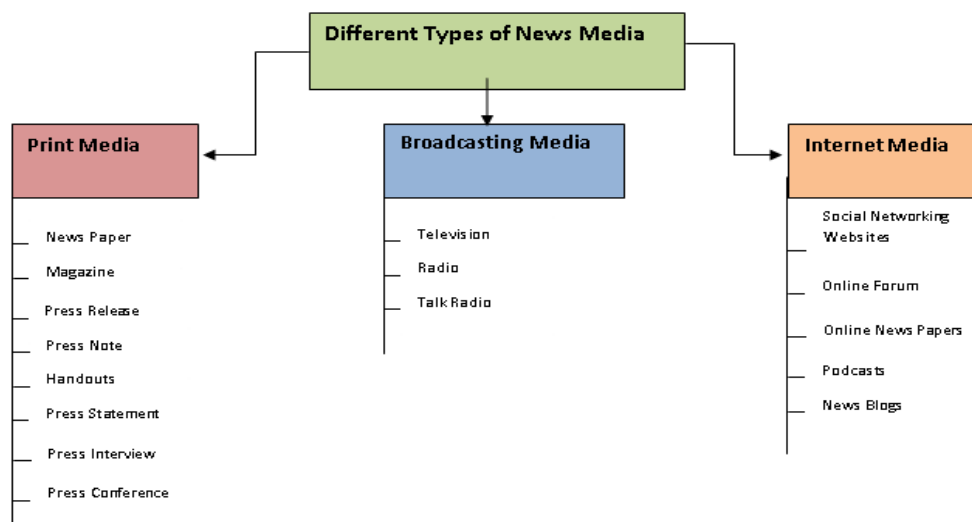
Figure 1: A layout depicting different types of media and their components

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[1]https://nwasianweekly.com/2016/10/why-reading-news-is-important-10-life-lessons-for-reading-news/

[2]http://www.partnerpress.be/en/blog/yet-another-blogpost-test-pager

[3]https://www.sparknotes.com/us-government-and-politics/american-government/the-media/section1/

1.2.1.   Print Media: Print media is the distribution of printed or written information to a large number of recipients (readers). Print media also include photographs to elucidate the incident or situation. Photograph or pictures help the reader in understanding the situation of crucial occurrences in a better way. In spite of emergence of online media, the allurement and importance of print media has not reduced. Print media has an edge of learning everlasting impression on the brain of the reader along with the extensive description and scrutiny. Print media includes newspapers, magazines, press release, press notes, handouts, press statement, press interviews and press conference.

1.2.1.1. Newspaper:- The periodical publication (i.e. daily, semi-weekly, weekly, bi-weekly, tri-weekly, monthly) of penned particulars about contemporaneous affairs, incidents, occurrences and happenings in the typed form using black ink on white or grey paper is referred to as newspaper. Information about the current happenings of the world, information about politics, sports, business, weather, entertainment, health, medicine, science and fashion is presented in newspaper. In the newspapers, there is a classified addsection where businessmen, companies buy space to present their advertisements.

1.2.1.2. Magazines: - Magazines are the print publication of the current events and diverse topics of interest at regular intervals i.e. weekly, bi-weekly, monthly, quarterly. These magazines can be purchased by paying subscription fees in advance or by paying on the spot at railway stations, bus stands, book shops etc. Newspapers only inform the public about the current happenings, while magazines enlighten and entertain the public at large. The writing style of magazines is exalted decumbent bearing picture, graphs and photographs. The cover page of magazine is visually appealing to attract the readers. It can be image based, illustration based, type based or concept based. The paper used in magazine is quite fine, it is clay coated to give it glossier look.

1.2.1.3. Press release: - Press officers or information officers are employed by the employers i.e. government bodies, statutory officers, universities and commercial organizations to portray their positive picture in the public in the form of press release. This press release is then sent to the newspaper for publication purpose. It is the duty of the newspaper staff (news reporters) to ensure that only correct information should be published in their newspaper. The major difference between the press officers and the news reporters is that press officers are the employees of the public figures and want to portray their positive image while news reporter depict the true and fair picture /details of the event or occurrence in the interest of the readers.[1]

1.2.1.4. Press Notes: - Press notes are issued by government departments while making announcements on important matters which are in the interest of general public like hike or reduction in the rate of tariffs, subsidies announced by government for electricity usage, in agricultural purposes, subsidy on food grain, fertilizers and subsidy for gas cylinder etc. Press note do specify the date, place, heading of press note and name of department issuing it. There are sent to the newspapers for the publication but no change could be made by news reporters or newspapermen in the press notes. They are required to be published as it is by newspaper agencies.

1.2.1.5. Handouts: - Handouts are issued by the government agencies attached with the government and corporate bodies. Handouts contain information in the interest of general public. This information may or may not be published by the newspapers like particulars about the excursion of the ministers and details of the nomination and election of important government officials.

1.2.1.6. Press Statement: - When an individual in his discrete position wants to make anything public then he or she can pen down the information and send it to the newspapers. The newspaper official can publish it as per their engrossment.

1.2.1.7. Peer Interviews: - One yet another source of news is press interview. These are conducted by the newspaper officials to get detailed facts about some public figures or about their inventions, research or about their activities in different fields. They are interviewed in order to secure some important information with the objective of increasing the publicity of the newspaper concerned.

1.2.1.8. Press Conferences: - Press conference are organized by publically known figures i.e. businessmen, companies, corporations, government officials and politicians in order to provide information on certain important matters. News reporters cover these events. In the beginning of the press conference, the person organizing the conference specifies the reason for calling the press conference. In further proceedings newsmen ask certain questions in order to clear their own doubts as well as the doubts of the public at large.

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[1]http://www.thenewsmanual.net/Manuals%20Volume%201/volume1_18.htm

1.2.2. Broadcasting Media: - News is transmitted via broadcasting media in the form of audio and video signals to the listeners and viewers i.e. recipients. News broadcasting media includes radio and television.

1.2.3.1. Television: - There are various television channels on which news are broadcasted at specific time. In addition to this, there are news channels on which news are broadcasted throughout the day. Since 1980, television has been used to broadcast news.[1] Television also provides video coverage of the events.

1.2.3.2. Radio: - In the 1950s, when televisions have not been invented, radios have been used to transmit news in the form of audio signals for the listeners. Even till date many people listen to radio news while they commute in the morning and in the evening. Rural area inhabitants, who are not having sufficient funds to purchase television, usually buy radio to keep them updated. Even people residing in urban areas listen to radio news in the car while travelling though they are not having radios at their places.

1.2.3.3. Talk Radio: - It is a program conducted via radio in which there is a single host. In this program, some special guests and reputed personalities are interviewed or a talk is held between guest and host on recent happenings or occurrences or incidents taking place all over the world. Listeners are provided with the facility to call or talk via telephonic conversations. It has emerged in the year 2005.[2]

1.2.3. Internet: - with the help of internet, news are posted on various online modes on real time basis i.e. as and when an event occurs. During the traditional times when news have been broadcasted through radio and television only those persons have been able to know about the happenings of the world who have been actually listening the news. While in the modern times, when news is being shared through online modes, every internet user gets notification on his or her smart phone about the happenings of the world. So, he gets updated. There are various internet or online sources with the aid of which news are shared quickly like social networks, online forums, online newspapers, news blogs and podcasts etc. There is a provision of providing feedback or opinion by the reader of the news. Moreover news are presented using multimedia in online mode i.e. audio, video, graphs, text etc. Another important feature of the online news is that news can be rectified and updated whenever required.

1.2.3.1. Social Media or Social Networking Sites: - Social networking is an online mode of staying associated with family, relatives and friends, clients and peers etc. It includes WhatsApp, google(+), Facebook, Twitter, YouTube, Instagram, Snapchat, Tumbler. News is posted on social sites and people also read news from social media. This news is open for discussion as well. Even one can post one's comment on the news, which can be viewed all over the world. Various news publishers publish their news on social media in order to increase news readability like BBC and Mondo.

1.2.3.2. Online Newspaper: - Online newspaper is an electronic version of newspaper. Free access to these papers is provided online. Moreover, if one needs newspaper of past date, one is not required to wait and take permission from librarian, one can read it online. Online newspapers have chat rooms i.e. they have added interactive features on their websites, where reader can post their comments and ask their queries and reporters respond to these queries.[3]

1.2.3.3. News Blogs: - Blog is an informatory web page where a single author or a group of authors post their views on a single topic. And these views appear in a reverse chronological order with latest views at the beginning. News blog reports current happenings and engrossing latest events by single author or a group of authors in a reverse chronological order.

1.2.3.4. Podcasts: -It is an episodic tele-record of audio cast or radiocast, video cast, PDF and online published files that can be downloaded from worldwide and can be played anytime from anywhere. Since the term is coined from iPod and broadcast because earlier people have been listening podcasts via Apple iPod. But actually, any device having MP3 player can play audio podcast. In addition to this, some people say that it is the recording of the audio files only.[4]All these media files i.e. audio, video, PDF, online publication files must have RSS feed. RSS stands for really simple syndication that inexorably update details. Moreover it is available on real time basis in reverse chronological order[5] i.e. information is uploaded in chronological order, so latest

[1]http://www.sparknotes.com/us-government-and-politics/american-government/the-media/section1/page2/

[2]https://en.wikipedia.org/wiki/Talk_radio

[3]https://quod.lib.umich.edu/j/jep/3336451.0005.402?view=text;rgn=main

[4]https://www.podcasthero.com/what-is-a-podcast/

[5]https://rss.com/blog/how-do-rss-feed-works

information appears at the top. Podcasts include national public radio news as well as drama serials.[1] Some important podcast networks are NPR, ABC, TWIT, GonneGeek , GIMLET, 5 by 5, ESPN, C/net, SModcast, BBC radio, The verge, Revision 3, Radiotopia, noodle.mx , nerdist, WONDERY, MamaMia, The Ringer, The Guardian, Relay FM, panopoly, podcast one, Forbes, Carolla digital WNYC, VOX , MAXIMUM, FUN, BBC world service, quick and dirty steps etc. For example: BBC (British Broadcasting Corporation) Podcasts basically informs, educates and entertains people. Information about daily happenings, sports (football, cricket, tennis, formula 1, Rugby U, tennis, golf, athletics, cycling, Olympics), weather, entertainment, documentaries, comedy, drama, music, performance, events, science and nature etc. is available as BBC podcasts.

1.2.3.5. Internet Forum: - It is a networked discourse webpage where public can post messages in the form of colloquy. Internet discussion forum has tree like structure i.e. internet discussion forum has sub forums. These sub forums may further have sub forums in order to discuss certain topics. Each sub forum can discuss several topics. In the topics each new discussion started is called thread.[2]For example: A post is created in forum. Any person can comment on the post. This discussion is called thread. New thread can be created by the members. Some are registered members and some are anonymous. Registered members have usernames and passwords, even they can add their pictures and they are also required to observe regulations and directions of the administrator. In the internet forums discussion can be held on various news updates as well. The topics range from medicine to technology and vacations, hobbies and politics etc.[3] For example: Digg, NCOWIN, Piston Head, Slashdot, Voat Inc. Piston Head is an online news forum wherein discussion regarding recent developments in automotive industries are held.

1.3. Transition of News Media from Print into Electronic to Social Media:-

"Every time a printed newspaper reader dies, he or she is not replaced by a news reader"(Jeffery Cole, 2002)[4]Journalism i.e. reporting of ongoing present day happenings has emerged in lithographed configuration i.e. written from newspaper. However with the enormous evolvement in telecommunication and automatic technology over last few years, journalism range has extended and its precision has enlarged by all inclusive realm of information technology. The present day phase on that transformative hierarchy starting from newspaper, radio and television is online journalism.Online media have the lion's share and well favoured score to settle as top most used medium for news transmission at the present time.Almost 80% of the Indian residents use internet especially social media i.e. Facebook, Twitter, Instagram, LinkedIn in order to pave awareness regarding news and news organizations with the aid of chat bots send updates via WhatsApp or other messengers to chief patrons about recent occurrences by avoiding the hurdles of reach ability and time.[5]Chat bots and bots are software that communicates with computer user in a manner that it imitate or copy human communication to certain magnitude. This inter communication differ with respect to the level of entanglement from easy watchword besetting inquires to magnified dialogue approach employing innate tongue transformation and artificial intelligence methodology. Similar to individuals engaged in data communication, these bots can also engage in live discussion and live events. But bots do not have access to all the messages, bots can only access the communication that is forwarded to them.[6]Chat bots are now being used in journalism. Use of chat bots in journalism has enhanced the efficiency of journalists and they can focus on premier enactments such as comprehensive investigation, publishing, examining numerous resources with contemplation and rigour. Even deep learning technique is also being used in journalism to detect fake news and problems in the set up with the aid of entropy estimation (Theodora and Andreas, 2018).There is a great role of AI technology in spreading of news automatically via digital mediums. In the China, there is a news agency named Xinhua which is running with the aid of artificial intelligence. It has been disclosed that there is a virtual news reporter which is running on AI concept and is competent enough to dropship recent occurrences i.e. news around the clock (24/7) on its webpage and on interactive media. This virtual news anchor has the proficiency and capability of expert news commentators and has potential to replicate human being's gesture, voice and

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[1]https://www.journalism.org/2006/07/19/what-is-podcasting/

[2]https://en.wikipedia.org/wiki/Internet-forum

[3]https://en.wikipedia.org/wiki/List-of-the-internet-forums

[4]https://www.digitalcentre.org/Columns/prediction-printed-newspapers/

[5]http://www.thehindu.com/thread/technology/the-rise-of-the-digital-era-in-journalism/article25733413.ece

[6]https://developers.google.com/chat/concepts/bots#:~:text=Bots%20in%20Google%20Chat%20appear,sends%20them%20a%20direct%20message.

expressionNews updates are provided via news bots or stock bots to the individual users as per their interest because individual users subscribe for certain news updates and provide revenue to new agencies.[1]

1.4. FAKE NEWS

Fake news means misleading information which is made public in order to harm the reputation of an individual or an entity to spread false information about a product offering in order to earn huge profit at the launch of the product or to play with social or religious sentiments of public for political benefits. Fake news can be misinformation or dis-information. Misinformation is distorted information that is spread erroneously i.e. by mistake which misleads others but dis-information is spread intentionally to misguide general people or to influence them or to conceal certain facts from them.

1.4.1. Seven Types of Mis and Dis-Information

The mis-information and dis-information can be spread by the journalists in order to be profitable and remunerative or for amusement and pleasure. This information could be generated mistakenly by unskilled or unpracticed news reporter or over- burdened journalist. It could also be created willingly in order to influence the beliefs of political parties and policy makers. In some cases this information can also be created and dispersed by news bots that function like journalists and have the capability to act swiftly and spontaneously.[2]Figure 2 depicts many sorts of mis- and dis-information, which are explored in the sections below.
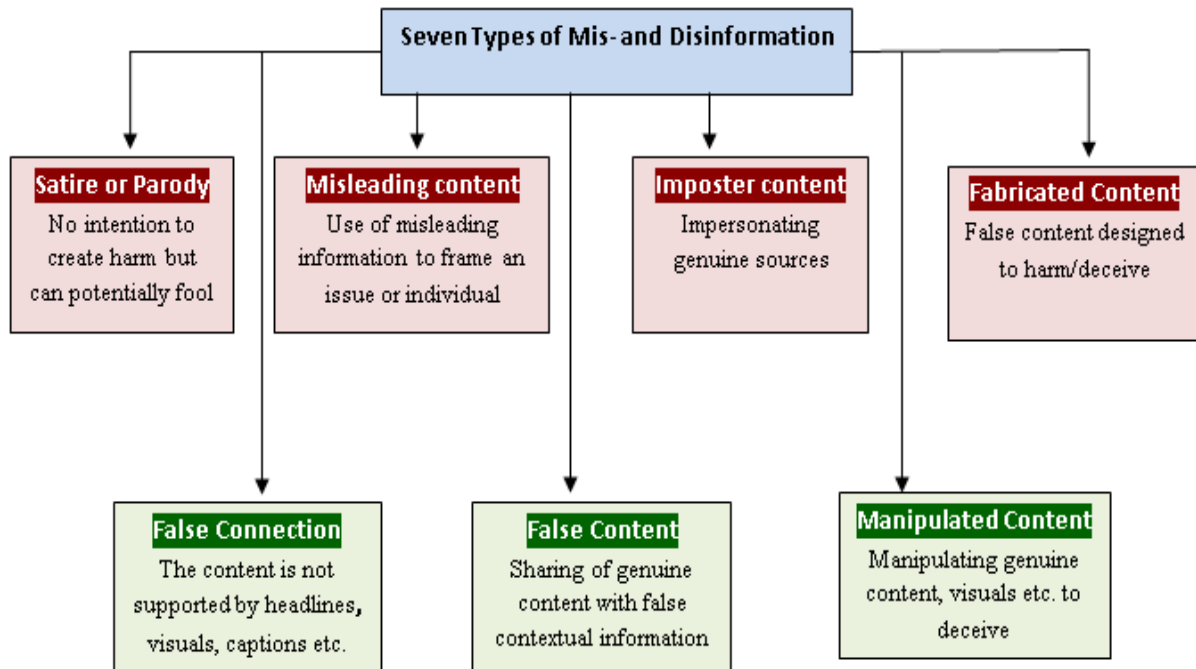
Figure 2: Seven types of mis-and dis-information.

1.4.1.1. Sattire or Parody:- The spreading of information in order to create hilarity, comedy, sarcasm, amplification, dramatization or mockery in order to reveal as well as denounce certain individuals foolishness, immorality and wickedness specifically in connection with coetaneous polity and frosty matters.[3]

1.4.1.2. False Connection: -In these news original snapshots, photos or video recordings are used to formulate fallacious or distorted chronicle. Inspite of the genuineness in news to some extent but employing remodeling of visually descriptive in order to aggrandize a narrative that deceive others by creating fallacious relationship.[4]

1.4.1.3. Misleading Content: - Misleading content is that information which is presented or made public in order to mislead others i.e. to give wrong idea or impression to others. For example stating the remarks or observation as reality or verity.

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[1]https://www.thehindu.com/thread/technology/the-rise-of-the-digital-era-in-journalism/article25733413.ece

[2]https://guides.lib.umich.edu/fakenews

[3]https://guides.ucf.edu/fakenews/satire

[4]https://www.pagecentertraining.psu.edu/public-relations-ethics/introduction-to-the-ethical-implications-of-fake-news-for-pr-professionals/lesson-2-fake-news-content/manipulated-content-false-connection/

1.4.1.4. False Context: - It is the mixing of veracious and fallacious content and positioning this content in distorted state of affairs i.e. in false context. This information secures unreasonable repute and dependability. This disinformation is extremely minacious as it is strenuous to segregate true content from false content.[1]

1.4.1.5. Imposter Content: - There are web pages of various newspapers but sometimes fake news web pages are created to give an impression to the visitors that it is a website of a long established conventional news agency. These web pages befool the readers deliberately.[2]

1.4.1.6. Manipulated Content: - It is that information which is maneuvered with an objective to allure heed and inspire entrants to a site. Snapshots and videos are purposely and intentionally maneuvered to increase the number of persons visiting the site or to enhance the income from website access. Manipulated content create public interest and excitement by utilizing astonishing new captions. At the cost of honesty, correctness and exactness; clickbait i.e. manipulated content is created to increase the number of visitors to a website.[3]

1.4.1.7. Fabricated Content: - It is cent percent i.e. totally erroneous. The purpose of this content is to defraud or cheat public for monetary, economic or ministerial benefits.

1.4.2. Fake News in Print Media, Electronic Media and Social Media
As per the Ormax Media Survey Report released in the month of April 2021about the reliability of various new media, newspaper is the most credible source of news with the rating of 62% followed by radio (with the credibility rating of 56%), TV (53%), online journalism sites and software applications have rating of 37%, internet community have rating of 27% and messenger app have credibility rating of 24%.[4] Conventional journalism associations have acted as doorman in ascertaining which news is correct and verifiable and which is erroneous. But over the period of time, these news agencies are in condition of pecuniary hardships and there is a steady growth of online journalism. This information superhighway acts as a contemporary vehicle for dispersing false information.For fake news to exist, there are basically three requirements, i.e., apparatus and system for maneuvering as well as circulating information via community platforms. Community platforms act as a podium for disseminating information and the third one is stimulation or provocation i.e. motivation for dispersing false information. It is also known as a fake news triangle (Figure 3).

Figure 3: Fake news triangle showing different components of fake news.

Standards and rules are disregarded, obliterated and intentionally disbanded while sharing information on community platforms. In order to enhance psychic and spiritual response among the readers, fake news are shared and due to these reactions, fake news disperse at a very fast pace. Moreover, the quantum of information is such that it becomes burdensome for the public to gauge its veracity. Moreover, this false news is shared anonymously. In addition to this chat bot also have the ability to post and share news via their community platform account.

1.4.3. Fake News impact on Society
No doubt with the aid of social media, news travel at a very fast pace, at lowest price with convenient ingress. Social media permits usage and dissemination of news. But fake news also travel very fast with the aid of social networks as there no checks and permissions are required. It can badly affect the society.Let's look at an

[1]https://prevency.com/en/what-is-disinformation

[2]https://cameron.libguides.com/FakeNews/TypesOf

[3]https://www.webwise.ie/teachers/what-is-fake-news/

[4]https://mediasamosa.com/2021/05/04/ormax-media-report-on-fake-news-2021/

example to help us comprehend it. At the time of election in the year 2016 in U.S., in order to make Mr. Trump won the elections, fake news were spread through social media against Ms. Clinton that Comet Ping Pong, a pizza outlet at Washington DC was engaged in pedophile sex ring i.e. child sex racket in collaboration with Ms. Clinton. In order to curb it, a destructive episode occurred at Comet Ping Pong, a pizza outlet. A person came there with a rifle and started shooting. Luckily no one was injured and that person was arrested by the police. After police enquiry, it was revealed that this person had done it due to that very news on social media. In addition to this Mr. Trump won the election. After winning Mr. Trump wired on social networks that no action could be taken against Comet Ping Pong until they are found guilty.The outcome of the incident is that an ordinary man who has not at all concerned with it has been arrested because he has believed that very fake news and has undertaken criminal activities. Moreover, it benefits only political parties who spread fake news for their benefit without bothering about other people impairment.[1]

Some fake news sources broadcast fake news in order to earn money. Like abcnews.com is the original web address of abc news channel and a fake news site was created by Paul Horner as abcnews.com.co to share false stories and earn huge profit of about $10,000 per month.[2]

In addition to politics, Fake news has also been planted in other fields including Science & Technology, Health, and Medicine etc. For example in the field of Taxonomy, researchers sometimes discover a species which has already been discovered by scientists. They wrongfully assume that discovery as a new discovery and classify that as a new species without being approved by some recognized taxonomists. They also publish their discovery in journal of repute and also place it in museum. Afterwards, when scientists disapprove their discovery, researchers do not rectify their errors due to torpidity, reticence to confess their weakness or due to careless frame of mind (Kundu, 2018).But when some reader encounters such a situation or reads such a discovery and after verification, he or she realizes that a researcher has wrongfully claimed that discovery as his own, it degrades and discredits the researcher in the mind of the reader.

Fake news creates confusion and misapprehension in the mind of the reader as well as the society. So, it is very necessary to detect fake news.

1.5. Traditional Methods of Detecting fake News
Fake news has had a long-term impact on our society, and as a result, its identification has always piqued the curiosity of many scholars.The following sections give an overview of various traditional methods being used for Fake news identification.

1.5.1. **Follow an Expository Approach**: - Fake news is written to prompt a psychic retaliation like annoyance and terror. Reader must control his emotional feelings and pain. He must logically and objectively analyze the news before reacting. He must try to probe the reason," Why has this news been penned down?"[3]

1.5.2. **Examine the Origin of fake News**: - If a reader comes across news which is skeptical and dubious, he must try to probe its origin and purpose. Reader must check the URL of the news. If there is a spelling mistake or URL has odd reverberating appendage like 'suggest', 'proffer', he or she may suspect that information is fallacious or erroneous. There is a verity examining webpage i.e. Snopes, with the help of which one can confirm the originality of the information.

1.5.3. **Checking any other Source of News**: -If the news is not available at any other source, it indicates that it is a fake because if an episode or incident takes place, numerous news agencies delineate the incident. So, examining any other source of news helps to detect fake news.

1.5.4. **Exploring the Proof: -**A dependable editorial will have a number of proofs i.e. views of specialist and resource persons, inquiry statistics and details as well as authorized data. The persons who have visited the site must also have given their views. If there are no views doubt should be raised in the mind of the reader whether the incident has occurred or details and facts have been perverted.Moreover, reader should also examine the history, reliability and recognition of news writer and publishing agency. If the news is available at community platforms, reader must check its source. He must scrutinizes the former articles available at the source webpage and also examine whether red flags have been raised on the material already shared. If there are red flags than that is a symbol of danger. Reader should not believe that very post. In addition to this, reader should also check

[1]https://www.marubeni.com/en/research/potomac/backnumber/19.html

[2]https://www.marketwatch.com/story/this-person-makes-10000-a-month-writing-fake-news-2016-11-17

[3]https://www.skillsyouneed.com/learn/fake-news.html

the age of the news site by pasting its url on domain age checker web page because most of the false information web pages exist for few days only.

1.5.5. **Do not believe photos being displayed**: - It is quite uncomplicated to design fabricated image. Moreover an original photo can be used to share false or erroneous information. Reader can check the authenticated source of the photograph as well as he can substantiate whether the photograph has been adapted or not by using Google image search and Tin Eye webpage. Images are fabricated because images attract the attention of the reader.

1.5.6. **Examine the news flawlessness**: -Spurious news is generated to sustain and nourish readers' prejudices, expectations and terrors. Online readers and community platform enjoyers could not instantly concede that their social media community network companions are unfurling fallacious information. So, reader should thoroughly investigate the news to ensure its verity.[1]

1.5.7. **Ensure the purpose of the news**: - Sometimes, the news is presented in humorous form so that the public can understand the vexatious actuality and it's after effects. They can also make an effort to ameliorate the situation and reality. Readers should confirm the purpose before believing and sharing any news update.

It is very important to detect false news in order to reveal true and fair information to the society and to avoid any misconception in the minds of readers. With the passage of time and advancement of technology, web technocrats are creating fake news in such a way that traditional ways of detecting whether the content is real or fake are insufficient.So, there has been a dire need to innovate new methods for detecting fake news to tackle advancement of technology.

2.1. Machine Learning (ML) and Artificial Intelligence (AI) Techniques for fake News Detection

In recent years, ways to disseminate information has evolved from print (e.g. newspapers, magazines, tabloids) to electronic media (e.g. social media feeds, blogs, online news platforms etc.) (Ahlers et al., 2006). The introduction of the World Wide Web, the revolution in mobile device use, and the adoption of social media platforms such as Facebook, WhatsApp, Instagram, Telegram and Twitter, among others, have ushered in new ways of spreading knowledge never seen before in human history (Ahmad et al., 2020). These innovations in information dissemination have influenced all aspects of our life, including the dissemination of news. People now-a-days are spending a significant amount of their time interacting with online social media platforms. People are increasingly turning to social media to find and consume news instead of traditional media (Shu et al., 2017).This alteration in consumption behavior can be attributed to the convenience that social media platform offers to their users (Ahmad et al., 2020; Sharma et al., 2020) including:-

a. Easy availability of news from diverse sources.

b. News on social media is updated and timely often near real-time.

c. Consuming news on social media is significantly less expensive than traditional journalism.

d. Social media platforms make it very convenient to share, comment and discuss the news with other users or friends

e. Gives opportunity to debate over various burning issues such as politics, health, education, science & technology, entertainment etc.

Due to the above discussed inherent properties, social media has evolved as much powerful means for dissemination of news and now outperforms all other traditional media including television. However, certain entities use this ability to simply, quickly, and cheaply deliver news in a bad way, distributing false news for monetary gain, political gain, generating prejudice in opinions, altering mindsets, and promoting satire or absurdity (Lazer et al., 2018; Garcia et al., 2020; Ahmad et al., 2020). Furthermore, the widespread dissemination of fake news has the potential to have enormous negative consequences for both individuals and society (Sharma et al., 2020) such as:-

a. Shattering the authenticity of the news ecosystemas fake news spread much faster than the genuine news as observed in 2016during the U.S. presidential elections.

b. Deliberately manipulating the consumer's behavior to simply accept false or biased beliefs, typically related to political messages or consumer products (Robb 2017; Soll 2016).

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[1]https://www.mindtools.com/pages/article/fake-news.htm

c. Changing people's perceptions of and responses to real-world events. Some false news is created with the goal of instilling distrust and confusion in the public, making it difficult for them to distinguish between what is genuine and what is not.

The tendency of spreading fake news has accelerated dramatically in the recent decade, as evidenced by the 2016 presidential election in the United States.These fake news articles do not authenticate facts and are therefore affecting many aspects of life including politics, health, sports, entertainment and science (Lazer et al., 2018). Therefore, it becomes foremost important to identify and label fake news to mitigate its negative effects. However, the identification of fake news online is very complex and daunting task. Fortunately, researchers have developed a number of computational techniques based on ML and AIto tackle the growing fake news menace. The scientific study of algorithms and statistical models used by computer systems to perform a certain task without being explicitly programmed is known as ML (Mahesh, 2018). ML is used to handle data more efficiently, particularly in scenarios where there is a great challenge in interpreting exact information from data. ML is inspired by the way human brain learn by training itself through a variety of situations during its growth. In the last few years, easy availability of huge data, enhanced computational power and introduction of advanced algorithms have made ML and AIwidely acceptable and popular (Badillo, 2020 ML2). ML has been applied extensively to solve diverse problems such as Pattern Matching, Image Recognition, Bioinformatics, Drug Discovery, Financial Modeling, Consumer Behavior, Weather Forecasting, Education, Fake News Detection and many more.   Therefore, this part aims to provide an overview of the major ML methodologies and algorithms followed by their applications in fake news detection.

2.1. ML Basics
Before discussing various paradigms of ML, the following section given a quick overview of the various technical terms used in ML.

2.1.1. Data and Datasets
Data and datasets are the focus of machine learning. A dataset, often known as a sample, is a collection of several data points. Each data point represents an entity that we want to investigate.A sample collected from a diseased tissue, temperature at a specific time, a news blog, an advertisement, and so on are all examples of datasets.

2.1.2. Features
Data in a dataset consists of some measured or collected featuresreferring to some properties of the data. Features can be numeric (e.g. integers, real values), categorical (e.g. true, false, fake, real; male, female i.e. predefined values without any order) or ordinal (e.g. disease stage i.e. predefined values that intrinsically follow a particular order).Each feature correspond to one dimension of the feature space, and its concrete value for a given data point places the data point in a well-defined location within that dimension (Badillo et al., 2020). A feature vector is a collection of all the values of all the features of a data point.For example source of news, length of the article, number of retweets, life time of a post etc.

2.1.3. Data Transformation
Most machine learning algorithms are designed to handle large datasets with many dimensions, and they frequently contain derived features from the raw data.This step is known as data transformation and includes approaches such as log-transformation, products, ratios etc. Data transformation is an extremely important preprocessing step and greatly influences the model performance.

2.1.4. Ensuring Data Quality
As ML is dependent on data, maintaining data quality is vital to build an accurate model. A carefully chosen ML algorithm and visual inspection of data helps to take care of extreme values and outliers in the data. However, it is often challenging to deal with missing values. Data missingness is not supported by all machine learning algorithms, which may necessitate data transformation as a preprocessing step. Many methods exist to impute missing values. However, their performance depends upon the data set and the method used.The most frequent method of imputation is to replace a missing value with the feature mean across all samples where it exists. However, this method is prone to overfitting (Dorogush et al., 2018). In addition to dealing with missing values, it is also very important to take care of any bias in the data. Data samples for machine learning should ideally be a random subset of the population. However, because some biases present in the data, this criterion is rarely met. These foundations may have an impact on the mode's capacity to generalise beyond the training/test dataset. Biases can be addressed in a variety of ways, such as altogether eliminating or down-weighing biassed samples or attributes (Cortes et al., 2008). Furthermore, many datasets are uneven in the sense that one or more samples are underrepresented, which can make many machine learning techniques challenging to implement.

One approach to resolves this issue is undersampling of the overrepresented class or oversampling of the underrepresented class. We may also implicitly include the misclassification cost in the objective function (Newby et al., 2013). It's crucial to define a distance or similarity measure between two data points in the feature space during the final quality control stage. The simplest method, the Euclidean distance measures the distance, d(A,B), between the numerical feature vectors representing data points A and B. However, more complicated distance metrics might be utilised keeping in view the type andas well as complexity of data (Hu et al., 2016).
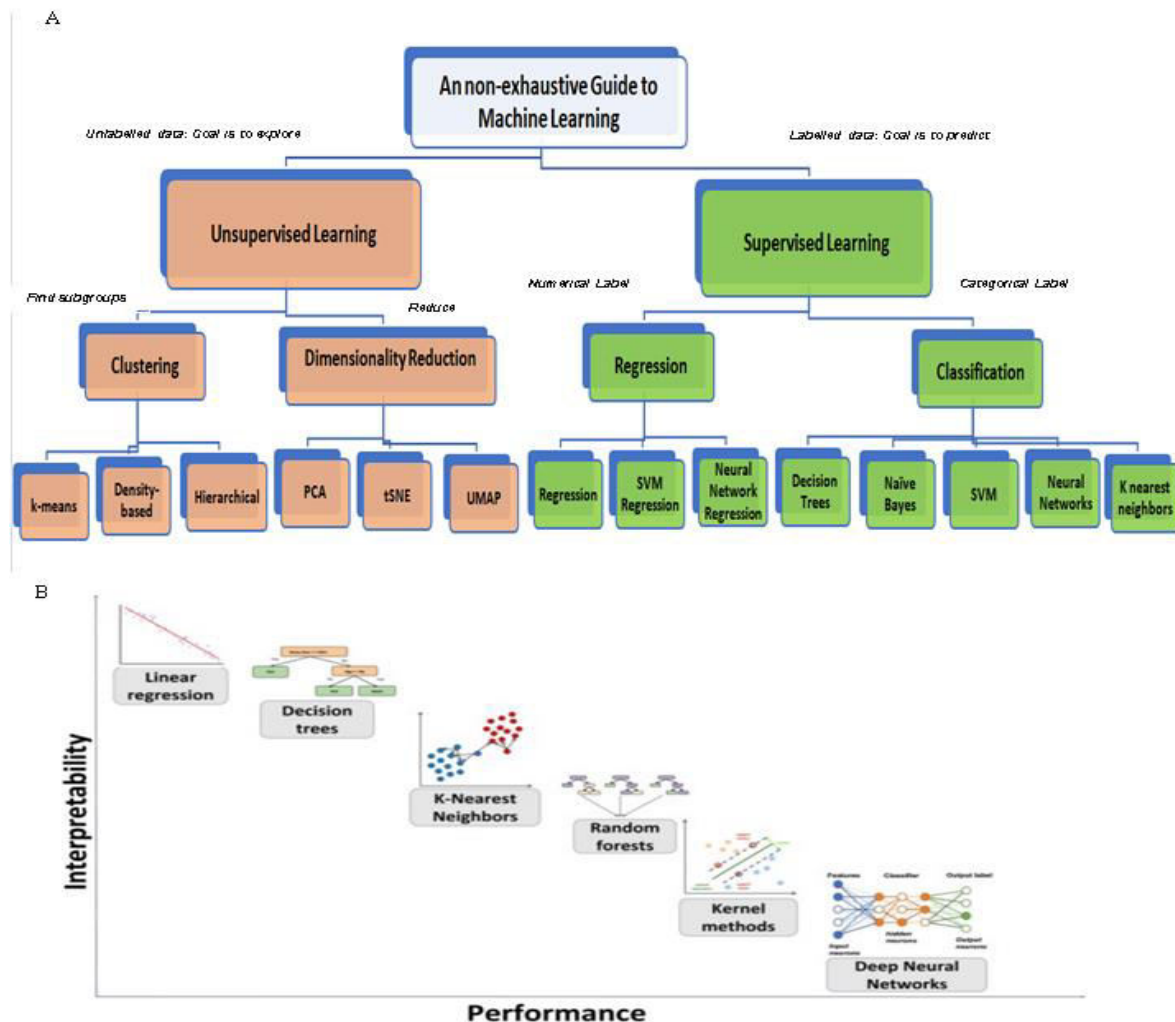
Figure 4.A taxonomy and summary of the most common machine learning algorithms. (a) Taxonomy of many methods into two categories: unsupervised and supervised machine learning methods. (b) Overview of machine learning approaches, demonstrating the variety of available methods generally scaled to their interpretability as well as performance, ranging from simpler and more interpretable algorithms to more complex algorithms with possibly greater performance but less interpretability. The amount of free parameters, model complexity, data type, and the particular notion of interpretability used all influence the placement of methods in the graph (Lipton 2018 ML2). PCA stands for principal component analysis, while SVM stands for support vector machine. tSNE stands for t-distributed stochastic neighbour embedding, and UMAP stands for uniform manifold approximation and projection. The figure was adapted from (Badillo, 2020).

2.2. Ml Approaches

In the subject of machine learning, there are two primary paradigms: supervised and unsupervised learning (Figure 4). Objects in a dataset are categorized using a set of attributes, or features, in supervised learning. The classification process establishes a set of criteria for categorizing things exclusively on the basis of feature values.In the context of the fake news such an object-to-class mapping refers to distributing the news items to either fake or real class. The features in this classification can be structural features, message features, network features, context etc. The goal of supervised learning is to create a system that can accurately assign a class to new objects based on the features available (Tarca et al., 2007). Supervised learning can be applied to discrete

as well as continuous data. For example, it can be used to predict a categorical characteristic such as class label (discrete data) as done inthe classical discriminant analysis.On the other hand, it can also be applied to predict a continuous characteristic of the objects as achieved in regression analysis. In any application of supervised learning, the classification algorithm is aimed to either return a value of ''doubt'' (highlighting the ambiguity one of several possible classes the object should be assigned to) or ''outlier'' (indicating that the object is so different from any other object previously observed that any conclusion on class membership is dubious).

Unsupervised learning, as contrast to supervised learning, does not employ preexisting class labels. The goal of this method is to look through the data and find commonalities between things. Groups of objects (clusters) are defined based on these commonalities. In other words, unsupervised learning is used to discover natural groupings of the data. In a nutshell, supervised learning uses data with associated class labels, and the learning outcome is to associate labelled data with their corresponding classes, whereas unsupervised learning uses data without labels, and the learning process not only defines labels but also associates objects with them. The complete explanation of various ML algorithms under these two categories is beyond the scope of this chapter, however a quick introduction to major unsupervised and supervised methods is given below: -.

2.2.1. Unsupervised Learning Algorithms

2.2.1.1. Clustering
In clustering methods, relevant subgroups (clusters) are identified in a given dataset without having prior knowledge about the common properties these subgroups might share. A cluster is a collection of data that are "similar" to one another. The points that belong to various clusters are more "distinctive.A variety of approaches exist for clustering depending upon the way the data points are grouped together based on "similarity". For example, one approach known as k-means clustering (Lloyd, 1982) identifies a user provided pre-defined number (k) of clusters in an iterative process. Each cluster is represented by a cluster centre, which is an artificial data point obtained from either mean or median of the values of points present in the cluster. In the second approach called hierarchical clustering a hierarchy of clusters is created using different algorithms (Hastie et al., 2008). For instance, the Neighbor Joining (NJ) algorithm first computes all the pairwise distances between the data points in a given dataset. These distances are then used to create groups following an iterative process which in each step clusters two points having the smallest distance. The resulting representation is a tree-like cluster structure (Badillo et al, 2020). The third important clustering approach is known as density-based clustering (Kriegel et al., 2011). In this approach the region of the feature space which is most dense in data points forms a cluster while low density regions are considered as noise. Depending upon the underlying data, density-based clustering may results in complex cluster shapes. The k-means clustering requires a predefined number of clusters which greatly influences its outcomes. As more information about the true number of clusters is not known a priori, this can constitute a limitation. However, neither hierarchical nor density-based clustering requires prior knowledge of the number of clusters to be produced.

2.2.1.2. Dimensionality Reduction
In ML datasets, the number of features is often very high leading to very high dimensionality of the feature space with tens of thousands of measurements in each sample. The analysis of high-dimensionality datasets associates with a phenomenon called "curse of dimensionality" (Zimek et al., 2012). In high-dimensional spaces, this relates to data sparsity and counterintuitive geometrical features.The "curse of dimensionality" makes analysis as well as visualization a challenging task for all the data analysis approaches including ML. Dimensionality reduction transforms high-dimensional data points into a very few (two or more) dimensions while maintaining the majority of the variance and relative distances. A number of dimensionality reduction approaches exists to overcome this problem including Principal Component Analysis (PCA, Pearson, 1901), t-Distributed Stochastic Neighbor Embedding (van der Maaten, 2008), Uniform Manifold Approximation and Projection (Becht, 2019) and a neural network based autoencoder. More insights into the dimensionality reduction methods have been reviewed by Nguyenet al., 2019).

2.2.2. Supervised Learning Algorithms
The ML task of learning a function that translates an input to an output based on sample input-output pairs is known as supervised learning.As the name suggests, the supervised ML algorithms works under external assistance. The given input dataset is categorized into training and test datasets. The training dataset consists of anoutput variable which must be predicted or classified. The training data is used to learn sometype of patterns based on which the algorithm predicts or classify test data sets (Tarca et al., 2007). The overall workflow of supervised ML algorithms is depictedbelow. Two major categories of supervised learning are Classification and

Regression which deals with categorical and numerical data, respectively. Various algorithms under these categories have been briefly discussed below.

2.2.2.1. Classification
In classification our aim is to classify a collection of objects (say i = 1. . . n) into Knumber of predefined classes. For example in concern to Fake news detection, we may define classes as mostly true, true, barely-true, half-true,pants-fire and false (Sharma et al., 2020).

2.2.2.1.1. K-Nearest Neighbors (KNN)
All existing, labelled data points (training data) are stored in a database in kNN learning. When a new, unclassified data point is discovered, its feature values are used to position it in the n-dimensional feature space. In the first step, distance of this new data point from all of the existing data points in the database is calculated by using an appropriate distance measure (e.g. Euclidian distance) so as to identify its k closest neighbors.The known labels (classes) of the above identified k closest neighbours are reviewed in the second stage, and the new data point is assigned to a class to which the majority of its neighbours belong. (Badillo et al, 2020). For example, for k=12, if ten of the closest neighbors are labeled as member of class X and two as that of class Y, the new data point will be assigned to class X.This algorithm is very simple and straightforward without building an explicit model from learning and rather follows "instance based learning" (Mitchell, 1993). This approach however has some challenges for example, skipping the explicit learning step misses identifying features which may be really relevant to class prediction, while others may be simple noise. As a result, instead of the genuine underlying patterns, noise will drive the class assignments.

2.2.2.1.2. Naïve Bayes
This algorithm is based on the computing a simple statistics from the specified training data set during the learning phase of the algorithm. In the subsequent step, a conditional probability based on Bayes Theorm is used to obtain classification. The presence of one feature in a class is assumed to be independent of the presence of any other feature in the class by the Nave Bayes classifier (Mahesh 2020). This approach is mostly used for clustering and classification, and it is based on the conditional probability of occurrence with specific applications in text data classification. Due its simplicity and straight forwardness, it is often utilized to establish a baseline classification performance level to be used as a standard to improve upon by other sophisticated methods.

2.2.2.1.3. Decision Trees, Random Forests, and Gradient Boosting
Breiman et al. (1984) defined a decision tree as a graph that represents decisions and their outcomes in the form of a tree. (Mahesh 2020). This tree like graph consists of nodes and edges, the nodes represent a choice or an event whereas the edges represent the conditions or decision rules. Depending upon the problem, the leaf nodes of a decision tree may consist of probabilities,classes, or continuous values (in case of regression). An iterative training process is followed to select individual features which are the most salient at each node in the tree. Input space X is iteratively divided into subsets starting with X itself. There are several heuristic algorithms to build a decision tree classifier.Decision trees are usually constructed following a top-down approach. In this approach the process to build a decision tree starts from the root node which is thensuccessively partition the feature spaceinto tree branches. The construction of a decision tree is a three step process. In step 1, the splitting rules for each internal node are selected by determining the characteristics and thresholds used to split the dataset on each node.Step two identifies the terminal nodes. During this step a decision is taken whether to further split a node or to make it as a terminal nodeand a class label is assigned to it. By minimising the anticipated error rate, class labels are allocated to terminal nodes in the last stage. Binary decision tree classifiers are the most often utilised (Tarca et al., 2007). Many approaches are used to construct decision trees including the most famous Classification and Regression Trees (CART, Breiman et al., 1984)and Iterative Dichotomiser 3 (ID3, Quinlan, 1986).Now a days, classical decision trees are seldom used in ML due to a number of limitations including overfitting. However, two new approaches have evolved from the original decision tree algorithm. These are Random Decision Forests and Gradient Boosting Frameworks. The Random Forest method is an ensemble learning technique to solve complicated problems by combining several classifiers. Hundreds or thousands of deep decision trees ("strong predictors") are created in random decision forests. TAs a result, the random forest algorithm's 'forest' is trained via bagging or bootstrap aggregation. Bagging is a meta-algorithm that increases the accuracy and stability of machine learning algorithms while reducing variation and dealing with overfitting. Each of these trees are likely to be overfitted, however, their combined output reduces overfitting and generates more precise output.In a gradient boosting approach, however, each of the individual trees is a shallow decision tree ("weak predictor"), and the algorithm reduces

the classification error over time by adding more and more trees in succeeding rounds.Two important gradient boosting algorithms include XGBoost and CatBoost.

2.2.2.1.4. Support Vector Machines (SVM) and Regression (SVR)
For the linear example, machine learning and statistics theory and techniques have traditionally been extremely well developed. However, nonlinear approaches are frequently required in real-world data analysis tasks in order to find the kind of relationships that allow for accurate prediction of attributes of interest. One can occasionally have the best of both worlds by employing a positive definite kernel (Hofmann et al., 2008). The kernel refers to a dot product of two vectors in a (possibly very high-dimensional) feature space.Kernel methods make use of kernel functions, which allow them to operate in a high-dimensional, implicit feature space without ever computing the coordinates of the data in that space, instead computing the inner products between all pairs of data in that space.This operation is often computationally cheaper than the explicitly computation of the coordinates (https://en.wikipedia.org/wiki/Kernel_method). The "kernel trick" refers to this method (Theodoridis 2008). Kernel functions have been developed for a wide range of data types, including text (including sequence data), vectors, graphs and images.

SVM (for classification) and SVR (for continuous output) are among the various kernel methods which have the great ability to deal with very high-dimensional datasets while being robust against noise. Aligned with the general principle of regression, SVR's goal is to hypothesize a function on the input(s) that can estimate for the observed output (Badillo et al., 2020). Similarly, the SVM seeks to determine the best decision boundary (margins) between classes. The margins are drawn so that the gap between the margin and the classes is as little as possible, reducing classification error.The essential principle behind SVM/SVR is to identify a subset of training data called support vectors which define the model, which is generally a hyperplane in some given feature space.

2.2.2.1.5. Neural Networks
A neural network is a collection of computer algorithms that have been trained to recognise underlying patterns or relationships in a piece of data, much like the human brain.Therefore, neural network consists of neurons and the corresponding connecting edges. Each of the edges connecting the neurons possess different weights (Badillo et al., 2020).The input layer, hidden layer(s), and output layer are the three layers that make up neural network architecture.To generate an output signal, each neuron applies an activation function to the weighted input signal. A fully connected, three-layered node structure, also known as a feedforward neural network, is the most common neural network architecture for data classification, with signals flowing from the input to the output layer via the hidden layer.The hidden layer only receives the values of the feature vector x from the input layer. Each hidden unit weights the outputs of the input layer differently, adds a bias term, and transforms the result with a nonlinear function, most often the logistic sigmoid (Tarca et al., 2007). Similarly, all the outputs of the hidden layers are processed by the output layer. Mostly, each data class is represented by one output unit.The number of hidden layers determines whether a learning system is shallow (with only one or a few levels) or deep (with many layers) (with several hidden layers). The ability of neural networks to adapt to the changing input makes them efficient to produce the best possible outcome without redesigning the output criteria (Mahesh et al., 2020). Neural networks can be either supervised (with already existing clue about the output for a given input) or unsupervised (no prior clue about the output). Neural network class of algorithms has evolved a lot from simple straightforward to more complex forms as discussed below: -

2.2.2. 1.6. Reinforced Neural Network
Reinforcement learning refers to goal-oriented algorithms that learn how to attain a complex aim (goal) or maximize along a specific dimension over a set of steps, such as maximising the points scored in a game over a set of movements. Starting from scratch, this class of neural networks can achieve superhuman performance given the appropriate circumstances. These algorithms, like a youngster bribed with spankings and candy. These algorithms are penalized for making bad decisions and rewarded for making good ones, which is known as reinforcement.

2.2.2.1.7. Recurrent Neural Network (RNN)
RNNs are designed specifically for time series data and capture the sequential relationship between data from one time point and the next. Long short-term memory (LSTM) and gated recurrent networks are two RNN versions that can cope with more complicated data types in a more efficient manner (GRU).

2.2.2.2. REGRESSION

2.2.2.2.1. Linear Regression

The simplest of the regression techniques, linear regression seeks to identify the relationship and dependency between variables. It uses linear functions to model a relationship between the continuous scalar dependent variable y (referred to as label or target) and one or more (D-dimensional vector) explanatory variables (referred to as independent/input variables, observation data, observation values, features, attributes, dimensions data points, etc.). (Nasteski, 2017).

$Y = m X + c$

On the basis of the input independent variables, regression analysis predicts the value of a continuous dependent target variable. The multiple regression models involving the linear combination of input variables take the following form: -

$Y = a_0 + a1X1 + a_2 X2 + a_3 X3 + \dots..$

Linear regression (Lin et al., 2008)can also be defined as one of the supervised learning algorithms since it uses a model based on a set of labeled data (training data) to predict labels on unlabeled data (test data).

2.2.2.2.2. Logistic Regression

Logistic regression extracts weighted sets of attributes from the input, calculates logarithms, and combines them linearly. Each attribute is multiplied by a weight and then added up in logistic regression. A logistic regression is a regression that fits data to a logistic function and predicts the probability of events. Logistic regression, like many other types of regression analysis, involves many predictors, which can be numeric or subtype specific (Nasteski, 2017).

2.3. Applications of Machine Learningand Artificial Intelligence in fake News Detection

ML algorithms have been applied in almost every aspect of generating data, particularly big data. As discussed earlier in this section, fake news detection is a challenging task to which researchers have applied ML and other AI techniques. The current section will discuss various aspects of ML applications in detecting fake news.

2.3.1. Fake News Features or Indicators

Fake news content shows some characteristic features related to linguistics, source of news, intentions, structural features, and network features etc. which can aid in segregating fake news from real news. Some of these features (Molina et al, 2010)have been discussed below: -

2.3.1.1. Message Features: - A variety of message features have been reported including punctuation errors, spelling mistakes, biasness in frequency of certain words, spelling mistakes, etc. Also some lexical components (for example words "you", or "should") indicate some promotional content or opinion piece. In addition, visual features such as variation in pixel structure can also help in detecting fake images from real ones using reverse image search approach.

2.3.1.2. Sources and Intension Features: -These features includesources used in the messages as well as thesources where content has been created**.** For example if the source of the article is not traceable or not verified, it's a strong indicator of an article to be fake.Similarly, information about the origin or pedigree of an article also plays an important role as an article originating from an obscure site or a social media post is more likely to be fake.

2.3.1.3. Structural Features: - Structural also aids in identifying fake content. For example many fake news sources use fictitious sites in the URL often mimicking the URL of a traditional well recognized outlet, but ending in for instance .com.co (e.g. xyz.com.co). These fabricated URL also bears a fairly recent registration date. One another structural feature is the 'contact us" section, which shows a personal email account instead of the official email account of an organization. Structural features also number of tweets, average tweet length, thread lifetime (number of tweets between first and last tweet), depth of conversation tree (Buntain & Golbeck 2017).

2.3.1.4. Network Features:-These include the features related to the dissemination of articles as well as the technology used. For example fake news is often shared through pre-identified accounts and our own personal networks of friends and family.

Combination of the above said or some more features can be fed to an ML algorithm to train it for fake news detection as indicated in the table 1 and Figure 5 (Molina et al., 2021) Fake news indicators have been used to construct a decision tree for fake news detection. For detailed information about various fake news indicators for specific content type an article by Molina et al, 2021 may be referred.

Table 1: Example of "Fake News" features/indicators converted to Y (Yes), N(No) questions for a Decision Tree Algorithm. N[a] refers to features not available. (Table adapted from Molina et al, 2021).

Content type	Fact-checked	Emotionally charged	Source verification	Registration inconsistency	Site pedigree	Narrative writing	Hum or
Real News	Y	N	Y	N	Y	N	N
False News	N	Y	N	Y	N	Y	N
Ploarized content	N[a]	Y	N	N	N	Y	N
Satire	N	N[a]	N	N[a]	N	N	Y
Misreporting	N	N	N	N	Y	N	N
Commentary	Y	Y	Y	N	Y	Y	N
Persuasive information	N	N[a]	N	N[a]	N[a]	Y	N
Citizen journalism	N	N[a]	N	N[a]	N[a]	N[a]	N
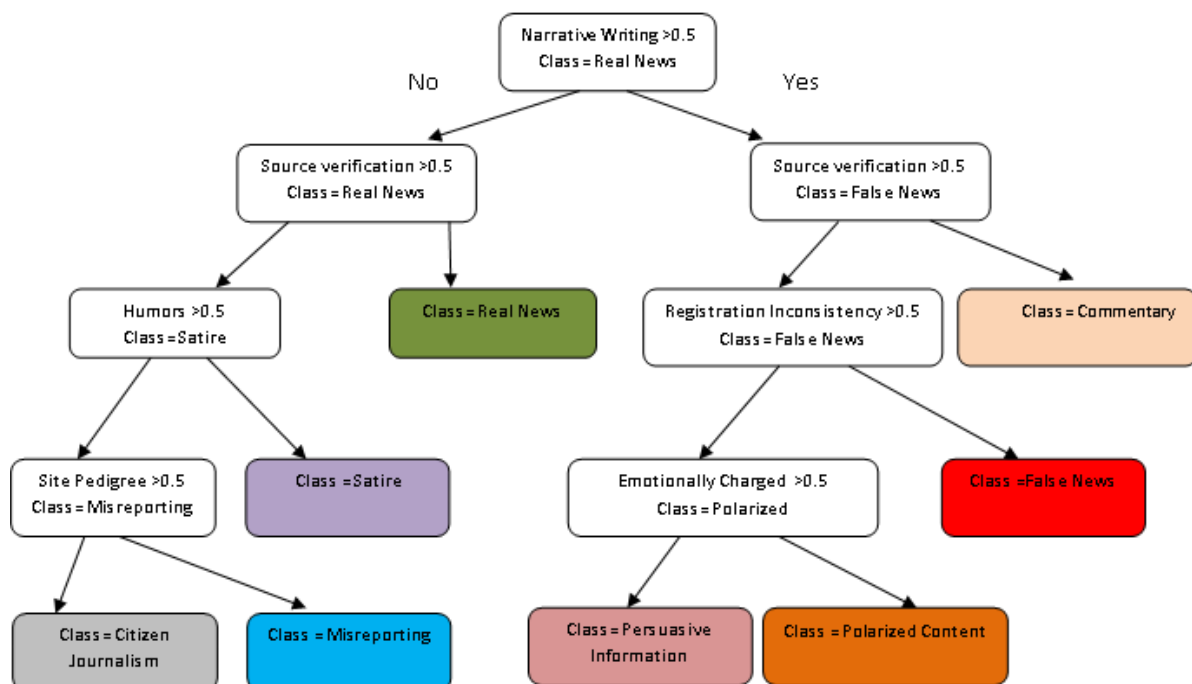
Figure 5: Example Decision Tree using subset of the indicators mentioned in table 1. Figure adapted from Molina et al., 2021.

2.3.2. Fake News Datasets

Fake news can be obtained from a variety of sources such as social media sites, search engines, news agency websites or websites for fact checking etc. Internet harbors a number of publicly available datasets for classification of Fake news as discussed below: -

2.3.2.1. LIAR: - "Liar"Liar Pants on Fire" is a fake news detection benchmark dataset (Wang, 2017). It contains 12,836 hand categorised remarks gathered from the POLITIFACT.COM website in a variety of circumstances, such as news releases, TV/Radio interviews, campaign speeches, and so on.The class labels corresponding to different classes for news truthfulness include pants-fire, false, barely-true, half-true, mostly true, and true (Sharma et al., 2020).This dataset in English contains a full analysis report as well as links to source documents for each case. The LIAR dataset can be accessed from https:// github.com/ thiagorainmaker77/ liar_dataset, https://metatext.io/datasets/liar-dataset etc.

2.3.2.2. Buzz Feed News: -The Buzzfeed news dataset contains a thorough sample of news from nine news organisations that were published on Facebook during the week leading up to the 2016 US election, September 19 to 23, and September 26 and 27, 2016. Each assertion in each post and linked article was fact-checked by five BuzzFeed journalists. Buzzfeed News offers two graph-based datasets, one for fake news and the other for factual news. Buzzfeed News has two datasets, one for false news and the other for true news, each with 91 observations and 12 features/variables.The BuzzFeed News data for 2016 elections can be downloaded from

https:// github.com/BuzzFeedNews/2016-10-facebook-fact-check/tree/master/datawhile some other fake news datasets can also be searched and downloaded from https:// github.com/ Buzz Feed News/everything

2.3.2.3. Credbank: - This is a large-scale crowd-sourced dataset including roughly 60 million tweets spanning 96 days beginning in October 2015. Over 1,000 news events are referenced in the tweets. Thirty Amazon Mechanical Turk annotators evaluate each occurrence for credibility. (Mitra and Gilbert, 2015)CREDBANK was created by extracting tweets from Twitter's public sample stream, identifying subjects within them, and using human annotators to determine which topics were concerning events and which of these events contained valid content.The programmes then used Twitter's search API to expand the number of tweets associated with each occurrence (Buntain & Golbeck 2017). CREDBANK data can be downloaded from http://compsocial.github.io/CREDBANK-data/

2.3.2.4. Pheme: - The University of Warwick collaborated with Swissinfo, a division of the Swiss Broadcasting Company, to create the PHEME rumour scheme data collection (Zubiaga et al., 2015). Swissinfo journalists collaborated with Warwick researchers to construct the PHEME data collection by observing a succession of major events on Twitter and identifying conversation threads that were likely to include or generate rumours.In this context, a "rumour" was described as a disseminated unverified and relevant remark that could subsequently be validated as true, untrue, or unconfirmed. PHEME consists of 330 conversation trees out of which 159, 68 and 103 were labeled as true, false, and unverified, respectively (Buntain & Golbeck 2017). The original PHEME dataset can be obtained from https:// figshare.com/ articles/ dataset/ PHEME_rumour_scheme_dataset_journalism_use_case/2068650 and its extended version is available for download at https://github.com/elkasrawi/Extended-Pheme-Dataset

2.3.2.5. BS Detector: -This data comes from a browser addon called BS detector, which was created to verify the accuracy of news stories. It compares all links on a web page to a manually produced list of domains to look for untrustworthy referrals. Rather than human annotators, the labels are the outputs of the BS detector.

2.3.2.6. ISOT: -The ISOT Fake News dataset is a compilation of thousands of fake news and factual articles culled from a number of respectable news sources and sites identified as untrustworthy by Politifact.com.The ISOT Fake news dataset contains both true as well as false articles from the internet dominantly related to political arena. The true articles have been extracted from a very reputed news website reuters.com while the fake news articles have been gathered from various sources, mostly from the websites flagged as red (Fake) by politifact.com (P2). In this collection of 44,898 articles, 21,417 are truthful while 23,481 are Fake articles (Ahmed et al., 2017; 2018, P2). This dataset can be accessed from https:// www.uvic.ca/ engineering/ ece/ isot/ datasets/fake-news/index.php

2.3.2.7. Buzz Face: -This The BuzzFeed dataset was supplemented with Facebook comments on news articles to create this dataset. The collection contains 2263 news stories, each with 1.6 million comments. BuzzFace is available for download at https://github.com/gsantia/BuzzFace.

2.3.2.8. Face Book Hoax: -This dataset contains information acquired using the Facebook Graph API from posts on Facebook pages related to scientific news (non-hoax) and conspiracy pages (hoax). The dataset contains 15,500 posts from 32 pages (14 conspiracy and 18 scientific) and has over 2,300,000 likes. Facebook Hoax dataset can be downloaded from https://github.com/gabll/some-like-it-hoax.

2.3.2.9. Fake News Net: - Fact-checking websites PolitiFact and GossipCop contributed fake and actual news stories to the FakeNewsNet collection. It includes material from news stories, tweets about news articles, and social engagements such as responses, retweets, and favourites. The collection contains approximately 2 million tweets connected to fake and actual news stories, as well as engagements and user profiles of those who interacted with them. This dataset can be accessed at https:// github.com/ KaiDMML/ FakeNewsNet/.

2.3.2.10. Fake News Dataset COVID-19: -In addition to the COVID-19 pandemic, we are also combating a "infodemic." Fake news and rumours abound on social media. Rumors can have devastating effects if you believe them. In the event of a pandemic, this is exacerbated. To address this challenge, Patwa et al., 2020 have generated and released a carefully annotated dataset of 10,700 social media postings and pieces of true and fake news on COVID-19.They compared the annotated dataset using four machine learning baseline algorithms viz.,Decision Tree, Logistic Regression, Gradient Boost, and Support Vector Machine (SVM). With SVM, they achieved the best performance of 93.46 percent F1-score. This dataset is available for download at https://paperswithcode.com/dataset/covid-19-fake-news-dataset.

2.3.2.11. Datasets Available at Kaggle (https://www.kaggle.com/): - In addition to the above discussed datasets, many fake news datasets have been made available at Kaggle.com includinghttps:// www.kaggle.com/ c/fake-news/data and https://www.kaggle.com/jruvika/fake-news-detection used for analysis by P2.

2.4. Review of ML Algorithms for fake News Detection

A variety of ML algorithms as discussed previously and their variations have been used by different researchers for Fake news detection. Researchers have explored various dimensions such as Posts sharing attitude, sentiment analysis, identifying fake users, identifying fake news, detecting fraudulent attempts to get sensitive information, analyzing fake content, automatic real-time detection of malicious content, Understanding users behavior etc. Both unsupervised as well supervised ML methods have been implemented by researchers to successfully explore the arena of Fake news detection. A summary various ML approaches used for Fake news detection is given in Table 2.

Table 2: A summary of various ML algorithms used for Fake news detection. Adapted from Steni and Sreeja, 2020. NBC: Naïve Bayes Classifier, SVM: Support Vector Machine, SGD: Stochastic Gradient Descent, NN: Neural Networks, RNN: Recurrent Neural Network, LR: Logistic Regression, RF: Random Forest, DT: Decision Tee, CNN: Convolution neural network, KNN: KNearest Neighbors

Objectives	Methods	Reference
Fake news prediction using Deep Learning technique in conjunction with pre-trained word embedding approach	Deep Learning, Pre-Trained Embedding	Bogale and Zhu, 2020
Combining different Machine Learning algorithms to automated classification of news articles	LR, SVM, Multilayer Perceptron, Ensemble Learners (RF, Bagging, Boosting, Voting)	Ahmad et al., 2020
Binary classification of news articles by employing Artificial Intelligence, Machine Learning and Natural Language Processing	NBC, RF, Bagging, LR	Sharma et al., 2020
Proposing a model for fake news detection on social media	DT, RF, FNDNet, Context-free models, Contextual -based model	Kaliyar et al., 2020
Comparing various Machine Learning techniques for identifying Fake news	NBC, SVM, SGD, NN	Ahmad and Lokesh Kumar, 2019
Detecting Fake news on Twitter using Semi-supervised learning	NBC, DT, Adaboost, SVM, bidirectional RNN	Dong et al., 2019
Detecting Fake news using geometric deep learning method with propagation-based approach	Geometric deep learning approach, CNN	Monti et al., 2019
Evaluation of prediction power and automatic detection of Fake information on Facebook.	lexical Features, Syntax Features, Semantic Features, Linguistic Features	Reis et al., 2019
Building a model to detect Fake content on social media.	SVM, KNN, NN, DT	Vicario et al., 2019
Analytics-driven framework to detect fake news to reduce the risk of misinformation.	K-mean and affinity propagation	Zhang et al., 2019
A Propose a Fake news detection model	Theory-driven model, Lexicon level, Syntax level, Semantic level, Discourse level	Zhou et al., 2019
Creating an algorithm to check reliability of Facebook news.	N-grams, Sentiment analysis	Solis et al., 2019
Identifying fake news, users, likes on Twitter.	linguistic approach, NBC	Atodiresei et al., 2018
Classifying information using Deep neural architecture	DNN	Fernández-Reyes et al., 2018
Proposing a method to identify false information	n-gram, semantic features	Zhuk et al., 2018
Predetermine the fake News on online social network.	Tensor Decomposion approach	Ghafari et al., 2018

Building a Publicly available dataset for fake news detection	CNN	Wang, 2017
Automatic generation of news headlines	Deep learning Model, RNN	Dandekar et al., 2017
Fake news detection and compare various classifier and feature extraction	TF-IDF, LSVM	Ahmed et al., 2017
Automatic real-time detection of fake news on Facebook	DT, RF	Dewan and Kumaraguru, 2017
Proposing a Fake news detection model on Facebook	NBC	Granik and Mesyura, 2017
Analyzing the reaction of Facebook users	K-mean clustering	Savyan and Bhanu, 2017
Understanding user behavior, fake news analysis, classification approach and detecting the misinformation on Twitter	classification approach-flat classification and hierarchical classification	Rajdev and Lee, 2015
Classifying Emotion on a specific topic in Facebook	NBC, Rocchio, Perceptron	Troussas et al., 2013
Analyzing usage pattern of Facebook users	SVM, Apriori Algorithm, DT	Bozkır et al., 2010

As inferred from the table, though almost all the ML algorithm variants have been employed to solve the problem of fake news detection, Naïve Bayes Classifier (NBC), Support Vector Machine (SVM), Decision Tee (DT), Random Forest (RF), Neural Network (NN), Recurrent Neural Network (RNN), Convolution Neural Network (CNN), k-Nearest Neighbor (KNN) and its variants seems to be dominantly used in this scenario. A pattern based analysis approach was developed to identify usage time and access frequency of Facebook using DT, SVM and Apriori Algorithm (Bozkır et al., 2010). Similarly models have been developed based on user behavior and user reactions on Facebook using K-means clustering (Savyan and Bhanu, 2017). NBC was used to detect Fake news (Granik and Mesyura, 2017).Researchers also developed commercially available benchmark "LIAR" dataset for fake news detection using the CNN technique (Wang et al., 2017). Ahmed et al. proposed a method to detect false information spread on social media by combining N-gram feature extraction with machine learning techniques such as KNN, SVM, LR, Linear SVM, DT, SGD, and Term Frequency-Inverted Document Frequency (TFIDF). In addition, Linear SVM was also used as a classifier in this study (Ahmed et al., 2017). An automatic real-time detection tool called Facebook Inspector (FbI) was developed to detect malicious content on Facebook (Dewan and Kumaraguru, 2017). Using tensor decomposition approach developed an algorithm to predict and identify the fake news on online social network (Ghafari et al, 2018). A linguistic based NBC technique was used for identification of Fake news and Fake users on Twitter (Atodiresei et al., 2018). Geometric deep learning has been applied to create models detecting fake news on the basis of approaches used to propagate fake news instead of traditional content based methods (Monti et al., 2019). In another approach, set of traditional features (Lexical, Syntax, Semantic and Psycholinguistic) were used to compare the prediction accuracy of various supervised learning approaches (KNN, NBC, RF, SVM with RBF kernel and XGBoost) for automatic fake news detection with RF and XGBoost giving the best performance as per the statistical parameters used. The authors in this study also proposed some handcrafted new textual feature sets (Reis et al., 2019). In another study, the authors applied a deep two path semi-supervised learning approach for fake news detection from Twitter using NB, DT, Adaboost, SVM, bidirectional RNN ML methods. Each of the path belongs to supervised an unsupervised approaches, respectively (Dong et al., 2019). RNN and CNN methods were used to spontaneously detect the fake content on political domain (Shilpa and Jawahar 2019) while Deep CNN based FDNet-A system was developed for Fake News Detection (Kaliyar et al., 2020).Ananalytical driven model has been introduced to analyze and detect the fake news using the k-means and affinity propagation methods in order to reduce the risk of misinformation (Zhang et al., 2019).Linear regression and logistic regression was used to predict fake news as well as to determine various fake news topics on social media(Vicario et al., 2019; Guess et al., 2019). A comparative study using different ML algorithms (NBC, SVM, SGD and NN) was carried out on a dataset of 2000 news samples from various sources including social media, news websites, online gossips etc., to assess the performance of the ML algorithms for Fake News Detection (Ahmad and Lokeshkumar, 2019). In this comparative study, NN gave best accuracy of 93.6% followed by 87.5%, 76.8% and 68.4 % by SGD, SVM and NBC, respectively. In a recent attempt, Binary classification of news articles using Artificial Intelligence, Machine Learning and Natural Language Processing was performed (Sharma et al., 2020). Researchers used NBC, RF, LR and Passive Aggressive Classifier for Classification using LIAR dataset. LR gave best accuracy of 65% which was further improved to 80% using

grid search parameter optimization technique. Another recent study used ML Ensemble methods for automatic classification of news articles based on textual features (Ahmad et al., 2020). The researchers used combinations of various ML algorithms including LR, SVM, Multilayer Perceptron, Ensemble Learners (RF, Bagging, Boosting, Voting) and noticed superior performance as compared to using the individual algorithms.In a very recent study, researchers combined Deep Learning (CNN and long short-term memory) and word embedding techniquesto detect bogus news early. Using various measures, the researchers evaluated three pre-trained word embeddings in the context of the false news problem. They used three real-world scenarios in a series of trials. Such type of AI approaches lacks appropriate large datasets and face challenge of knowing "which word embedding best captures content aspects". In the above mentioned study researchers also created a dataset from a scrape of 13 years of continuous data (Bogale and Zhu, 2020).

In addition to the above predominant ML techniques, Sentiment analysis, N-grams and Natural language Processing techniques have been used to check the reliability of a news articles from Facebook (Solis et al., 2019). Models have been built based on Semantic features (Bharadwaj and Shao, 2019)as well as a combination of N-grams and Semantic features (Zhuk et al., 2018) to detect the fake news from the online articles.In another approach Semantic and Syntax features were combined to obtain good quality of text (Dandekar et al., 2017). Information on Social media of often distributed in form of images. Manipulated images thus become a big source of Fake information including Fake news. To address this issue, an image veracity based model has been recently proposed. This model targets the information available in the form of photos on various social media sites for validity. It entails an algorithm that verifies the truth of image text by investigating it on the internet and then assessing the trustworthiness of the top 15 Google search results by computing the reality parameter (Rp), which, if it exceeds a threshold value, classifies an event as real or false(Vishwakarma et al., 2019).In a different approach the performance in predicting the Facebook update status was compared using NBC, Rocchio andPerception. This approach is still not much developed to identify fake information on social media (Troussas et al., 2013).

Explainable Artificial Intelligence (XAI) for fake News Detection

AI Algorithms have been used in a large number of applications encompassing various fields related to Education, Social Sciences, Science & Technology, Medicines, Consumer Behaviors to name a few. No doubt, AI-based decision making is impacting the society, its accountability and fairness, however is under question (Mohseni et al., 2021).Machine learning algorithms are widely employed in online platforms and social media to evaluate user data in order to improve the user experience and boost company profits. However, a lack of openness in crucial sectors might create data privacy and model trustworthiness concerns, thereby lowering consumer trust and confidence in the long run (Mohseni et al., 2019). In this regard, academics look at how algorithmic processes communicate in a variety of contexts, including online advertising (Eslami et al. 2018), social media feeds (Eslami et al. 2015), and tailored news search engines (Ter Hoeve et al. 2017).As discussed in the previous section, ML and its automation in terms of AI has been gaining importance to detect Fake and Malicious content in various forms on social media and internet. AI has been now extensively used in developing automated models for identification of Fake news.In the social media sphere, users are exposed to algorithmically picked content, and news feed and search algorithms function similarly to decision-making algorithms (Trielli and Diakopoulos 2019). Accepting algorithmically generated news without question could lead to the unintentional large-scale transmission of false and produced information, with consumers being exposed to false information and it being shared on social media.Algorithm interpretability has been demonstrated to improve user attitudes regarding algorithms in a number of studies (Mohseni et al., 2020). XAI approaches have been therefore used to add transparency into black-box machine-learning systems (Gunning 2017). Users can benefit from interpretability by developing a mental model of how algorithms work and developing appropriate trust in intelligent systems (Rader et al., 2018).

Several attempts have been made by various researchers to club ML and human computer interaction to provide explanations to Fake news detection systems. For example Shu et al., 2017 included news publisher information, user stance, and user engagement in their Tri- Relationship false news detection system to incorporate more data for representation learning. Alternatively, Popat et al., 2018 used the Google search engine to gather similar occurrences from the web, using language similarity as a criterion. To obtain data from web sources, they rely on external news articles. To explain predictions of natural language processing (NLP) models, back-propagation, perturbation, local approximation, and decomposition procedures were divided into four groups (Du et al. 2019). Back-propagation algorithms are used to calculate the gradients or variants of gradients of a model prediction with respect to each input (Hechtlinger 2016). Gradient values can be used to reflect the contribution of each word input to the model prediction.The occlusion of input text, on the other

hand, may create changes in model prediction in perturbation-based techniques, resulting in estimated word contributions (Li et al., 2016). Unlike the other two strategies, decomposition-based methods can model the data flow process by calculating the additive contribution of each input word to the final forecast (Murdoch et al., 2018). Finally, local approximation-based methods can explain the model's predictions by approximating a sophisticated model's behaviour around an input instance (Ribeiro et al., 2016).

Recent interpretable fake news systems have proved the benefits of interpretability for fake news detection, such as supporting end-users in identifying model defects so that model predictions can be trusted appropriately. The XFake detector in (Yang et al. 2019) uses a tree-based model representation to express the overall decision paths for incoming news items. Fake news identification was also interpreted using feature-based explanations based on important user comments from relevant news stories (Shu et al. 2019).AI-based news review assistant tools have been proposed to be embedded in news feed platforms which can help users by providing them suggestions regarding news credibility instead of automatically predicting Fake news. In this regard, a news reviewing and sharing interface has been developed (Mohseni et al., 2021). These researchers also created a dataset of news articles which was then trained on four interpretable false news detection algorithms. In the first approach, Bi-LSTMwith an additional self-attention layer was trained solely on news headline to obtain attention explanations supporting its predictions.They integrated news story headlines and a group of linked articles in the second model. A hierarchical attention network was established using hierarchical attention at the phrase and article levels (HAN) (Yang et al., 2016HAN rates each article and selects the most essential sentences, resulting in a sentence representation for each article using word embedding techniques (taking average of word embedding). On the basis of news items, related articles, and the source of articles as input, the researchers employed a knowledge distillation strategy (Hilton et al., 2015) to approximate a deep architecture (teacher) with an RF (student) model in the third model.In the fourth approach, a Bi-LSTM network model was trained utilising both news items and related articles, as well as Word2Vec word embedding approaches. The findings suggest that explanations helped participants create adequate mental models of intelligent assistants in a variety of scenarios and change their trust to account for model restrictions.Mohseni et al., 2020 created a news review interface employing a news dataset from Snopes news headlines (with ground truth) and supporting news articles taken from the top 16 Google hits in another novel study involving trust evolution over time in XAI for Fake news detection.This approach also used same four models as discussed in the previous work by Mohseni et al., 2021. Researchers noticed significant effect of ML explanations on changes in user trust over time.

LIMITATIONS AND FUTURE PERSPECTIVES

Ever increasing reach to social media platforms using internet technologies has made information very easily available. However, this ease of getting information is being exploited some individuals or organizations to disseminate false information over the internet for personal gains. Number of ML, AI and XAI approaches has been evolved to tackle this issue. However, these techniques have their own limitations which hamper them from effectively detecting and countering disinformation. For example, the "overinclusiveness" of AI technologies creates a risk of over-blocking of the accurate and lawful content (Kertysova, 2018). Although lot of improvements has been made in terms of accuracy, the AI techniques are still prone to reporting false negatives or false positives. False positive leads to identifying a content/ bot account as Fake when they are instead not Fake and can severely affect the freedom of expression and may lead to censorship of a genuine content This type of false prediction happens as automated technologies possess limited ability to assess the accuracy of individual statements (Marsden and Meyer, 2019). The current AI technologies are very useful in dealing with simple declarative statements and lack the human like power to recognize complex statements containing embedded or mis implied claims or situations requiring contextual or cultural cues (Graves, 2018).AI systems also lack mastery in human concepts such as sarcasm and irony and therefore fail to address more nuanced forms of disinformation[1].This situation is further aggravated by language, cultural and political barriers. In addition, some methods are prone to replicating and even sometimes automating human biases and personality traits thus leading to biased predictions favouring a particular group of people (Lee et al., 2019). As the technologies are often influenced by their developers[2], biasness on the part of the programmers (in terms of their values and priorities) as well due to the limitations of the underlying datasets (flawness, incompleteness and underrepresentation) may lead to development of biased algorithms(Lee et al., 2019).The availability and quality of datasets is very important to develop appropriate algorithms. Fake news detection using ML and AI

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[1]AI won't relieve the misery of Facebook's human moderators - The Verge

[2]https://hbr.org/2018/10/auditing-algorithms-for-bias

mostly use textual data and is predominantly confined to political arena. Textual data is often available from the fact checking websites like "Politifact" and "Snopes". Recently many new datasets have been made available by the researchers to aid in developing ML algorithms. Also, Fake news spread is expanding to fields other than political for example economics, science and technology, health etc. which lacks sufficient datasets to explore. So, developing more robust datasets covering wider areas is one of the future perspectives to make Fake news detection more applicable and acceptable.

The limitations of the architecture and design also impact the extent to which a particular platform can be exploited to spread disinformation (Kertysova, 2018). For example WhatsApp architecture supports end-to-end encryption which makes the shared messages out of the reach of content moderator. This feature is good in terms of privacy, but has been exploited to spread Fake news and hate speeches during election campaigns and sometimes has resulted in very serious consequences in some of the countries[1].

The ML algorithms have their own inherent limitations which must be taken into account while using them for various datasets (Ahmad and Lokeshkumar, 2019). For example NN if very effective but very demanding in computational power, SGD is faster to learn but noisier, SVM guaranteed to achieve optimality but lose sequentiality and NBC is simpler to se but often show high memory latency. The AI systems have one major limitation in terms of complexity and opacity[2]. Based on their training behavior the most applicable ML algorithms such as Neural Networks, Deep Neural Networks use very complex logic for automatic decision making which is almost impossible to understand. These Ml algorithms are therefore often tagged as "black box solutions"[3]. Recently, various researchers as well as companies have been focusing on developing Explainable Artificial Intelligence (XAI) solutions with verifiable, more accountable and transparent frameworks leading to more reliable solutions (Gunning, 2016). The XAI systems for Fake news detection are in their initial stage and pose challenges in terms of model selection, feature learning and human understanding of news and information (Mohseni et al., 2021). Interaction of users with AI and XAI assistants had an effect on their performance, mental model and trust but did not significantly improve task or boost user trust and mental model. Therefore much work is needed to be done in fine tuning XAI models to make AI explanations more trustworthy and transparent. In future other types of explanations including knowledge graphs and multi-modal retrieval may be explored to be used in the area of Fake news detection.

CONCLUSION

With the increasing penetration of social media in human lives information dissemination has become very fast. This easy to spread information is being exploited by some individuals, agencies, political parties and other groups to spread rumors, Fake news, malicious and fraudulent content for specific political, religious, economicgains. Fake news identification from various online media is a cumbersome and challenging task, so various computer technologies ranging from Machine Learning to Artificial Intelligence to Explainable Artificial Intelligence have been explored by various researchers with a varied degree of success. These attempts have highlighted some limitations in using these technologies which will pave a way to further improve these intelligent learning systems making them more trustworthy, acceptable and transparent to be applied to various types of Fake news detection problems. As these technologies much depend upon the underlying datasets, there is a need to develop more robust and diverse datasets offering a wide range of applications in the fields of politics, social science, economics, health and science & technology

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[1] 'WhatsApp murders': India struggles to combat crimes linked to messaging service | India | The Guardian

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[3] Explainable AI: Why We Need To Open The Black Box (forbes.com)

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ANALYZING IMPACT OF SINGLE VIEW AND MULTI VIEW BIG DATA BASED ON CLUSTERING QUALITY VIA K-MEANS TECHNIQUE

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ABSTRACT

Due to the revolutionary advancements in the signal sensing devices and its availability to civilians, the real time datasets are now having multiple views. Thus such a multi-view datasets are quite common in era of big data domain. As against learning of single-view, learning of multi-view has plenty of benefits. Clustering has been very useful technique in machine learning and data mining. Traditional clustering techniques use only single set of features of the available dataset. However for the multi-view dataset with multiple features, how to ensemble all of these data views is a major concern. Thus problem is termed as multi-view clustering problem. The key benefits of multi-view clustering against single view clustering are accurate description of data, reducing noises of data, and wider range of applications. This paper studies the impact multi view K-means clustering available in mvlearn python package with the traditional K-means clustering technique. To assess the impact of simple K-means technique and multi-view version of K-means technique, two datasets are utilized namely, nutrimouse and simulated dataset. In order to analyze the impact of multi view clustering on clustering quality, traditional k-means technique is applied to individual views, concatenated view of the both the datasets, followed by the application of multi-view version of K-means technique on the both the datasets. We analyzed the clustering quality of multi-view K-means technique using various performance evaluation parameters such as Jaccard Coefficient (Jacc), Fowlkes Mallows Index (FM), Normalized Mutual Information (NMI), Rand Index (RI), and clustering execution times.

Keywords: Multi-view dataset, Multi view clustering techniques, K-means, Jaccard Coefficient (Jacc), Fowlkes Mallows Index (FM), Normalized Mutual Information (NMI), Rand Index (RI)

1. INTRODUCTION

Due to advancement in the micro electro mechanical devices (MEMS), multi-view datasets are quite common in many real time data mining and clustering applications. Clustering is important category of unsupervised learning techniques. It has been very successfully deployed for heterogeneous data analysis, gene expression analysis, social network analysis, as well as market analysis [1]-[3]. The main aim of the clustering is to divide (partition) the given dataset into several sub-clusters such that data elements in one cluster are with similar features than those in different sub-clusters. However, the existing clustering techniques are suitable for single-view data. Due to high revolution in Internet and computing devices, enormous data are generated from different sources for an underlying application. The data associated with each of these sources carries valuable information, which in turn enforces the requirement mining the valuable and intrinsic hidden patterns in the data; it is a necessity to take full advantage of the information contained in multiple sources [4]. This process is termed as multi-view learning. In general, each data view corresponds to one important source of valuable information. For instance, web pages can be simultaneously considered by both the page-contents (one view) as well as page hyperlink information (another view). That means the web page itself consists of lot information in terms of words appearing on it. The same web page generally has many links pointing to other web pages which in turn contain other sort of related information in terms of words. The multimedia data is also simultaneously described by video signal obtained from camera as well as audio signal from mic. Similarly, an image can be described by its color, shape as well as location.

Integrating all the information available in multiple data views can provide great benefits to data clustering. The straightforward solution to utilize this total information of all data views is to concatenate the data features of each view together and then apply suitable traditional single view clustering technique. However, this approach generally fails to distinguish the information available in inter-linkage of different data views [5]. In other words in the concatenation let single view clustering approach, the important data views and less important data views are treated equally. This would in turn deteriorate the ultimate clustering performance. To take better advantage of the multi-view information, the ideal approach is to simultaneously perform the clustering using each view of data features and integrate their results based on their importance to the clustering task. The availability of such multi-view data has forced the research community to go for multi-view learning of multi-view data especially in the context unsupervised learning [6]. However in unsupervised learning set up for multi-view clustering, it is not possible for the traditional single view clustering techniques to make a full use of

the multi-data. Merely concatenating the features from all the data views into a single data union, and then applying the single-view clustering technique usually may not work out effectively in unsupervised clustering. In order to solve the problem associated with the clustering of the multi-view dataset, the approach based on the Multi-view clustering is must.

Many traditional single view clustering techniques such as K-means [6], [7], DBSCAN [8], Fuzzy C-means (FCM) [9], [10], Spectral Clustering [11], [12] and so on have been proposed in the literature. In order to focus more on multi-view data clustering, we have used multi-view version of popular K-means algorithm from mvlearn python package. This paper attempt to solve the problem of clustering the multi-view data clustering using K-means based approach. The key contributions of this research work are as follows.

1. In this work we implemented the multi view K-means clustering algorithm using mvlearn python package as well as traditional (single view) K-means clustering algorithm using sklearn python package.

2. We investigated the efficacy of the multi-view K-means technique on two multi-view datasets namely, nutrimouse and simulated dataset. We investigated the efficacy of multi-view K-means algorithm in two phases namely, Phase I (Multi-view Clustering of Nutrimouse Dataset via K-means technique), and Phase II (Multi-view Clustering of Simulated multi view Dataset via K-means technique).

3. We analyzed the clustering quality of multi-view K-means technique using various performance evaluation parameters such as Normalized Mutual Information (NMI), Jaccard Coefficient (Jacc), Fowlkes Mallows Index (FM), Rand Index (RI). We also compared the execution times of single view K-means clustering and multi view K-means clustering. From the values of these clustering quality performance evaluation parameters, it is proved that multi-view version of K-means algorithm has high clustering quality as compared to its single view counterpart. Additionally, the execution time for multi-view K-means algorithm is very low as compared its single view counterpart in both Phase I and Phase II.

2. RELATED WORK

Traditional clustering techniques mainly deal with single view data. To deal with multi-view data, traditional clustering techniques generally consider each data view separately, and then deploy a simple integration (ensemble) based mechanism to get the final clustering results. Therefore to utilize the total information, all data views are concatenated together and then a suitable traditional single view clustering technique is applied [2]-[5]. However, this approach generally fails to distinguish the information available in inter-linkage of different data views. In other words in the concatenation let single view clustering approach, the important data views and less important data views are treated equally. This would in turn deteriorate the ultimate clustering performance. To meet with this challenge, multi-view learning technology is required. Different from traditional single view clustering algorithms, multi-view clustering methods integrate the information from different views to achieve the better performance. Hence, multi-view learning has become an important topic in the field of machine learning.

The research community has proposed many novel algorithms to solve the problem of multi-view clustering. Based on the K-means algorithm, a two-level variable automatic weighted clustering algorithm called TW-k-means was proposed [13]. A novel multi-view K-means clustering method was presented to solve the problem of large-scale multi-view data clustering [14]. It can learn the weight of each view adaptively, and is robust to the outliers. Based on the Fuzzy clustering means (FCM) based technique, a large number of multi-view clustering algorithms has been proposed. By introducing collaborative mechanism into classical FCM, a collaborative clustering algorithm called Co-FC algorithm was developed in [15]. Based on FCM algorithm, a multi-view fuzzy clustering algorithm called Co-FKM was proposed in [16], which reduced the disagreement between the partitions on different views by introducing a penalty term in the objective function. A multi-view fuzzy clustering algorithm called Co-FCM was also proposed based on the classical FCM algorithm in [17]. It was further developed into the multi-view weighted collaborative fuzzy clustering algorithm (WV-Co-FCM) by applying different weights to different views.

To deal with the clustering of high dimensional data, a correlational spectral clustering algorithm based on kernel canonical correlation analysis has been proposed in [18]. This algorithm initially projects the multi-view data from different feature spaces to a common low-dimensional subspace. K-means or other clustering algorithm was then used to cluster the data in the low- dimensional space. The authors in [19] has proposed novel multi-view clustering algorithm based on canonical correlation analysis, wherein the algorithm uses canonical correlation analysis to project the multi-view data to a common low-dimensional subspace, and then used K-means or other clustering algorithms to cluster the generated low-dimensional data. Some researchers

apply non-negative matrix factorization technology to multi-view data clustering, and propose some multi-view clustering algorithms. A multi-view clustering algorithm based on joint non-negative matrix factorization was proposed in [20], where a joint non-negative matrix factorization method was used to normalize the coefficient matrix from each view into a common consistent matrix that was considered as a potential representation of the original data. K-means and other clustering algorithms were then used directly to cluster the consistent matrix. The authors in [21] proposed a multi-view kernel k-means (MVKKM) algorithm which assigns a weight for each view according to the view's contribution to the clustering result and then combines the kernels derived from the weighted views together. However, it is based on the inner product kernels for all views, and has no explicit mechanism for feature selection. To address the above issues, there are some other efforts that investigate feature selection in multi-view data clustering. A framework was proposed in [22], which constructs models respectively for the multi-source learning and feature selection. However, this work is designed for supervised learning and cannot deal with the unsupervised situation.

3. PROPOSED K-MEANS BASED MULTI-VIEW CLUSTERING APPROACH

The traditional K-means is one of the widely used of clustering single view datasets [6], [7], [21]. Being simple to use, it has a huge potential to deal with the large-scale datasets. It has been successfully utilized in wide variety of applications ranging from computer vision, and social network analysis to market segmentation. Let the dataset contains N samples, then corresponding matrix can be represented as $X = [x_1, x_2, ... x_N]$. Taking Euclidean distance as the similarity measure, data samples are clustered into $C(2 \leq C \leq N)$ clusters. The cluster centers can be presented by matrix $Z = [z_1, z_2, ... z_N]$. The objective function of the K-means algorithm is defined as

$$P(U,Z) = \sum_{i=1}^{C} \sum_{j=1}^{N} u_{i,j} \left\| x_j - z_i \right\|^2 \tag{1}$$

As can be seen, Eq. (1) adopts the Euclidean distance to measure the similarities between data samples. However, there are many data structures or data distributions in real world. Thus, it is not always suitable to apply this basic form of K-means to accurately identify the hidden patterns of datasets. What is more, some datasets may be not separable in the low-dimensional space. Thanks to mvlearn python package which has built in K-means function for clustering multi-view dataset.

Multi-view data, in which each sample is represented by multiple views of distinct features, are often seen in real-world data, and related methods have grown in popularity. mvlearn is a Python library which implements the leading multi-view machine learning methods. It's simple API closely follows that of scikit-learn for increased ease of-use. The package can be installed from Python Package Index (PyPI) or the conda package manager and is released under the Apache 2.0 open-source license. Additionally, mvlearn can be used to generate multiple views from a single original data matrix, expanding the use-cases of multi-view methods and potentially improving results over typical single-view methods with this data [23]. The experimentation in this research work is split in two phases namely, Phase I and Phase II. The Phase II experimentation is further divided into two cases. Single view and multi view K-means technique is applied on simulated dataset with high separation and high overlapping in View 1 and View 2 in Case A, and case B respectively.

Phase I: Multi-view Clustering of Nutrimouse Dataset via K-means technique

Phase II: Multi-view Clustering of Simulated multi views Dataset via K-means technique

A. Performance when cluster components in both views are well separated,

B. Performance when cluster components in both views are highly overlapping.

In this research work, we investigated the efficacy of the multi-view K-means technique on two multi-view datasets namely, and simulated dataset [23], and nutrimouse [24]. The nutrimouse dataset comes from a nutrition study in the mouse. It was provided by Pascal Martin from the Toxicology and Pharmacology Laboratory (French National Institute for Agronomic Research). It contains the following components:

- gene: data frame (40 * 120) with numerical variables
- lipid: data frame (40 * 21) with numerical variables
- diet: factor vector (40)
- genotype: factor vector (40)

In order to evaluate the clustering quality of multi-view K-means technique, various performance evaluation parameters such as Normalized Mutual Information (NMI), Jaccard Coefficient (Jacc), Fowlkes Mallows Index (FM), Rand Index (RI), and clustering execution times, are used. The details of these metrics are given below.

1. Normalized Mutual Information (NMI) [1]-[3]:
NMI gives us the reduction in entropy of class labels when we are given the cluster labels. In a sense, NMI tells us how much the uncertainty about class labels decreases when we know the cluster labels. It is similar to the information gain in decision trees. It is mathematically given by Equation (2).

$$NMI(Y,C) = \frac{2 \times I(Y;C)}{[H(Y) + H(C)]} \qquad (2)$$

Where, Y- Class labels, C- Cluster Labels, H(.)- Entropy, I(Y;C)- Mutual Information between Y and C.

2. Jaccard Coefficient (Jacc) [1]-[3]:
If the true labels of a dataset are known, the quality of the applied clustering technique can be computed by finding out the difference between the true labels and the predicted labels. The useful quality measures in this context are Jacc and FM. Thus the generated feature subset quality can be measured using Jacc and FM. Both Jacc and FM can vary between 0 and 1, with 1 indicating complete overlap and 0 indicating no overlap. Thus higher the value of these two coefficients, higher would be the clustering quality.

The Jacc is a statistical method of comparing the similarity between two sets. It is defined as the size of the intersection divided by the size of the union of two label sets, is used to compare set of predicted labels for a sample to the corresponding set of actual labels. Let $K = K_1, K_2,..., K_m$ and $P = P_1, P_2,..., P_n$ be two clustering result set, then Jacc index can be computed using Equation (3).

$$Jacc = \frac{a}{(a+b+c)} \qquad (3)$$

Where,

a- Number of point pairs belonging to same cluster set of two clustering results K and P

b- Number of point pairs belonging to same cluster set in K but not in P

c- Number of point pairs belonging to different cluster set in K but same in P.

3. Fowlkes Mallows Index (FM) [1]-[3]:
This is the cluster evaluation method. This method measure the similarity between two clustering results. The higher value for the FM index shows the higher similarity between the clusters. The score ranges from 0 to 1. A high value indicates a good similarity between two clusters. Let $K = K1, K2,.., Km$ and $P = P1, P2,.., Pn$ be two clustering results then FM index can be given by Equation (4).

$$FM = \frac{a}{\sqrt{(a+b)(a+c)}} \qquad (4)$$

Where,

a- Number of point pairs belonging to same cluster set of two clustering results K and P

b- Number of point pairs belonging to same cluster set in K but not in P

c- Number of point pairs belonging to different cluster set in K but same in P.

4. Rand Index (Adjusted Rand Score- RI) [1]-[3]:
The Rand Index computes a similarity measure between two clustering's by considering all pairs of samples and counting pairs that are assigned in the same or different clusters in the predicted and true clustering's. Let $K = K_1, K_2,..., K_m$ and $P = P_1, P_2,..., P_n$ be two clustering result set, then Rand Index (RI) can be computed using Equation (5).

$$RI = \frac{a+b}{(a+b+c+d)} \qquad (5)$$

Where,

a- Number of point pairs belonging to same cluster set of two clustering results K and P

b- Number of point pairs that are not belonging to same cluster set in K and P

c- Number of point pairs belonging to same cluster set in K but different cluster in P.

c- Number of point pairs belonging to different cluster set in K but same cluster in P.

4. DISCUSSION ON RESULTS:

Phase I: Multi-view Clustering of Nutrimouse Dataset via K-means technique:

In order to analyze the impact of multi view clustering on clustering quality, traditional k-means technique is applied to individual views, concatenated view of the both the datasets, followed by the application of multi-view version of K-means technique on the multi view Nutrimouse dataset in Phase I. We analyzed the clustering quality of multi-view K-means technique using various performance evaluation parameters such as Jacc, FM, NMI, RI, and clustering execution times. Fig. 1 illustrates the clustering results on multi view Nutrimouse dataset, wherein we observe that the clustering quality with multi view approach is little bit improved than its single view counterpart. Clearer picture on clustering quality, we can get from Table 1 values of performance evaluation parameters of clustering. We can see that NMI, Jacc, FM, and RI values obtained for multi view clustering are better than its single view counterpart. Although the improvement is not much convincing, but the execution time required to run multi view K-means clustering algorithm is far less than its single view counterpart.
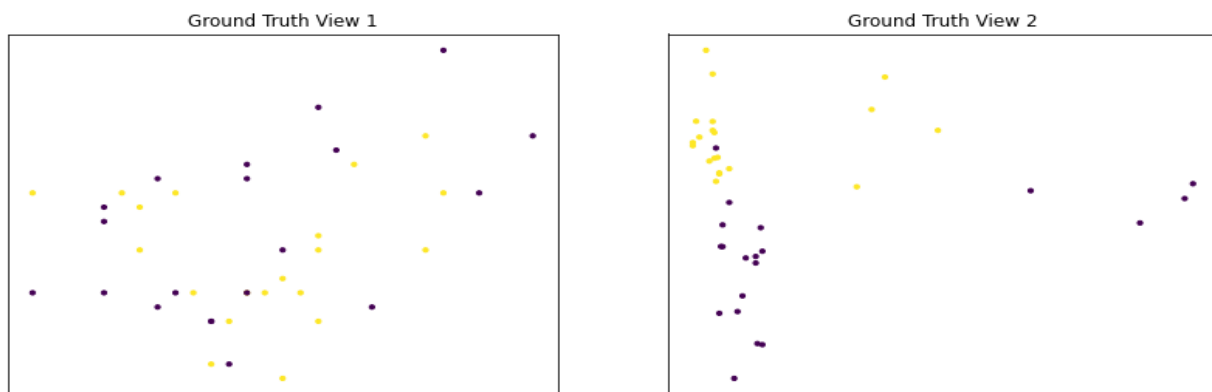
(a) Single View vs Multi View Clustering on View 1 of Nutrimouse Dataset
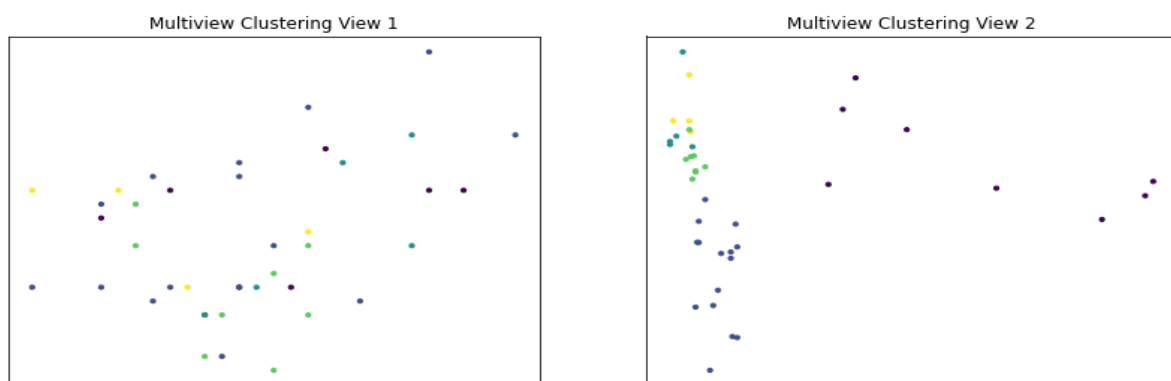
(b) Single View vs Multi View Clustering on View 2 of Nutrimouse Dataset
Fig. 1: K-means technique based Clustering on Nutrimouse Dataset (Phase I)

Table 1: Comparison of Clustering Quality of Single view and Multi view K-means based approaches for Nutrimouse Dataset for Phase I

Clustering Approach	NMI	Jacc	FM	RI	Execution Time
Single view K-means for View 1 of Dataset	0.547	0.075	0.664	0.446	0.38
Single view K-means for View 2 of Dataset	0.422	0.225	0.535	0.284	0.36
Single view K-means for Concatenated Dataset	0.422	0.225	0.535	0.284	0.38
Multi view K-means for whole dataset	0.448	0.423	0.605	0.468	0.23

Phase II: Multi-view Clustering of Simulated multi views Dataset via K-means technique
In this phase, we apply single view and multi view K-means algorithms on simulated multi view dataset. In this two experiments are conducted which are indexed (A), and (B) as given below. For each of these experiments, we run both single view K-means clustering and multi view K-means clustering. For evaluating single view performance, we run the algorithm on each view separately as well as all views concatenated together. We run each algorithm across 100 random cluster initializations in both the experiments. The clustering results are discussed below in detail.

A. Performance when Cluster Components in Both Views are well Separated:
Here we can see that multi-view K-means clustering performs about as well as single view K-means clustering for the concatenated views, and both of these perform better than on single view clustering for just one view. The results of clustering for Case A are illustrated and summarized with Fig. 2, and Table 2 respectively.
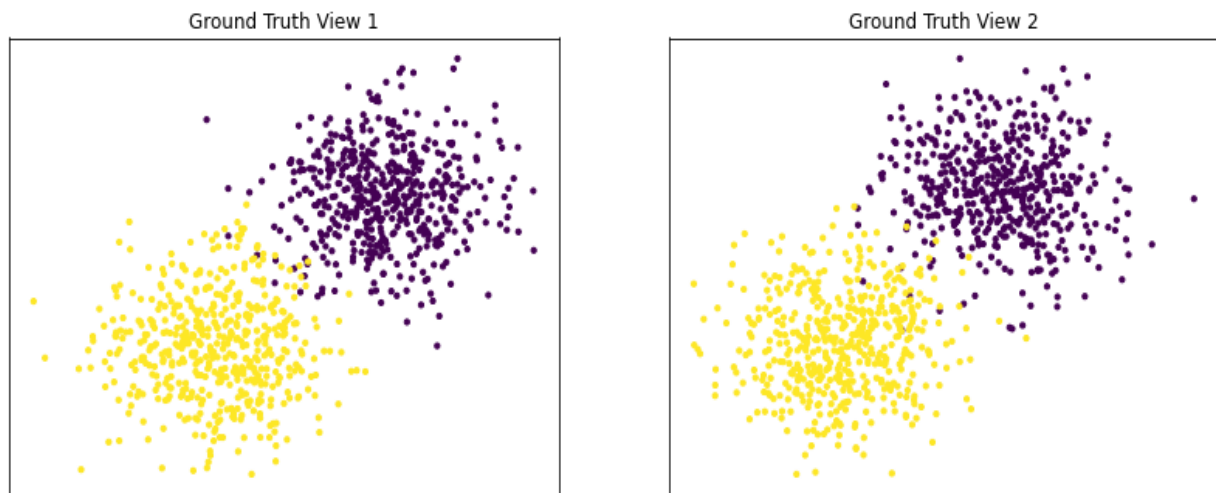
(a) Single View vs Multi View Clustering on View 1 of Simulated Dataset for Case A

(b) Single View vs Multi View Clustering on View 2 of Simulated Dataset for Case A
Fig. 2: K-means technique based Clustering on Simulated Dataset for Phase II

(Case A: When cluster components in both views are well separated)

Table 2: Comparison of Clustering Quality of Single view and Multi view K-means based approaches for Simulated Dataset for Phase II, Case A
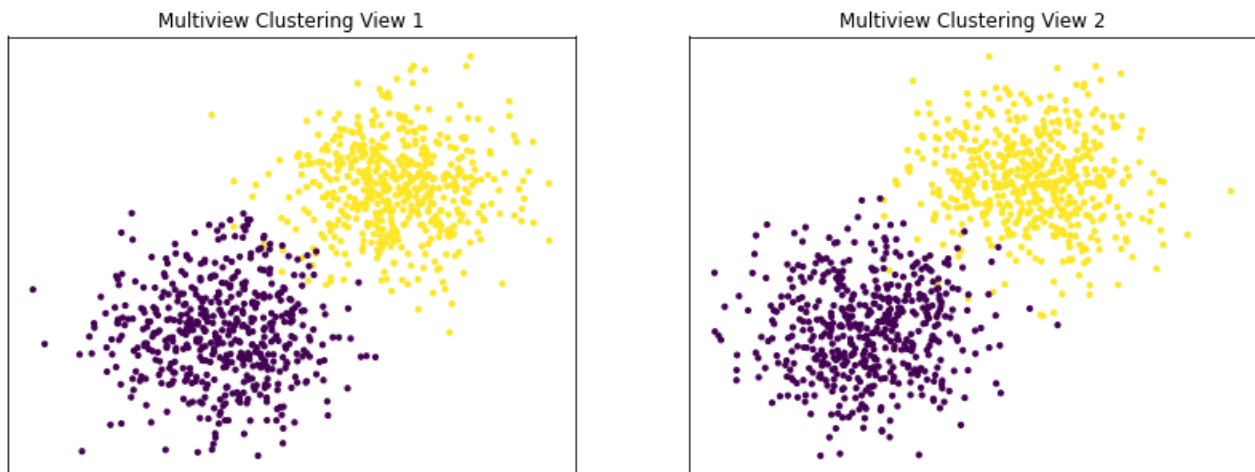
Clustering Approach	NMI	Jacc	FM	RI	Execution Time (in sec)
Single view K-means for View 1 of Dataset	0.901	0.987	0.974	0.994	0.72
Single view K-means for View 2 of Dataset	0.888	0.985	0.970	0.941	0.74
Single view K-means for Concatenated Dataset	0.99	0.99	0.998	0.996	0.75
Multi view K-means for whole dataset	0.99	0.993	0.999	0.997	0.275

B. Performance When Cluster Components Are Relatively Inseparable (Highly Overlapping) In Both Views:

Here we can see that multi-view K-means clustering performs about as poorly as single view K-means clustering across both individual views and concatenated views as inputs. The results of clustering for Case B are illustrated and summarized with Fig. 3, and Table 3 respectively.

(a) Single View vs Multi View Clustering on View 1 of Simulated Dataset for Case B

(b) Single View vs Multi View Clustering on View 2 of Simulated Dataset for Case B
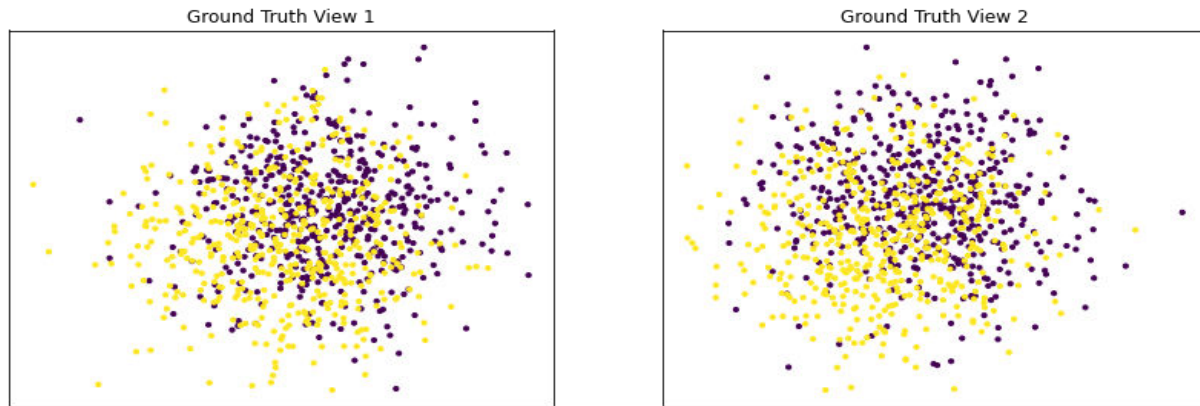**Fig. 3:** K-means technique based Clustering on Simulated Dataset for Phase II

(Case B: When cluster components are relatively overlapping)

Table 3: Comparison of Clustering Quality of Single view and Multi view K-means based approaches for Simulated Dataset for Phase II, Case B

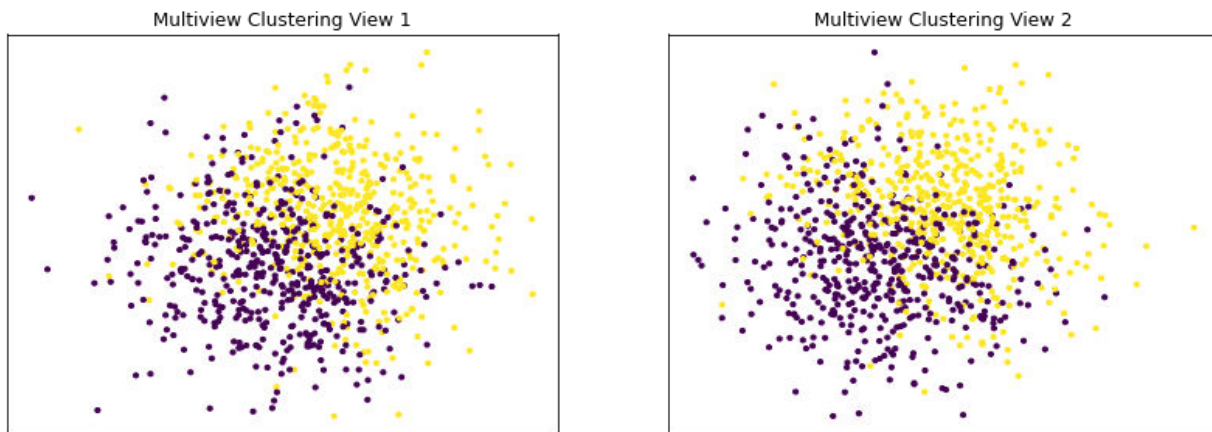| Clustering Approach	NMI	Jacc	FM	RI	Execution Time (in sec)
Single view K-means for View 1 of Dataset	0.062	0.445	0.541	0.083	0.72
Single view K-means for View 2 of Dataset	0.044	0.378	0.530	0.059	0.74
Single view K-means for Concatenated Dataset	0.098	0.318	0.566	0.132	0.75
Multi view K-means for whole dataset	0.109	0.508	0.573	0.147	0.275

Thus from the values of clustering quality performance evaluation parameters NMI, Jacc, FM, and RI obtained in Phase I and Phase II experiments, it is proved that multi-view version of K-means algorithm has high clustering quality as compared to its single view counterpart. Additionally, the execution time for multi-view K-means algorithm is almost half than that with its single view counterpart in both Phase I and Phase II.

5. CONCLUSION
Clustering has been very useful technique in machine learning and data mining. Traditional clustering techniques use only single set of features of the available dataset. However for the multi-view dataset with multiple features, how to ensemble all of these data views is a major concern. Thus problem is termed as multi-view clustering problem. The key benefits of multi-view clustering against single view clustering are accurate description of data, reducing noises of data, and wider range of applications. This paper studies the impact multi

view K-means clustering available in mvlearn python package with the traditional K-means clustering technique. To assess the impact of simple K-means technique and multi-view version of K-means technique, two datasets are utilized namely, nutrimouse and simulated dataset.

We investigated the efficacy of multi-view K-means algorithm in two phases namely, Phase I (Multi-view Clustering of Nutrimouse Dataset via K-means technique), and Phase II (Multi-view Clustering of Simulated multi view Dataset via K-means technique). We analyzed the clustering quality of multi-view K-means technique using various performance evaluation parameters such as Normalized Mutual Information (NMI), Jaccard Coefficient (Jacc), Fowlkes Mallows Index (FM), Rand Index (RI). We also compared the execution times of single view K-means clustering and multi view K-means clustering. From the values of these clustering quality performance evaluation parameters, it is proved that multi-view version of K-means algorithm has high clustering quality as compared to its single view counterpart. Additionally, the execution time for multi-view K-means algorithm is very low as compared its single view counterpart in both Phase I and Phase II.

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PREVALENCE OF ADOLESCENT OBESITY AND PARENTAL PERCEPTION REGARDING RISK FACTORS OF OBESITY

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ABSTRACT

Obesity is one of most neglected public health problems; affecting every region of the globe. Almost all countries are facing obesity endemic, although great variation exists between and within countries. In developing countries such as India especially in urban populations, childhood obesity is emerging as a major health problem. In view of these contexts, the present study was undertaken to estimate the prevalence of overweight and obesity in urban population of adolescents studying in educational Institutions in Guwahati Metro, Assam. To assess the prevalence of obesity among adolescents in Government and Private urban educational institutions with association of socio-demographic variations. An attempt to estimate the parental perception of obese adolescents was also made. A cross-sectional study was conducted among adolescents, aged 13-19 years in urban educational institutions to assess prevalence of obesity using Agarwal BMI growth chart and used to collect the data on parental perceptions of overweight and obese adolescents through structured questionnaire. The overall prevalence of Overweight and Obesity 5.76% and 5.76% according to Agarwal BMI growth chart. The prevalence of obesity was found to be higher in Private schools than Government schools (63.15% Vs 36.84%), out of total obesity. High prevalence of obesity was found in girls, in first born child, in nuclear family and in high socio-economic status. The prevalence of parental obesity of obese and overweight adolescents was 48% in mothers and 11% in fathers. Parents perceived Lack of physical activity (85% agree), Parent's eating habits (32% agree; 42% strongly agree), parental obesity (20% strongly agree) influencing adolescents obesity. Adolescent obesity is a major public health problem globally because of changes in lifestyle.

Keywords: Obesity, Overweight, Prevalence, Adolescents, Perceptions, Risk factors.

INTRODUCTION

The World Health Organization(WHO) has described obesity as one of most neglected public health problems; affecting every region of the globe.[1] Almost all countries are facing obesity endemic, although great variation exists between and within countries.[2] In United state, the prevalence of obesity has remained fairly stable at about 17% and affects about 12.7 million children and adolescents. The prevalence of obesity was 8.9% among 2- to 5-year-olds compared with 17.5% of 6- to 11-year-olds and 20.5% of 12- to 19-year-olds. Surveys from 144 countries (in 2010) suggest that 43 million preschool children (35 million in developing countries) are overweight and obese and 92 million are at risk of overweight.[3] The worldwide prevalence of childhood overweight and obesity increased from 4.2% in 1990 to 6.7% in 2010. This trend is likely to continue and the prevalence is expected to reach 9.1%, or 60 million, in 2020. The estimated prevalence of childhood overweight and obesity in Africa in 2010 was 8.5% and is expected to reach 12.7% in 2020. The prevalence is lower in Asia (4.9% in 2010) than in Africa, but the number of affected children (18 million) is higher in Asia.[4] Childhood obesity is common in United Kingdom also and according to the health survey conducted in 2004, obesity among 2-10-year olds was 14% and among 11-15-year olds was 15%.[5]

India, which already is the third most obese country in the world, is showing increasing incidence of overweight children and adolescents in urban areas. Latest estimated show prevalence of obesity among adolescents (13-18years) has grown from 16% to 29% over the last 5years.[6]

Obesity is a complex disorder that results from a combination of biological, social, environmental and behavioral factors. With globalization, adolescent's lifestyles have undergone a drastic change in terms higher consumption of energy-dense food, lower physical activity and more sedentariness.[7]

There are a few studies, reporting prevalence of childhood and adolescent obesity and overweight from different parts of India (Punjab, Maharashtra, Delhi and South India) that range from 3% to 29%, and also indicate that the prevalence is higher in urban than in rural areas.[8]

In view of these contexts, the present study was undertaken to estimate the prevalence of Overweight and Obesity in urban population of adolescents studying in educational Institutions in Guwahati Metro, Assam.

MATERIALS AND METHODS

A cross sectional study was conducted on adolescents in 10 urban schools in Guwahati metro, from January to June 2016. Ethical clearance from Institutional ethical committee was obtained. After getting permission from school authorities, the data was collected from students of class vi to xii. The school was selected by stratified random sampling method. The sample size of this study was 330. Sample was selected by stratified and multistage random sampling procedure. For the selection of schools, a list of all schools was obtained from the school authorities of the district education office. At first I have divided into two strata-such as Government and Private. From two strata I have selected 10 numbers of schools 5 from government and 5 from private schools by a simple random sampling technique. Probability, proportional to the size sampling technique was used to select the sample from each school.

The subjects were adolescents, 13-19 years of age, in the city of Guwahati metro. After reaching the concerned school, classes were selected by using simple random technique. I have selected one class from each school by a simple random sampling technique. Each class was having 3-4 sections. One section is randomly selected from each class and all students in selected section are included as samples. In this way data was collected for 330 adolescents from 10 numbers of schools. After obtaining verbal consent, had all performed standardized anthropometrical measurements of the adolescents in school uniform without shoes. Weight was measured in the upright position without shoes to the nearest 0.1 kg using calibrated electronic weighing machine. Height was measured without shoes to the nearest 0.1cm using calibrated stadiometer. Body mass index (BMI) was defined as the ratio of body weight to body height square, expressed as kg/m^2. Overweight and obesity was assessed by Agarwal BMI chart.[9]

Complete data was collected from each adolescent using a pre-designed, pre- tested questionnaire. Questionnaire schedule was designed on basic of demographic variables, such as age, sex, number of sibling, educational level, and type of family, family income, occupational status of the parents etc. and also respondent's opinion about impact of physical activities and diet on healthy lifestyle. The socio-economic status (SES) was assessed based on the Kuppuswamy classification.[10] Survey was conducted among parents of obese/overweight adolescents. Likert scale was used on perceptions of risk factors and health complications of obesity, barriers and benefits in the community, childhood/adolescents obesity strategies, preventing childhood/adolescents obesity. Statistical analyses were done using Statistical Package for Social Survey (SPSS) for Window version 18.0. The χ^2-test was used to determine level of significance between appropriate parameters. ''p'' value <0.05 were considered statistically significant. The results were tabulated and graphically represented using Microsoft Office for Window 2008.

RESULTS

Socio-Demographic Profile

In relation to the demographic data, it had been observed that the highest number of the adolescents (Governtment-87, 26%, Private-83, 25%) belongs to age group 13years. Majority (91, 27%) of the adolescents were female, 122, 36% belongs to nuclear family, most of the adolescents (Govrntment-87, 26%, Private-94, 28%) were 1st first, 65, 19% In Government and 70, 21% in Private have 4 family members. Majority of the respondents (Government-108, 32% Private-122, 36%) belong to general caste. Majority of the adolescents (Government-315, 95% Private-305, 92%) were non-vegetarian. 71, 21% of the mothers of participants have studied high school in Government and same number of the mothers of participants have studied graduate level in private school. Majority of adolescents (Government-211, 64% Private-180, 54%) belong to the income group of Rs ≥30,000 and 15,000 to 20,000 per month respectively.

Prevalence of Obesity among Adolescents

The overall prevalence rate of Overweight and Obesity (19) 5.76% and (19)5.76% .The percentage of obesity was higher in Private schools than Government schools (12, 63.15% vs 7, 36.84%), out of total obesity. (Fig-1 and Fig-2)
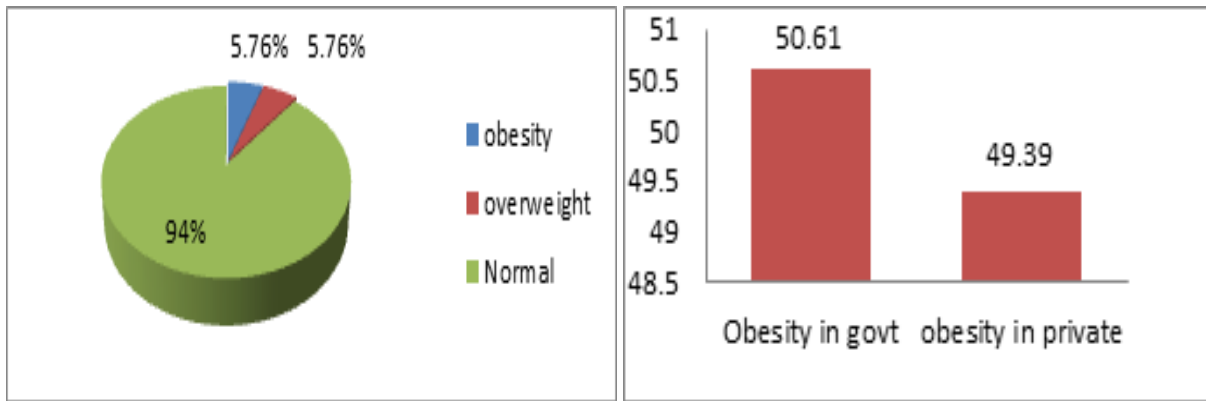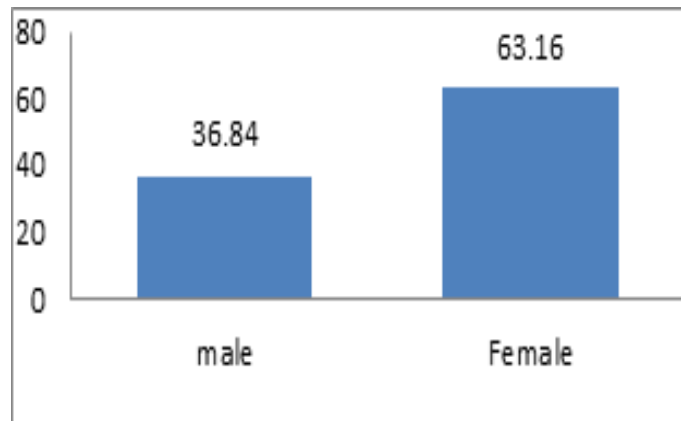
Fig-1: Prevalence of Overweight and Obesity among adolescents. **Fig 2:** Prevalence of obesity in adolescents according to category of school

Prevalence of obesity among adolescent according to age and sex, it reveals that at the age of 13 years prevalence rate is highest,(12, 57.89%) and girls,(12, 63.15%) are more obese than boys (7, 36.84%)

Table -1: Prevalence of obesity among adolescent according to age

Age	Obesity	
	Frequency	**Percentage**
12	0	0%
13	12	57.89%
14	5	26.31%
15	2	10.53%
16	0	0%

FIG-2: Prevalence of obesity among adolescent according to sex

Prevalence of obesity is highest among the 1st child (11, 57.89%), within the Hindu religion (14, 73.68%), among general caste (14, 73.68%), in Nuclear family (13, 68.42%), in family size more than 5 members (7, 36.84%). Prevalence of obesity among adolescent according to mother's educational qualification and occupation, it seems that among Graduate or post graduate and Housewives, obesity is highest (8, 42.11% &13, 68.42%). In relation of socio-economic status, the prevalence of obesity was higher (7, 36.84%) in families with higher monthly income(15,754/--31,506/-)

Parental Obesity
Out of 35 parents of obese and overweight adolescents, it was found that the prevalence of obesity and overweight among mothers are 48% and 34% respectively. 11% of fathers are obese and 51% are overweight.(Table-2)

Table- 2: Prevalence of parental obesity

Variable	Weight category		
	Obesity (N, %)	**Over weight (N, %)**	**Normal (N, %)**
Mother	17(48%)	12(34%)	6(17%)
Father	4(11%)	18(51%)	13(37%)

Association between Prevalence of Obesity and Socio-Demographic Variables in Government and Private Educational Institutions

Association between prevalence of obesity and socio-demographic variables in Government and private institutions were analyzed. Significant association was found between prevalence of obesity with socio-demographic variables i.e Size of family in the govt. institution (*P*=0.038), Caste in the Private institution (p=0.001), Fathers education in the Private (p=0.003), Fathers occupation in the Govt. (p=0.003) is statically significant at 0.05 level of significance (Table-3).

On analyzing the association of obesity with health problems of participants and parents, it was found that the health problem of adolescents (p=0.000) and health problem of mother (p=0.017) were statically significant at 0.05 level of significance (Table-4).

Table- 3: Significant association between prevalence of obesity and socio-demographic variables in Government and private institutions

Demographic variable	Weight category			χ^2	P-Value
	Obesity	Non-obesity	Total		
Size of family(Govt)					
3members	1	37	38		
4members	0	65	65		
5members	3	38	41		
>5members	3	20	23		
Caste(Private)				8.559	.036
General	8	114	122		
ST	4	20	14		
SC	0	9	9	28.961	.001
OBC	0	8	8		
Others	0	0	0		
Fathers education(Private)					
Illiterate	3	4	7		
Primary school	0	6	6		
Middle school	0	10	10		
High school	1	21	22	20.152	.003
Post high school	0	12	12		
Graduate	1	51	52		
Professional	7	47	54		
Fathers occupation(Govt)					
Unemployed	0	3	3		
Worker	1	58	59		
Private employee	1	69	70	15.704	.003
Govt employee	5	23	28		
Profession	0	7	7		

Table- 4: Significant association between prevalence of obesity and health problems

Health problems	Weight category			χ^2	P-Value
Health problems of the student	Obesity	Non-obesity	Total		
Hypertension	4	0	4		
Diabetes Mellitus	2	0	2		
Kidney problem	0	0	0		
Thyroid problem	0	0	0		
None	13	311	324	100.029	0.000
Mother's Health problem					
Hypertension	3	9	12		
Diabetes Mellitus	1	15	16		
Kidney problem	0	0	0		
Thyroid problem	3	26	29		
None	12	261	273	10.254	0.017

Father's Health problem					
Hypertension	1	11	12		
Diabetes Mellitus	3	26	29		
Kidney problem	0	0	0		
Thyroid problem	0	2	2		
None	15	272	287	1.543	0.672

Perception and Awareness of Adolescents about their Weight Status
In this regards, 3 questions were asked to the adolescents, i e, Question-1: ''what do you think/how do you feel about your weight?'' Question-2: "Have you tried to do anything to get a healthier weight?" Question-3: "What do you think about the physical activity on impact of healthy weight?''

Question-1: ''What do you think/how do you feel about your weight?''

On responses of the question-1, from the survey report it was found that 75% of respondents expressed their feelings as their weight is normal, 15% of respondents overweight and 5% of respondents felt their weight is underweight.

Participant's Responses
I feel that my weight is perfect as per my height.

I know my weight is normal.

I am overweight and I need to lose some weight.

I am overweight.

I am very thin and I am trying to increase my weight by taking good food

Question No-2: "Have you tried to do anything to get a healthier weight?"

Survey result revealed that 80% of adolescents were not doing anything to get healthier weight and only 20% of respondents had tried to do exercises and dietary measures to maintain their body weight.

Participant's Responses
I am not doing anything because my weight is quiet ok.

No. I am not doing any exercise

Yes, I maintain good diet and less oily food.

I am doing regular exercise in the morning and afternoon I used to do cycling, outdoor game.

Question No-3: "What do you think about the physical activity on impact of healthy weight?''

On the basis of responses of the respondents, it was categorized into 3 aspects that is ''positive impact'',

''Negative impact'' and ''No impact''. Out of 330 respondents, 75% of responses had positive impact, whereas 20% had no impact and 5% had negative impact.

Statements of Respondents:

	''Positive impact''	**''Negative impact''**	**''No impact''**
Adolescent's responses	Physical activity can help to maintain a healthy weight, it help us away from various diseases	I don't think Physical activity can improve my weight as I am already very thin	I didn't get any good impact because, inspite of regular exercise, my weight status remains same.

Parental Perception
Survey was conducted among parents of obese/overweight adolescents. Likert scale was used on perceptions of risk factors and health complications of obesity, barriers and benefits in the community, childhood/adolescents obesity strategies, preventing childhood/adolescents obesity.

Perceptions of Risk Factors and Health Complications of Obesity
Survey results revealed that parents were likely to agree, strongly agree and disagree on risk factors of adolescent's obesity. Parents perceived Lack of physical activity (30, 85% agree; 5, 14% strongly agree), High

calorie food advertising (25, 71% agree; 10, 28% strongly agree), Watching television and playing video games (32, 91% agree; 3, 8.5% strongly agree), Eating foods that have too much fat and sugar (25, 71% agree; 10, 28% strongly agree), contributing to adolescents obesity. Parent's eating habits (20, 32% agree; 15, 42% strongly agree), parents exercise habits (20, 32% agree; 15, 42% strongly agree), parents healthy lifestyle (35, 100% agree), influencing adolescents obesity. However, 18, 51% of parents agreed and 7, 20% of parents strongly agreed parental obesity has an influence on a child becoming obese while 10, 28% of respondents disagreed with this statement. 25, 71% of parents agreed and 10, 28% of parents disagreed as adolescents obesity is a important health problem in the society.

Perception of Parents about their Child's Weight
(25) 71% of parents agreed, (5) 14% strongly agreed and (5) 14 % disagreed about their being concerned about their child's weight. (20) 57% of parents agreed and (15) 42% disagreed their child to be an appropriate weight for his/her age. (20) 57% of respondents disagreed, (5)14 % strongly disagreed, (5) 14% agreed and (5) 14% strongly agreed their children was obese.

Perceptions of Barriers and Benefits in the Community
According to the survey report, respondents disagreed their child felt safe in their community (35) 100%), and health programs in their community that focus on obesity(25) 71% disagree, (10) 28% strongly disagree and Parks, playground areas, recreational centers, and community centers play a role in preventing childhood obesity(30) 85% disagree, (5) 14% agree. (25) 71% of respondents agreed lack of enough areas in their community for my child to participate in physical activity and (10) 28% of parents strongly disagreed.

Perceptions and Importance of Childhood/Adolescents Obesity Strategies
Survey revealed that (25) 71% of survey respondents disagreed that the schools play a role in their child developing healthy behaviors; (20) 57% of parents agreed that the school can prevent childhood obesity more than they can and also (26) 74% of parents disagreed about their community involvement in preventing obesity. It was found that (20) 57% of parents encouraged their child to drink water instead of sugary drinks. Providing education about healthy behaviors (15) 42%, and providing low fat-meals to prevent obesity (10) 28%.

Importance for Preventing Childhood/Adolescents Obesity
Most of the parents responded on the importance of preventing childhood/adolescents obesity, such as Limit the screen time (42% Moderately important, 28% Extremely important, 28% Somewhat important) having their child participate in an after school program (28% extremely important; 28% moderately important, 42% somewhat important), Limit portion sizes of meals (14% extremely important; 42% somewhat important, 28% slightly important), Participate in exercise with their child (57% somewhat important, 42% extremely important) Limit high calorie foods (57%slightly important, 42% not at all important)

DISCUSSION
The overall prevalence rate of Overweight and Obesity among adolescents aged 13years -19years was found to be 5.76% and 5.76% respectively. Several studies done in India showed a higher prevalence of overweight and obesity among adolescents. Similar study conducted in North India, reported the prevalence of overweight and obesity among aged group 10-19 years, 11% and 5.7% respectively.[11] In a study, from Chennai, the prevalence of overweight and obesity among adolescents was 22%.[12] In another study, from Kolkotta, overall prevalence of Overweight and Obesity were 28.5% and 4.2% respectively.[13] The percentage of obesity was higher in Private schools than Government schools (63.15% vs 36.84%), out of total obesity. A study done by Patnaik et al showed that the prevalence of Overweight and Obesity was 14.1% and 14.53% in private school.[14] another study revealed that prevalence of obesity was found to be higher in private school and staying in nuclear family.[15] In present study, the prevalence of Obesity was higher in girls,(12, 63.15%) than boys (7, 36.84%). Similar findings reported by Kumar S. et al. i.e higher prevalence of obesity in girls (8.82%) than in boys (4.1%).[16] Another study from Bangalore, reported higher prevalence in girls (13.1%) than boys(5.0%).[17]

Prevalence of obesity is highest among the 1st child (11, 57.89%), within the Hindu religion (14, 73.68%), among general caste (14, 73.68%), in Nuclear family (13, 68.42%), in family size more than 5 members (7, 36.84%). Prevalence of obesity among adolescent according to mother's educational qualification and occupation, it seems that among Graduate or post graduate and Housewives, obesity is highest (8, 42.11% &13, 68.42%). A study showed that parental education could be used to identify adolescents with a higher likelihood of obesity.[18] The prevalence of obesity was higher (7, 36.84%) in families with higher monthly income(15,754/- -31,506/-)   A study revealed that the subjects belonging to high socioeconomic status would score significantly higher on body mass index than the subjects from low socioeconomic status group.[19]

On regards of adolescent's perceptions, survey revealed that 75% of respondents expressed their feelings as their weight is normal, 15% of respondents overweight and 5% of respondents felt their weight is underweight. Similar study conducted by Ramesh showed that among overweight subjects 14.1% perceived themselves as normal weight whereas 31.7% normal weight subjects had a perception of being obese.[20]

On regards of parental perceptions, regarding risk factors and health complications of obesity, Barriers and Benefits in the Community, childhood/adolescents obesity strategies, preventing childhood/adolescents obesity, it was found that majority of parents agreed lack of physical activity(85%), high calorie food advertising (71% agree), Watching television and playing video games (91% agree), Eating foods that have too much fat and sugar (71% agree), Parent's eating habits (32% agree, 42% strongly agree), parental obesity(51% agree), parents healthy lifestyle (100% agree), influencing adolescents obesity. 71% of parents concerned about their child's weight, 57% of parents agreed and 42% disagreed their child to be an appropriate weight for his/her age. 57% of respondents disagreed,14 % strongly disagreed,14% agreed and 14% strongly agreed their children was obese. 100% of respondents did not feel safe in the community for their children, 71% of parents disagreed about the facilities in the community, involvement and awareness programmes which play a role in preventing childhood/adolescents obesity. 71% of respondents disagreed that the schools play a role in their child developing healthy behaviors. Most of the parents responded on the importance of preventing childhood/adolescents obesity, such as Limit the screen time (42% Moderately important, 28% Extremely important, 28% Somewhat important) having their child participate in an after school program (28% extremely important; 28% moderately important, 42% somewhat important), Limit portion sizes of meals (14% extremely important; 42% somewhat important, 28% slightly important), Participate in exercise with their child (57% somewhat important, 42% extremely important) Limit high calorie foods (57% slightly important, 42% not at all important). From perception of the parents, it is clear that parents, schools and community have a vital role regarding awareness and prevention of adolescent obesity, but still it is inadequate and insufficient in our present society.

CONCLUSION

The present study was aimed to compare the prevalence of obesity among adolescents of Government and Private urban educational institutions. The overall prevalence rate of Overweight and Obesity 5.76% and 5.76% respectively according to Agarwal classification; Among the selected demographic variables, the prevalence of obesity is higher in private school than government school (63.15% vs 36.84%). The prevalence of obesity is high in among girls, in first born child, in nuclear family and high in high SES.

Present study was concluded that adolescent obesity is a major public health problem globally because of changes in lifestyle. Schools should be play a pivotal role in maintaining healthy behaviors in the form of eating habits and promoting physical activities, periodic screening for overweight among school adolescents should be done in schools followed by counseling of parents of overweight adolescents on lifestyle modification should be emphasized and at the family level parents need to be role models by living a healthy lifestyle.

ACKNOWLEDGEMENTS

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COMPARATIVE ANALYSIS AND IMPACT OF INDUSTRIAL EFFLUENTS ON WATER QUALITY OF DIFFERENT SOURCES

PUSHPA YADAV, S. TALUKA, SOMA SHARMA AND ANUP YADAV

ABSTRACT

Industrial effluents entering into a water body directly or indirectly represent a heavy source of water pollution. It affects the water quality and competing demand on limiting water resources. A study of four water samples, collected from bore well, Sewage Treatment Plant (STP), canal, and pond of industrial area of Bawal, was carried out to analyse the impact of industrial growth on water quality. The samples were analysed for physiochemical parameters, like pH, electrical conductivity (EC), Total Dissolved Solid (TDS), Total suspended Solids (TSS), Total Solid (TS), nitrates, phosphates, alkalinity, and minerals, like iron (Fe), magnesium (Mg), potassium (K) etc. Results show that STP water has very high EC (1778 µs/cm), a low concentration of K, and found rich in Mg and Fe contents. Ground water has very low EC (6.94 µs/cm), very high TDS (3800 mg/L) and TS values (3804 mg/L) and found rich in nitrates. Ground water has highest concentration of potassium (51 mg/L), whereas pond water and canal water has not shown presence of potassium, but a low concentration (0.75 mg/L) of K was found in STP water. Iron concentrations were found to follow the order, STP water (2.2 mg/L) > ground water (1.27 mg/L) > canal water (1.00 mg/L) > pond water (0.96 mg/L). Surprisingly all water samples have higher concentration of iron than the permissible limit for drinking purpose but comply with the standard limits for irrigation water. Ground water was found unsafe for drinking purpose and its quality deteriorated and needs further treatments to improve its quality. STP water may be used for irrigation purpose after a proper treatment. Results show that there is direct leaching of contaminants to the ground water through soil which harms the quality of water.

1.1 INTRODUCTION

Water is the imperative and primary requirement of living beings for their survival. Life cannot be imagined without water. A person can remain alive for few days without food but can't survive without water. Population of world has been increasing exponentially year by year but natural resources are present in a limited quantity and humans are consuming these natural resources without having concern about their scarcity. Postel et al has reported that the exigency of water jumped up to six fold between 1900 and 1995, that is greater than two-fold increase in population. Not only India but world is facing paucity of fresh water. Shortage of water is mainly affected by regional water balance, climate, altitude, soil composition, vegetation cover, precipitation, and percolation.[1] Scarcity of fresh water is itself a major problem but polluting the available consumable water has become a gigantic problem. People of some regions of our country are still depends on the open water sources like streams, rivers, lakes, and ponds, which are highly prone to get contamination that may be either natural or anthropogenic. Industries are one of the major consumers of water resources and dominating polluting agencies. A huge amount of water get consumed by several factories for cleaning of floor, dilution, cooling, and various other industrial processes. Waste water is generated from petroleum refineries, steel, paper, and pulp industries, dying factories, illegal disposal of pesticides, de-icing agents, and industrial-site drainages. Direct disposal of such waste water pollutes the soil as well as water bodies and ultimately affects the lives of living beings. Organic, inorganic as well as microbiological contamination of water has becomes an alarming issue for the society.[3] Referring to United Nations report released on March 22, 2010 on World Water Day, 80% of urban waste in India reaches in the country's rivers, and uncontrolled industrialization across the country without concerning about environment will worsen the problem.[4] Heavy metals constitutes a hazardous group of pollutants. Their presence in water above the permissible limits make the water unhealthy for drinking as well as for irrigation purpose. According to WHO, scarcity of safe drinking water or polluted water is responsible for about 80% of diseases in the world.(WHO1997) According to Tripathi et al, detergents, domestic sewage, farm manure, gases (e.g., chlorine, ammonia), anions (e.g., sulphide, sulphite, cyanide), metals (e.g., cadmium, zinc, lead), oil and oil dispersants, organic toxic wastes (formaldehydes, phenols) pathogens, pesticides, polychlorinated biphenyls and radionuclides are the major pollutants of water.[1,5] N Jain et al reported the long term use of post methanation distillery effluents can affect the ground water quality. Nitrate and other toxicants may leaches to ground water by the regular use of PMDE for irrigation. Various organic and inorganic ions get added to the ground water with the use effluents.[6] However, some studies have shown that the increased values of available N, K, P and exchangeable Na in distillery effluents than the paper mill effluents and control water. Some positive results were found with the use of post methanation effluents in irrigation after proper dilution.[7]

Deverajan et al has interpreted that the controlled and safe use of distillery effluents may reduce the use of fertilizers.8 Several studies have been conducted on the assessment of water quality degradation near various industries like glass, paper and pulp, leather, oil refineries, dying, steel processing units, and sugar mills in major industrial cities. Decline in water quality has been reported by many researchers. However, many studies have reported the reuse of treated and diluted waste water for irrigation can be a better option. Good nutrient value had been reported in few studies in the treated waste water from industries, but presence of toxic heavy metal is again a serious threat to the environment. Industrial area Bawal comprises many small and large scale industries. Only a handful of reports has been submitted regarding the impact of industrialization in Bawal town on the water quality. In this article we are presenting a study on the effect of industrial growth on nearby water bodies and ground water in Bawal Industrial area.

1.2 METHODS AND MATERIALS

1.2.1 Study Area
Industrial model township Bawal is a large industrial centre developed by Haryana State Industrial and Infrastructure Development Corporation. Its geographical coordinates are 28.5" North and 76.350"76.350" East. It is situated near Delhi-Jaipur national highway. Many small and large-scale industries, national and multinational industries are situated here. Area selected for sampling is surrounded by many industries like paper and pulp, paint industry, automobile, steel processes industry, cement industry etc.

1.2.2 Sampling and Methodology
Four water samples were collected from the industrial area of Bawal. Samples from a canal adjacent to the industrial disposed sludge (about 75 meter), from a pond (3 km away from sludge), ground water and STP water were collected in plastic bottles. Sampling bottles were cleaned and dried properly and were rinsed with the target water before sampling. Later the samples were taken to laboratory and filtered with 0.2 macro-meter membrane. Samples were stored in a icebox and analysed for pH, EC, TSS, TDS, TS, nitrates, potassium, phosphate, Mg, Fe and Na. Sodium and potassium was determined by flame photo meter. pH and EC were measured by pH meter and conductivity meter respectively. Phosphate, potassium, and nitrate were measured by following standard methods IS 3025 Part 31, 45, and 34 respectively.

1.3 RESULTS AND DISCUSSIONS
The water samples were characterised for different physico-chemical parameters and the data is compiled in table 1

Table 1: Physico-chemical water parameters of four sampling site

| Parameters	Source I	Source 2	Source 3	Source 4
pH	7.19	8.00	6.78	6.55
EC (μs/cm)	6.94	1778	261	154.4
TDS (mg/L)	3800	1109	168	102
TSS (mg/L)	>5	237	18	14
TS (mg/L)	3804	1346	186	116
Nitrates (mg/L)	42	44	0.68	0.72
Phosphates(mg/L)	75	81	1.3	1.2
Potassium (mg/L)	51	0.75	ND	ND
Magnesium(mg/L)	ND	0.4	ND	ND
Iron (mg/L)	1.27	2.2	1.0	0.96
Sodium (mg/L)	96	182	12	9

Source 1: Ground water, Source 2: Sewage treated plant water, Source 3: Canal water nearby disposed sludge, Source 4: Pond water
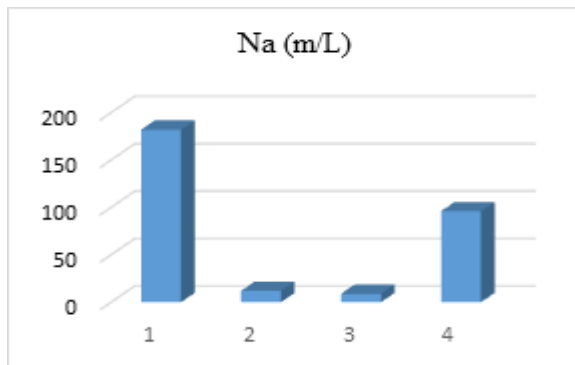
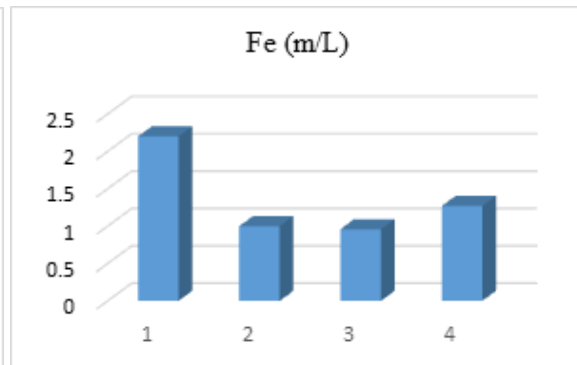**Comparative Plots of Water Parameters of Different Sources**
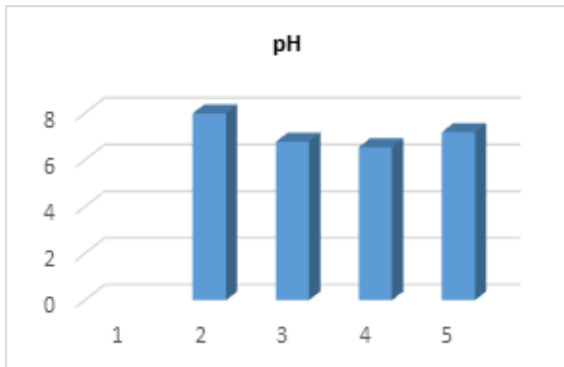
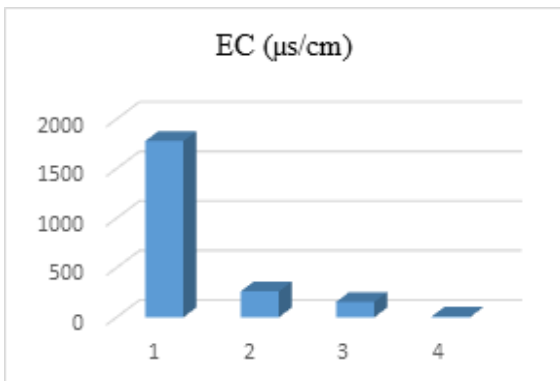**Figure 1:** pH plots for different water samples
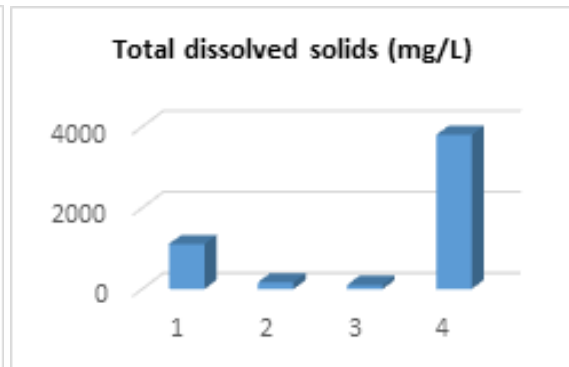
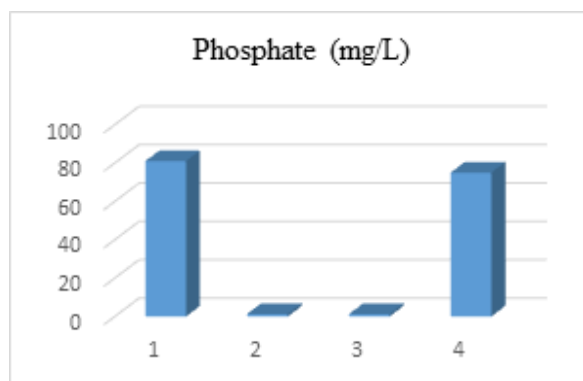**Figure 2:** TS plots for different water samples

Figure 3: Na content in water samples

Figure 4: Fe content in water samples

Figure 5: EC Plots in water samples

Figure 6: phosphate content in water samples
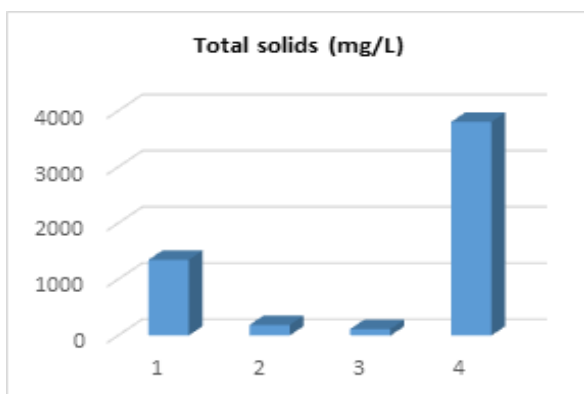
Figure 7: Total dissolved solids in water samples
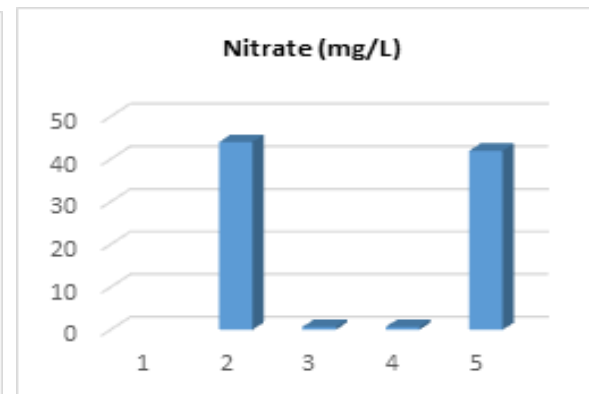
Figure 8: Nitrate content in water samples

1.3.1 PH

pH of all the samples are in range of 6.5-8.0, which comply with the range suggested by WHO for drinking water and FAQ for irrigation water. Water pH were found to follow the order i.e. STP water (8.00) > ground water (7.19) > canal water (6.78) > pond water (6.55). STP water is found alkaline. Lowest pH was recorded in pond water as shown in Table 1 and Fig. 1.

1.3.2 Ec (Electrical Conductivity)

EC of the STP water(1778 µs/cm) is found highest, showing the high concentration of ions in it, whereas the ground water had showed (6.94 µs/cm) lowest electric conductivity, showing the low concentration of ions in it . According to WHO, EC values of drinking water should be below or up to 400 µs/cm. EC of canal water (261 µs/cm) is found higher than the pond water (154.4 µs/cm) that is due to the long distance of pond from the industrial sludge than the canal (about 75 meters away from the disposed sludge). However canal and pond water, both adhere the permissible limits of EC for drinking as well as irrigation water. Increased EC values of STP and Canal water are showing the direct effect of industrial wastes on the water as shown in Table 1 and Fig. 5. Pond is open and 3 km away from the industrial area and it get contaminated due to domestic sewage, animals and pollutants. EC values of ground water, pond water and canal water are in the range suggested by WHO. So if cattle drink this water, it may not be harmful to them regarding EC issues. But high TDS, K, Fe, and Na levels of ground water can't be ignored.

1.3.3 TDS (Total Dissolved Salts)

TDS (3800 mg/L) and TS (3804 mg/L) of ground water were found very high. STP water had also showed higher TDS (1109 mg/L) and total solids values (1346 mg/L) but lower than ground water as shown in Table 1 and Fig.2.. Canal water adjacent to industrial sludge had showed greater values of TDS (168 mg/L) and total solids (186 mg/L) than the pond water. The high values of TDS and total solids reflects the greater concentration of ions in canal water than the pond water. Permissible limit of TDS for drinking purpose is 500 mg/L (IS- 10500, 2012) and TDS greater than 2000 mg/L is unsuitable for irrigation purpose (FAQ 2006). Ground water TDS (3800 mg/L) was found much greater than the recommended limits and do not comply with the standard limits of drinking and irrigation water. TDS of STP water adhere to the permissible limit of irrigation water.

1.3.4 Total Suspended Solids & Total Solids

Total suspended solids were reported highest in STP water (237 mg/L) followed by canal water (18 mg/L) followed by pond water (14 mg/L).It was found less than 5 mg/L in ground water. STP water contains many treated industries effluents that consist of many suspended solids in it. Canal is passing side by the disposed sludge, its TSS concentration is due to nearby sludge. Total solids follows the order i.e. ground water (3804 mg/L) > STP water (1346mg/L) > canal water (186 mg/L) > pond water (116 mg/L) as shown in Table 1 and Fig.7.

1.3.5 Na (Sodium)

Sodium content in water samples follow the order, STP water (182 mg/kg) > ground water (96 mg/kg) > canal water (12 mg/kg) > pond water (9 mg/kg) as shown in Table 1 and Fig. 3. Sewage treatment plant water is rich in sodium content, that is due to various chemicals and materials used in industries. Higher concentration of Na in ground water can be correlated to leaching of various ions through soil and reaches to ground water. Adequate amount of Na is required in human body but it is not considered as an essential element for plant growth. It could be beneficial for growth of algae and cyanobacteria (Allen and Arnon 1955). Previous studies had reported the adverse effect of Na ion on nutrient uptake, transport and accumulation of nutrient ions. Tavakkoli et al 2010 had observed the diminished potassium and calcium ion nutrition in salinity treated bean plants. Ground water and STP water are found rich in sodium concentration. It can be inferred that STP water should be further treated to reduce its sodium concentration, before its application as irrigation water.

1.3.6 K (Potassium)

Ground water had showed highest concentration of K (51 mg/L), which is above the permissible limit (12 mg/kg) as per WHO guidelines. Drinking of this ground water may cause diseases related to exceeded level of potassium. It was not found in pond and canal water, however STP water had reported little amount of K (0.75 mg/L) as shown in Table 1. Negative effect of sodium, potassium and magnesium on soil hydraulic properties were reported by C. J. Smith et al 2014. Their damaging effects were observed to follow the order Na > K > Mg.(C. J. Smith et al). Irrigation with potassium and sodium rich water could alter the soil hydraulic properties of soil.

1.3.7 Nitrates

STP water was found rich in nitrates (44 mg/L) followed by ground water (42 mg/L). Lower values of nitrates was reported in canal (0.68 mg/L) and pond water (0.72 mg/L) as shown in Table 1 and Fig. 8. Nitrates concentration in ground water and STP water meets the Indian standards for irrigation water. Plants require nitrates and phosphate in good amount for proper growth. Appreciable amount of nitrates and phosphates in STP water and ground water makes them suitable for irrigation but values of other parameters should also be taken in consideration.

1.3.8 Phosphates and Magnesium

STP and ground water are rich in phosphate, whereas the canal water and pond water had shown the almost similar values of phosphate. STP water (81 mg/L) showed the highest amount of phosphate followed by ground water (75 mg/L) followed by canal (1.3 mg/L). and pond water (1.2 mg/L). High concentrations of phosphates could be a factor for depletion of dissolved oxygen in water sources and degrade the water quality and also indicates the presence of pollutants in water. (WHO, 1993). According to WHO 1993 Standards, permissible amount of phosphate is 0.3 mg/L. Ground water had reported very high concentration of phosphate, it is matter of concern and indicates the contamination in it.

Magnesium was not found in the Ground water, canal water and pond water but very little amount of Mg was found in STP water.

1.3.9 Fe (Iron)

Fe concentration follows the order STP water (2.2 mg/L) > ground water (1.27 mg/L) > canal water (1.0 mg/L) > pond water (0.96 mg/L).According to WHO guidelines for drinking water, permissible limit of Fe is 0.3 mg/kg as shown in Table 1 and Fig. 4.. Water of all four sampling sites shows high concentration of iron. This shows direct influence of industrial wastes and pollution on the water quality. It is very surprising to see the higher concentration of iron in ground water, which makes it unfit for drinking purpose. However all the studied water samples were found to adhere to recommended permissible limit of iron for irrigation water i.e. 5.0 mg/L.

1.4 CONCLUSIONS

TDS of ground water is found very high (3800 mg/L) as compared to the standard permissible limit for drinking purpose (500 mg/L) and irrigation purpose (2000 mg/L). It is rich in iron concentration (1.27 mg/L), which is above the permissible range (0.3 mg/L) for drinking purpose but comply with the standard limits for irrigation water. Potassium content (51 mg/L) in ground water is also above the permissible limit as per WHO (12 mg/L) guidelines. Ground water and STP water were found rich in sodium concentration. Ground water had reported high concentration of phosphate (75 mg/L), which is too much higher than the permissible limits (0.3 mg/L) as per WHO guidelines 1993. It is matter of concern and indicates the increased degree of contamination in it. Out of the four sampling sites, TDS and Total solids had showed highest values in ground water. It could be inferred that ground water of this area is unsafe for drinking purpose, however it was not found too much harmful for irrigation purpose but the enhanced TDS value, higher potassium concentration, higher values of phosphate and increased concentration of Na cannot be ignored. This deteriorated quality of ground water could be correlated with the industrial influence on it. pH of all the four sampling sites were found within the range as per WHO guidelines. STP water had showed pH (8.0) TDS values (1109 mg/L), TS (1346 mg/L), concentration of K (0.75 mg/L), Fe (2.2 mg/L) and good amount of nitrates (44 mg/L). All these parameters are comply with the permissible limits of irrigation water. Out of four sampling sites, only STP water had showed a little amount of Magnesium. This water had also reported highest value of EC, which shows the presence of various ions in it. STP water could be good alternative for irrigation water in this era of scarcity of irrigation water. But increased level of EC, phosphate and sodium in STP water could impart adverse effect on the crops. As increased phosphates can alter the soil pH and promotes the algae growth. It is an essential nutrient for the plants but too much higher value can alter the production of crops. So STP water should be further treated to reduce the level of EC, phosphate and Sodium in it. Canal water adjacent to industrial wastes is further found more contaminated than the pond water. EC of canal water (261 µs/cm) is found to be higher than the pond water (154.4 µs/cm). All the measured parameters of canal water had showed greater values than pond water and comply with the standards of drinking water but increased concentration of iron (above the permissible limit for drinking purpose) in both the samples could be due to contamination of these water sources. As canal is about 75 meters away from the sludge, is found more contaminated than pond water. Now except Fe, all the parameters of canal and pond water are within the range as per WHO guidelines for drinking water, but if contamination persists, it would be a serious threat to living beings. Direct influence of industrial wastes on the water quality can be seen here on the ground water, canal water and pond water, but the ground water is found more unsuitable for drinking as well as irrigation. Further concentration of heavy metal in these water sources should be inferred before reaching to any conclusion.

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THE ROLE OF SALES IN CUSTOMER DEVELOPMENT

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ABSTRACT

Entrepreneurs and customer development teams can carefully assess the supplier's status to assess whether business and service needs are being complied with. The next step is to participate in customer development. The marketing plan should pave the way for the first steps in customer development and marketing processes. After receiving important customer feedback and obtaining consultation with the customer development team, the organization will consider the concept, model, and / or MVP to provide key clients. One should also discuss, evaluate and improve product marketing processes. For example, a good relationship with a product development team can help marketers meet the real needs of a new product. In particular, the customer development team should contribute to advertising in order to communicate and create marketing, distribution and application information produced. By connecting partners in the company, partners can connect and collect information such as new product development processes, such as new product development processes, with partners and company partners. This information is recommended to attract leading customers and suppliers from the new product development program. It is important to focus on the product information and explain how the product describes the client's situation and problem. A few things are important in these two relationships, which can be a feature of the customer development team that allows good vendors to participate in the development of the development process.

Keywords: Entrepreneur, Customer Development, Sales, Product Development

SALES LEARNING CURVE

The marketing plan should pave the way for the first steps in customer development and marketing processes. Ideally, the client development team should develop and manage the system. Customer relationships are one of the three most important parts of the system. Creating a new business is a complex process that requires a lot of marketing effort and business skills, along with the general visibility, i.e., the ability to tune clients and products to transform design-based issues, system and product features, as well as systems and applications. And also, an ability to understand customer concerns and have problems with products, presentation, prices and other issues. There is no set list, and the goods do not last more than a week. What is required on the first day of sales is being calm and reasonable, not to close the order and build the organization. The first seller's goal is to build a business model by closing orders that are out of stock. It may or may not be the person who can create sales categories. **(Blank, 2007)**

This advance sale includes information about major auctions conducted by research in different market segments and models. After receiving important customer feedback and obtaining consultation from the customer development team, the organization will consider a concept, prototype, and / or MVP to provide key clients. You should also discuss, evaluate and improve product marketing processes. It should help you create a boot marketing message based on a variety of new products, such as USP's and marketing strategy development, intermediate steps, market implementation goals and repetitive sales models.**(Keuster et al, 2017)**

The first step is to establish the business creation of customer firmness. Marketing should benefit many customers to get the best results by discussing problems and solutions. This process of customer verification takes time. All product errors should be set as arguments and not as labels. Many problems appear in sequence only after they have been identified and resolved. **(Leslie & Holloway, 2006)**

The next step will be to participate in customer development. Describes the creation of a value proposition, sales message, and street map until the results are predicted and success repeats. Until, your application validates your methods and models, your marketing and sales costs, like all other costs, should remain low. The time when sales go faster is when you end your sales journey. This can help small organizations grow and increase sales. Until then, everything should be solid.

The following sections discuss the role of marketing in a high-tech business environment before discussing specific marketing activities and email marketing.

Marketing Retailer as Inspirational Information

Merchant renaming is an important role for the seller. Acceptance of this role helps to understand complex customer issues and customer builds. In addition, the link between foreign customers and the market. By connecting partners in the company, partners can connect and collect information such as new product development methods, their partners and company partners. Listen to the forum. Marketing professionals who are aware of this important role are aware of many tools that can promote the company's short- and long-term goals (e.g., selling new products and creating a strong market environment).**(Breg, et al, 2014)**

Consumers may think the advertiser should understand the market and the customer in order to understand the best market for this new product. Effective communication from potential customers and new product factory designers is essential in creating ideas for continuous product development and gathering internal support to transform existing product concepts. This information is recommended to attract leading customers and service providers from the new product development program. Due to strong customer interaction, the relationship encourages information sharing that helps identify low performance (MVPS) products. Customer development teams, especially vendors, should work with key clients to help define and implement appropriate creative management processes. These relationships are governed by law, legal or informal. Customer identity information may be compromised in B2B areas where competitors may worry about losing it. **(Bose, 2002)**

Marketing is the first way to live close to the trust of business capitalists. However, sales are limited until the product exceeds the guarantee and the new product maintains a superior level of quality. However, it is important to maintain a certain level of income and organizational costs for the actual sale of the product.

Retailers should pay close attention to ideas on when they would like to buy a new product, even if the product is labeled. Therefore, it is important for advertisers to remain motivated and to have the full support of their partners, including the businessman himself. Inorder to sell, Retailers should trust new products.

It will help to understand consumer disagreements about service ideas. **(Zablah et al, 2018)** It is a major challenge and the need to work on a new product development team to create a market margin for the product and assist interested customers in the targeted category. To meet these requirements, retailers need operational resources. These resources can reside in an organization, group, or individual level, and will help you inspire people. For example, a relationship with the product development team can help retailers understand the acutal needs of a new product. R&D leaders and business trusts are an important asset to organizations that retailers can rely on to market new products or ideas. At the team level, Customer Support is an important inspiringsource. At the personal level, many variables can serve as resources, including prior knowledge of the development of new solution or businesses, including time management technology, learning skills, flexibility and self-awareness. **(Weitz et al, 1986)**Successful people, for example, will feel more secure and more confident. Qualified new business engineers can better solve problems and respond to problems, while solution providers can gain instant trust by collecting customer feedback. Integrated technical and commercial skills are also important. Experienced traders in both countries are better able to combine their market knowledge and technical knowledge. They can effectively move the opportunities of professional staff in the enhancement of a new product and the needs and problems of customers. Entrepreneurs and customer development teams can carefully assess the supplier's status to know whether business and service needs are being complied with. **(Cialdini, 2014)**
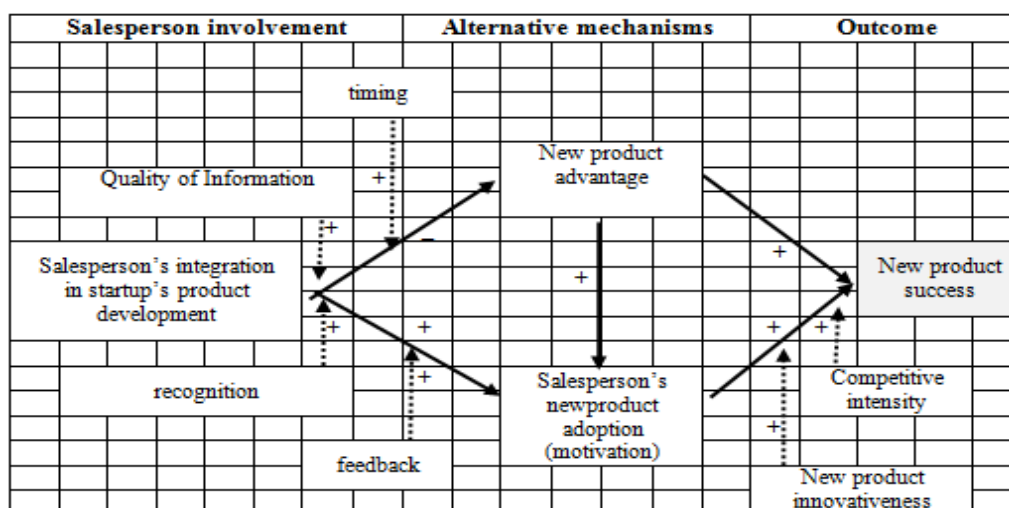

Figure 1: Salesperson involvement in new product development process (source: Kuester et al. 2017)

Two methods are important (see Figure 1). First, the profit in the market. Second, the combination of high sales performance and the team of engineers stimulates the emotional involvement of retailers and the interest in selling new products. Retailers will develop a positive attitude towards new products, accept them with confidence, and, as a result, will work hard to convince motivated and courageous consumers to try them. These methods increase the chances of a new product being accepted and successful in the market**. (Geery & Barrieau, 2011)**

A few things are important in these two relationships, which can be a feature of the customer development team that allows good vendors to participate in the development process. First, the association between vendor integration and the cost of new products depends on the quality of the information the seller transmits. The impact of the integration of suppliers on product development is enhanced when the market information provided is relevant and directly related to the development team of innovative developers. It equates to premature participation and the latest sales of the system (time). Numerous studies have found that important design decisions are made early in the engineering process. Customer and market needs are taken into account when these decisions are made only by the engineers. As a result, many products fail to achieve success. Therefore, it is recommended to participate in pre-sales. By avoiding mistakes, it greatly improves the relationship between the supplier and the level of revenue your product receives. Finally, the level of feedback from the supplier about how the engineering team identified the supplier and how that information was used to create a new product design is important. Higher awareness creates a commitment to advertising and thus better balance between marketing and adoption of a new product. The feedback from the development team regarding the use of vendor information is equally reassuring.

Success rates of new products in the market depend on the cost of the product or profit and the seller from the new products. The relationship between the acceptance and success of a new product vendor depends on the level of innovation in new products and competitive conditions. A study shows that management, reducing uncertainty, and customer education are all important for new and innovative products. The study also pointed out that it will grow in a market that is characterized by a high level of customer competition in purchasing new products. Many providers offer high resistance due to the selection of clients in many competing products that work hard to attract customers. Therefore, new customer development teams should recognize the value of purchasing suppliers or employees and the organizational team in such a way that integration contributes to the success of new market innovations. In particular, the customer development team should contribute to advertising in order to communicate and create marketing, distribution and application information produced. Ensure and manage timely interactions, trust (opinion) and accountability.

Initial Solution Sales Activity
Sales models are often found in existing companies. They believe that retailers do not have an easy goal to sell a product or service, but a full product with a clear price tag. In reality, new products and services are "new to the customer".Therefore, there is no real need for a new service and no real understanding of its benefits. This 'unnecessary' situation removes all accountability for the seller ... Customers reward ... Continue.**(Pekka et al, 2018)**

Therefore, the main task of marketing is to find the best customers, listen to their feedback about product ideas, and perhaps hire to help develop new products together. This includes decisions or sales prices that are not active auctions. It aims to increase the number of customers by fully reflecting the supplier's contribution to the customer business processes.

The Marketing Solution incorporates three sets of functions. **(Hartmann et al, 2018)**

1. Relationships: Find, connect with and develop relationships with key stakeholders.

2. Value Function: Develop, approve, communicate and measure the value that influences customer motivation to apply appropriate solution ideas.

3. Control functions: Obligation acquisition and integrated system development to keep the buying and selling process up-to-date. Having proper management procedures helps.

The context is fundamental and is supported by relationship management and task management. Relationships open the door to customer communication. They care about and focus on ensuring, directing and developing key relationships with key customer stakeholders (e.g. DMU members) to support individual and organizational success. Control provides continuity. They monitor progress through collaboration, through applications, measuring progress and monitoring each other's commitment to sustainable development. The seller's goal is to

create a marketing strategy that is close to the initial process (including the procurement process) and prospective customers through the customer business and procurement process.

Despite the initial focus on identifying the changing agent of the leading customer organization, all stakeholders in the procurement process will participate and begin the procurement process. At the time of purchase, many of the most important solutions affect the players as an important and significant factor in the current situation. The first thing based on the value is to analyze the issue the seller understands, and to plan to understand the customer business process alongside customer solution.It should have a positive impact on all participants' comprehensive analysis. The seller works with this participant to ensure maximum impact by aligning the buyer's domain value proposition. Use of price statistics, analytics research, and other important communication tools to understand, influence, harmonize and develop the views of major stakeholders is essential. **(Hult et al, 2011)**
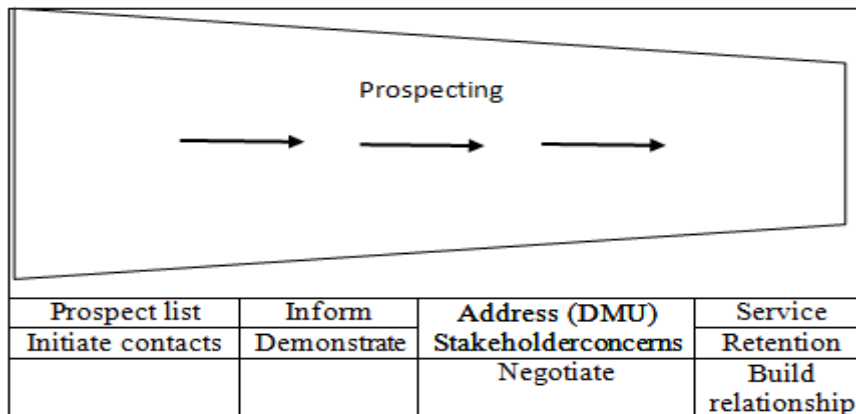
Customer service and vendor integration should facilitate prototype and MVPS identification. Based on this (advanced) information, and the work with the customers, the seller can create a news message to attract more customers and increase sales for beginners. The first step could then be to ensure the next price of the new product (solution) and to identify the steps to be taken in the sale.

A complex product or solution is often important to remember that careful implementation is necessary in order to enjoy the value of the product. In other words, it means that new methods and processes can be developed so that organizations can enjoy a number of new products in context of customer process. This incorporates human learning and ensures that new processes are developed and managed appropriately. Vendors should be included as a service that can help customers to assist and start paying in this process.

Finally, the client data can be used to determine the amount that has to be verified. This is the future customer price by setting up a plan or price to negotiate with the company's top customers and using information on development and production costs.

Developing Marketing Strategies

Based on these marketing efforts, a solution must be developed to lead customers into the marketing process to reach potential customers in the target market. This street map explains how to sell to potential customers through a salesperson. In general, there are four stages: exploration, interaction, pleading, and maintaining a relationship. This is shown in Figure 2 along with some key features.

Prospecting			
Prospect list	Inform	Address (DMU)	Service
Initiate contacts	Demonstrate	Stakeholderconcerns	Retention
		Negotiate	Build relationship

Figure 2: The Selling Process as Funnel

Search means a need to sell inorder to compile a targeted audience list. A list can be updated based on relevant data or, for example, purchases from merchant. You can review the list to see promising opportunities for better results. The next step involves first contact. On the other hand, network communication is important because it is easy to communicate (in a contracting agency). In private networks, you can define and find contacts. The main goal is to attend the first meeting. During the visit, the seller should make sure that you get as much information as possible about the expected person and his or her circumstances. Another purpose is to inform the trustee of the institution, its establishment, and its services. The focus should be on the first solution that provides technology and functionality rather than just a product or feature. The demo can help explain what the product can do and remove any possible doubts. More customer training information may be needed to help customers understand and connect to your site.

The most important aspect of marketing is data collection. Asking the right questions and listening carefully will allow you to learn about the obstacles and reasons for adoption. There are many questions left about who makes the decisions and why they are important. Therefore, data collection should include obtaining additional information about decision-making units (DMUs) and various DMU members, that is, access to them.

The third stage is independent in cases where the client is interested and the start is disappointing in the community, it is vital to arrange well. It requires effective marketing and communication (as well as conflict resolution solutions) with all stakeholders to increase access. Once the agreements have been defined and final limits (e.g., minimum amounts) have been set, the negotiation strategy should also be put in place. Finally, the product and service phase begins to help strengthen the relationship. The first step, product delivery, is critical to customer satisfaction. Second, maintaining and developing relationships helps develop the first business.

The answers to the following questions will help in improving the marketing and marketing processes. (**Franke & Park, 2006**)

- Who can be your customers? What are your hopes for the next six months? How can you communicate with them and talk to them? Who do you meet and what is their role in the company? How will you negotiate?

- Customer and customer shopping cycle. Are there key features of the customer shopping cycle and how will you manage your expectations? So how can we change the way we do things? Are you successfully completing each stage of the cycle and what are the potential obstacles? Who are the customers of this program and where are they located? What obstacles do they face and how can they be overcome?

- Price proposals and marketing presentation strategies. What is our value proposition and how is it different from its competitors? How does this relate to your proposed business objectives? Should you reduce expenses, increase your income, or do both? Can we substantiate it? What will increase customer interest?

- Obstacles to overcome. What hinders marketing success from competing with other companies, distrust of startups or new technologies, etc.? What are the most common conflicts? In general, who will oppose each other and how will your marketing and sales plans deal with them? Should I Teach Before Selling? What assurances can we get from respected officials to ensure our hope?

- Integration and Marketing. Are well-maintained and well-maintained prices ready to sell? Or do I need to estimate the value better? What marketing activities (promotions, events, discounts, etc.) are planned and how do they support the sales cycle? Is the time right?Will there be synergies? What additional marketing or other services do you need (e.g. better after-sales service, tracking)?

- Goals and setting goals. What are your goals for attracting new customers and selling existing customers? What marketing activities can help you achieve these goals? What is the sales budget needed to develop and implement these marketing activities?

- Sales and Leasing. Are your sales representative well-educated and competent? Or do you need more training? Are there enough sales or should most people be hired? So, what qualifications and profiles do you need? Do additional auctions incur additional costs? What employment steps will you take?

- Control. Has the work been suspended and is it working properly? What can I learn from this test? What if a goal is kept or a new goal is made?

Compared to business modeling tests, conventional marketing is less defined and targeted at rebels, and guarantees larger benefits of marketing from a flexible marketing approach. 'All communication services based on information obtained from customer communication or trading natural resources'. (**Rackham, 1995**)

Improving Marketing Messages
Sales reports should confirm that there are new solutions. Strong profit estimates for a unique proposal, to provide additional benefits, cost savings and productivity improvements, as well as to provide customers with clear results and types of outcomes such as improved production. This will often help you with your customer feedback. We focus on product information and explain how the product describes the client's situation and problem.

The marketing message should be short and emphasize the value of the new product (or service) you offer customers in your target market. Therefore, the benefits should be emphasized over features or skills. The description of the physical features of a product should be carefully linked to its specific benefits. This makes it easier for the consumer to associate the product with the problem. Customers can provide references as a guarantee. By doing so, the perceived risk can be reduced, and trust can be built.

It is required to send an important message to the trusted DMU (or exchange agent). In the presentations and programs of Q&A, this helps to fully satisfy Hope's needs by showing an understanding of their situation and answering all their questions. Also, make sure everyone in the group feels a part of it. In fact, more powerful and accurate messages should be made for all DMU (and external) DMU participants. If your team is involved in introducing a new product to the introduction, it is a good idea to make sure everyone contributes and understands their role. The introduction requires self-disclosure, and flexibility may suddenly disappear from the market, so it is important to pay special attention to building confidence in future plans. Links, investor support, all prize winners and social science or expert links are available. Growing new revenue can also be used as an indicator of the attractiveness, success and performance of a particular product.

If possible, it is advised to advertise high-tech products as part of the launch. For example, it makes sense to invite people to the show by asking them to use the program or giving them a choice. This is one of the best ways to reduce stress and anxiety. However, plan ahead, considering all the options available. Nothing should be left to chance. A good introduction emphasizes all the important details without irritating the audience. Link it to your head to focus on your client's business. Yes, the audience will ask questions. Do not worry if you do not know the answer. Just agree, write it down, get a reply, and make sure you send it to the whole group within 24 hours. They will view it as a response and loyalty to customers who need someone they can trust.

It has been observed that many new technologies enter the market from the ground up. Compared to existing products in the market, many new technologies and their applications do not work. Therefore, retailers should pay special attention to how good and bad applications are presented to consumers. Conflict management can bring a huge difference in the approach customers analyze negative aspects. If there are a few negatives, the order doesn't really matter. But if the situation is serious, you may have to deal with it first. All good things should be considered because bad things do not interfere. The good news is that you may now have a constructive message that makes customers feel happy. **(Colm et al, 2020)**

CUSTOMER EXPECTATIONS

Startups that create new technologies and applications often face major problems and delays. Initially, sales may be affected by the lack of portable products to show customers; however, delays in creating and producing the final product are also factors that can be calculated and expected. Customer frustration and negative feedback may result in unexpected delays.It is therefore important to develop customer relationships with an understanding of customer expectations.

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FLOWSHOP SCHEDULING PROBLEM WITH THE OBJECTIVE OF MINIMIZING TCT FOR n-JOB m-MACHINE CASE WHERE n>m

R. DURGADEVI, S. JAYAKUMAR AND G. VASUDEVAN

ABSTRACT

Scheduling is a decision making function deals with number of jobs and number of machines. For the number of jobs is greater than number of machines, JayaVasualgorithm performs better than Palmer's, Gupta, RA(Rapid Access), Jayvasu, Jayavasudev and JJV algorithms. This Jayavasu algorithm performs not only for n≤m ("Flowshop scheduling problem with the objective of minimizing TCT", Passing paper) but also for n is greater than m (n>m). Due to complexity of the problem obtaining appropriate objective is the need of favour. Here we choose total completion time (TCT) as our objective to address the n>m flowshop scheduling problem.

Keywords: Flowshop, TCT, scheduling, Heuristics.

1. INTRODUCTION

Scheduling is the significant assignment in arranging the process, enterprises circumstance and administration which has been a devoted research field in activities research. Scheduling is the method involved with getting sorted out, picking and timing utilization of resources to do every one of the activities important to create wanted yields at the ideal times while fulfilling countless relationship constraints among the activities and resources. Hence, we can characterize it as the portion of resources throughout some undefined time frame to play out an assortment of assignments in an optimum manner. Normally scheduling is a dynamic capacity. Scheduling happens in an extremely wide scope of financial activities. Scheduling hypothesis has its starting point in manufacturing ventures in the mid 1950's. By and large, scheduling is considered as an autonomous area of exploration inside activities research after the fundamental paper distributed by Johnson in the year 1954. There are such countless significant distributions seemed comparative with these present reality problems in activity research journals. The papers correspondingly started another string of scheduling. So scheduling framework comprises of ventures of different kinds, for example, coordinated factors frameworks, material necessity arranging framework, flow shop, job shop process, assembly shops, move lines, research groups, the board arranging gatherings, high volume dull lines and dispatch and control stations.

A flowshop scheduling problems be at the time every one of the jobs share similar sequencing arrangement operating every one of the machines. In flowshop scheduling, a similar sequence innovative requirements request that the jobs pass between the machines. Thus there is a characteristic (processing order)sequence of the machines described at every mechanical constraint as the single job in flowshop scheduling. Often happening functional scheduling problems centre around two significant choices:

▪ The progressive mentioning of the places that is destined to be arranged consecutively by something like two machines.

▪ The machine stacking plan which distinguishes the successive course of action of start and finish times on each machine for various jobs.

Supervisors normally favour job sequence and related machine stacking plans that license absolute office handling time, mean flow time, normal lateness with normal delay to occur limited. The flowshop contains m various machines orchestrated within series working that a bunch of n jobs are to arise handled. Every one of the n jobs need m tasks and every activity is to occurexecute on one different machine. The flow of effective task is operating in one directiononly; hence each job should be prepared through among each machine in a provided recommended sequence. In case machines are come to $(1,j), (2,j), (3,j),…,(m,j)$. The overall n-jobs, m-machines flow shop scheduling problem is very imposing. Thinking about and a discretionary succession of jobs on each machine, there are $(n!)^m$ potential timetables with presents mathematical troubles. Along these lines, endeavours in the past have been made by specialists to lessen this number of feasible time tables however whereas could reasonably be expected without thinking twice about suitable order. Research on flowshop measure shows entire isn't adequate think about $(n!)^m$ programme to which a similar job sequence happens on every machine with the end goal of accomplishing optimality. Then again, it isn't generally fundamental think about $(n!)^m$ programme in look up for best.

In this paper, we introduce Total Completion Time (TCT) is the sum of completion time of all jobs on the last machine. Our aim is to minimize the TCT, when compared to other methods given below.

2. LITERATURE REVIEW

Johnson [3] was planning and presented by the flowshop problems, target of minimizing the makespan. After such countless experts discovered various heuristic for makespan minimization in the flowshop planning problems. Palmer [8], in the year 1965 gave heuristic calculation. It is known as palmer's slope index method and its very well may be applied to the huge estimated issues by offering need to the jobs so that jobs with processing times that will in general increment from one machine to another will get higher need. Gupta [2]in the year 1971, recommended one more algorithm that be like Palmer algorithm. He characterized the slope index in an alternate way before considering few appealing realities through optimality of Johnson three machine standard problems. Later on, Dannen bring [1]during the year 1977 fostered the algorithm calculation called rapid access (RA) that joins total benefits of CDS and palmer's heuristic (slope index) calculation. It's outcome do through deliver one finest arrangement just as quick along with basically on the point of beneficial. Just a choice about tending to 'm-1' counterfeit two machine issues, it handles simply a solitary fake issue applying Johnson algorithm that planning resources have being browse a backup conspire. In the year 2016, Jayakumar S, Meganathan R and Sathiya Shanthi R [4], to track down a heuristic approach with makespan objective for solving n- job two-machine FSSP. In the year 2019, Jayakumar Sundaramoorthy, Meganathan Rangaraji, Sathiya Santhi [5], to track downaheuristic approach as solving permutation flowshop scheduling problem minimizing the makespan objective. And furthermore S. Jayakumar and Vasudevan [6] in the year 2019, tracks down a Heuristic Approach for permutation flowshop scheduling problem with objective of makespan. Jaya Vasu [9] in the year 2020, algorithm it was discovered that their calculation is predominant than Palmers heuristic calculation and also his algorithm found the solution inquick time when compared to CDS algorithms. Hence they conclude that their algorithm performs better when solving the Horizontal rectangular matrix problem. In the same year, Jayvasu[10] algorithm it has discovered that his calculation yields better outcome in straightforward technique contrast with other calculation as palmer, CDS, Gupta, RA and NEH. Likewise this calculation reason that at whatever point Johnson technique neglects to tacklem-machine n-job problems Jayvasu calculation do appropriate single facing address at contrasted with NEH, palmer, CDS, Gupta, and RA calculations. In the year 2020, Jayavasudev[11] calculation performs better compared to the calculations as Johnson's, NEH, palmer, CDS, Gupta, and RAheuristic, Jayavasudev algorithm is the best suitable algorithm for minimizing the makespan objective in solving FSSP. Jayasankari S, Jayakumar S and Vijayaragavan R [7] in the year 2021, an efficient strategy is created to get the minimum total elapsed time. In light of the outcome acquired shows in that JJV calculation do advance compared to Gupta, Palmer, JV and Nagamelleswara Rao & others calculations. And furthermore this calculation gives close to the ideal arrangement instead of the ideal one. JJV calculation is simple, elegant and superfast in taking care of flowshop planning issue when contrasted and CDS and NEH calculations.

3. VARIOUS ALGORITHMS

Later review out of this writing, it have been tracked down especially few algorithms were utilized along with produced for minimization of TCT for n-job m-machines flowshop scheduling problems. Effective algorithms are at this point one issue concern flowshop scheduling problems and in the current work, an endeavor accepts as contrasting as seven algorithms being TCT minimization in flowshop scheduling problems. The current task be one expansion about every task finished and looked at the heuristics analyzed viz. Palmer's, Gupta's, RA, Jayakumar Vasudevan, Jayvasu, Jayavasudev & JJV algorithm in Flowshop Scheduling on n-jobs and m-machines (n >m) problems.

4. ASSUMPTIONS

The comparative investigation has been finished by considering a few suspicions which are:

1. Each job must be handled on all machines in the request (j= 1,2,….,m)

2. Each machine measures just each job inturn

3. Each job is handled on each machine inturn

4. Arrangement times as every job do associated with every planning times.

5. Assumptions aren't permitted.

6. Machines never independent and are open all through every arranging interval.

7. The essential machine is believed to be arranged whichever and anything job is to be taken care of on it first.

8. Machines can exist inactive.

5. COMPARISION OF RESULTS (PROBLEMS GIVEN IN ANNEXURE)

n-job m-machine(n>m) problems given in annexure were solved using the algorithms Palmer's, Gupta's, RA, JayaVasu, Jayvasu, Jayavasudev and JJV. Solved TCT values are tabled as given below:

S. No	nxm (n- job, m-machinen>m)	Palmer TCT	Gupta TCT	RA TCT	JayaVasu TCT	Jayvasu TCT	Jayavasudev TCT	JJV TCT
1	4x3	**85**	87	87	87	87	**85**	92
2	4x3	80	91	91	91	91	86	**74**
3	5x3	96	**91**	97	96	107	123	102
4	5x4	132	**108**	130	125	131	131	129
5	5x4	108	109	108	**106**	111	125	120
6	6x4	155	**153**	**153**	**153**	**153**	186	184
7	6x4	**160**	167	162	**160**	161	167	187
8	6x5	**288**	291	299	299	304	304	294
9	6x5	232	225	**214**	**214**	216	221	223
10	7x3	226	**178**	181	179	179	203	217
11	7x3	186	180	195	**163**	171	169	219
12	8x3	217	211	**205**	211	211	208	259

6. RESULT ANALYSIS

Comparision of TCT result of above problem stated in annexure among the algorithms are Palmer's, Qupta's, RA, JayaVasu, Jayvasu, Jayavasudev and JJV.

CONCLUDE THE FOLLOWING

3 out of 12 problems Palmer's heuristic do well when contrasted with different heuristic given in the literature

4 out of 12 problems Gupta's heuristic do well when contrasted with different heuristicgiven in the literature

3 out of 12 problems RA heuristic do well when contrasted with different heuristic given in the literature

5 out of 12 problems JayaVasu heuristic do well when contrasted with different heuristic given in the literature

1 out of 12 problems Jayvasu heuristic do well when contrasted with different heuristic given in the literature

1 out of 12 problems Jayavasudev heuristicdo well when contrasted with different heuristic given in the literature

1 out of 12 problems JJV heuristic do well when contrasted with different heuristic given in the literature

7. CONCLUSION

As n-job m- machine instance, the problems given in the annexure where tested and found that JayaVasu heuristic is superior compared to other algorithms found in the literature. Here we conclude that JayaVasu algorithm is the best heuristic approach to solve flowshop scheduling problems along with objective of minimizing total completion time(TCT) for n-job is greater than m-machine (n>m).So far, only makespan objective is analysed in the literature and hence we are the first to choose Total Completion Time as an objective and used the entire algorithm available in the literature for solving TCT as the objective and we are the first to analyze TCT.

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ANNEXURE

1

J/M	M1	M2	M3
J1	2	5	7
J2	4	6	8
J3	3	1	1
J4	7	4	3

2

J/M	M1	M2	M3
J1	3	2	1
J2	6	2	5
J3	4	5	3
J4	7	6	4

3

J/M	M1	M2	M3
J1	2	6	4
J2	3	4	5
J3	2	3	4
J4	6	4	2
J5	2	2	7

4

J/M	M1	M2	M3	M4
J1	5	4	5	3
J2	6	2	1	6
J3	2	7	1	3
J4	3	6	2	4
J5	4	3	4	5

5.

J/M	M1	M2	M3	M4
J1	2	5	6	5
J2	4	6	7	2
J3	3	3	2	3
J4	2	2	3	6

| **J5** | 1 | 4 | 4 | 1 |

6.

J/M	M1	M2	M3	M4
J1	2	3	4	5
J2	3	4	5	4
J3	4	5	6	5
J4	5	4	7	2
J5	6	3	3	3
J6	5	2	2	1

7.

J/M	M1	M2	M3	M4
J1	6	5	4	3
J2	5	4	3	6
J3	4	3	5	5
J4	3	2	6	6
J5	2	1	5	6
J6	1	6	4	4

8.

J/M	M1	M2	M3	M4	M5
J1	4	9	8	7	5
J2	6	4	6	5	6
J3	5	6	7	6	4
J4	7	7	5	4	3
J5	8	5	4	3	9
J6	9	8	3	9	7

9.

J/M	M1	M2	M3	M4	M5
J1	2	5	4	2	5
J2	6	3	7	3	6
J3	5	4	6	5	4
J4	3	6	3	2	3
J5	4	2	5	4	4
J6	2	5	8	7	5

10.

J/M	M1	M2	M3
J1	2	1	4
J2	3	4	5
J3	5	5	6
J4	5	6	4
J5	6	3	5
J6	7	2	6
J7	3	5	7

11.

J/M	M1	M2	M3
J1	5	2	3
J2	2	6	4
J3	1	2	2
J4	7	5	6
J5	6	6	1
J6	3	7	5
J7	7	2	4

12.

J/M	M1	M2	M3
J1	5	2	3
J2	2	6	4
J3	1	2	6
J4	7	5	2
J5	6	6	1
J6	3	7	5
J7	7	2	4
J8	5	1	7

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EUROSAT DATASET: PREPROCESSING OF IMAGES TOWARDS LAND USE WITH DISTINCT FILTERS

REENA THAKUR AND DR. PRASHANT PANSE

ABSTRACT

The complex feature in the images is noise which reduces the quality of the images. For researchers, in the field of image processing, removing the noise from medical images, satellite images, and subsequently on other images is a challenge. Approach towards noise reduction is achievable by multiple available methods. Speckle noise in satellite images is rather more recurrent, which are frequently affected with multiplicative noise like Speckle. The interpretation and processing of RGB-EuroSAT satellite images to be difficult because of Speckle noise. The RGB-EuroSAT satellite images are functioning, freely, easily, and openly accessible. These are then supported for Land use - The earth observation method helps to identify land cover. A EuroSAT dataset is offered, which comprises 27,000 labelled and geo-referenced images, divided into 10 classes.

Thus, to remove speckles present in the images, we introduce various filter-based approaches. In this research paper, several filtering techniques for removing speckle noise from satellite images are presented, and the image quality is recovered. Although there are many speckle-reducing filters available, some are better suited to the usage of satellite images, wherein statistical parameters are computed for all filtered output images. SNR, PSNR, and SNR are statistical measurements that are compared. The table includes the filter name and accompanying statistical measurement values, as well as the best values of all statistical measures and the output images.

Keywords: RGB-EuroSAT, Filters, pre-processing, Land Use-Land Cover, machine learning, Noise.

1 INTRODUCTION

Presently, we are on the era of open, freely, and unceasing access to the satellite image data for the implementation of earth observation. Government programs such as ESA's Copernicus as well as NASA's Landsat are taking exceptional strive to certify that such type of data is publicized for commercial use as well as for non-commercial use in order to determine ingenuity and entrepreneurship. Calamity restoration, urbanization, agriculture, climate change, and environmental monitoring applications are all intuitive. with the use of such data by (Bischke et al, 2016, "Detection of flooding", 2017a, "The Multimedia", 2017b). However, as per (Huang, et al, 2018) Earth-Observation imagery or satellite images, first must be prepared and then converted into systematized connotations to avail full use of data for such applications. Land use - land cover classification explained by (Basu, et al, 2015), (Yang, et al, 2010) are one type of fundamental semantics that inherently provides labels defining the type and purpose of the provided physical land.

In order to have a highly interconnected level of operation, in a civilized country for a specific industry, one need to have more than sufficient amount of data. Even though we consider a land to be just one dimensional, but it is necessary to keep in consideration that an appropriate knowledge of land use-land has become very much relevant where the nation is trying to fix the challenges of unsystematic, chaotic growth, environmental deterioration, pruning of agricultural land, and loss of sturdy wetlands. Land use data are very relevant while studying environmental mechanisms and issues, which are simultaneously needed to be identified, so that the living standard and its conditions could be enhanced.

The reason of degradation in satellite images while image processing and transmission process is majorly due to noise. By suppressing speckle noise, major aim is to ensure the important components of the images are well-maintained by the noise reduction filters. In mathematics, two basic noise models available are Additive Noise and Multiplicative Noise. Additive noise is simple to comprehend, follow, easy modelling as well as its elimination; conversely, multiplicative noise is difficult to model and thus difficult to eliminate because it is dependent on the image. In an image, speckle is a noise-like change, as defined by (Gooman, 1976) Speckle is a type of multiplicative noise that originates when a sound wave pulse arbitrarily clashes with fine particulates or artefacts on a scale proportional to the sound wavelength.

The intended EuroSAT dataset is constituted of 27,000 labelled and about 10 classes are divided under geo-referenced images of land use and land cover. The public can access the EuroSAT dataset at https://github.com/phelber/EuroSAT (Helber, 2018, 2019). We presented a pre-processing approach in order to

minimize incorrect discernment while keeping low elision accuracy. We show how various filters may be used to denoise noisy images, which can then be used to observe and notify any changes in land use and land cover, as well as how they can be used to improve geographical maps.

2 DATASET FORMATION

The satellite images of Sentinel-2 have the capacity of compressing around 1.6 TB images in a day. Evidently, the limitation of supervised machine learning can be caused undoubtedly because of the absence of labelled ground truth data with the inclusion of the volume dataset. The EuroSAT dataset contains 10 various classes wherein each class has about 2000-3000 images. With the patches of sizes 64 x 64 pixels, this dataset has 27,000 total images. For the aim of producing thousands of image patches, we hereby consider about 10 separate land use-land cover classes. Here, the initiated dataset has the inclusion of classes: Perennial (Annual) Crop, Perpetual (Permanent) Crop and Pasturages (Posture), so that there can be a clear difference between various agricultural land usage. The dataset also prejudices in opposition to built-up areas: Roads (Pavement), Manufacturing (Formulating) and Residential Buildings. Many water bodies available in the class Lake, Class River, Class Sea. The addition of various other undeveloped environments is being included, in their respective classes, such as forests(woodland) and herbaceous vegetation.

A list of the 10 classes affected, represented with four samples per class (see Fig. 1).

Fig 1: Samples of EuroSAT Dataset per Class

3 PRE-PROCESSING SATELLITE IMAGES

A satellite image is the process of precisely returning through the successive radar pulses. Speckle is defined as the discrepancy termed granular pattern whose effect is strength varying from pixel-to-pixel. But the risk is that these speckle noises can distort an image's information by changing pixel intensities without a pattern i.e., randomly in heterogeneous areas of an image. Due to these random noise in the image, the effects can be

considered that their will surely be the hindrance in human and computer vision equipment in order to obtain data from those images. Eventually, as the speckle holds the information about the area's microstructure, it is commonly understood as the noise in the process of image applications. Recently, the culture of data science and remote sensing has been coming up to the world stage and aligning itself at that stage. First, companies like Kaggle (Google 2019) have shown tremendous accuracy in the correct classification using advanced algorithms for machine learning. The concept of the competitions being held by the Kaggle is very simple yet unique, whereby being the sponsoring organization, it is publishing its details for the contestants, to actively collect the data as feedback for their purpose of models on their respective website and giving away the cash prize in return to the winners. Secondly, Sentinel-2 as well as Landsat-8 are the two Earth-observing satellites which has have been proving their data to be publicized without requiring any sort of monetarily requirements i.e., for no money and absolute free, described by (Harris,2015). Few methods which are based on the pixels and sub-pixels are more frequently in usage in order to detect any sudden shifts in the time series explained by (Zhu, 2014; Verbesselt, 2010; Kennedy, 2010, Deng, 2018). The disturbance and recovery algorithm could be detected by using very commonly used algorithm i.e., Landsat-based algorithm, Continuous Detection and Classification of Change (CCDC) and Breaks for Additive Season and Trend (BFAST) algorithm by (Verbesselt, 2010).

3.1 Speckle Noise Pre-Filtering

Removal of speckle noise can be employed in two categories of techniques. First category, it involves methods like multiple-like processing, where there is consideration of average of various independent "looks" or rather images of specific portions of the obtainable declination spectral bandwidth, or obtainable atomization states of similar areas throughout the image creation as explained by (Lee, 1994; Lillies, 2004). Second category, it consists of the methods which smoothen the image with the help of digital image processing, following the image is created. Reduction of speckle using digital image processing can again be executed by two major approaches. First approach, here, we are achieving digital filtering by including the usage of different filters in the frequency domain. Second approach, we are achieving digital filtering, whereby noise (unwanted signals) is eliminated by considering the average as well as statistic manipulation of the values of neighbouring pixels in the spatial domain. The difference between the filters can be done on the basis of peak signal to noise ratio (PSNR), root mean squared error (RMSE) as well as signal to noise ratio (SNR) in graphical representation and tabular format. This specific paper dominantly focusses on the second approach, wherein substantial focus is effectuated over the service of digital filters in the spatial domain so as to minimize the speckle noise in EuroSAT dataset images.

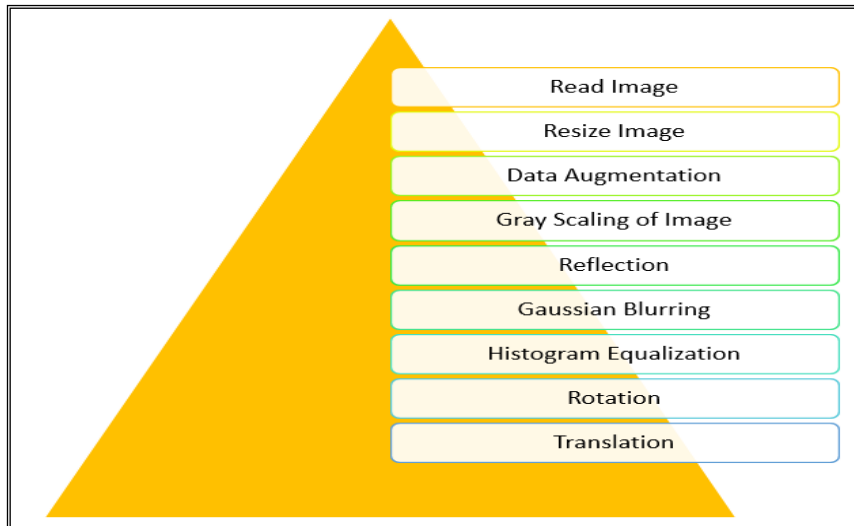### 3.2 Steps to Image Pre-Processing

Because of the effect of cloud as well as cloud shadow or effect of speckle noise, a nine-step pre-processing method consisting of read image, resize image, data augmentation, grey scaling of image, refection, Gaussian blurring, histogram equalization, translation and rotation was used to eliminate "noisy" observations.

Algorithm 1. EUroSAT Dataset Preprocessing using Filters
‖ **Packages:** Imported
‖ **Modules**: Imported
‖ **Storing images**: Use List
‖ **Definitio**n & **Declare**: Numerous Filters, window size & Python   List
‖ **Input & Output**: 1-10 class EuroSAT Image & Denoised Image
Begin
Initialize:
noisy image is formulated ← class image + (class image * gauss * 0.09)
do
Gaussian_fiter (Image from Class 1...10)
For ← k in range [tot]:
Apply formula and calculation
display Filter
display Other Filters
select image from ← Image Class of (1...10)
Evaluation Parameters
Calculate SNR (original_Image, filtered_Image):
Initialize Num to 0
Initialize Den to 0
Run for loop for I & k

```
den = den+ (filtered_image [:] [:] – original_image [:] [:]) **2
num = num + original_image [:] [:] **2
end
end
Calculate PSNR value (original_Image, filtered_Image):
np.mean((original_image – filtered_image) ** 2)
check for mse to 0:
then calculate RMSE
Calculation/Estimation:
Total_Time taken for Program Execution
Plot_Graph:
Horizontal ←["Filter"]
Vertical ← [ "PSNR", "RMSE", "SNR"]
Comparison of Filters:
end(begin)
```

3.3 Image Pre-processing Steps- The following figure shows the main nine image pre-processing steps (see Fig. 2). The key goal of these steps is to enhance the quality of the image by removing unwanted anomalies and improving some necessary image features sufficiently, so that the image classification can be benefitted from this enhanced information to work on.

Fig. 2: Steps for Image Pre-Processing

4. Evaluation of Statistical_Parameters

Here, by applying numerous filters to the class image to remove the noise, then depending on the PSNR values, the recovery of image will be estimated.

The following evaluation parameters such as Signal to Noise Ratio (SNR) have been calculated first followed by the calculation of Peak Signal to Noise Ratio (PSNR), and finally finding the Root Mean Square Error (RMSE) for the estimation of the filter performance.

1. Evaluation of SNR:

Signal to Noise Ratio (SNR) represents a quantity of desired signal to the backgrounds noise level. The surroundings noise is smaller and on the contrary the SNR is greater. SNR is in represented in decibels specified as in equation (1).

$$SNR = 10\log (\sigma^2_g / \sigma^2_e) \qquad (1)$$

Where, σ^2_g is termed as the image variance free from noise, and σ^2_e is termed as error variance.

2. Evaluation of RMSE

The root mean squared error is the difference between predicted values and the observed values.

$$MSE = \sum^M_{x=y=1}[f(x, y) – F(x, y)]/M^2 \qquad (2)$$

Wherein, f - an original image, then F - a noise free image after applying filter; M - the size of image.

Root mean squared error = √Mean squared error   (3)

3. Evaluation of PSNR

The peak signal to noise ratio (PSNR) is the relation between the max possible power of a signal to the corrupting noise power available in the image described by (Achim,2006).

Peak Signal to noise ratio = 20 log (255 / Root mean squared)   (4)

It has been observed that when the PSNR value is higher then the noise value in the image is less, and hence the quality of the image is higher.

5 EMPIRICAL RESULT

Firstly, the image is read and by applying nine standard steps of image pre-processing if necessary. The following fig. 3 shows the application of filters on the selected image. The various filters have been applied on the image consisting of speckle noise. Secondly, the false unease rate is abridged by applying filters methods. Finally, these pre-processed images would be used for classification to achieve higher efficiency and accuracy.

In particularly, the proposed and divided into train, test and validate of EuroSAT dataset is geo referenced based on earth observation data, which is openly and freely available. It is available on https://github.com/phelber/EuroSAT, which is ready for the public access (see Fig. 3).

Fig. 3: (a) Filters on Class 1 & 2   **Fig. 3: (b)** Filters on Class 3 & 4

Fig. 3: (c) Filters on Class 5 & 6   **Fig. 3: (d)** Filters on Class 7 & 8

711
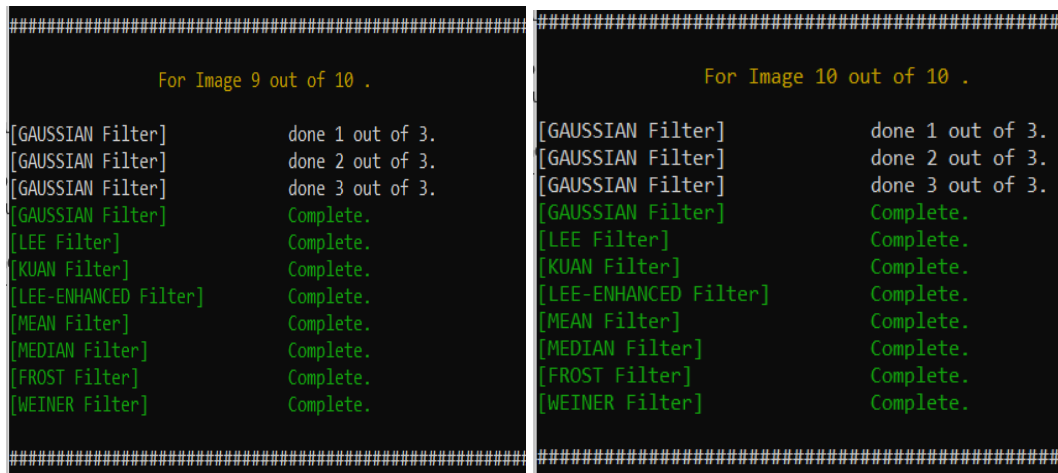
Fig. 3: (e) Filters on Class 9 & 10

Fig. 3: Applying Filters on 10 classes of EuroSAT Dataset (Total Time Taken 14.727734804153442 sec.)

DISCUSSION AND RESULTS ANALYSIS

As implemented and executed by using the estimated statistical parameters below, when suppression is required while conserving peaks as well as edges to the greatest extent possible, we recommend using a Gaussian filter. If we only have to maintain the peaks and aren't concerned about the edge impact, Gaussian filters with an appropriate spatial standard deviation will suffice because they are computationally less expensive than other filters. Lee-Enhanced filters will be employed if we don't care about peaks or edges and merely need to reduce noise.

a. Real Eurosat Images (Herbaceous Vegetation)

Table 1: (Image 3, iteration 3)

Filters	PSNR	RMSE	SNR
Gaussian	23.073762	17.899961	18.819059
Lee	19.126084	28.199147	14.871381
Kuan	19.108987	28.254710	14.854283
Lee-Enhanced	18.808426	29.249528	14.553723
Mean	18.808426	29.249528	14.553723
Median	18.866944	29.053132	14.612241
Frost	19.381966	27.380531	15.127263
Weiner	26.934453	11.476713	22.679750
Highest PSNR value is of Weiner which is 26.93445305692118. Hence, it's the best filter out of all.			

(a) (b)
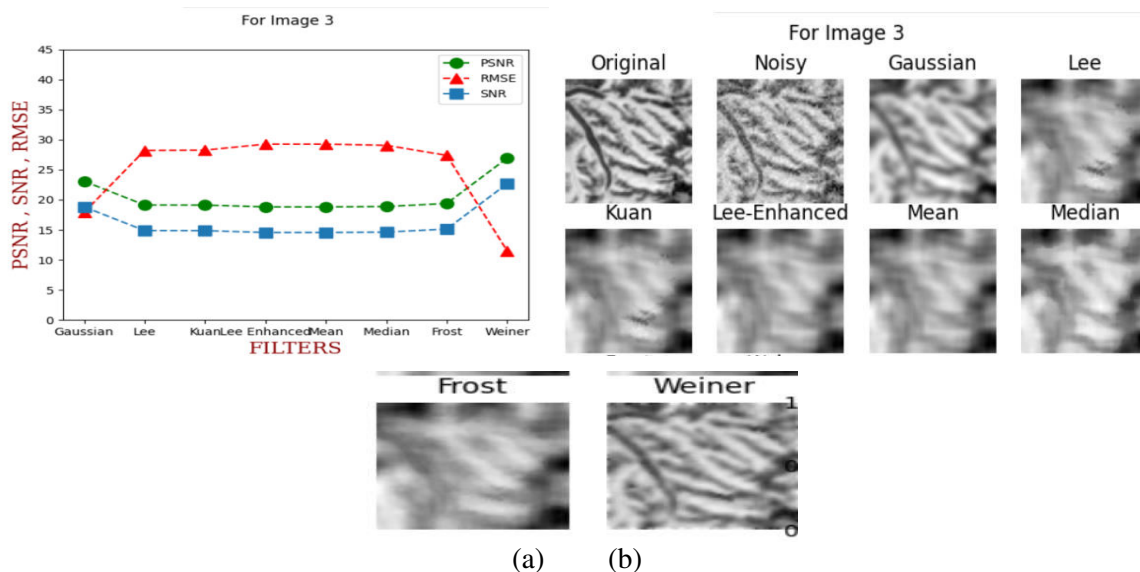
Fig. 4: Pre-processing based on EuroSAT images. Patch 3 (Herbaceous Vegetation) is selected for class understanding. (a) PSNR, RMSE & SNR Comparison (b) Output Noisy Patch 3 (Herbaceous Vegetation) after applying filters

b. Real Eurosat Images (Residential)

Table 2: (Image 8, iteration 8)

Filters	PSNR	RMSE	SNR
Gaussian	24.152788	15.808868	19.805739
Lee	21.879810	20.537599	17.532762
Kuan	21.879810	20.537599	17.532762
Lee-Enhanced	21.876589	20.545217	17.529540
Mean	21.876589	20.545217	17.529540
Median	21.715133	20.930689	17.368084
Frost	22.100614	20.022094	17.753565
Weiner	26.490310	12.078825	22.143261
Highest PSNR value is of Weiner which is 26.49031014782421. Hence, it's the best filter out of all.			

(a)   (b)

Fig. 5: Pre-processing based on EuroSAT images. Patch 8 (Residential) is selected for class understanding. (a) PSNR, RMSE & SNR Comparison (b) Output of Noisy Patch 8 (Residential) after applying filters

c. Real Eurosat Images (River)

Table 3: (Image 9, iteration 9)

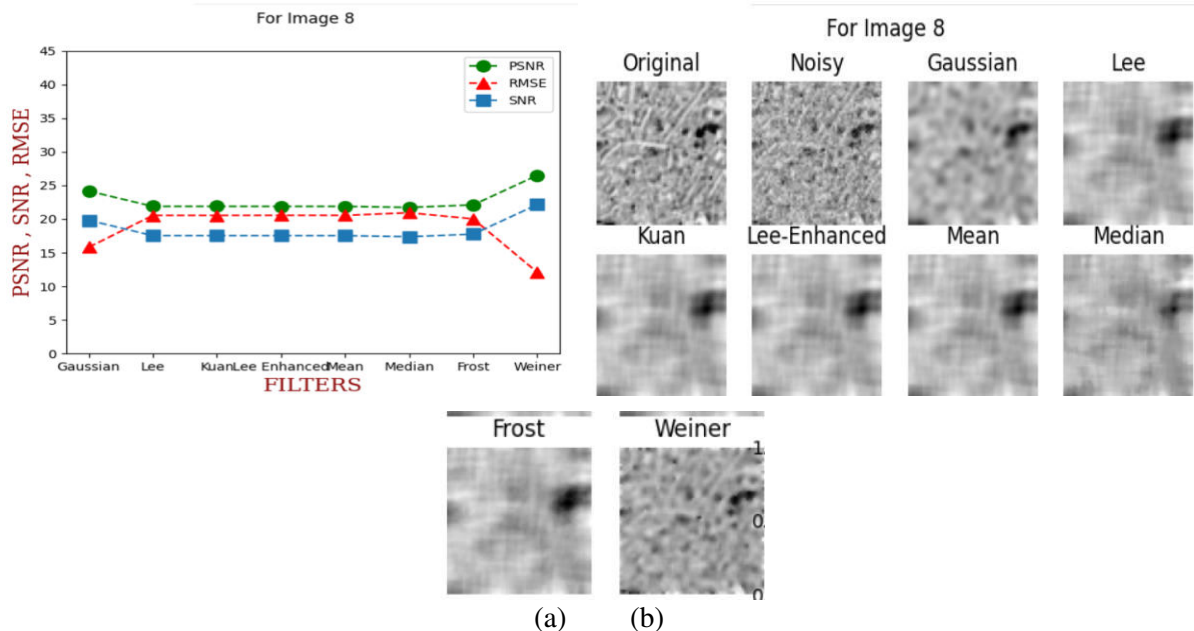| Filters	PSNR	RMSE	SNR
Gaussian	30.553363	7.566099	21.958760
Lee	27.832945	10.348871	19.238342
Kuan	27.828353	10.354342	19.233751
Lee-Enhanced	27.717580	10.487239	19.122978
Mean	27.717580	10.487239	19.122978
Median	27.935209	10.227741	19.340606
Frost	28.217625	9.900542	19.623022
Weiner	32.826641	5.823822	24.232038
Highest PSNR value is of Weiner which is 32.82664105443298. Hence, it's the best filter out of all.			

Fig. 6: Pre-processing based on EuroSAT images. Patch 9 (River) is selected for class understanding. (a) PSNR, RMSE & SNR Comparison (b) Output of Noisy Patch 9 (River) after applying filters
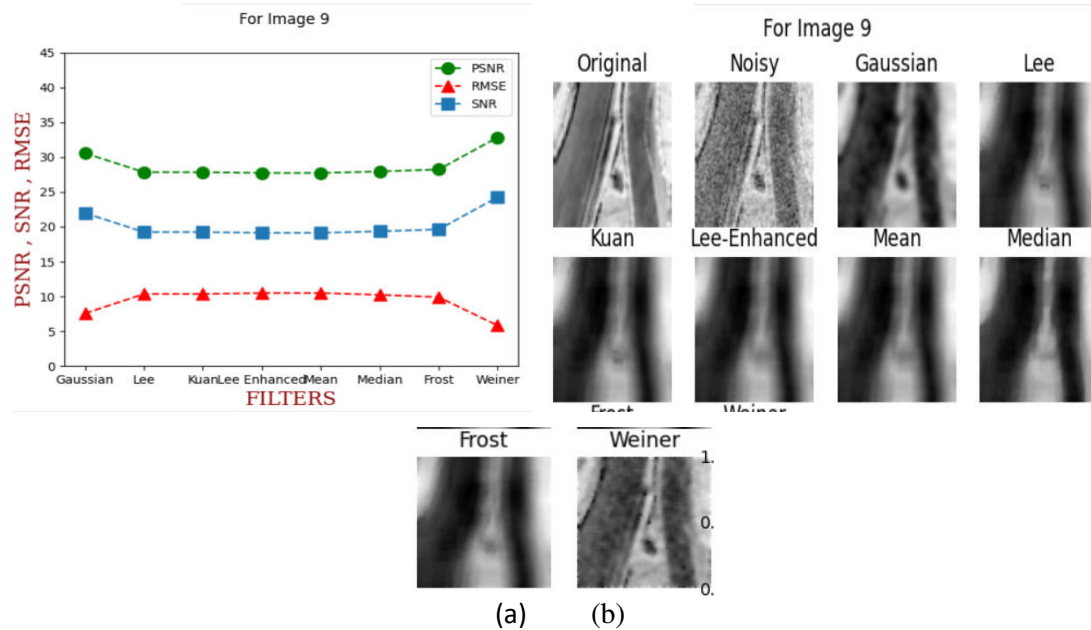
DISCUSSION AND CONCLUSION

In respect to the paper, in order to enhance the quality of image and minimize the speckle noise from the images received from the satellite, can be achieved by seven filtering techniques. Irrespective of the availability of the filters present in order to minimize the speckle; It has been observed that only certain filters are more appropriate to tackle the issue of speckle noise in the satellite images, also statistical parameters are determined for the purpose of the images to be expected from using all the filters. Here, the RMSE, PSNR and SNR statistical indicators are now being differentiated. The best statistical measure values with output images, including the filter name and related statistical measurement values are being shown. For this purpose, the EuroSAT dataset is depicted for the practical approach on the basis of satellite images. We have used this specific dataset from publicly open and available Sentinel-2 satellite image which is present in the program of Copernicus earth observation. The preferred dataset consists of 13 different spectral bands with 10 classes, accommodate a total of about 27,000 geo-referenced and labelled images. The referenced dataset may be utilized for various real world the implementations of earth observation. This dataset can be used for Land use and land cover classifications. From the results, it has been observed that the Weiner filter is giving better performance in comparison with other filters as shown in fig 4, 5 and 6.

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SYZYGIUM AROMATICUM (CLOVE): A SPICE AS A HERB

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ABSTRACT

The dried bud of Clove is used in food all over the world to add flavour. However, only a small percentage of users are aware of its medical qualities. Clove has been used for thousands of years across the Asian subcontinent, not just as a spice but also as an ayurvedic medication. Clove contains antioxidant, antibacterial, anti-inflammatory, and hepatoprotective biochemicals such as eugenol, ethanol, thymol, benzene, flavonoids, hexane, and methylene chloride, which add to its nutritional value.

Keywords: Antioxidant, β-caryophyllene, eugenol, eugenyl acetate, spice.

INTRODUCTION

Ayurveda, Chinese medicine, and western herbalism all use cloves. The scented dried flower buds of a tree in the Myrtaceae family are known as Syzygium aromaticum (Clove) [6, 17]. Cloves have also been found to be antimutagenic, anti-inflammatory [7], antioxidants [6], antithrombotic [17] , and antiparasitic [19]. According to Sofia et al., 2007 Syzygium aromaticum extract was the most effective against multidrug-resistant Pseudomonas aeruginosa and Escherichia coli [16]. It is highly valued for its medicinal properties and plays an important role in the spice trade. Cloves have a high amount of manganese. These also abundant in magnesium and calcium, as well as dietary fibre, vitamin C, vitamin K, and omega-3 fatty acids. Cloves, among other minerals, are abundant in proteins, iron, carbohydrates, calcium, phosphorus, potassium, sodium, and hydrochloric acid. They're also high in vitamins A and C, as well as manganese and dietary fibre [7]. Clove's most important component is phenylpropene eugenol, which gives it its characteristic aroma. The majority of the clove is made up of eugenol, which makes up 70 to 90% of the entire weight, with the remaining 15% consisting of dry weight [14]. Clove essential oil has been demonstrated to inhibit mould, yeast, and bacterium growth [2].

Botanical Classification

Kingdom: Plantae

Division: Magnoliophyta

Class: Magnoliopsida

Order: Myrtales

Family: Myrtaceae

Genus: Syzygium

Species: aromaticum

Botanical Features

The clove tree is an evergreen that grows up to 8-12 metres (26–39 feet) tall with large leaves and crimson blossoms placed in terminal clusters. When the flower buds are ready to be plucked, they first seem pale, then turn green, and ultimately turn a bright crimson colour. Cloves are picked when they are 1.5-2 centimetres (0.59-0.79 in) long and feature a long calyx that finishes in four spreading sepals, as well as four unopened petals that form a little central ball. Qaranful (Arabic), Karamfil (Bulgarian), Ding xiang (Chinese), Kruidnagel (Danish), Garifalo (Greek), Mikhaki (Georgian), Nelke (German), Szegfu (Hungarian), Cengkeh (Indonesian), Choji (Japanese), and Laung (Urdu/Punjabi/Hindi) are some of the names given to the Clove [11].

Phytochemical Constituents of Clove

GCMS analysis is commonly used to determine the chemical composition of this oil. The volatile oil in high-quality clove buds is composed primarily of eugenol (70 to 85 percent), eugenyl acetate (10 to 15 percent), and beta-caryophyllene (5 to 12 percent). The characteristic pleasant aroma of clove is due to minor ingredients such as methyl amyl ketone, kaempferol, gallotannic acid, -humulene, humulene, methyl salicylate, crategolic acid, and benzaldehyde [4, 10]. Clove buds contain 15-20% essential oil, with eugenol (70-85%), eugenyl acetate (15%), and β-caryophyllene dominating the composition (5-12 percent). Other essential oil components in clove oil include vanillin, crategolic acid, tannins, gallotannic acid, methyl salicylate, flavonoids such as eugenin, kaempferol, rhamnetin, and eugenitin, and triterpenoids such as oleanolic acid. The oil contains substances such as methyl amyl ketone, methyl salicylate, α and β-humulene, benzaldehyde, β-ylangene, and chavicol.

PHARMACOLOGICAL VALUE OF CLOVE

Antibacterial Activity

Sofia et al., 2007 during investigation found that 3% aqueous extract of clove was helpful against E. coli, S. aureus and B. cereus [16]. Ali et al., 2005 and Fu et al., 2007 studied antimicrobial activity of clove oil aginst and found it effective against S. aureus, S. epidermidis, B. subtilis e. coli, P. vulgaris, P. aeruginosa and H. pylori [1, 3]. Clove's inhibitory effect is attributable to the presence of several components, including eugenol, eugenyl acetate, β-caryophyllene, 2-heptanone, acetyl-eugenol, α-humulene, methyl salicylate, iso-eugenol, methyl-eugenol, phenyl propanoides, dehydrodieugenol, trans-con These compounds can denature proteins and react with phospholipids in cell membranes, causing permeability to be altered.

Antifungal Activity

Some studies have indicated that clove oil and eugenol have antifungal activity against yeasts and filamentous fungi, including several foodborne fungal species and human pathogenic fungi. Clove oil show strong antifungal activity against Candida albicans, Cryptoscccus neoformans and Aspergillus fumigatus due to presence of eugenol [12, 18].

Antiviral Activity

Eugenin isolated from clove bud essential oil exhibited a potent inhibitory effect against herpes simplex virus at a dose of 10µg/ml. Kurokawa et al., 1995, 1998 studied antiviral activity of eugeniin from Clove against Herpes virus and HSV-1 [8, 9].

Antioxidant Activity

Because of its high antioxidant activity, clove essential oil is one of the most well-known oils for food or supplementation. Clove and eugenol have antioxidant capabilities comparable to BHA and pyrogallol, which are synthetic antioxidants. Clove buds show higher antioxidant activity and polyphenol content like tetraethylammonium chloride, gallic acid and flavanol glucoside [13].

Anticarcinogenic activity

Clove essential oil has been proven to have anticarcinogenic and antimutagenic properties due to its strong free radical scavenging activity. Clove oil may have chemopreventive qualities, according to preliminary research, notably in cases of lung, skin, and stomach cancers. Clove ethyl acetate extract promotes cell cycle arrest and death while suppressing tumour growth. One of the components of clove ethyl acetate extract, oleanolic acid, was discovered to have anticancer properties. Eugenol also exhibited better curative outcomes in patients with skin cancer and melanoma.

Analgesic activity

To test the analgesic impact of eugenol, rabbits were given it intravenously and intragastrically. Paracetamol was a common medication. Eugenol was found to have a stronger ability to reduce fever than paracetamol. Because of its potential to ease tooth ache, eugenol is a typical analgesic used in dental offices [5].

Anti inflammatory activity

Clove oil works as an expectorant, clearing respiratory passages and treating a number of upper-respiratory ailments such colds, eye sties, bronchitis, sinus problems, cough, and asthma. Clove has been used to treat nose obstruction and musculoskeletal pain in traditional medicine, hinting that it has anti-inflammatory qualities [15].

Antithrombotic Activity

Clove oil inhibited platelet aggregation induced by arachidonic acid (AA), platelet-activating factor (PAF), and collagen. It inhibited AA and PAF-induced aggregation better than collagen (IC50: 4 and 6 M, respectively) (IC50: 132 M). Clove oil (50-100 mg/kg) gave 100 percent protection against PAF (11 mg/kg)-induced thrombosis and shock due to pulmonary platelet thrombosis, and 70% protection against AA (2.0 mg/kg)-induced thrombosis and shock in rabbits.

Anesthetic Activity

Clove oil is used as a safe anaesthetic in aquatic investigations. It has had a minor anaesthetic effect on humans and fish since antiquity. The major ingredient of clove oil, eugenol, inhibits the synthesis of prostaglandin H (PHS), which is why it is analgesic. Clove oil and eugenol have been discovered to be efficient anaesthetics for rabbit fish.

CONCLUSION

Based on above information we should develop more medicinal products from clove because it has antioxidant, antifungal, antiviral, antibacterial, anti-inflammatory, analgesic and other activities.

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UNDERSTANDING THE BASE COMMUNITY STRUCTURE IN THE DYNAMIC SOCIAL NETWORKS

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ABSTRACT

Community detection in dynamic evolving social network analysis is one of the most studied topics and has applications in many fields. Tremendous research is carried out in this field. Most of the studies focus on detecting communities on the initial static network known as base communities, and further updating these communities for evolving data. As base communities laid the foundation for processing the evolving data in dynamic social networks, it is essential to understand the base community structure. This paper deals with analyzing non-overlapping base communities in the undirected network. To understand the community structure and community parameters network internal as well as community internal parameters were used.

Keywords: Data mining, Graph, Dynamic social network, evolving data, community detection, modularity, incremental approach.

1 INTRODUCTION

Social network analysis deals with the qualitative and quantitative analysis of a social network [1]. To look at the larger view, a social network usually comprises entities tied by some connection or interactions based on a shared interest. To state an example, employees of an organization are connected as colleagues bound by the principles and ethics of that organization. Employees working at an organization share ties related to work, likes-dislikes, and friendship, and it becomes a necessity for the management to analyze the network consisting of its employees to run the administration, to solve and avoid disputes if any, and for the overall well-being of the organization. A social network thus comprises units or nodes connected in some way or the other and analysis of patterns formed by the relations or interactions between the actors is termed social network analysis.

Studying the pattern of relations in a network has become a popular area for research. To foster individual, local as well as global development, analysis of communities as a whole has led to a better understanding of causes and requirements thus leading to better provision and allocation of resources. SNA thus proves to be a significant tool for analyzing complex social structures [10]. These social networks are represented by a graph where the vertex (node) represents an individual or organization and interaction between them is represented by edges.

A community in the social network is formed based on the criteria that there exists a densely connected set of nodes as compared to the out-of-group interactions. Detection of such communities helps in understanding the foundations of interactions that take place between the nodes. The formation of communities laid a foundation for the analysis of huge social networks. An entire network can be partitioned into smaller clusters based on a condition that further makes it simpler to magnify a certain part of the network based on a requirement and analyze the properties of a community for the desired result. A large complex network consists of a huge number of vertices and edges and it is a tough task to extract useful information from such a network.

1.1 BASIC IDEA

In the real world, networks are broadly classified into static and dynamic networks [22]. The static network consists of fixed nodes and interactions between them. Whereas dynamic networks depict the ever-changing nature of networks over time. These changes can be accommodated in two ways. In the first approach, the communities are generated from scratch every time the network changes. In the second approach, initially at the first timestamp, communities are generated from a static network, and these communities will be updated for changing data in the dynamic social network. A variety of dynamic community detection methods are based on the second approach [2][3][4][5]. In the initial phase, the densely connected nodes are grouped into a single community (non-overlapping) referred to as the "Base community" in this research. Precise base communities are essential to generate the appropriate communities in dynamic community detection.

Community structure may be affected by the topological structure of the network like 'small-world', 'scale-free', or 'assortativity'. To understand the base community phenomenon the relation between network structure, community structure, and community phenomenon is discovered.

2   METHOD

Dynamic community detection is the process of dividing the network at each snapshot of a continuously changing network. Base communities are generated at the initial timestamp and updated at each snapshot in the dynamic network These communities will be adopting the changes in the network and accordingly update the community structure. To understand the base community structure properly, the relation between community internal parameters and community evaluation parameters with network internal parameters needs to be studied. The conceptual model of this research is given in figure 1.
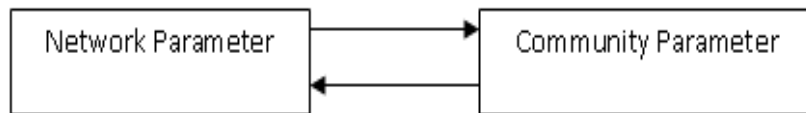
Fig.1: Conceptual model

To analyze the working of the verity of community detection algorithms, synthetic networks are often used. Lancichinetti, Fortunato, and Radicchi (LFR) [8] proposed the most realistic artificial network generator known as the LFR benchmark. Networks of varying sizes and network parameters are generated by LFR. The mixing coefficient mu defines the required average proportion of edges between a node in the community and nodes existing outside the community. The value of mu determines how the communities are defined in the network. Small values of mu indicate a smaller number of links between the communities. Thus, it detects clearer community structure in the network. Whereas a large value of mu makes community detection difficult. The values of tau1 define the power-law exponent for the degree distribution and tau2 define the power-law exponent for the community size distribution of the generated network. The average degree and minimum degree of the node in the created graph must be in the range of [0-n]. The values of parameters used for experimentation in this paper are given in table 1.

Table 1: LFR benchmark – used input parameters and their values.

Parameter	Value
N	100
Mu	0.1,0.2…….0.9
avg_degree	10, 20, ………90
$\tau 1$	1.5, 2.0, ………5
$\tau 2$	1.5, 2.0, ………5
min_community	20

Total 327 undirected networks are generated using the parameters given in table 1. In the initial timeframe t0, the existing non-overlapping community detection method is applied to the networks to discover the communities. Leiden algorithm [11] is an extension of the most popular method proposed by Blondel et.al [9]. Leiden algorithm is a three-phase process based on modularity maximization. Leiden algorithm ensures that communities are well-connected and faster than Blondel.

2.1   Networks are Characterized by the following Parameters

The number of nodes and edges defines the size and connectedness of the network. The ratio of no. of edges to the no. of nodes in the network is defined by the density of the network [12]. Density can be used to find communities in the network.

The clustering coefficient [16] is a measure of the degree to which nodes in a network tend to group. A high clustering coefficient indicates strong ties in the nodes of the community.

Small world measure [14] is defined by a high clustering coefficient with the shortest average path length between two vertices.

Scale-free network [17] is a network that has power-law degree distribution regardless of size. Assortativity [15] is the tendency for nodes to connect to other nodes based on the degree of the node. High degree nodes tend to connect high degree nodes and vice versa. The positive value of Assortivity indicates similar degree nodes are connected.

Algebraic connectivity [18] indicates how easily the network will synchronize. The second smallest eigenvalue of the Laplacian matrix defines algebraic connectivity. It is also known as the Fiedler vector.

The minimum number of paths between the two nodes in the network defines the shortest path [21] and the longest of the shortest path defines the Network diameter [19].

In this paper community evaluation measures used are modularity, number of communities, conductance, and coverage.

Modularity [20] is the most widely used measure in the community evaluation process. The basic intention of the community detection process is to find a group of densely connected nodes. Modularity measures the degree to which densely connected groups within a network can be decoupled into separate communities. Modularity value range (-1,1). Modularity value 1 indicated strongly interconnected nodes in the community also known as a strong community structure. To understand the number of nodes accommodated in the calculated communities, the number of communities parameter is important. The more the number of communities higher the nodes in the network processed and defined in the community.

Apart from modularity and number of communities, conductance, and coverage. Conductance [10] measures the connectedness of the community in the graph. The Low-conductance group of nodes tends to correspond to higher-quality communities. The community has a small conductance means there are many more connections within a community than between members of the community and nodes from outside of the community. The coverage [10] parameter is defined as the fraction of the no. of edges within the community to the total number of edges in the network. Disjoint communities have coverage value 1.

3 EXPERIMENTATION

To understand the quality and usefulness of detected communities the network community's internal parameters and their measuring parameters are correlated with network parameters. LFR benchmark generates artificial networks. To capture the heterogeneity in the generated network, the LFR benchmark network iterated twenty times for a single set of input values. It means around 6,540 graphs are generated. Concerning every graph, the network parameters mentioned above are calculated. On every graph, a non-overlapping community detection method is applied to detect the communities. Community is a subgraph of the network it is essential to understand the effect of network measures on community structure and evaluation parameters. For these generated communities along with the community internal parameters, community evaluation parameters are calculated.

After the community generation phase correlation between the network parameter and community parameter is calculated. The correlation between the community parameter and network parameters will be represented by a heat map as shown in figure 2.
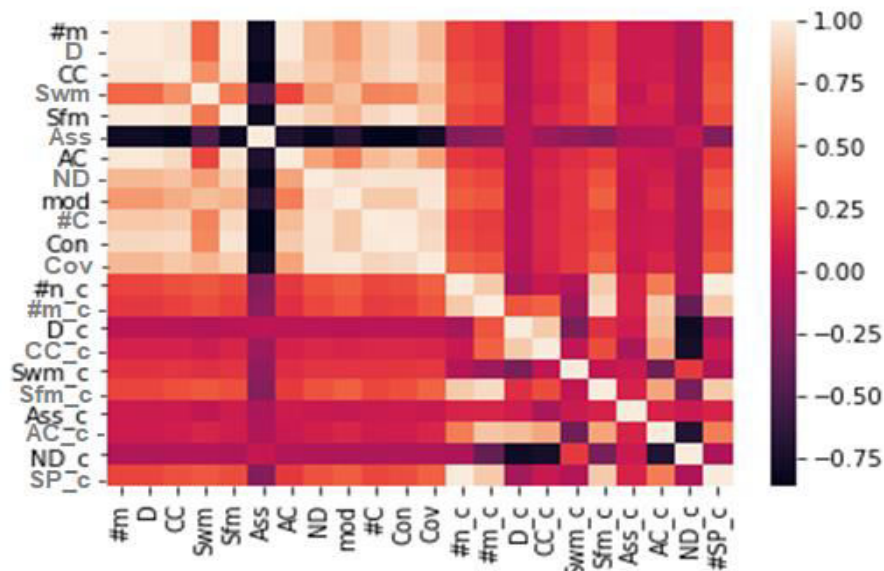
Figure 2: Correlation between network parameters and community parameters

Heat maps are used to visualize complex data that can be understood at a glance. Here, the number of edges(#m), Density (D), Small-world measure (Swm), Scale-free measure (Sfm), Assortivity (Ass), Algebraic connectivity (AC), Network Diameter (ND) describes network parameters. Modularity (mod), Number of communities(#C), Conductance (con), and Coverage (cov) describes community evaluation parameters.The number of generated communities (#n_c), the number of edges in the community(#m_c), Density of the community (D_c), Small-world measure of the community (Swm_c), Scale-free measure of the community (Sfm_c), Assortivity of the community (Ass_c), Algebraic connectivity of community (AC_c), Network

Diameter of the community (ND_c) describes community internal parameters. In this heat map, 'light' colors depict strong while 'dark' colors depict no correlation. From figure 2, all network parameters except small world measure are strongly correlated to community measuring parameters. Assortivity measure is inversely proportional to all community evaluation parameters. Also, it is observed that network parameters and community parameters are independent of each other. Thus, while updating the base communities the relation between the network and community parameters should be considered for better communities.

4 CONCLUSION AND FUTURE SCOPE

Most of the existing community detection techniques in dynamic social networks are two-phase processes. Initially, the base communities are discovered and these communities are updated for the changes in dynamic networks. As base communities act as a foundation for the further process precise base communities are needed. To understand the base community structure, the relation between the network structure and community structure is explored. It is observed that network structure parameters are correlated with community evaluation parameters and do not share any correlation with community structure parameters. To the best of our knowledge, no related research has focused on this aspect and thus observations presented here shall provide a better understanding of base communities, which act as a foundation for evolutionary data in dynamic community detection methods.

In social network networks, a node can be part of more than one community known as an overlapping community. In future work, overlapping base communities are analyzed.

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A STUDY ON HAND WASHING HABITS AMONG HIGH SCHOOL STUDENTS IN KERALA

SUNI K. P AND DR. DHINU M. R

ABSTRACT

Good health is an asset for individuals, their communities and the nation at large. A nation cannot progress without a healthy population. There are large numbers of factors which affect our health. Some of these are balanced food, clean water and clean environment which help to remain healthy while others such as germs and stressful environment cause diseases and disorders. Keeping your body clean is an important part of keeping you healthy and helping you to feel good about yourself.Every school have a major role to improve students health by providing clean toilets, soap for hand washing, purified water for drinking and other sanitization facilities. School authorities should give awareness classes for students regarding importance of personal hygiene.

INTRODUCTION

According to the World Health Organization (WHO), "Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases. Hygiene is a concept related to cleanliness, health and medicine. It is as well related to personal and professional care practices. In medicine and everyday life settings, hygiene practices are employed as preventative measures to reduce the incidence and spreading of disease.

Health is the level of functional and metabolic efficiency of a living organism. The World Health Organization (WHO-2006) has defined human health in its broader sense as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity". Health, or health and well-being, are also includes a supportive environment, personal security, freedom of choice, social relationships, adequate employment and income, access to educational resources, and cultural identity (Diaz et al., 2006; Millennium Assessment 2005). Over the last decade, health promotion practitioners have increasingly been asked to think about the relationships between humans and the environment in terms of ecosystems (Brown, 1994) and to adopt an 'ecological' approach to health promotion (Kickbusch, 1989) with the environment an integral part of human development (Hancock, 1993a).

Hygiene - specifically hand-washing with soap - is one of the most important interventions for human health and development and is a universal necessity.Developing educational and communication materials for WASH, and strengthening school health club programs, are also instrumental to reinforcing hygiene promotion in schools.

Chronic diarrhea can have a negative effect on child development (both physical and cognitive) In addition, lack of WASH facilities can prevent students from attending school, impose a burden on women and diminish productivity. Although access to sanitation has been improving over the past decades, the World Health Organization (WHO) estimates that still "2.5 billion people – more than one third of the global population – live without basic sanitation facilities". In 2015, 750 million people lacked access to safe, clean drinking water and approximately 2,300 people die every day from diarrhoea.

Presently an attempt to evaluate the frequency of hand washing and hand-washing with soap after using toilet is a mark of ensuring hygiene.   Diarrhoeal diseases kill 2 to 3 million children in developing countries every year. Hand washing with soap alone could cut deaths into half UNICEF reports "one of the major problems faced by hundreds of millions of school-age children is infection by parasites and flukes. Water and sanitation related diseases affecting children include diarrhoea, trachoma, schistosomiasis, scabies, and Guinea worm. All of these compromise children's attendance and performance at school and, not uncommonly, can result in death" (Annan, 2001)

RESULTS

During the Past 7 Days, how did you usually Wash your Hands before Eating at School?

Classification of school students based on washing hands indicates that 16.35 percent of boys and 10.10 percent of girls never washed their hands before eating at school. While 68.73 boys and 87.53 percent of girls do wash hands in a dish of water used by others, 13.49 boys and 2.26 percent of girls do wash their hands before eating in a dish of water used only by themselves.At same time 1.43 percent boys and 0.12 percent girls do wash their hands before eating under running water or tap.

Classification of School Students Based on Washing Hands

Responds	Boys		Girls		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
No Wash	217	16.35	85	10.10	302	13.92
In a dish of water used by others	912	68.73	737	87.53	1649	76.03
In a dish of water used only by me	179	13.49	19	2.26	198	9.13
Under running water or tap	19	1.43	1	0.12	20	0.92
Some other way	0	0.00	0	0.00	0	0.00
Total	1327	100.00	842	100.00	2169	100.00

Classification of School Students Based on Washing Hands

	No Wash	Wash used other	Wash used Me	RW/Tape	SM other
Boys	16.35	68.73	13.49	1.43	0
Girls	10.1	87.53	2.26	0.12	0
Total	13.92	76.03	9.13	0.92	0
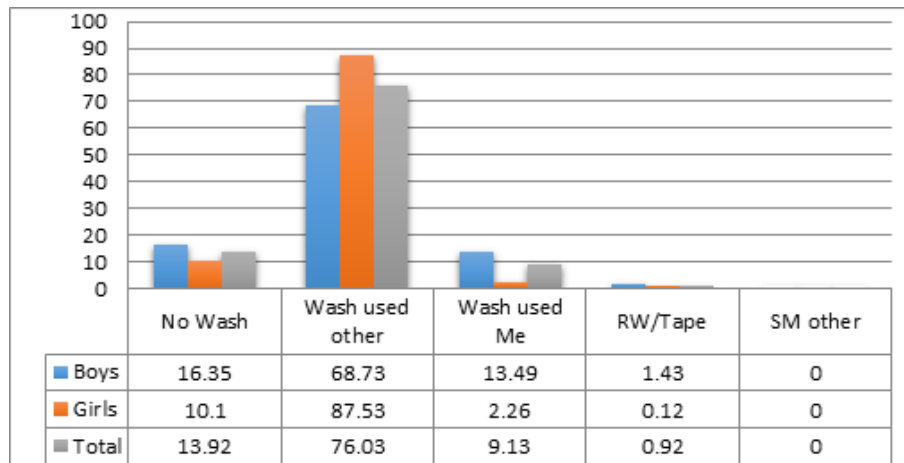
Classification of school students based on safe toilet at School reveals that 63.15 percent of the boys and 54.16 percent of the girls had the privilege of safe toilets while 36.85 percent of boys and 45.84 percent of girls did not have safe toilets at schools

Classification of School Students Based on Safe Toilet at School

Responds	Boys		Girls		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Yes	838	63.15	456	54.16	1294	59.66
No	489	36.85	386	45.84	875	40.34
Total	1327	100.00	842	100.00	2169	100.00

Classification of School Students Based on Safe Toilet at School

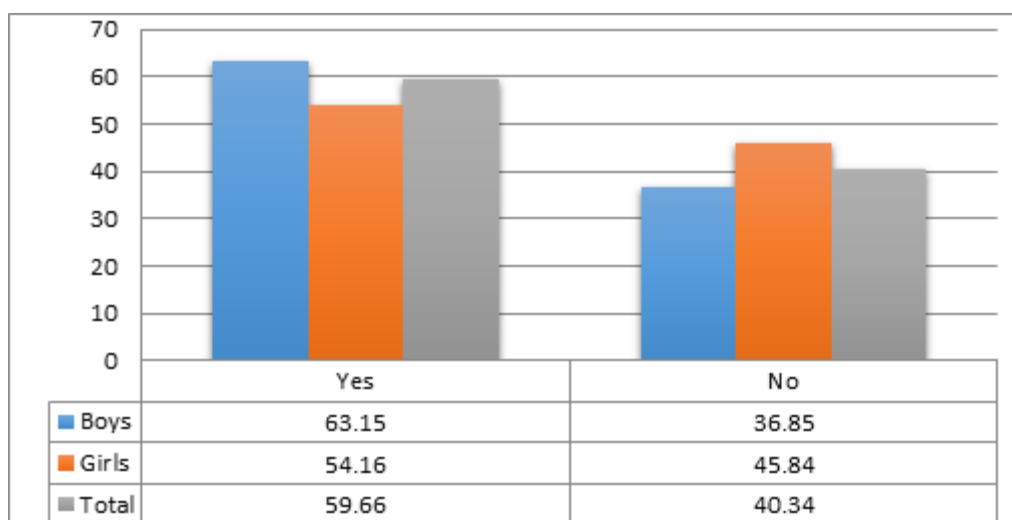|	Yes	No
Boys	63.15	36.85
Girls	54.16	45.84
Total	59.66	40.34

Classification of school students based on clean toilet at School shows that65.11 percent of the boys and 52.26 percent of the girls had the privilege of clean toilets while 34.89 percent of boys and 47.74 percent of girls did not have clean toilets at schools

Classification of School Students Based on Clean Toilet at School

Responds	Boys		Girls		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Yes	864	65.11	440	52.26	1304	60.12
No	463	34.89	402	47.74	865	39.88
Total	1327	100.00	842	100.00	2169	100.00

Classification of School Students Based on Clean Toilet at School

	Yes	No
Boys	63.15	36.85
Girls	54.16	45.84
Total	59.66	40.34
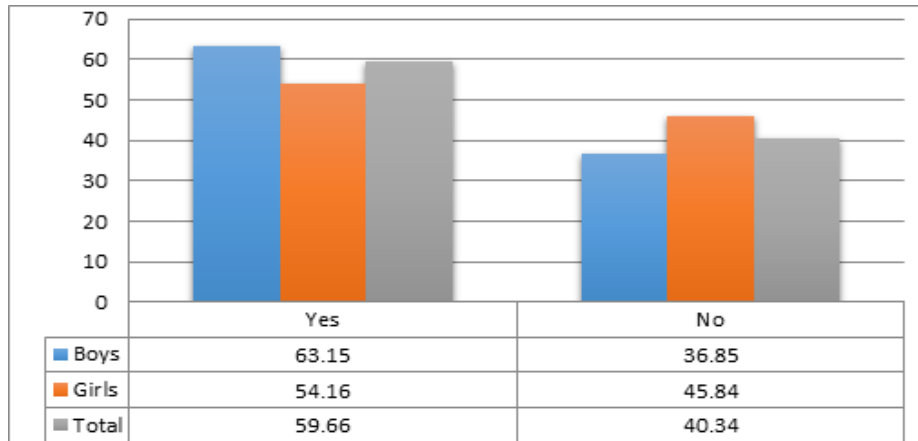
Classification of school students based on washing hands after toilet use soap indicates that 65.79 percent of boys and 73.63 percent of girls never washed their hands with soap after using toilet while 19.22 percent of boys and 19.71percent of girls rarely washed their hands after using the toilet.

Classification of School Students Based on Washing Hands after Toilet Use

Responds	Boys		Girls		Total	
	Number	Percentage	Number	Percentage	Number	Percentage
Never	873	65.79	620	73.63	1493	68.83
Rarely	255	19.22	166	19.71	421	19.41
some time	114	8.59	21	2.49	135	6.22
most time	57	4.30	26	3.09	83	3.83
always	28	2.11	9	1.07	37	1.71
Total	1327	100.00	842	100.00	2169	100.00

Classification of School Students Based on Washing Hands after Toilet Use

	Never	Rarely	some time	most time	always
Boys	65.79	19.22	8.59	4.3	2.11
Girls	73.63	19.71	2.49	3.09	1.07
Total	68.83	19.41	6.22	3.83	1.71
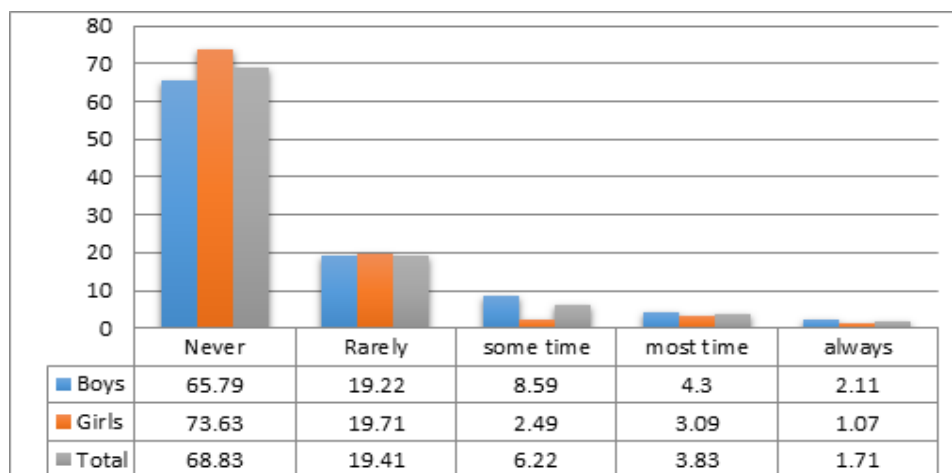
DISCUSSION

Hygiene is an issue of paramount importance especially in children for their healthy well-being. Further, food and drinking water is a major source for the spread of infection. Associated with this the habits like washing one's hands with soap after each visit to the toilet and drinking purified water to prevent dysentery, gastroenteritis etc. play a major role in preventing infectious disease.

Diarrhoea accounts for the death of two to three million children in developing countries every year (WHO, 2015). Proper hygiene like washing ones hands regularly with soap alone would cut this toll to fifty percent.Present data reveals that there exist lacunae in this aspect among the High school going students. Washing hands indicates that 16.35 percent of boys and 10.10percent ofgirls never washed their hands before eating at school.

The availability of safe toilet at schools reveals that only 63.15% of boys and 54.16 % percent of the girls had the privilege of safe toilets while 36.85 percent of boys and 45.84 percent of girls did not have safe toilets at schools. When it comes to clean toilet 65.11 percent of the boys and 52.26 percent of the girls had the privilege of clean toilets. Present study on the habit of washing hands using soap after using toilet indicates that 65.79 percent of boys and 73.63 percent of girls never washed their hands after using toilet while 19.22 percent of boys and 19.71percent of girls rarely washed their hands using soap after using the toilet, is in fact a matter for grave concern given the nature of spread of contagious diseases in today's world. While, the overall state percentage of students never or rarely washing their hands with soap is ameagre21.75%. UNICEF figures on mortality as a consequence of lack of basic sanitation facilities and safe drinking water is a staggering 2.6 billion annually. Also, thousands of children die on daily basis owing to diarrhoea and other water born diseses.

CONCLUSION
Present study reveals that majority of students including boys and girls habitually are not inclined to washing their hands after using toilets. This is a matter of grave concern affectint the overall health and wellbeing of the community at large, therefore a concerted effort is required to create an awareness to inculcate this aspect of hygiene in high School students.

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DIFFERENTIAL PRIVACY PRESERVATION APPROACHES FOR DISTRIBUTED DATA SECURITY FOR LARGE DATASET

ROHIT RAVINDRA NIKAM AND DR. REKHA SHAHAPURKAR

ABSTRACT

Objectives: *To propose suitable privacy preservation techniques during data distribution in distributed environment.*

Methods*: This study has proposed privacy preservation techniques for the sizeable unstructured dataset. The different privacy preservation approaches have been implemented involving fingerprint insertion and removal. The anonymization, generalization, random permutation, slicing and fingerprint generation methods were used during data distribution. The framework demonstrates huge data privacy protection and fingerprint insertion system displays good data security, and unique fingerprints are generated using fingerprint insertion algorithms. The real time health care dataet has been used for ditrbution that contains around 100000 records. The evaluation was done with a stand-alone machine and a Hadoop Distributed File Systems (HDFS) environment.*

Findings*: If one fingerprinted tuple is absent in the database, this technique provides 100% privacy, according to the experimental results. To offer copyright protection to information in big data, certain fingerprint approaches are applied. In addition, the proposed system includes hashing-based insertion and detection algorithms that minimize fingerprint insertion and detection time while avoiding collisions.*

Novelty and applications*: This system provides higher privacy on large unstructured data during the distribution. These proposed fingerprint insertion and removal techniques provide internal and external data leakage attacks. Using this method system can easily identify the traitor when any malicious event has happened.*

Keywords: key generation, anonymization, fingerprint insertion, distributed systems, SHA-256, hash generation, data protection.

1. INTRODUCTION

The privacy preservation-based service recommendation is very popular due to social media advancement [1]. Privacy preservation is about obtaining data mining algorithm results without jeopardising the underlying dataset. Data mining methods are scrutinised for privacy issues with data privacy approaches are described in [2]. When it comes to data mining privacy, the two-fold is crucial. First, any sensitive raw data in the dataset is recognised and deleted from the original database, guaranteeing that the receiver does not compromise the authenticity and privacy of other people's personal data. Second, sensitive data mining information should be destroyed to protect individual privacy. The numerous data privacy preservation techniques cannot detect similarity attacks [3] [4]. Data leakage is another issue during the data distribution in a distributed framework. We proposed differential privacy preservation techniques to eliminate those problems during the data distribution on large datasets.

The major contribution of this research to develop a privacy preservation technique during the data distribution of sensitive data. This work has evaluated with bigdata environment and numerous privacy preservation techniques are applied on broadcasted data. K-anonymity is a modern privacy concept. K-anonymity ensures that no data can be traced to a group of fewer than k persons. This section we also describe a various state-of-art systems developed by various existing researchers. This section also focused on techniques used and influence on privacy of data during distribution in trusted as well as untrusted environments.

To avoid the sensitive variance attack while publishing electronic health information, Khan et al. [1] proposed the -sensitive k-anonymity privacy model, in which the threshold defines the diversity level of an equivalence class. There is a detailed assessment of data publication that protects privacy.

Lee and Chung [2] provided a mechanism for distributing an original dataset's e-DP version. To construct an e-DP version of an original dataset, the approach suggested in [3] employs anonymization methods based on generalisation, suppression, and insertion, as well as DP. Encryption, interruption, and anonymity are the three primary privacy protection strategies. Encryption is a valuable way of data security; AES [3] is a popular

encryption algorithm. The encryption approach, on the other hand, has the most complexity of the three. Disruption is the process of introducing noise to data in line with a predefined distribution, making it harder for attackers to collect data precisely, such as differential privacy.

Data breaches [4] and the abuse of user data [5] are no longer surprising to the ordinary customer, resulting in friction between users and suppliers. Personal data protection legislation exist in countries such as the USA, the European Union, Japan, and Taiwan to encourage businesses to respect their customers' privacy and give greater protection. For example, under GDPR, the EU may levy significant penalties for data privacy breaches of up to 4% of a company's annual worldwide sales or up to EUR 20 million. Several clauses of the GDPR guarantee that a user has significant control over the information in specified instances.

Vendors must pay closer attention to user privacy not only to avoid hefty fines that could hurt their bottom line, but also to maintain long-term relationships with their customers. Following the Facebook–Cambridge Analytica data controversy, users tightened their privacy settings on the site, complicating Facebook's capacity to exploit user data, according to Rohit Nikam and Rekha Shahapurkar [6]. Implementing more severe privacy protection rules and procedures enables vendors to establish long-term connections with consumers, allowing them to gain a competitive edge from big data.

The motivated intruder test [7], which is outlined below, is used by the UK ICO to put the ideas into practise. On the one hand, the intruder has no previous knowledge of the data, is not involved in any criminal activity, and is not in the business of jeopardising data security. On the other side, the invader has a reason to invade a person's privacy and may reidentify an individual using other public data sources such as information systems, libraries, and also the Internet.

The idea of k-anonymity is the most popular among nontechnical people when it comes to engineering solutions for organisational data analysis. Some areas and nations have included pertinent notions into their legislation. In the draught of the Verification Guidelines for the Process of Personal Information Deidentification issued by Taiwan's National Standard Technologies Council [8], for example, indirect or developed a semi and k values are mentioned.

In [6] states that smart settings leverage big data and IoT-based apps. The purpose is to discover key application areas, trends, data formats, and challenges. This is the first comprehensive research of its kind, assessing academic publications published in peer-reviewed journals between 2011 and 2019. They conducted a comprehensive review of these data, addressing six main study topics. Researchers discovered that emerging big data and IoT technologies may be used to monitor, maintain, and improve natural resources. This research looks at smart environment monitoring, smart agriculture, smart metering, and smart disaster alerts.

According to [7], the kernel weights do not need to be normalised. Our method employs many Laplacians of affinity weights to decompose the input image from fine to coarse scale. To avoid noise/artifact amplification or detail loss, a structural mask mixes these image components. With only a few control parameters, the proposed method adds to existing image editing tools by providing: 1) low computational and memory requirements, making it suitable for mobile device implementations (e.g., as a final step in a camera pipeline); and 2) a range of filtering application areas from detail enhancement to denoising.

The novel intrusion detection classification accuracy using a novel ensemble SVM-based CGO approach. Pre-processing removes unwanted, noisy, and redundant data from the dataset according to [8]. A CGO approach is utilised to increase classification accuracy of the pre-processed data. This data is evaluated to make better business decisions. Organizations employ big data analytics tools and software to improve marketing, revenue opportunities, and operational effectiveness.

The [9] a four-dimensional framework for evaluating and creating privacy-preserving big data analytics technologies. They also assist identify the potential advantages and drawbacks of commercial big data analytics that protect privacy. The authors provide five privacy-preserving big data analytics tips for businesses. It is the first comprehensive study we know of on privacy-preserving big data analytics. Our research may help firms enhance their strategic use of big data analytics in the workplace and better harness big data for long-term organisational innovation and growth.

According to [10] the current PPDM strategies are thoroughly examined and categorized based on their data modification methodologies, which is the study's key contribution, which will aid researchers in this subject in developing a thorough grasp of PPDM. Furthermore, the benefits and limitations of different PPDM approaches were compared and studied in this research. The massive increase in keeping customers' data (i.e., big data) has

spawned a new study field known as privacy-preserving data mining (PPDM). A fundamental challenge in PPDM is how to change data using a particular technique to construct a strong data mining model on modified data while satisfying a stated privacy requirement with little information loss for the intended data analysis activity. The present review research aims to use data mining jobs without jeopardizing the security of people's sensitive information, especially at the record level.

According to [11] a examines and analyses these vulnerabilities, and proposes an architecture called the BD federation accessibility broker to overcome the eight major security flaws. The federated authorization reference model is proposed in this work to codify the creation of secure BD solutions in the Apache Hadoop stacking overview of known challenges to privacy and security caused by big data as the main driving factor inside the AI and ML pipeline to study the assaults, we design an adversarial model. In addition, we examine and describe the assaults' defensive techniques and responses. It look at Standards Developing Organizations (SDOs) that are actively engaged in establishing guidelines to preserve privacy and assure the security of big data and AI systems, given the influence of AI systems in the market and across the overwhelming majority of business sectors. Our long-term objective is to bridge the gap between research and standards to improve the consistency and efficiency of AI system development while ensuring customer satisfaction and a high level of trustworthiness.

According to [12] big data is critical in various industries, including finance, information technology, aerospace, and medical applications. The purpose of this subject is to handle heterogeneous data, and new techniques and scientific approaches are required due to the increasing expansion and demand in this field. As a result, ongoing difficulties must be addressed as technology advances and data accumulates at an unpredictably rapid rate. They give protection, the security measures & issues facing big data technology are highlighted. For the comprehensive performance metrics for big data, analysis to retain the possible risk and privacy problems related to data security are effective.

According to [13] a careful examination of privacy-preserving big data analytics the authors provide well-designed taxonomies that provide systematic and rigorous classifications of this difficult study subject. The phrase "big data" has lately gained popularity. We have seen the phenomenal expansion of data in terms of greater volume, higher velocity, and more diversified variety, thanks to the proliferation of social networks, the Internet of Things (IoT), and outsourced cloud computing.

The study focuses on massive data management security and privacy issues, according to [14] for CPS. They analyse performance attributes, dependability, and failure rate in a hostile big data environment. In cyber-physical systems, communication, networking, and computing are all combined. Cyber-physical systems regulate and monitor human-made systems and are closely linked to the Internet and its users through computer-based algorithms. A Weibull distribution-based intrusion detection probability model examines the system's performance metrics, reliability, and failure rate. In terms of false negative and positive probability for each attack strategy, they looked at how the system's reliability increased.

According to [15] the K – mean clustering method, which is based on better map reduction techniques, was the focus of the study. They may use the method to reduce unneeded input and output data, optimize data storage, and accomplish data privacy outsourcing. We used this project's medical datasets, and we suggested an enhanced map reduction-based K – means clustering method that works well and can be outsourced to a cloud server. Big Data is a rapidly evolving technology encompassing massive data collections that are inefficiently handled using standard computer approaches. Map Reduce is a novel way to reduce the amount of storage space required for massive datasets. The concept behind map reduction is to divide a file into blocks and verify the presence of each block in the storage. PPDDM approaches were reviewed in 231 scholarly publications published in the last 20 years, according to [16]. Compare the solutions and identify the field's remaining issues. This analysis highlights the absence of standard criteria for evaluating new PPDDM approaches and provides ten specific criteria. This paper will explore the unclear definitions of privacy and security in the industry and how to establish a clear and suitable privacy description for new PPDDM approaches.

The [17] study location privacy protection for non-uniform dispersed road networks. Meanwhile, view LBS's cost function as a mixed-integer programming issue. A road truncation strategy is proposed to safeguard location privacy. The high-density road portion is meant to be shortened. According to [18], the system provides a systematic review of alternative privacy preservation options and a critical study of current privacy-preserving big data analytics strategies. A four-dimensional framework is proposed for studying and creating next-generation privacy-preserving extensive data analytics methodologies. So that we may better understand how privacy-preserving big data analytics might benefit businesses, this article offers five tips for using privacy-

preserving big data analytics in business. This is the first thorough research on privacy-preserving big data analytics.

The [19] goals are to deepen the patent data, manage the data access procedure, and secure the patent data. Examining established patent review procedures, the patent data are saved on multiple block nodes following data fragmentation utilising blockchain technology. Then the data is encrypted and shared. Thus, data access control may be limited to certain people. According to [20], This research proposes a technique to secure data privacy for distributed data mining in the edge-cloud scenario. Because participants may have restricted computational capabilities, building a model using a learning technique like an artificial neural network (ANN) isn't easy. So, using the AdaBoost framework, we present a distributed data mining approach to lessen reliance on computing resources and data collecting. [21] This study has three sub-modules: parsing, mining, and noise. Modules include a composite grammar and a noise theory. The PQL framework uses differential privacy theory to ensure the security of diverse mining techniques. However, the mining outcomes rely on their collaboration.

The [22] presents a PHT implementation that respects data providers' sovereignty and autonomy while using few communication channels. Conduct a DA use case using data from three dispersed data suppliers. The [23] crowdsensing architecture is not safe because of its centralised design and single point of failure. Adversaries may employ linkage attacks, Sybil attacks, and DDOS assaults to get node identities or other important information. The position of crowd sensors is potentially a potential attack vector. As a result, various blockchain-based approaches must be presented to achieve blockchain privacy. The solution may either be a crowdsensing environment on a private blockchain or smart contracts that protect users from various blockchain threats.

The main objective of maintaining privacy during data mining is to build a solution that modifies the original dataset while preserving privacy. K-anonymity is a modern privacy concept. K-anonymity ensures that no data can be traced to a group of fewer than k persons. A database owner wishes to guarantee that no one can connect the data obtained from the dataset to the people who developed it. The rest of the study is divided into the following sections: Part II addresses previous research's privacy preservation methods. Section III depicts the materials and methods employed in the proposed system implementation, whereas Section IV depicts the suggested algorithm definition. Section V describes the experimental setting for evaluating the planned work and results using our strategy, as well as comparisons with other current techniques. Section VI discusses the finished work and its prospective scope, while Section VII conclusion of future work.

2. MATERIAL AND METHODS

2.1 INTRODUCTION

This section we discuss a privacy preservation approach that works with vertically partitioned data that is spread over many places. The privacy technique provides datasets that fulfil the k- anonymization and other privacy output, that allowing data to be disseminated for mining purposes. The two methods we prposed these are geove below

1. **Hash Base Data Privacy**

2. **Key Encryption Based Data Privacy**

This methods provide unique solution for data rivacy during the distribution, and its effective when it deals with fingerprint insertion technique. The data that has been tampered with is then released for privacy preservation and distribution process. The cost of data extraction on a steeply or horizontally segmented dataset is the cost of preserving private information. Perturbation is a technique for preventing data from being revealed. It's a heuristic-based strategy that distorts the original data to protect individual information.
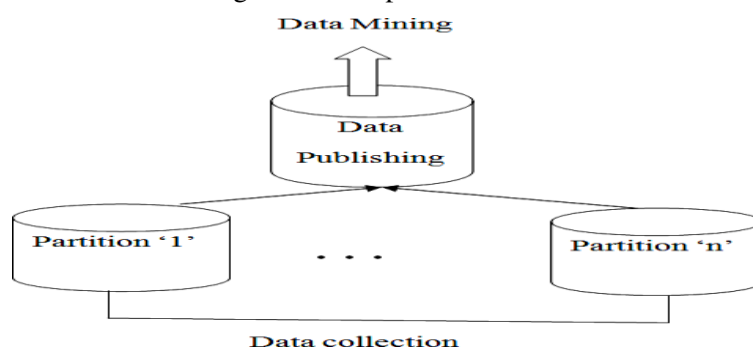
Figure 1: Privacy preservation data distribution techniques

Generalizing, suppressing, aggregating, blocking, and swapping are some of the disturbance strategies. This method is one of the most private data mining techniques for centralized data, but it comes at the expense of accuracy. Both the data supplier and the centralized server that publishes the skewed data are aware of how the noise is introduced. The perturbation algorithm's success is predicated on the idea that the injected noise will make it difficult for the centralized server to distinguish the original confidential material from the particularly challenged

2.2 K-Anonimity

Definition: An index of useful information If T is separated into a parcel, each gathering Gi (1 = I = p) in the section has at least K records, and T is either averaged or inspected, T fulfils K-obscurity. When private columns are discharged for detection purposes, names are removed from the table in order to de-recognize the person; yet, by coordinating moderately from the confidential table with those from the open table, one may surely view the individual. In this way, k-Anonymization is utilised to make k tuples comparable in any case via assumption or suppressing. Generalization is a technique for replacing property estimates with less accurate but semantically unsurprising attributes. For instance, the month of derivation may be replaced with a consistent date origination that appears in more records, making the identification of a certain person more difficult. Obfuscation implies removing a specific biological esteem and replacing incentive opportunities with an unique esteem "*," displaying that any esteem may be inserted rather than an unique set of characteristics esteem.

2.3 L-Diversity

The top-down algorithm is similar to the base-up method. The main difference is in the order in which coalition checks are performed, starting with 0-foe and working up. When an infringement by any foe is detected (early stop) or all m-foes are examined, the algorithm comes to a halt. The basic idea of a bottom-up speculating method is represented by the algorithm. It begins speculating with the rudimentary data table T. At every point in time, the algorithm selects the best speculation g that minimises data loss and improves protection detection. The data measure ILPG(g) = IL(g)/PG captures this inclination (g). The algorithm then performs the speculation child (Best) Best on the table T and repeats the cycle until the table T satisfies the provided k-anonymity requirement.

2.4 Hash Base Privacy Preservation Techniques SHA 256 Hash Function

Bottom-Up Generalization is a k-anonymity strategy that works well. Each record in a k-anonimity objective gathering is indistinguishable from at least k-1 other records relating QID. Fundamentally, the Bottom-Up Generalization (BUG) method to steganography is an iterative method that starts with the lowest degree of anonymization and progresses to the highest level of anonymization. For our technique, we utilise the statistical information trading off as the scan measure, i.e., the Information Loss per Privacy Gain (ILPG). The Advanced BUG entails the following steps: segment data, run the MRBUG Driver on divided proportionally information examination, join the obfuscation levels of the parcelled assortment of sources, and apply assumption to unique assortments with fully integrated cryptographic protocols levels without mistreating the k-anonymity.

When the hypothesis g is true, let A(QID) and Aggregated (QID) be the base anonymized values in T. There are several possible assumptions that may be conducted given an information table T. However, the majority of hypotheses have no bearing on the overall anonymity tally. In a sense, A(QID) = Ag (QID). As a result, there is no compelling reason to consider all hypotheses in order to promote productively selecting a speculation g. To be sure, we may limit ourselves to the most fundamental hypotheses.

2.5 Security Analysis

Starting with (n-1)-adversaries and working down until an infringement by an m-adversary is identified or all G m-foes are pruned or checked, the Top-down method examines the coalitions in a best down way using descending pruning. When dealing with large scale informational indexes on the HADOOP platform, we use this strategy to overcome the adaptability problem of previous TDS techniques. TDS is a repetitive procedure that starts at the top space esteems in trait action trees and works its way down. Finding the optimum specialisation, executing specialisation, and updating hunt metric estimates Such a TDS technique is repeated till k-anonymity is broken, in order to illustrate for the most information would be used in that. An inquiry metric is used to determine the exemplary character of a speciality. Different android application authorizations are obtained from android apps. These authorizations serve as a dataset for the processing. In this way, we use the data gain per security loss (IGPL) as the inquiry measure in our method, which is a trade-off statistic that prioritises both security and data needs. The specialisation with the highest IGPL value is considered the best and chosen for each round. Whenever you get a Top-Down Specialization response, The user may go through each specialty to find a desirable balance between protection and accuracy. Clients may pause at any time and

get a summarised table that satisfies the anonymity requirement. Taking care of both blatant and incessant qualities. Produce a scientific classification tree for constant attributes gradually.

A few approaches for anonymizing information on a small scale have been presented. Speculation for k-anonymity and bucketization for 'l-decent variety' are the most popular. Property is divided into three categories using the two methodologies:

- A few properties are qualifiers, such as Name or Social Security Digit;

- A few properties are Quasi Identifiers (QI), which the enemy may definitely know (possibly from other freely accessible repositories) and which, when considered together, can possibly recognise personnel, such as Birth date, Sex, and Zip code;

- A few properties are Sensitive Attributes (SAs), which are obscure to the foe and are viewed as touchy;

- A few between speculation and bucketization, one first removes identifiers from the data before segmenting tuples into cans.

In the next step, the two techniques are compared. Speculation transforms each container's QI-values into "less specific but semantically dependable" qualities, so that tuples in the same can't be distinguished by their QI esteems. By randomly permuting the SA esteems in each container, bucketization separates the SAs from the QIs. An arrangement of pails with permuted sensitive property estimates makes up the anonymized data.

Cutting vertically and on a level, plane splits the informative gathering. Vertical parcelling is completed by dividing attributes into segments based on their interrelationships. Each part has a collection of qualities that are intimately linked. By combining tuples into horizontal partitioning, even splitting is completed. Finally, values in each portion are carelessly permuted (or placed) within each can to break the linking between distinct segments. The basic idea of cutting is to break the affiliation cross sections while maintaining the link within each segment. This reduces the information's dimensionality and favours usefulness above conjecture and bucketization. Cutting jam is useful because it puts closely related characteristics together and preserves the links between them. Slicing guarantees protection by disrupting the link between unrelated features, which are uncommon and hence distinguishable. Consider that, although the informational index consists of QIs and one SA, bucketization necessitates the disruption of connections; on the other hand, cutting may combine a few QI characteristics together with the SA, maintaining property associations per delicate feature. Cutting provides security assurance in the sense that the slicing mechanism ensures that for given tuple; there are often many coordinating containers.

2.6 Computation and Communication Evaluation
This study secures relational tables by using various privacy methods to provide identity protection and traitor detection using fingerprints techniques in a distributed setting with little distortion.
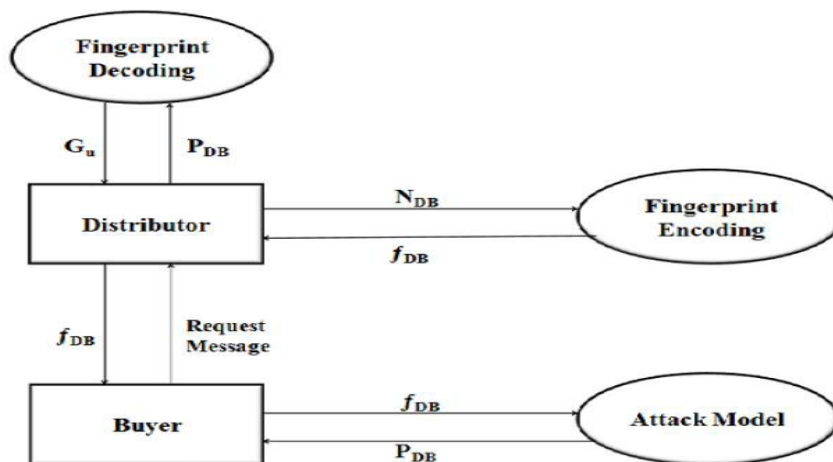
Figure 2: Privacy protection using fingerprint insertion technique

Distributed computing is gaining traction as a viable model for enabling rapid period for today's large-scale data-intensive implementations. Via programmed asset booking, portioning, and knowledge management, this model provides efficient resource usage, improved execution, and responsiveness. The MapReduce model is increasingly being used for realizing parallel software bases, which reorganizes the application development process for incredibly dynamic figuring bases. Many implementations specific diagram choices must be made

when constructing a MapReduce setup, including hub mechanism force and network consists, document structure selection, knowledge discovery and apportionment, and device topology selection, to name a few. In addition, a typical setup can require the fine-tuning of a number of parameters in order to achieve optimal performance. With the exception of a few site-specific interactions, such as Google's MapReduce platform, this configuration area is mostly uninhabited. In any case, determining how applications will work on specific MapReduce setups is essential, particularly when optimizing existing setups or creating new ones.

2.7 Hash Based Privacy

The SHA (Secure Hash Algorithm) relates to various linked ciphered hash function that makes a hash an incentive from any sort of information, for example, a record, password, or for this situation, a certificate digit. This amount is essentially interesting to key in; thus, a little modification of information will achieve an absolutely remarkable hash in light of the torrential slide impact. Moreover, there isn't any sound method to manage figure a specific information input that will acknowledge pined for hash esteem and it is difficult to utilize the hash a motivation to recoup the essential information. The most normally utilized in this dynasty is SHA-1 and is also applied in numerous day-to-day safety products and customs.

All things considered; the question remains whether it's safe utilizing SHA-1 for the purpose of encoding Master card digits? Since the probability of two charge card digits that have a comparative hash regard is close to nothing, this is unrealistic to discover a circumstance where the hash of a superior than normal card digit balances the hash of a frightful card digit, as necessities be restricting the likelihood of a fake positive. Similarly, the strike is an effect ambush, not a pre-picture attack. As I in advance stated, an effect strike identifies two bits of information per a comparable hash; anyway, the assailant is not able to gather hash, therefore can't disrupt the instruments that utilize SHA-1 for monitoring variations in hashed information. Then again, a pre-picture snare empowers somebody to locate a repulsive Visa number that makes a hash limit pass on a hash estimation of a huge card digit. Nonetheless, in view of the fact that you are using a boycott, the assailant can't manipulate this, on the premise that the testing technique would find the dreadful card number on the refuse list. The Table 1 presents SHA-256 results of plain data.

Table 1: SHA-256 view

Name	Address	Zip code	Age	Symptoms	Disease
PJ	Nairobi	452***	[0-25]	398ed52a42b0fd22abb8252393a73e29	cancer
KJ	Goa	145***	[26-50]	bcf82b421a0beb03c7d682fada277afa	cancer
Jhon	Sidney	365***	[26-50]	c7e36c2e7d63e53228831b18a61a092f	cough
Khan	Jakarta	356***	[51-75]	e4b87007c431335a0f27b0cd1c1597bc	diabetes
RJ	Delhi	145***	[26-50]	bcf82b421a0beb03c7d682fada277afa	cancer
NP	Smp	365***	[26-50]	c7e36c2e7d63e53228831b18a61a092f	cough

On the off chance that you are as yet worried, alternatively can think of utilizing SHA-224, SHA-256, SHA-384 or SHA-512, here and there all things considered alluded to as SHA-2. This will need additional loading room, notwithstanding, in light of the fact that SHA-1 makes a hash value size of 160 bits and SHA- 224, for instance, makes an estimation of 224 bits. Likewise, the correlation procedure would be a little slower.

2.8 Key Base Privacy or Encryption

In this structure, it records and moreover encrypts the video, before securing it for later use. The contemplation is that whereas the officer is on obligation, the camera can faithfully be recording. The video, regardless, is isolated into tinier bits for potency. When a selected timespan passes, the video that was recorded is knotted exploiting private writing key thus on after deliver. Bound data, together with the date and time of the video, the name of the video, the private writing key, and also the name of the consumer is accumulated aside for later use. This strategy is dismal used for any time span that the officer is on data.

By the fruition of their day of labour, the officer accomplishes the video from the backend server. The backend server created the scrambled recordings by accomplishing grouping calculations, disentangles them, and portrays them subject to their substance and also the data that was as currently utilized. Order rules incorporates whether or not the video was recorded within a protected position, wrongdoing and type of wrongdoing that has been recorded by the video, and whether or not the video contains touchy/fragile substance. This order is then accustomed play out further secret writing for access management. Right once a colonel desires to urge to the accounts, he can sign into the healing program, which is able to apportion the simplest potential decoding keys base on the interest. Within the event that the officer has the fitting keys, he could revisit and decipher the key accounts.

Table 2: Key base encrypted view

Name	Address	Zip code	Age	Symptoms	Disease
PJ	Nairobi	452***	[0-25]	06F6620636F726F6E61727920	cancer
KJ	Goa	145***	[26-50]	646F6D697A6174696F6E20737	cancer
Jhon	Sidney	365***	[26-50]	656C20363030206D6720666	cough
khan	Jakarta	356***	[51-75]	7374656E6F7369730A2020202045	diabetes
RJ	Delhi	145***	[26-50]	41726D2920696D706C616E	cancer
NP	Dhaka	365***	[26-50]	E742053797374656D0A20	cough

In key base hashing algorithm, it creates too much lengthy encrypted text, however the major difference in key base hashes it generates likely cipher data up to 256 bytes.

2.9 Statistical Analysis

Statistical the collaboration of the players in the case of distributed partitioning also poses a danger to privacy. Each location has its own data partitioned vertically. All of the participants are aware of the pseudo id mapping, therefore determining the mean reveals the ids involved in the mean calculation to all of them. Because the ids are faux ids, the coordinator obtains no information from the intermediate outcomes. Because the attribute name, values, and ordering are all local to the participants, cooperation by the participants has no influence on attribute identification. These variables are not exposed unless the particular participant discloses their own attribute characteristics. The coordinate contains the attribute's ordering, which is provided by the participant. It's a forgery that will be reordered later. Collusion of participants or both participants and coordinator prior to publication of the perturbed dataset does not result in any privacy violation since the real or disturbed data is not shared at all.

Participants' collusion may provide information about the colluding parties but not the other parties. Any participant may not provide statistical information such as the midpoint, minimum, or maximum value of other parties. Variance, party with largest variance, and subset of ids are the intermediate outcomes shown. These interim findings provide no insight into the real values of third parties' qualities. Other parties' data values are almost unaffected by collusion.

After the altered and k anonymized dataset is released in a centralized server, participants' collusion may expose specific information. It may show the k row ids that are utilized to calculate the mean and variance distribution. Because the new dataset is produced using the mean of a collection of values, the real variance is always smaller than the original. Despite the fact that the data's mean and location are known, the exact value is unknown. Because all of the k values belong to the same person, they are hidden. The characteristics are made public, but the values are tampered with and k anonymized, so there is no risk of privacy being compromised

2.10 Statistical Analysis

The coordinator and the parties must both initiate Phase 0 of the process. In the first stage of the coordinator's startup, the coordinator makes requests to N parties and gets information from all of them. The flag is initialized in the second step. Step one's communication cost is N communications to participants and N communications from participants. The coordinator's initialization requires a communication cost of O (2N). The cost of calculation is the cost of initializing the ids and the flag. The cost of calculation is O (constant).

The first stage in the parties' initialization may need N conversations to transfer information from the first to the last participant. In the second stage, each party includes at most k 1 rows in the dataset to make the number of rows multiples of k. There is no necessity for dialogue in this situation. The cost of calculation is O(constant). Party one, or any one of the parties, transmits a random number sequence to all other parties in step three. It necessitates N communications at a cost of O(N). The parties sort the rows based on the pseudo id in step four. In each party, sorting requires an O (m log m) calculation. Each party does this calculation independently of the others. Phase 0's overall communication cost is O(N), whereas phase 1's communication cost is O (m log2 m). Step one in phase one is to verify the flag bits, which requires O(constant) calculation and N communication to seek the maximum variance from each side at a cost of O(N). Step two assigns' values with an O(constant) calculation cost. Step three need N contact in order to obtain the information. With a cost of O(N), the maximum variance from each side is obtained. Steps four and five need an O(constant) calculation cost. Steps six and seven need O (2) communication cost when combined. Step eight sends a request to all parties to disrupt the data instances, which necessitates N communication at a cost of O(N). Phase one requires a communication cost of O (3N) and a calculation cost of O(constant). Almost every recursive call splits the subset into two. As a result, phase one's total communication cost is O(N log2 N) and computing cost is O(constant).

The calculation in phase 2 is dependent on the coordinator's request for variance computation, perturbation, or to discover a subset of pseudo ids. Each party's variance must be computed by first identifying the pseudo ids and then calculating the variance. To work in parallel, all N participants individually compute the variance, which requires a calculation cost of O(m). Only the party with the greatest variance does the subset calculation. The party begins by sorting its dataset by the property with the greatest variance, which requires a calculation time of O(m log m). The calculation cost of finding the midpoint and separating into two subgroups is O(m). All parties participate in the calculation of perturbation. All parties must first locate the pseudo ids before calculating the average of the instances. It necessitates an O(m) computation cost. Then, instead of the original numbers, use the mean value, which has an O(constant) calculation cost. The cost of computing phase 2 is around O(m (log m + 1)). The total cost of all steps of calculation is N log2 N (m log m) = O(N log2 N (m log m) = O(N log2 N (m log m) = O(N log2 N The total cost of communication is about O(N log2 N)

3. RESULTS

In extensive experimental analysis we calculate the matrices for accuracy in the system performance assessment. The system is built on an open- source Java 3-tier architectural framework with an INTEL 2.8 GHz i3 CPU and 4 GB RAM. After the system has been implemented, a comparison between a number of current systems and the proposed system has been made. Figures 3–7 explain GUI testing in full, including data validation.

Original Students Data   Show   Back

Name	Gender	Mobile	Qualifica...	Age	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eight	Ninth	Tenth
101	Bohra	female	423303	MA	96	64.8111	95.9175	36.2035	81.4946	91.6061	48.3926	77.5791	39.1659	44.7374
102	chris	female	423305	MCS	99	35.2147	93.2689	92.9937	36.6395	47.1279	88.5661	41.5398	53.4818	58.9531
103	Bohra	female	423303	MA	63	56.4837	97.6068	75.1747	47.7792	63.9791	66.7809	56.5094	39.5347	60.1839
104	chris	female	423305	MCS	63	86.7154	74.4836	71.6099	65.2871	47.9447	97.8332	83.8344	73.3258	88.9017
105	smith	female	423365	M.phamar	28	40.9257	96.0114	59.4415	71.8829	58.7491	48.1751	47.1618	41.0961	67.4569
106	smith	female	423365	M.phamar	79	88.2944	88.9719	39.2279	63.2165	83.6082	36.2294	58.6093	96.5739	43.3036
107	scott	male	423308	M.Tech	24	48.0742	50.1555	63.3055	40.5547	83.3189	89.2879	51.0107	83.5204	52.0978
108	smith	female	423365	M.phamar	54	55.7011	85.7725	70.7663	85.7333	96.4038	79.1811	43.5292	70.8766	93.7612
109	scott	male	423308	M.Tech	91	98.3665	54.8566	87.4297	94.5005	85.3316	54.0199	71.2009	48.3161	78.8836
110	scott	male	423308	M.Tech	18	49.3728	65.7401	99.0143	43.9318	39.6781	84.4951	47.0763	49.0862	94.4646
111	smith	female	423365	M.phamar	93	98.0021	64.9419	50.3899	82.7479	79.2782	90.5192	78.5868	89.7086	96.9647
112	smith	female	423365	M.phamar	58	86.3776	59.1628	63.3052	70.1084	70.9574	37.3746	52.5571	77.3804	41.9485
113	chris	female	423305	MCS	89	36.8965	98.5259	74.3483	58.7919	80.3005	40.0088	70.9282	50.7853	68.2607
114	monty	male	423306	BE	70	83.2424	57.7428	54.0997	57.6038	65.1408	44.6935	96.7401	73.4881	90.6767
115	Bohra	female	423303	MA	84	79.7783	36.5183	82.4872	70.3776	45.0121	63.9235	47.2533	41.1397	58.3137
116	jhonson	female	423307	ME	62	78.2405	66.2348	64.2412	80.0527	85.7168	68.1942	83.2597	59.3711	96.7771
117	lee	female	423309	PHD	57	92.1233	36.7786	82.0881	46.0252	35.4109	87.1486	60.6512	78.4939	75.0489
118	Bohra	female	423303	MA	26	87.9632	65.2847	78.8933	96.2726	88.2038	57.5283	87.1747	88.9697	43.5021
119	monty	male	423306	BE	55	43.8811	62.5871	53.3941	77.6527	58.2091	91.4058	74.0051	93.0301	42.1409
120	monty	male	423306	BE	63	74.2493	83.2615	82.4233	93.2717	71.2625	55.3092	38.3173	72.8658	53.2378
121	harry	male	423304	BCS	43	85.1891	96.3481	70.6413	49.9014	88.1533	59.0755	74.4284	49.4112	49.9349
122	adam	male	423321	Msc	86	58.7964	71.1252	96.7413	81.1067	87.1802	57.5924	92.3186	42.9691	72.1384
123	jhonson	female	423307	ME	80	79.5247	90.6962	62.8968	53.0207	85.1604	74.0026	73.4149	87.7223	68.1232

Figure 3: Fingerprint inserted view for buyers during data distribution.

Figure 3 demonstrates the outcome of the proposed privacy preservation view. The data anonymization, generalizations, random permutation and specialization techniques are applied. The C-contains hold k-anonymity and li-diversity to generate heavy anonymized view during the data distribution. This evaluation has done on various sample sizes such as 100 mb, 200 mb and 5000mb etc.
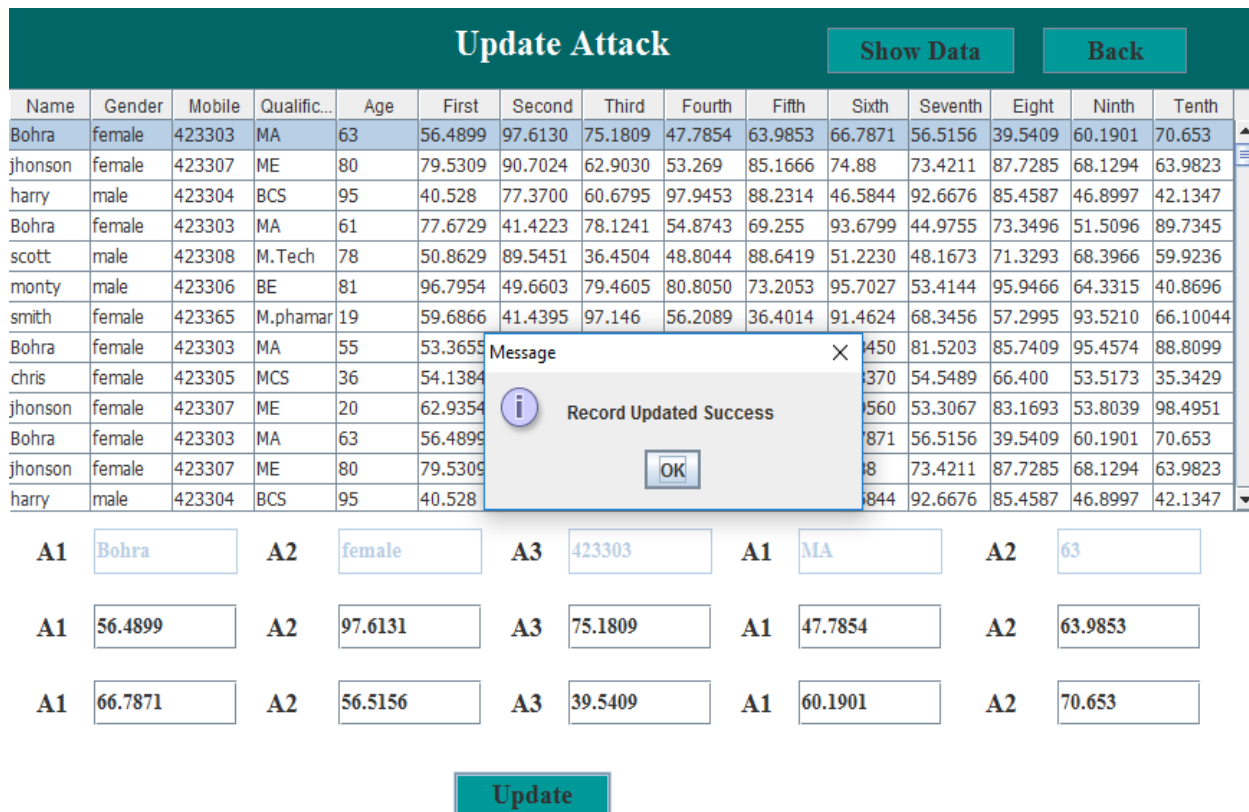
Figure 4: Buyers attack on original data.

Figure 4 describes a generation of similarity attacks on the dataset. In this experiment data owner generate a buyer dataset called D'. The original D has transformed with different algorithms such as Tardos code generation, mean calculation, fingerprint insertion etc. The user only inserts some prefix and suffix values into the original dataset that does not generate any negative influence on the original data. The traitor identification process executes the fingerprint removal task and checks the similarity between original and extracted data. If both sets show these are equal, then no attack has been generated, while if not the same, then the respective assigned user is the traitor for the transferred data copy.
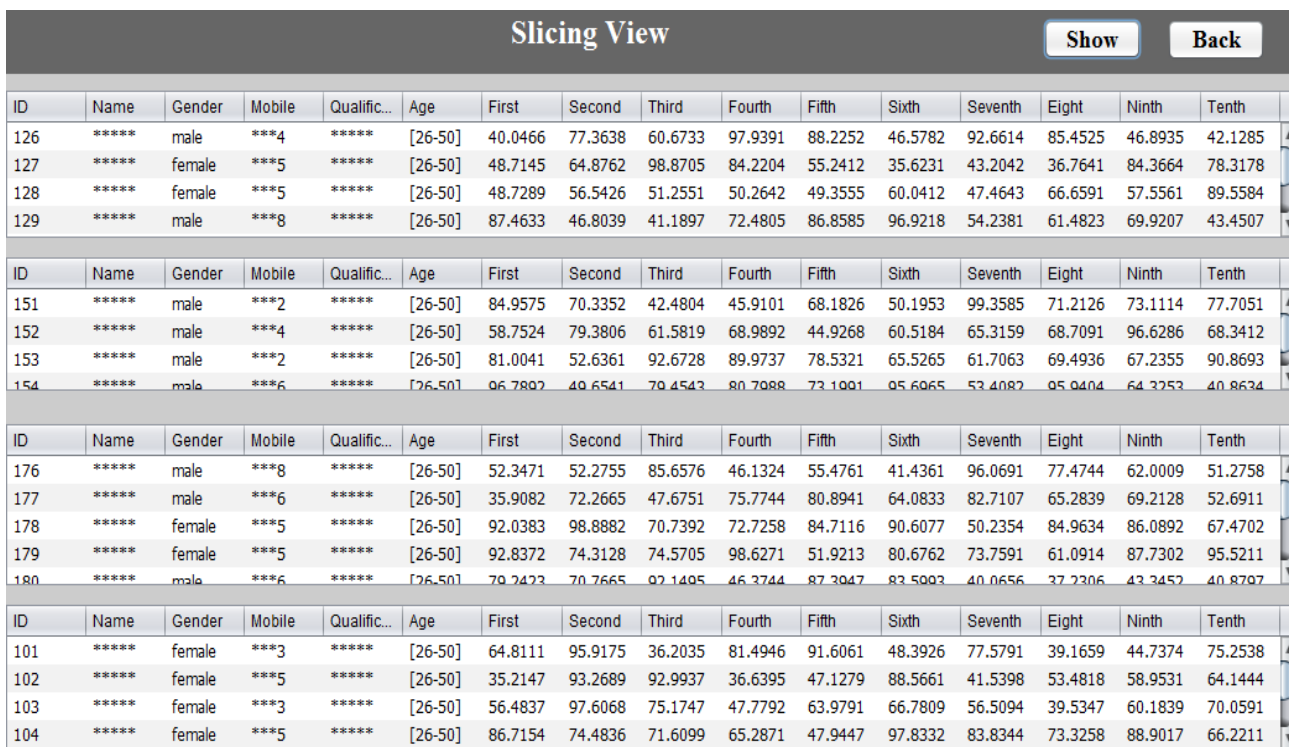

Figure 5: Slicing based privacy view.

The above figure describes privacy view generation using the slicing technique. The k-anonymity and L-diversity approaches are applied to extensive unstructured data to generate such a view. The Healthcare dataset contains a few sensitive attributes such as disease, name, address, etc. It needs to apply privacy preservation during the data distribution to eliminate the privacy breaching issues. The c-constraints can revoke such a problem by utilizing security functions in data distribution tasks. Bucketization is another technique to reduce data leakage issues when such frameworks deal with extensive data sets. This figure also describes various privacy views such as anonymization, generalization, random permutation, specialization etc. which gives higher privacy.
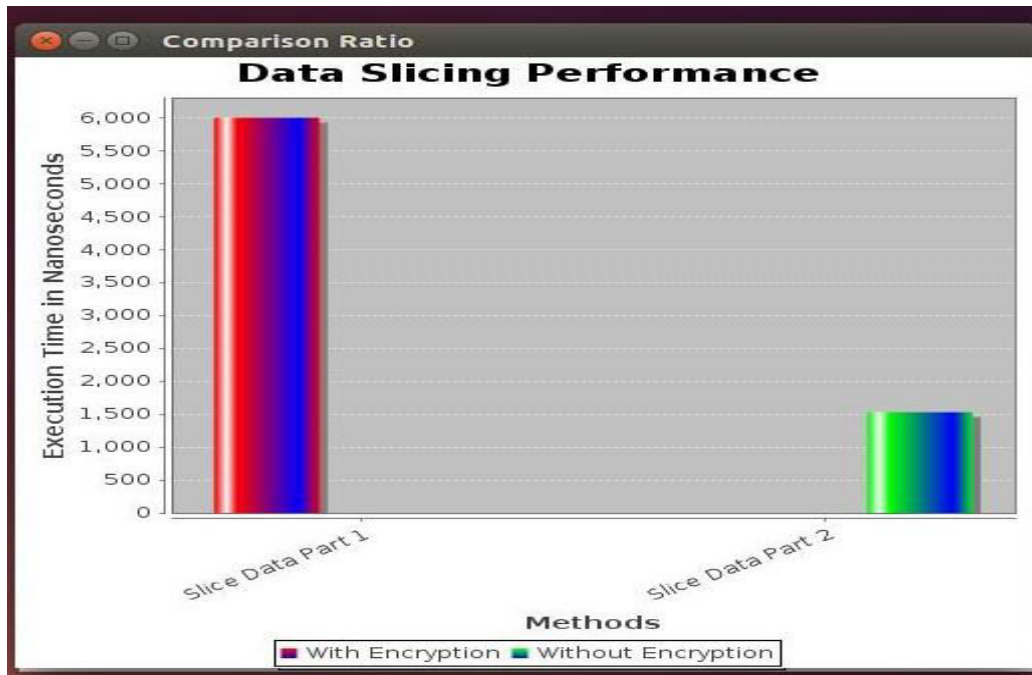

Figure 6: Data Slicing Performance.

The slicing view takes few times for generate to privacy view; it is basically transformation process between original data. The above figure 6 describes a time required for generation for distributed privacy view using slicing and bucketization.
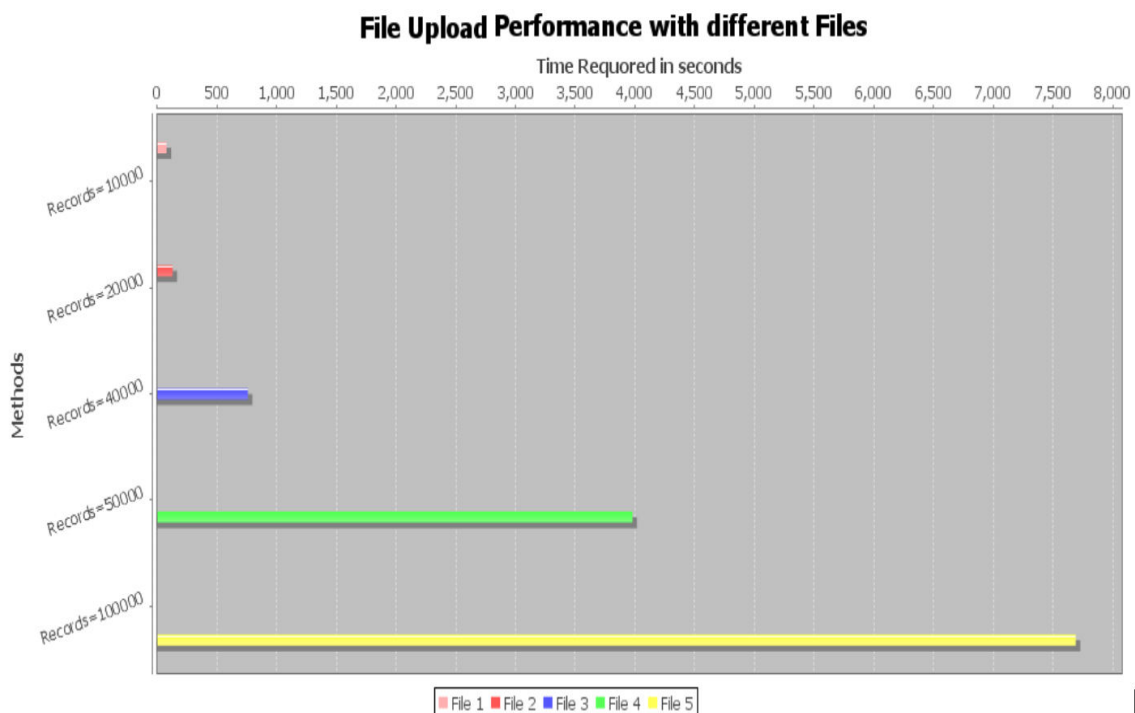

Figure 7: File Uploading Time Performance on Hadoop.

The above Figure 7 demonstrates file uploading performance with different number of records in single node Hadoop environment. The entire analysis demonstrates the secure data broadcasting in distributed manner. To protect users' privacy, data is anonymized by eliminating identifiable information. It implies that a person could not be identified solely based on anonymised data. However, the present anonymization strategies are becoming more useless as large amounts of data and strong data analysis tools become available. Anonymization in large data settings requires more than merely masking or generalising selected attributes. It is necessary to investigate if the anonymized data are susceptible to any threats. Different threat models and error propagation metrics for large data anonymization are investigated for this purpose. Furthermore, a fingerprinting method is utilised, which may protect against ownership theft while also assisting in the tracking of the traitor if an illegal duplicate is discovered. The addition of a fingerprint bit to a relational database may alter numeric data to some degree. This modification in numeric values may not result in a loss of database information. The suggested insertion procedure is a main key that is not reliant on the traitor

4. CONCLUSION

This research proposed various privacy-preserving techniques on extensive streaming data set in distributed environments. Different privacy techniques include data anonymization, generalization, random permutation, slicing, fingerprint insertion, and removal from virus protection. The system provides the highest security in untrusted distributed environments and stand-alone systems. This approach is effective when dealing with real-time streaming, which contains some sensitive information. Our experiment evaluates the entire execution with synthetic and real-time healthcare data sets. The system provides 100% privacy in fingerprint insertion techniques while the highest accuracy in privacy-based data distribution techniques. Implement different machine learning techniques for distributed dynamic data security will be the future work of the system.

5. ACKNOWLEDGEMENT

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CONTRACT AWARD BASED ON PREQUALIFICATION CRITERIA: A KEY FOR PROJECT SUCCESS

MANGESH M. KAPOTE, PRATIK PATIL AND SUNIL S. PIMPLIKAR

ABSTRACT
One of the most important and crucial step in any construction project is to choose the right contractor. The process of award of contract involves investigation, screening and selecting the best contractor for the given project. Selection of inappropriate contractor can trigger conflicts, time and cost overruns which in turn results in failure of the project. From the review of literature, it is observed that contract is awarded based on "lowest bidder" concept in many countries, thus compromising with quality and resulting in project failure. The goal of this research is to identify present contractor selection approaches and further measure the impact of contract award without using prequalification system, through quantification of 7 project performance criteria. The outcome of this study indicates the contractor selection should be done based on a quantitative prequalification system; otherwise, it may lead to negative impacts on project such as increase in claims cost, time and cost overruns to name a few.

Keywords: Contractor selection; multi criteria decision making; prequalification system; time and cost overruns.

1. INTRODUCTION
The success or failure of any project depends on the number of decisions made by the client; one of them is the decision to choose a competent contractor. This necessitates the use of an appropriate contractor selection criteria since it has advantages, to name a few - reduction of project risks, cost and time overruns, claims, number of disputes and the like (Ayettey and Danso, 2018). The performance of a project depends upon selection of a precise technique for picking up of the best suited contractor (Crist´obal, 2012). Mostly the public sector clients apply the competitive bidding system for selecting the right contractor for a given type of work and if required resort to alternative project procurement systems (Palaneeswaran and Kumaraswamy 2000; Hatush and Skitmore 1997; Shen et al. 2004; Singh and Tiong 2006). If contractors have to be selected, they must remain competitive and need to improve their performance in various aspects of selection process, further suggesting use of multi criteria and multi group decision making (Taylan et al. 2018; Alhumaidi 2015). The traditional way to select the contractor is one who bids the lowest tender price but it may compromise on quality and ultimately affect project cost, time and claims. Different studies and client organisations have used sets of essential criteria for contractor selection to measure the performance capacity of contractors. Financial steadiness, prior performance, experience, and key people availability were used as selection criteria by (Russell and Jaselskis 1992), whereas financial health, technical ability, management capability, and health and safety record were considered as selection factors by Hatush and Skitmore (1997); Singh and Tiong (2006). It may be inferred here that various researchers clearly hint at adopting a systematic, scientific, objective methodology to be used for scrutiny of tenders, emphasizing on use of prequalification document in the contracting process. The objective of this research is twofold: Evaluate the current contractor prequalification systems and to measure the impact of awarding contracts without the use of an appropriate contractor prequalification system. The first objective is achieved based on the review of literature documented over a period of two decades. For attainment of the second objective, project performance data from 4 road projects and 9 bridge works associated with these road projects has been analyzed. Since the projects are currently in the operating phase and the data is sensitive, names are kept anonymous.

2. CONTRACTOR SELECTION APPROACHES
The overall goal of the selection of contractors should be to determine the "best bidder," but not the "lowest bidder" (Topcu 2004; Shumank Deep et al. 2016; Alptekin and N. Alptekin 2017; Mohammed S El-Abbasy et al. 2013; Puri and Tiwari 2015). Considering this aspect, there is room for change in the bidding process in India and other developing countries. Bid documents are not specifically structured for different types of projects. (Pandit and Yadav 2015). Pre-qualification models must cope with nonlinear functions due to the intrinsic nonlinear relationship between service delivery and contractor characteristics (El-Sawalhi et al. 2007).

Generally, two types of contractor selection approaches as used by construction professionals are mentioned below;

1. Selection of contractor without use of a prequalification system

2. Selection of contractor with use of a prequalification system, involving

(a) Request for Qualification (RFQ)

(b) Request for Bid (RFB)

2.1. Selection of Contractor without Use of a Prequalification System
In this, there is a single bid / packet / cover system wherein after ensuring that the basic documents needed for ascertaining eligibility are submitted and the necessary earnest money deposit (EMD) amount has been submitted, contractor is selected based on the L1 concept i.e., awarding the contract to the lowest bidder.

1. Strengths
(a) Simple and speedy method

(b) Expected to be the most economic in competitive bidding

2. Weaknesses
(a) Quality of work may get affected due to non-competitive bid.

(b) Unjustifiable construction claims may result in disputes as well as very large unwieldy project completion costs

2.2. Selection of Contractor with Use of a Prequalification System
Despite the fact that there are a variety of contractor prequalification methods, the approaches are not effective without a well-defined set of decision parameters. There are various heads which have been identified by a number of researchers in evaluating and selecting the most appropriate contractor. There are seven major factors that influence contractors' performance: planning and control; business and personnel soundness; quality management; risk management; organisational competency; past performance; commitment and dedication (Doloi 2009). In this type of system, two approaches are used: qualitative or subjective approach and quantitative or objective approach.

2.2.1 Qualitative or Subjective Approach
In this approach, all the necessary data and documents as needed from bidding firms are obtained from the detailed notice inviting tenders (NIT) and then subjectively read thoroughly. A final impression about the capabilities and competencies of the bidder is made; if necessary, a grading system is used for ranking them. This analysis is done based on the techno-commercial data/information collected from the (RFQ). Finally, the (RFB) documents are given, only to those bidders who have prequalified grades/ranks.

1. Strengths
(a) It eliminates the incompetent contractors at the very initial stage.

(b) Its a structured process as compared to contractor selection approach without any prequalification criteria.

(c) Claims and disputes' cost may be reduced.

(d) Various prequalification criteria like technical capabilities, past experience, resources available are also considered along with financial aspects which help in selecting the most competent contractor.

2. Weaknesses
(a) As it is subjective in nature, specific strengths and weaknesses of the contracting firm cannot be identified.

(b) Grading / ranking done, being perception based, may get challenged in the court of law; further may go against the client, due to lack of objectivity.

2.2.2 Quantitative or Objective Approach
In this approach various techniques like Multi Criteria Decision Making (MCDM): Weighted Point Score (WPS), Analytical Hierarchy Process (AHP), Technique of Order Preference by Similarity of Ideal Solution (TOPSIS), VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), Fuzzy Set Theory (FST) etc. are used

2.2.2.1 Multi Criteria Decision Making
Multi criteria decision making (MCDM) is a method for making judgments when there is multiple, complimenting as well as contradicting factors needed to be considered. Following are some of the most effective MCDM methods used.

1. Weighted Point Score Method (WPS): In this method weights are assigned to the major heads of evaluation and all the variables under each major head are assigned with points based on a scale selected. This scale is either a 3-point, 5 point or 10-point scale, depending upon the complexity of the project, the level of the bidding competition, the magnitude of the work measured in terms of its time, cost, operating phase related performance expected, the time available for the scrutiny of tenders, whether bids are national / global, funding mechanisms, project uncertainties and risks associated, considered as major parameters impacting decision making. WPS Method along with quantification of different variables helps in selecting best suited subcontractor (Kapote and Pimplikar 2014). A total point value is calculated through summation, and the solution variants can be rated accordingly. In this system professionals consider the L1 Bid award criteria for financial bid / price bid, based on Evaluated Bid Price (EBP) as against the selection of the lowest bidder based on the price quoted. The EBP is determined by deciding appropriate weightages to both, the points scored by the bidders in scrutiny of their techno-commercial data / information as well as the quoted bid price offered. Prices are also adjusted for factors such as inflation, time value of money, transfer payments etc.

2. Analytical Hierarchy Process (AHP): Analytical Hierarchy Process (AHP) approach based on Multi Criteria Decision Making (MCDM) enables project management teams to recognize contractors who are most likely to achieve acceptable results in a selection process that is not solely dependent on the lowest bid (Balubaid and Alamoudi 2015). It's a technique of precisely calculating the weights of decision criteria. Pair-wise comparisons are used to examine the relative magnitudes of elements based on the experiences of particular experts. Each respondent compares the relative worth of each pair of items using a well designed questionnaire.

3. Technique of Order Preference by Similarity of Ideal Solution (TOPSIS): This method is centered on the theory that the best option should be the one with the smallest geometric distance from the positive ideal solution and the greatest geometric distance from the negative ideal solution.

4. VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR): VIKOR is used to address choice issues with conflicting and unequal criteria, providing that compromise is allowed for conflict resolution, the decision maker desires the closest solution to the ideal, and the alternatives are evaluated using all of the defined criteria.

5. Fuzzy Set Theory (FST): Many pre-qualification criteria used for contractor selection are subjective and vague in meaning, therefore determining a single universal system of assessment for all criteria is a challenging job (Plebankiewicz 2009). The use of fuzzy set theory enables the decision makers to demonstrate their evaluation of contractor's performance on decision criteria in linguistic terms rather than as crisp values (Singh and Tiong 2005). By employing the concept of linguistic variable, which really is a variable for whom the values are words or phrases in natural language rather than numerical values, Fuzzy Set Theory is an effective tool for dealing with ambiguous, inaccurate, and unpredictable circumstances (Nieto-Morote and Ruz-Vila, 2012). This generic concept is also applicable to the contractor selection approach, particularly when e-tendering is not resorted to.

1. Strengths

(a) Assessed bid capacity of the bidder is determined considering the previous turnover, current payment liabilities as well as the contracted project duration.

(b) Specific strengths and weakness of the contracting firms can be identified.

(c) Claims' and disputes' cost can be reduced significantly, thus enabling the attainment of project objectives.

(d) As it is an objective approach, it can smoothen the process of contractor selection and thus helps decision makers to select the most reliable, competent, accountable contracting firms.

(e) Optimal solutions are possible.

2. Weaknesses

(a) This approach is complex and time consuming as compared to other approaches.

(b) Decision makers need to be updated, trained further for ensuring the effectiveness of the process. Significant records and documentation aspects are absolutely essential to be maintained.

From the above evaluation it may be inferred that objective methods should necessarily be used on major projects during contractor selection process. Steps, as needed to eliminates their weak links, should be resorted to.

3. DATA COLLECTION

In all total 13 projects were considered for the study (4 Road Projects and 9 Bridge projects) from various contracting firms and Public Works Department (PWD) Maharashtra State, India. As aforementioned, the specific data from 4 road projects and 9 bridge projects on which no prequalification system existed has been used to quantify the objective project performance criteria. Following are the criteria that were considered for data collection; award price, lack of periodic meetings, lack of geotechnical investigations, working relationships, extra items, lack of fore warnings to extra items, lack of standard draft conditions, improper payment process, issues related on client part. The data collected through questionnaire survey, visits to offices of the professionals and interviews conducted enabled the computations of 7 project performance criteria. Each of these parameters mathematically describes some performance measure of a project. (Gogad and Pimplikar 2009; Douglas D. Gransberg et al. 1999).

3.1 Description of The Parameters Considered

Lack of Periodic Meetings: The project with absence of intermittent meetings were set apart as 1 and those having some timetable for occasional meetings were set apart as 0.

Lack of geotechnical investigations: The project in which work was not hampered due to adequate geotechnical overview was set apart as 0 and projects that were hampered due to geotechnical issues experienced at the hour of execution were set apart as 1.

Working Relationships: Working relationships were divided into three categories: adversarial, guarded adversarial, and partners, with scores of 1, 0.5, and 0 for each.

Extra items: This metric measures how many times the owner and contractor had to come to an agreement. After deleting administrative change orders, the number utilized in this analysis is an adjusted total.

Lack of Fore Warnings to Extra Items: The project was set apart as 1, assuming that there were no forewarnings to additional things which might result in cases and questions toward the finish of the undertaking. The project was set apart as 0 in the event that the respondent had great interchanges with respect to additional things.

Lack of Standard Draft Conditions: Projects that complied with some standard contract documents (MOS&PI, FIDIC, etc.) were marked as 0, and projects where the contract conditions were not met were marked as 1.

Improper Payment Process: The projects in which the respondent considered the payment process was wrong (delayed payments, mode of payment, incomplete payment etc.) were given a 1 and the projects in which the respondent thought the payment process was proper were given a 0.

Issues Related On Client Part: This parameter is useful for examining the impact of issues such as, land acquisition, material supply, site entry permits, power supply, etc. on the progress of a project that a client must undertake. Projects affected by the above reasons are marked as 1, and projects not affected by the above reasons are marked as 0.

Mathematical formulae for the criteria affecting the project performance

Sr. No	Criteria	Mathematical Formulation
1	% Cost Growth	$\dfrac{\text{Final Contract Amount} - \text{Original Contract Amount}}{\text{Original contract Amount}}$
2	% Increase per change order	$\dfrac{\%CG}{\text{No. of change orders}}$
3	% Time growth	$\dfrac{\text{Days Charged} - (\text{Total days allowed} + \text{Additional days granted})}{\text{Total days allowed} + \text{Additional days granted}}$
4	% Equivalent liquidated damage cost	$\dfrac{\text{Liquidated damage cost}}{\text{Total contract cost}}$
5	% Claim cost	$\dfrac{\text{Total cost of claims}}{\text{Original contract cost}}$
6	% Dispute cost	$\dfrac{\text{Total cost of disputes}}{\text{Original contract cost}}$

(*Source:* Douglas D. Gransberg et al. 1999)

Here,

Days Charged = Actual contract duration; Total Days Allowed = Original contract duration Additional Days Granted = Number of days added by change order

4. METHODOLOGY

Firstly all the basic details about the projects were collected like actual and planned duration of the project, contract amount decided initially and actual amount spent, project updations if any, lack of periodic meetings, lack of standard draft conditions etc. Then characteristics of the project were marked in Table 1. These characteristics were assigned the values ranging from 0 to 1 and based upon their relevance with the project. From Table 2, it is observed that 7 project performance criteria are computed for 4 road and 9 bridge projects and compared. Further, this data is organised in descending order, with the highest-value projects appearing first and the lowest-value projects appearing last. Later for each impact level frequency of occurrence of each project is calculated. Finally weights are computed for each of the road and bridge projects from where results have been obtained. Figures 1 and 2 represent graphically the parametric analysis done based on minimum negative project impact to the maximum one.

Figure 1: Parametric analysis of road projects considering weighted project impact
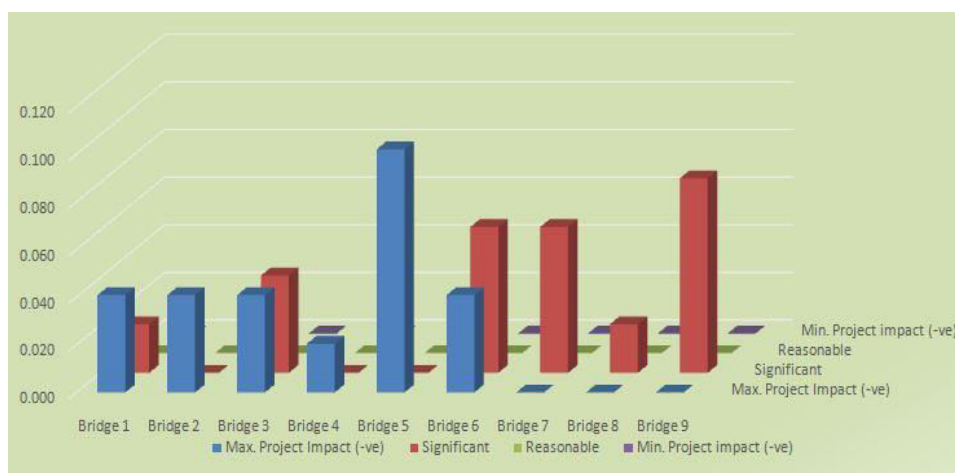

Figure 2: Parametric analysis of bridge projects considering weighted project impact

Table 1: Computations of 9 Project Characteristics

Sr. No.	Description of Characteristics	Road Projects				Bridge Projects								
		R1	R2	R3	R4	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	Award Price (Rs in Cr)	1.50	15	85	1.28	20.52	3.15	0.645	1.076	2.301	0.614	9.50	15.25	2.50
2	Lack of Periodic Meetings	0	0	0	1	0	0	1	1	0	0	0	0	0
3	Lack of Geo-technical Investigations	1	1	1	0	1	0	0	1	1	0	0	1	0
4	Working relationships	0.5	0	0	1	0	0.5	0.5	1	0.5	0	0	0	0.5
5	Extra items	3	5	4	0	15	2	0	7	4	0	5	8	0
6	Lack of fore warnings to extra items	0	1	1	0	0	0	0	0	0	0	0	0	1
7	Lack of standard draft condition	0	0	0	1	0	1	1	0	0	0	1	1	0
8	Improper Payment process	0	0	0	0	0	0	1	1	1	0	0	0	1
9	Issues related on client part	1	1	1	1	0	1	1	0	1	0	0	0	0

Table 2: Computations of 7 Project Performance Measures

Sr. No.	Performance Measurement Criteria	Road Projects				Bridge Projects								
		R1	R2	R3	R4	B1	B2	B3	B4	B5	B6	B7	B8	B9
1	% Cost growth	16.7	66.7	1.47	0	15.6	6.74	0	72.8	14.7	51.6	37.4	26.2	-12
2	Cost per change order (Rs in Cr)	0.083	2	0.312	0	0.214	0.106	0	0.111	0.0845	0	0.709	0.499	0
3	% Increase per change order	5.56	13.34	0.36	0	1.04	3.37	0	10.4	3.7	0	7.48	3.275	0
4	% Time growth	5.56	13.76	24.65	142	-20	8.33	125	0	0	0	0	14.2	100
5	% Equivalent liquidated damage	0.5	0.025	0	2.33	0	0.28	1.16	0	0	0	0	0.29	0.18
6	% Claim cost	0	16.7	1.47	0	3.65	3.17	0	27.8	6.5	50	15.7	14.8	0
7	% Dispute cost	0	10	0	0	0	0	0	0	0	0	0	0	4.8

Table 3: Parametric Analysis

Sr. No.	Performance Measurement Criteria	Road Projects				Bridge Projects								
		Max. Project Impact	Significant	Reasonable	Min. Project Impact	Max. Project Impact			Significant		Reasonable		Min. Project Impact	
1	% CG	R2	R1	R3	R4	B4	B6	B7	B8	B1	B5	B2	B3	B9
2	Cost per change order	R2	R3	R1	R4	B7	B8	B1	B4	B2	B5	B3	B6	B9
3	% Increase per change order	R2	R1	R3	R4	B4	B7	B5	B2	B8	B1	B3	B6	B9
4	% Time growth	R4	R3	R2	R1	B3	B9	B8	B2	B4	B5	B6	B7	B1
5	% Equivalent liquidated damage	R4	R1	R2	R3	B3	B8	B2	B9	B1	B4	B5	B6	B7
6	% Claim cost	R2	R3	R1	R4	B6	B4	B7	B8	B5	B1	B2	B3	B9
7	% Dispute cost	R2	R1	R3	R4	B9	B1	B2	B3	B4	B5	B6	B7	B8

Table 4: Frequency of Parameters Segregated As Per Impact on Project

Impact Level	Road Projects				Bridge Projects								
	R1	R2	R3	R4	B1	B2	B3	B4	B5	B6	B7	B8	B9
Max. Project Impact (Negative)	0	5	0	2	2	2	2	3	1	2	4	3	2
Significant	4	0	3	0	2	3	1	3	1	0	0	3	1
Reasonable	2	2	3	0	2	2	2	1	5	2	0	0	0
Min. Project impact (Negative)	1	0	1	5	1	0	2	0	0	3	3	1	4

Table 5: Weights of Parameters

Impact Level	Road Projects				Bridge Projects								
	R1	R2	R3	R4	B1	B2	B3	B4	B5	B6	B7	B8	B9
Max. Project Impact (Negative)	0.000	0.714	0.000	0.286	0.286	0.286	0.286	0.429	0.143	0.286	0.571	0.429	0.286
Significant	0.571	0.000	0.429	0.000	0.286	0.429	0.143	0.429	0.143	0.000	0.000	0.429	0.143
Reasonable	0.286	0.286	0.429	0.000	0.286	0.286	0.286	0.143	0.714	0.286	0.000	0.000	0.000
Min. Project Impact (Negative)	0.143	0.000	0.143	0.714	0.143	0.000	0.286	0.000	0.000	0.429	0.429	0.143	0.571

5. DISCUSSION OF THE RESULTS

5.1. For Road Projects (4 Nos.) and Bridge Projects (9 Nos.)

Findings on Road project.(Road 1, Road 2, Road 3 and Road 4 are abbreviated as R1, R2, R3, R4 respectively)

1. Except for R2 and R4 it is observed that remaining 2 roads i.e. R1 and R3 have a significant negative impact.

2. Maximum Negative Impact is observed in R2 further, whereas, in R4 both Maximum and Minimum Impacts are seen.

3. Reasonable Impact is observed for R1, R2 and R3.

Findings on Bridge project. (Bridge 1, Bridge 2,…., Bridge 9 abbreviated as B1, B2,…….B9)

1. Bridge projects B1, B2, B4 and B8 have a significant negative impact.

2. Maximum Negative Impact is observed in all the 6 bridge projects i.e., B1, B2, b3, B4, B5 and B8 further, for projects B6, B7 and B9 both maximum and minimum impact are seen.

3. Reasonable Impact is observed for 2 Bridges B3 and B5.

Finally, it may be inferred that collectively all the four roads and nine bridges have demonstrated Cost Growth, Increased Cost per Change Order, Increased Time Growth, Claim Cost, Equivalent Liquidated Damage.

6. CONCLUSION

Contractor selection based on use of quantitative techniques such as weighted point score and other multi criteria decision making (MCDM) techniques enables to decide the reliable, competent and right contractor for award of contract. Findings from the parametric analysis of 7 project performance criteria on 4 road projects and 9 bridge projects clearly show that contractor selection without using prequalification criteria impacts' negatively on projects and results into increase in claims cost, time and cost overruns and the like. Hence it is recommended that contractor selection should be done on the basis of an objective prequalification system with project specific micro level prequalification criteria, to be used for bid evaluation. This, in turn will add value for satisfactory implementation of the contract awarded between various parties to it.

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LIVE GAZE DETECTION BASED ON CONVOLUTIONALNEURAL NETWORK MODEL

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ABSTRACT

A colossal shift is needed to stem the rising mortality toll from car crashes, which are mostly the result of distracted driving. Finding out where a driver's gaze is focused might tell you a lot about their driving style. Installing technology that effectively identifies the driver's gaze at an affordable price can help to improve the driver's overall safety. When drivers' eyes are moved without their heads turning to gaze at objects, the accuracy of their gaze detection is compromised. Eye gaze prediction is critical for new consumer electronic applications, including driver tracking systems and innovative user interfaces, to function properly. For these systems to be effective, they must be able to operate in challenging and uncontrolled environments while requiring minimal power and cost. For this problem, the Convolutional neural network can be used to detect the active gaze. First, an innovative neural network model can be coded to manipulate each possible influence of the structure, such as the regions including both eyes and head location; the second alternative is data fusion, which integrates the gaze set of data into one single approach by combining them. Changes in ambient light, perceptions off of glass, and gesture optical blurring all affect the precision with which the pupil and corneal reflection centre can be discovered and classified in a car's surroundings. This work also includes pre-trained approaches, network architecture, and sets of data.

Keywords: Deep Learning, Convolutional Neural Network (CNN), Region of Interest (ROI), Global Positioning System (GPS), Eye tracking, National Highway Traffic Safety Administration (NHTAS).

INTRODUCTION

The obliviousness of the driver and street departure is indeed the major causes of road deaths[6]. Drowsy driving is the primary factor in moving vehicles, placing drivers, motorists, and pedestrian crossings in danger. In 2018, reckless drivers died 3300 people and wounded 5,29,000, according to the US Department of Transportation [7]. Whenever a driver is distracted away from the actual task on the road while driving, this is referred to as distracted driving. This could occur due to a variety of factors, the most prevalent being while on the headset, listening to the news, eating a meal, or while using a GPS navigation system (GPS). The National Highway Traffic Safety Administration reports (NHTSA), that texting and driving triple the risk of being involved in a car collision [8]. Operators can distract their eyes off the road for as long as possible while using a smartphone (EOR). To recap, this can be a big distraction for drivers, and technology that tracks the driver's gaze can be essential in averting car accidents. The classification of driver gaze fixation is becoming increasingly crucial in the goal of crash avoidance.

An eye-tracking investigation has indeed been applied to various implementations over the years, along with a driving tiredness notification system, intellectual health checks, a gaze-powered pushchair, and many other human-computer systemic approaches. Numerous constraints exist, such as the failure to implement consistent actual improvement, good reproducibility, device accessibility, and a device that is both lightweight and non-intrusive. Improvements in device resilience in the face of barriers such as changing lighting conditions, physical eye shape, other side-eye characteristics, and eyeglass reflections are also essential. In the past, various studies have suggested eye-controlled wheelchair systems; however, It has rarely mentioned the device's limitations concerning system performance, environmental and physical difficulties exterior to the device, algorithm novelty, or ultimate user convenience and preservation. Deep Neural Networks are a snipping and incredibly successful way to solve reasoned action and information troubles (CNNs). There are many technologies in which CNN is a leader. These methods varied from object recognition to telecommunication equipment, natural language, and even power chair government; the following paragraphs will have an in-depth analysis of relevant literature. [9] However, the headline is insufficient of precision, actual execution, and a knowing of the intricate details of this layout, all of which may be helpful for future sophistication. The effectiveness of gaze engagement tactics in smart interactive settings in real-world conditions has not yet been demonstrated despite the publication of numerous studies on the subject. An approach based on deep learning has been considered for addressing this problem, with a particular. The recommended study's architectural style is centred on data science and lists the following modules: In the first, we appear an innovative neural network architecture capable of attempting to manipulate any influence on, the structure, including the states of both eyes and head position, as well as numerous modifications; in the sec, we introduce an information fusion framework

that integrates so many divergent gaze sets of data, like those from the Living beings, Sight Research work. Pre-trained models, network architectures, and datasets are also included in this project, which will be used in the creation and development of Deep Learning models, and neural networks Based on eye movements and identification.

LITERATURE REVIEW

Choi et al. [5] developed a five-layered CNN-based approach for classifying driver gaze zones and estimating head posture. They compiled a dataset comprising various photographs of male and female drivers, as well as drivers wearing eyeglasses. They developed a CNN model using the dataset that can classify drivers' nine gaze zones and predict their head posture. Each gaze zone corresponds to a distinct location of the car, such as the left mirror, the right mirror, the rear-view mirror, the steering wheel, the gear shift, the middle, the left windscreen, and the right windscreen.

Naqvi, et al. [1] This task was captured by a Convolution neural model that used a vicinity (NIR) camera that wants to consider face and eye gestures while not impeding drivers' vision. The device is illuminated by one NIR sensing element, one optical zoom, or six NIR light-emitting diodes (LEDs). The NIR camera records the driver's frontal view and transmits it to a computer via a USB Cable.

Konrad et al. [2] To resolve this concern, we presented a CNN-based end-to-end image- based technique for near-eye showcases. They collected eye snaps of individuals peering at various data points on a device. A camera was assembled very near as possible to the subjects' faces to capture the photographs. They built a simple Network model (that uses the LeNet architectural style) on the set of data, which requires user pics as input and forecasts the users' gaze alignment based on the screen's x and y coordinates. The researchers decided to approach the gaze prediction problem as a classification task with multiple classes, each symbolized by a computer monitor point. The tactic generated an oblique inaccuracy of 6.7 degrees on the collected set of data, which would be inexcusable. Poor image quality (28x28) and the variability of the datasets used to train the network almost certainly account for the network's poor performance. The dataset contains only five subjects.

PROBLEM STATEMENT

- Driver distraction is perhaps the most prevalent cause of lane concentration deviation, and this can put drivers, cyclists, and pedestrians in danger of being struck by a vehicle. Because of studies, eye-tracking approaches are being gradually integrated into the driving tiredness alert system.

- There seem to be, unfortunately, numerous limits, such as reliable actual performance, high accuracy, device accessibility, and a compact, non-intrusive device.

- Even though the fact that much research on gaze interactions has been published, the effectiveness of these methods in smart interactive scenarios under realistic circumstances remains imperfect.

- To counter this issue, a deep learning-based visual attention estimation method was assumed, with a focus on Convolutional Neural Network methods.

OBJECTIVE

- Consideration has been given to the kind of Convolutional Neural Networks (CNN)-based deep learning-based eye detection methodologies.

- To merge pre-trained systems, network architecture, and datasets for developing CNN- based deep learning.

- Gaze Capture trains a deep neural network on binary images to estimate the user's gaze orientation

METHODOLOGY

Data Pre-Processing

The mechanism lifter is composed of a group of CNNs which have been separately trained. This is how it works: One of the CNNs is used to classify the area around the eye. The other ones figure out the exact location of the attributes. Unless all retinal reflections are free from obstruction as well as the pupil is not substantially interrupted, the classification model network indicates that the pupil is not considerably impeded. which is what it means (such as when a user blinks). If a network decides that the eye area is valid, several other networks decide the direction of the pupil centre and the reflections on the cornea.
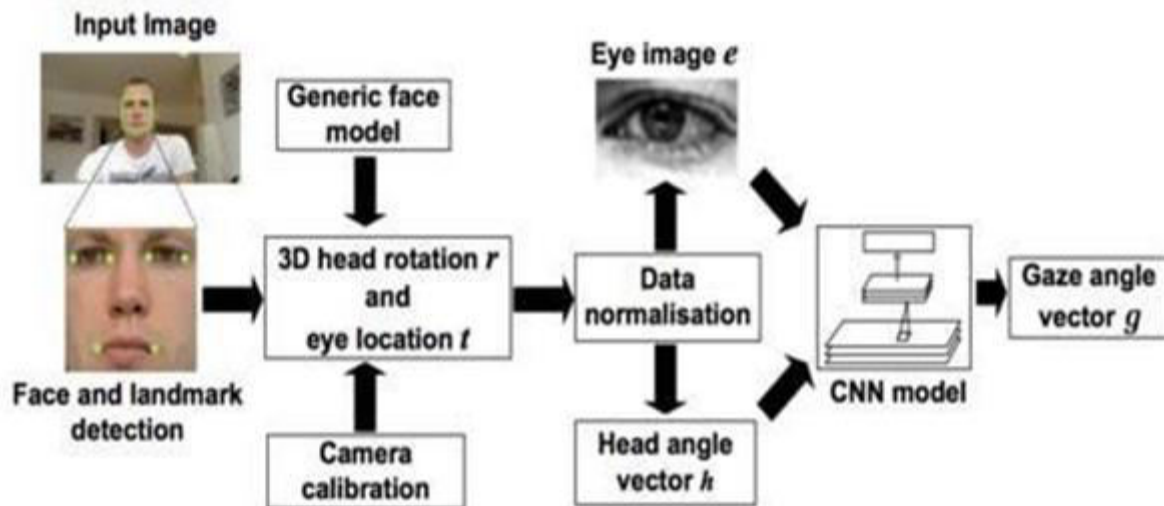
Fig. 1. Overall Proposed Pre-processing.[17]

There are a lot of things in common between the classifier and the location prediction networks shown in Figure 1. Following a neural network with batch normalization and selectable pooling, dense layers are formed that are totally and utterly connected and the earlier layers.

Estimation of Head Poses

A commercial head tracker is used to determine the presence of something like a head and the exact address of the cornea zones. Such territories serve as a means of internalization. the function extractor when it is run for the first time or when local monitoring fails. As a result, the machine only sometimes makes use of the detector for the body head. The portionsused to initialize the feature extraction technique are based on the prior structure's pupil centre calculated whenever the eye attributes were correctly observed. A power structure ofthe minimal surface CNN model is used to localize narrow eye area windows.
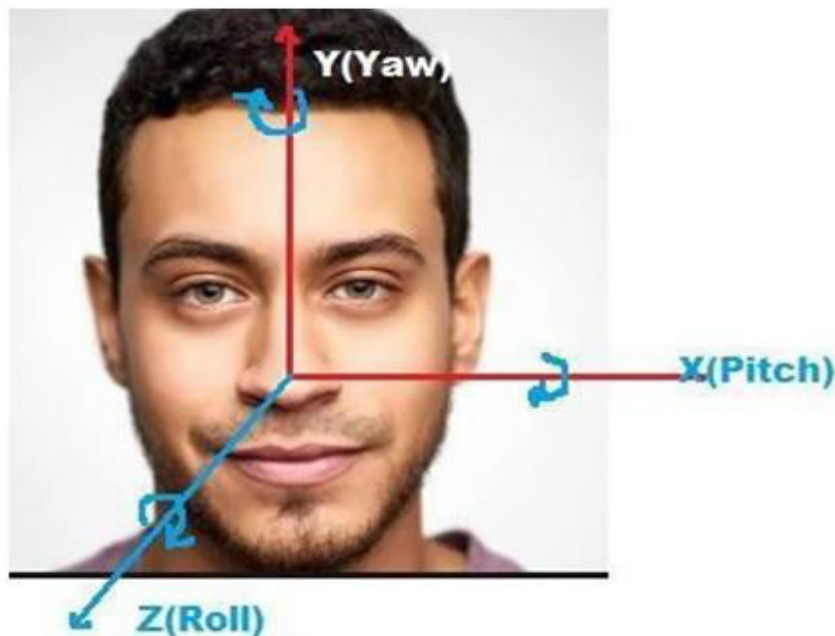
Fig. 2. Euler's Angles are used to calculate the pitch, yaw, and roll of the head.[17]

Training Details

Metrics: This metric can be found in the Gaze Capture dataset.

Loss function: Distance between the anticipated and the desired seems to be the Euclideanspace validation: A subset of datasets statistics can be used for confirmation.

Learning rate: Manual setup of the training set.Optimizer: Adams optimizer.

Epochs: epochs count.
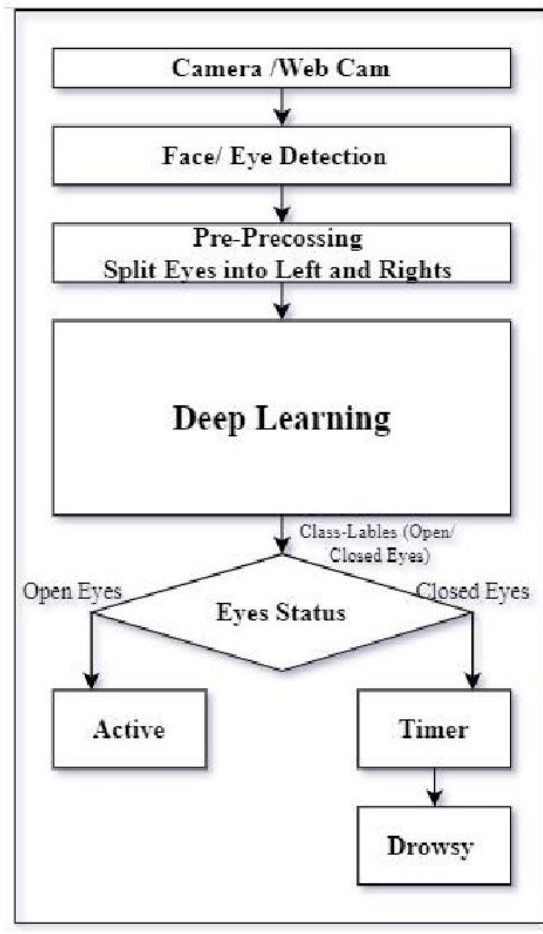
Fig.3. Flowchart of the proposed system
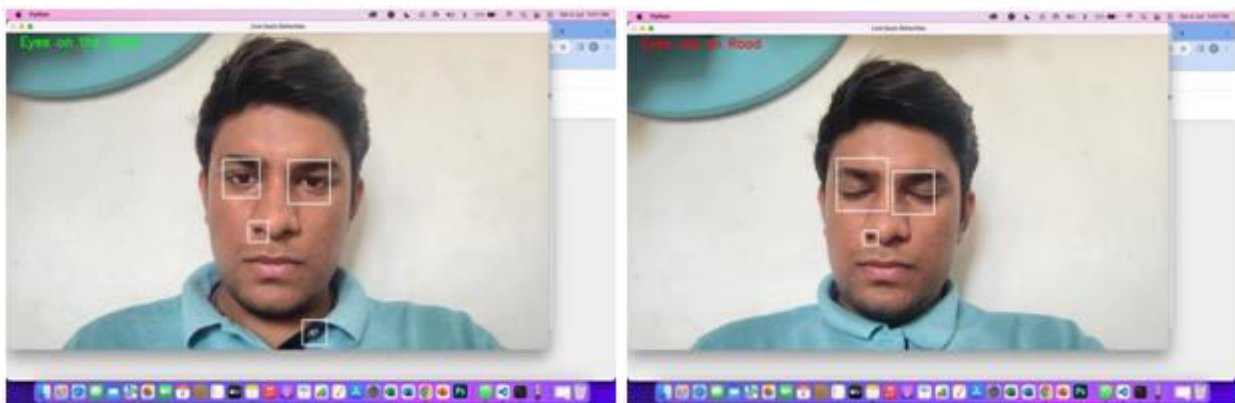
Fig. (a):- Eyes on the Road   **Fig.(b):-** Eyes Not on Road

Fig. (c):- No Face Detected

Fig.4:- Three seniors of the live gaze detection model

CONCLUSION

We're going to use a CNN to figure out what the driver is looking at when they're in their car. Facial expression left and right eye illustrations will be taken from the input data by using ROI (region-of-interest) represented by facial landmark points from the larger image tracker for operator gaze classification. The ROI is focused on facial landmarks. An even more fine-tuning was done with such a pre-trained CNN architecture focused on the VGG face network to get the gaze attributes from the network's going into detail layer for the cropped photos of the face, left eye, as well as the right eye. To come up with the final designation, three distances focusing on all the features are combined. In addition, the effectof the CNN concept on gaze classifying will be tried to look at.

To get the end classifier performance, three distances premised on all of the attributes that were found are merged. CNN will also be looked at for its effect on the way people classifytheir faces. The studies have found that when there is a lot of movement between the particular topic and the device, greater visual attention forecasts can be made if the 3D gaze-estimation concept has eye functionalities that are strong enough. They wanted to show howwell minimal CNNs could do when there was more relative movement. Some machines can learn how to improve the gaze method's reliability and precision (placement of cornea reflections cornea reflections and the pupil's centre). The eye features are most often used by a gaze-estimation method that just doesn't care about how the topic and mobile phone move together. Our combination eye-tracking new tech, which utilizes infrared ambient light, has a much higher degree of accuracy than past models that used ambient daylight andappearance-based methods to figure out where someone's eyes were.

The hybrid technique, which involves a step of feature extraction by computer vision followed by the generation of a geometrical 3D model, enhances results. This improvement may enable the development of phone applications that analyze the visual scanning behaviour of participants viewing a minimal number of items on a phone's screen.

APPLICATION

It has progressively become possible to use gaze research on various apps, such as continuing to drive fatigue alert systems, psychological health screening, a gaze-powered powered pushchair, as well as other human-computer systems, such as AI-assisted medicalcare systems and virtual treatment technologies [15],[16].

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SUSTAINABLE PLANNING OF ROAD INFRASTRUCTURE USING PROJECT DEFINITION RATING INDEX (PDRI) AND GREEN MATERIALS

APPA M. KALE AND SUNIL S. PIMPLIKAR

ABSTRACT

Road infrastructure can be built by using the sustainability concept. A conventional road causes environmental degradation as well as it affects the economy of physical infrastructure. To overcome this problem sustainable planning is a very prominent solution. This research explores to develop a matrix which maps the Sustainable Development Goals (SDGs) and Project Definition Rating Index (PDRI) tool. Sustainability in road construction is achieved by use of green materials hence reducing the global warming potentials and replacing existing materials.

Keywords: Sustainable Planning, Road Infrastructure, Project Definition Rating Index, Sustainable Development Goals, Global Warming Potentials, Carbon Credits.

1. INTRODUCTION

Road infrastructure can be built by using the sustainability concept [8]. A conventional road causes environmental degradation as well as it affects the economy of physical infrastructure. To overcome this problem sustainable planning is a very prominent solution [5].

The Project Definition Rating Index (PDRI) is a powerful, easy-to-use tool that identifies and precisely describes each critical element in a scope definition package. It also enables project teams to identify effectively the project risk factors related to desired outcomes for cost, schedule, and operating performance. By using the PDRI method, teams can capture mitigation action items and evaluate the completeness of scope definition at any point prior to detailed design and construction [9].

The Sustainable Development Goals (SDGs) or Global Goals are a collection of 17 interlinked global goals designed to be a "blueprint to achieve a better and more sustainable future for all".1) The SDGs were set up in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030. They are included in a UN Resolution called the 2030 Agenda or what is colloquially known as Agenda 2030. 2) The SDGs were developed in the Post-2015 Development Agenda as the future global development framework to succeed the Millennium Development Goals which ended in 2015[7].

The Global Warming Potential (GWP) was developed to allow comparisons of the global warming impacts of different gases. Specifically, it is a measure of how much energy the emissions of 1 ton of a gas will absorb over a given period of time, relative to the emissions of 1 ton of carbon dioxide (CO_2). The larger the GWP, the more that a given gas warms the earth as compared to CO_2 warmth over that time period. The time period usually used for GWPs is 100 years [10]. GWPs provide a common unit of measure, which allows analysts to add up emissions estimates of different gases.

Non-sustainability in many infrastructure projects is caused due to increase in the Global Warming Potential and due to loss of Carbon Footprints. By using sustainable alternative materials instead of conventional materials, sustainability in road infrastructure projects can be achieved. PDRI tool may enable the increase in effectiveness of the road project during planning phase; further contributing in the attainment of those SDG's which are applicable of any country to the road infrastructure.

2. OBJECTIVES

Considering the above, this study focuses on: -

1) Developing of mapping matrix between 13 PDRI categories used for Road Infrastructure of any country and the SDG's identified as applicable for Road Sector.

2) Comparing embodied energies & global warming potentials of conventional materials used for road construction and their replacements/alternatives.

3. METHODOLOGY

Research methodology designed for this study, is as follows: -

1. From the 17 Sustainable Development Goals, SDGs which are directly or indirectly related to the road infrastructure sector are identified primarily.

2. Subsequently, the connect between these SDGs and the PDRI tool used for Project Pre Planning is envisaged on the basis of which a mapping matrix between 13 PDRI categories applicable for Road Infrastructure and the identified SDGs is prepared.

3. Embodied energies, global warming potentials, carbon footprints are compared for conventional as well as alternative materials, on the basis of which comparison is made.

4. Finally, a sustainable road planning conceptual model is schemated.

4. ANALYSIS

From the 17 Sustainable Development Goals formulated by UNESCO, those which are directly and indirectly related to the road infrastructure are as follows:

In table 1, the mapping matrix between 13 PDRI categories used for Road Infrastructure and the SDG's identified as applicable for Road Sector in any country is given.

Table 1: Mapping matrix between 13 PDRI categories used for Road Infrastructure and the SDG's identified as applicable for Road Sector in any country

| Sr. No.	Number of the Sustainable Development Goals (SDGs) to be achieved	Description of Sustainable Development Goal (SDG)	Project Definition Rating Index Categories associated
1	3	Good Health & Well Being: Roads allow quicker and easier access to primary health care, improve doctor attendance and service quality in public health institutions, and enable access to specialized health care[1].	B, C, D, I, L, M
2	7	Affordable & Clean Energy: Supply chain management is a crucial component of the initiative, and roads can help in ensuring reliability of the supply, which is an important consideration to the consumer, and in reducing the cost of transportation and storage which is important in improving the viability and sustainability [1].	B, C, D
3	8	Decent Work & Economic Growth: It is well understood that poor transportation infrastructure is an important barrier to the reallocation of labour out of agriculture and entrance into wage labour markets. The majority of self-employment and informality is in the agricultural sector[1].	A, B, C, D, K, L
4	9	Industry, Innovation & Infrastructure: roads, like other infrastructure are subject to various adverse impacts. In the case of roads, the transportation impact, impact of activities of the surrounding populations and impacts of climate change are the three most pronounced impacts [1].	B, E, F, H, I, K, L, M
5	11	Sustainable Cities & Communities: if there are good roads, market forces will lead to transport demand being met by private transport operators. People also need public transport services to access markets, services and socio-economic opportunities, and the nature of services required often do not fit in neatly with the transportation solutions covered by national and State regulations [1].	B, C, D

6	12	Responsible Consumption & Use: Roads require substantial materials for their construction. Construction of engineered roads is material and energy intensive and substantial economies are possible by appropriately designing the roads using locally available materials or marginal materials not strictly conforming to classical specifications [1].	B, C, D, E, F, H, K, L, M
7	13	Climate Action: Road construction involves generation of GHGs at many points in the process, both on-site and off-site. There is a need to develop an indicator of the carbon footprint of rural roads, and to develop policies and strategies to minimise the footprint and to "green" the process of road development [1].	B, C, D,
8	15	Life on Land: Land being a scarce and non-replaceable resource, consideration needs to be given when planning and designing roads to avoid the alignment through areas under intensive irrigation to the extent possible even if it may result in a slightly longer route. The most immediate and obvious effect on land of road development is the elimination of its productive capacity [1].	A, B, C, D, F, G. J
9	17	Partnership for goals: Strengthen the means of implementation and revitalize the global partnership for sustainable road development, through a collaborative effort [1].	A, B, C, J, M

Table 2: Key of PDRI

A. PROJECT STRATEGY	**B.** OWNER/OPERATOR PHILOSOPHIES
C. PROJECT FUNDING & TIMING	**D.** PROJECT REQUIREMENTS
E. VALUE ANALYSIS	**F.** SITE INFORMATION
G. LOCATION & GEOMETRY	**H.** ASSOCIATED STRUCTURES & EQUIPMENT
I. PROJECT DESIGN PARAMETERS	**J.** LAND ACQUISITION STRATEGY
K. PROCUREMENT STRATEGY	**L.** PROJECT CONTROL
M. PROJECT EXECUTION PLAN	

(***Source:*** Evan Bingham, 2010)

Fig. 1: Interlinkages between 13 PDRI categories and Sustainable Development Goals
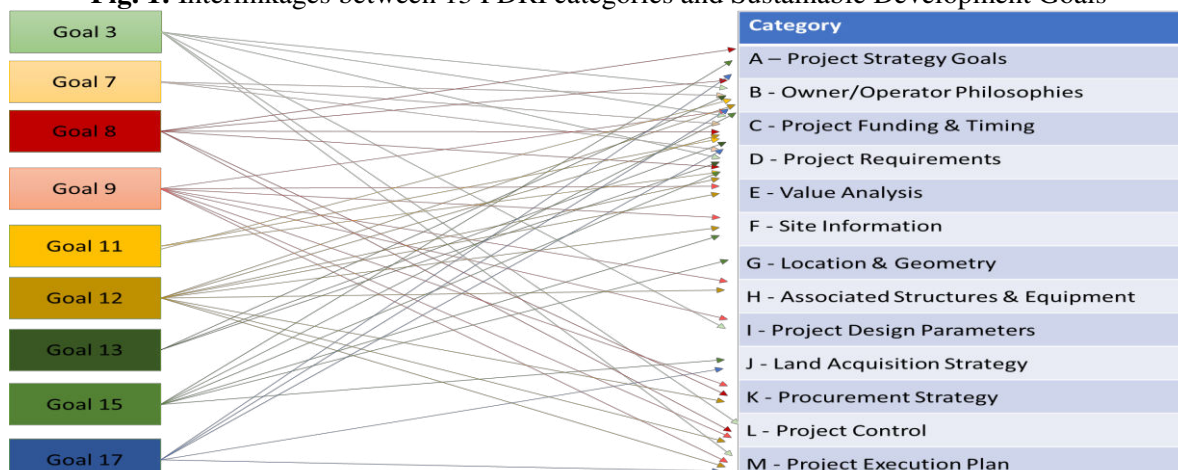
From the table 1 it is hinted that for SDG No. 9, out of 13 PDRI categories, 9 categories become very important. In fact, SDG No. 12, represents that goal which has maximum impact on project pre planning of the road infrastructure. The subsequent part of this research therefore focuses on computations which are very important from the perspective of responsible consumption and use. These details are presented below in the form of a comparative analysis of embodied energies used for conventional road materials like Soil, Aggregate, Asphalt, Bitumen, Concrete and the carbon footprint, vis-à-vis the alternative option of use of sustainable construction materials like Construction and Demolition Waste, Recycled asphalt, Crushed concrete, Fly ash and Slag from Thermal power plants, Metallurgical Slag, Lime, Silica fume, Foundry sand, Waste-rock, Ash from incineration plants for solid municipal wastes etc.

Project-01: Proposed Improvement & Maintenance of Road from MDR-13 Nirgudsar to Cholichamala Road CH Km 0/000 to CH Km 2/640 in Taluka: Ambegaon, District: Pune

Table 03: Embodied Energy Calculations of Conventional Materials used for road construction:

Sr. No.	Used Material	Mass (kg)	Embodied Energy per kg (MJ)	Embodied Energy (GJ)	GWP (Kg CO2 eq.)	GWP (tons CO2 eq.)
1)	Asphalt	1188000	11	13068	0.24	285.12
2)	Aggregate for Base Course	3564000	0.11	392.04	0.0090	32.07
3)	Cement Concrete	731500	1.1	804.65	0.14	102.41
4)	Granular Sub base (Sand)	311670	0.11	34.28	0.009	2.81
5)	Soil	2203630	0.11	242.39	0.010	22.04
			Total	14541.36	Total	444.45

From the table 3 it is seen that 444.45 equivalent Carbon Credits lost due to emission of CO_2 for project-01. The lost equivalent carbon credits can be earned if the conventional materials are replaced/alternative options are used.

Table 04: Embodied Energy Calculations if Alternative Materials used for road construction:

Sr. No.	Used Alternative Material	Mass (kg)	Embodied Energy per kg (MJ)	Embodied Energy (GJ)	GWP (Kg CO2 eq.)	GWP (tons CO2 eq.)
1)	Lime (Replacing Asphalt)	1188000	1.6	1900.8	0.43	510.8
2)	Fly ash Aggregate (Replacing Aggregate)	3564000	0.1	356.4	0.008	28.5
			Total	2257.2	Total	539.3

From the table 4 it is seen that 539.3 equivalent Carbon Credits will be gained if conventional materials such as Asphalt, Aggregate are replaced non-conventional such as Lime, Fly ash Aggregate materials.

5. RESULTS & DISCUSSION

1. Development of mapping matrix between 13 PDRI categories used for Road Infrastructure and the SDG's identified as applicable for Road Sector in any country has been done. This mapping matrix will enable the various planning authorities of road sector to incorporate specific scope elements during the feasibility studies itself, in such manner that PDRI scores may be computed for the future projects and on the basis of these values, whether sustainability aspects are incorporated in the infrastructure design or not can be ascertained. This, in turn will facilitate the formulation of a conceptual Sustainable Road Planning Model which is in alignment with the 17 SDGs goal attainment targeted by UNESCO. From table 1, mapping matrix indicates how 9 SDGs are directly and indirectly related to the 13 PDRI categories. SDG no. 12 (Responsible Consumption & Use) has the most impact on PDRI categories.

2. From the table 3 it is seen that total 444.45 equivalent Carbon Credits are lost due to emission of CO_2 for project-01. Out of which, asphalt and aggregate contribute 317.19 equivalent Carbon Credits lost due to emission of CO_2. If existing conventional materials such as asphalt and aggregate used in the project-01 are replaced with the alternative materials such as lime and fly ash aggregate mentioned in table 4, 539.3 equivalent Carbon Credits will be gained. Thus, a total of 222.11 equivalent Carbon Credits will be gained if asphalt and aggregate are replaced by lime and fly ash aggregate for project-01.

6. CONCLUSION

1. Using PDRI tool and the expectations from 17 SDG's a Sustainable Road Planning Conceptual Model when developed will be helpful for achieving the sustainability in road infrastructure.

2. Embodied energies, global warming potentials and carbon footprints of road infrastructure can be reduced by replacing conventional materials such as asphalt, aggregate with alternative materials such as lime, fly ash aggregate for road construction to achieve the sustainability in roads.

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REMARKS ON NANO MAXIMAL AND NANO MINIMAL HOMEOMORPHISM

D. EVANGELINE CHRISTINA LILY AND M. LELLIS THIVAGAR

ABSTRACT
The purpose of this paper is to define nano minimal and nano maximal homeomorphisms and investigate its characterizations. The notions of nano minimal and nano maximal open maps are also introduced and several characterizations of them are obtained.

***2010 MSC Subject Classification:** 54B05, 54C10.*

Keywords and Phrases: Nano minimal open set, Nano maximal open set, nano minimal homeomorphism, Nano maximal homeomorphism.

1 INTRODUCTION

The concept of minimal open sets was introduced by F. Nakaoka and N. Oda[6]. They also introduced and developed the ideas of maximal open sets, maximal and minimal closed sets[5]. S. S. Benchalli et al.[2] introduced and studied the notion of minimal open maps and minimal homeomorphism in a topological space. Thivagar et al.,[3] defined a new topology called nano topology which is defined on an approximation space in terms of lower and upper approximations and boundary region with respect to a subset X of the universe U. The elements of the nano topology are called nano open sets and their complements are called nano closed sets. He also defined nano minimal and nano maximal open sets and nano minimal and nano maximal continuous functions[4].

2 PRELIMINARIES

In this section, we recall some basic definitions which will be useful for this paper.

Definition 2.1 [3] Let U be a non-empty finite set of objects called the universe and R be an equivalence relation on U named as the indiscernibility relation. Elements belonging to the same equivalence class are said to be indiscernible from one another. The pair (U, R) is said to be the approximation space and let $X \subseteq U$.

(i) The lower approximation of X with respect to R is the set of all objects, which can be for certainly classified as X with respect to R and it is denoted by $L_R(X)$. That is, $L_R(X) = \bigcup_{x \in U}\{R(x): R(x) \subseteq X\}$, where $R(x)$ denotes the equivalence class determined by x.

(ii) The upper approximation of X with respect to R is the set of all objects, which can be possibly classified as X with respect to R and it is denoted by $U_R(X)$. That is, $U_R(X) = \bigcup_{x \in U}\{R(x): R(x) \cap X \neq \emptyset\}$, where $R(x)$ denotes the equivalence class determined by x.

(iii) The boundary region of X with respect to R is the set of all objects, which can be classified neither as X nor as not-X with respect to R and is denoted by $B_R(X)$. That is, $B_R(X) = U_R(X) - L_R(X)$.

Definition 2.2 [3] Let U be a universe, R be an equivalence relation on U and $\tau_R(X) = \{U, \emptyset, L_R(X), U_R(X), B_R(X)\}$ where $X \subseteq U$. Then $\tau_R(X)$ satisfies the following axioms:

(i) U and $\emptyset \in \tau_R(X)$.

(ii) The union of the elements of any sub-collection of $\tau_R(X)$ is in $\tau_R(X)$.

(iii) The intersection of the elements of any finite sub-collection of $\tau_R(X)$ is in $\tau_R(X)$. That is, $\tau_R(X)$ forms a topology on U called the nano topology on U with respect to X. We call $(U, \tau_R(X))$ as the nano topological space. The elements of $\tau_R(X)$ are called nano open sets and its complements are called nano closed sets.

Definition 2.3 [3] If $(U, \tau_R(X))$ is a nano topological space with respect to X where $X \subseteq U$ and if $A \subseteq U$, then the nano interior of A is defined as the union of all nano-open subsets of A and is denoted by N int(A). That is, Nint (A) is the largest nano-open subset of A.

The nano closure of A is defined as the intersection of all nano closed sets containing A and is denoted by Ncl (A). That is, Ncl (A) is the smallest nano closed set containing A.

Definition 2.4 [3]: Let $(U, \tau_R(X))$ and $(V, \tau_{R_1}(Y))$ be two nano topological spaces. Then a function $f : U \to V$ is nano continuous on U if the inverse image of every nano open set in V is nano open in U.

Definition 2.5 [3]: Let $(U, \tau_R(X))$ and $(V, \tau_{R_1}(Y))$ be two nano topological spaces. Then a function $f : U \to V$ is said to be nano open on U if the image of every nano open set in U is nano open in V. The function f is said to be nano closed on U if the image of every nano closed set in U is nano closed in V.

Definition 2.6 [3]: Let $(U, \tau_R(X))$ and $(V, \tau_{R_1}(Y))$ be two nano topological spaces. Then a function $f : U \to V$ is said to be a nano homeomorphism if

(i)   f is 1-1 and onto

(ii) f is nano continuous

(iii) f is nano open

Definition 2.7 [4]: A proper nonempty nano open set A of U is said to be a nano minimal open set(NMIOS) if and only if any nano open set which is contained in A is $\emptyset$ or A. A proper nonempty nano closed set F of U is said to be a nano minimal closed set(NMICS) if and only if any nano closed set which is contained in F is $\emptyset$ or F. The family of all nano minimal open sets in a nano topological space U is denoted by NMIO(U,X).

Definition 2.8 [4]: A proper nonempty nano open set A of a nano topological space U is said to be a nano maximal open set(NMAOS) if any nano open set which contains A is U or A. A proper nonempty nano closed set F of U is said to be a nano maximal closed set(NMACS) if any nano closed set which contains F is F or U. The family of all nano maximal open sets in a nano topological space U is denoted by NMAO (U, X).

Definition 2.9 [4]: Let U and V are two nano topological spaces. A map f: $U \to V$ is called

(i)   Nano minimal continuous if $f^{-1}(M)$ is an nano open set in U for every NMIOSM in V.

(ii) Nano maximal continuous if $f^{-1}(M)$ is an nano open set in U for every NMAOSM in V.

(iii) Nano minimal maximal continuous if $f^{-1}(M)$ is NMAOS in U for every NMIOSM in V.

(iv) Nano maximal minimal continuous if $f^{-1}(M)$ is NMIOS in U for every NMAOSM in V.

3 NANO MINIMAL AND NANO MAXIMAL HOMEOMORPHISM

Definition 3.1: Let U and V be two nano topological spaces. A map f: $U \to V$ is called a

(i)   Nano minimal open map (nano maximal open map) if the image of every proper non-empty nano open set in U is a NMIOS (NMAOS) in V.

(ii)   Nano minimal closed map (nano maximal closed map) if the image of every proper non-empty nano closed set in U is a NMICS (NMACS) in V.

(iii) Nano minimal maximal open map (nano minimal maximal closed map) if the image of every NMIOS (NMICS) in U is a NMAOS (NMACS) in V.

(iv)   Nano maximal minimal open map (nano maximal minimal closed map) if the image of every NMAOS (NMACS) in U is a NMIOS (NMICS) in V.

Example 3.2 : Let U = {a,b,c,d,e},U/R = {{a,b},{c,d},{e}} and X = {a,b} then $\tau_R(X)$ = {U, $\emptyset$, {a, b}}. Let V = {1,2,3,4},V/R_1 ={{1},{2,3}, {4}} and Y = {1,2} then $\tau_{R_1}(Y)$ = {V, $\emptyset$, {1}, {1, 2, 3}, {2, 3}}. Define a function f :U $\to$ V by $f(a) = 1$, $f(b) = 1$, f(c) = 3, f(d) = 2, f(e) = 4. Here f is a nano minimal open map, but not a nano maximal open map since f({a,b}) = {1} is not nano maximal open.

Definition 3.3: Let U and V be two nano topological spaces. A map f : $U \to V$ is called a nano minimal bicontinuous map(nano maximal bicontinuous map) if f is both nano minimal continuous(nano maximal continuous) and a nano minimal open map(nano maximal open map).

Example 3.4:Let U={a,b,c,d}, X={a,b} and U/R={{a},{b},{c,d}} then $\tau_R(X)$={U, $\emptyset$,{a,b}} and V={1,2,3,4},Y={1,2} and V/R_1={{1},{2,3}, {4}} then $\sigma_{R_1}(Y)$={V, $\emptyset$, {1}, {1,2,3}, {2, 3}}. Define a function **f** :U → V by **f**(a) = 2, **f**(b) = 3, **f**(c)= 4, f(d) = 4. Here f is a nano minimal open map and nano minimal continuous. Hence f is a nano minimal bicontinuous map.

Definition 3.5: Let U and V be two nano topological spaces. A map f:U→V is called a nano minimal homeomorphism(nano maximal homeomorphism) if f is bijective and a nano minimal bicontinuous map(nano maximal bicontinuous map).

Example 3.6 :Let U={1, 2, 3, 4}, X={1, 2, 4} and U/R={{1}, {4}, {2, 3}} then $\tau_R(X)$={U ,$\emptyset$,{1, 4},{2, 3}}. Let V={p,q,r,s}, **Y**={p,q,r} and V/ R_1 ={{p,q},{r,s}}then $\sigma_{R_1}(Y)$={V, $\emptyset$,{p, q},{r, s}}.Define a bijection **f** : U→ V by **f**(1) = p, **f**(2) = r, f(3) = s, f(4) = q. Here f is a nano minimal open map and nano minimal continuous. Hence f is a nano minimal homeomorphism.

Theorem 3.7 Let U and V be two nano topological spaces and f : U → V be a bijective map. Then

(i) F is nano maximal open if and only if f is nano minimal closed.

(ii) F is nano minimal open if and only if f is nano maximal closed.

Proof: (i) Let f be a nano maximal open map. Let F be a nano closed set in U. Then F^c is a nano open set in U. Since f is nano maximal open, f(F^c) is nano maximal openin U which implies (f (F))^c is nano maximal open in U. Hence f (F) is nano minimal closed in V. Therefore f is nano minimal closed. Conversely let f be nano minimal closed and G be a nano open set in U. Now G^c is nano closed in U and by assumptionf (G^c) is a nano minimal closed set in V. That is (f (G))^c is nano minimal closed and hence f(G) is nano maximal open in V. Therefore f is nano maximal open.

(ii) Proof similar to (i).

Theorem 3.8 Let U and V be two nano topological spaces and f : U → V be a bijectivemap.

(i) If f is nano maximal open then f^{-1} is nano maximal continuous.

(ii) If f is nano minimal open then $f^{-1}$is nano minimal continuous.

Proof: (i) Let f be a nano maximal open map. Consider f^{-1}: V → U. Let G bea nano maximal open set in U. Then G is nano open in U. By assumption f(G) isnano maximal open in V. That is (f^{-1})$^{-1}$ (G) is nano open in V. Hence f^{-1} is a nano maximal continuous map.

(ii) Proof similar to (i).

Remark 3.9 Converse need not be true for the statements in theorem 3.8. It is justifiedin the following example.

Example 3.10 : Let U={a,b,c,d}, X={a,b} and U/R= {{a},{b,c},{d}} then $\tau_R(X)$= {U, $\emptyset$, {a}, {a, b, c}, {b, c}} and V ={1,2,3,4}, **Y** ={2,3} and V/ R_1 ={{1},{2,4},{3}}then σ_{R_1}(Y)={V, $\emptyset$,{3},{2,3,4},{2,4}}. Define a function **f** :U → V by **f**(a) = 2, f(b) = 3, f(c) = 4, f(d) = 1. Here f $^{-1}$ is a nano maximal continuous map. But since f {a} = {2}is not a NMAOS, **f** is not a nano maximal open map.

Theorem 3.11 Let U and V be two nano topological spaces and f : U → V be a bijective map.

(i) If f is nano maximal homeomorphism then both f and f^{-1} are nano maximalcontinuous.

(ii) If f is nano minimal homeomorphism then both f and f^{-1} are nano maximalcontinuous.

Proof: It follows from Definition 3.5 and Theorem 3.8.

Theorem 3.12 Every surjective nano minimal(maximal) open map is a nano open map.

Proof: Let f: U → V be a surjective nano minimal (maximal) open map. Then image of every proper non-empty nano open set is nano minimal (maximal) open in V and hence nano open in V. Also $f(\emptyset) = \emptyset$ and $f(U) = V$ are nano open in V. Hence f is a nano open map.

Remark 3.13 Converse of Theorem 3.12 need not be true. It is justified in the following example.

Example 3.14 Let U ={a,b,c,d},X={a,b} and U/R = {{a},{b, c},{d}} then $\tau_R(X)$= {U, $\emptyset$, {a}, {a, b, c}, {b, c}} and V ={1,2,3}, Y ={1,2} and V/ R_1 ={{1},{2,3}} then $\sigma_{R_1}(Y)$ = {V, $\emptyset$, {1}, {2,3}}. Define a function f :U $\rightarrow$ V by f(a) = 1, f(b) = 2, f(c)= 3, f(d) = 1. Here f is a nano open map. But since f{a, b, c} = V is not a NMIOS, f is not a nano minimal open map.

Theorem 3.15 Every nano maximal open map is a nano minimal-maximal open map.

Proof : Let f : U $\rightarrow$ V be a nano maximal open map and G be a nano minimal open set. Then G is a proper non-empty nano open set and hence image of G is nano maximal open in V and hence f is nano minimal-maximal open.

Remark 3.16 Converse of Theorem 3.15 need not be true. It is justified in the following example.

Example 3.17 In Example 3.14, f is a nano minimal-maximal open map. But since f {a, b, c} = V is not a NMAOS, f is not a nano maximal open map.

Theorem 3.18 Every nano minimal open map is a nano maximal-minimal open map.

Proof: Proof similar to Theorem 3.15.

Remark 3.19 Converse of Theorem 3.18 need not be true. It is justified in the following example.

Example 3.20 Let U={a,b,c,d},X={a,b} and U/R={{a},{b,c},{d}} then $\tau_R(X)$={U, $\emptyset$,{a},{a, b, c},{b, c}}. Let V={1,2,3}, Y ={2} and V/R_1={{1},{2,3}} then $\sigma_{R_1}(Y)$ = {V, $\emptyset$, {2, 3}}. Define a function f :U $\rightarrow$ V by f(a) = 2, f(b) = 2, f(c) = 3, f(d) = 1. Here f is a nano maximal-minimal open map. But since f {a} = {2} is not a NMIOS, f is not a nano minimal open map.

Theorem 3.21 Every nano minimal homeomorphism is a nano homeomorphism.

Proof: Proof follows from Theorem 3.8 and every nano minimal continuous map is nano continuous.

Theorem 3.22 Let U and V be two nano topological spaces and f : U $\rightarrow$ V be a bijective nano minimal continuous map. Then the following statements are equivalent.

(i) F is a nano minimal homeomorphism.

(ii) F is a nano minimal open map.

(iii) F is a nano maximal closed map.

Proof: (i) $\Rightarrow$ (ii) It follows from definition.

(ii) $\Rightarrow$ (iii) By Theorem 3.7, every nano minimal open map is nano maximal closed.

(iii) $\Rightarrow$ (i) By Theorem 3.7, f is nano minimal open and by assumption, f is nano minimal continuous. Hence f is a nano minimal homeomorphism.

4 CONCLUSION

In this paper, we have defined some new classes of maps namely nano minimal open and closed maps, nano maximal open and closed maps, nano minimal and nano maximal homeomorphisms and established the relations between these mappings. We have also established characterization of these mappings.

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SOME PROPERTIES IN SOFT JC CLOSED SET IN SOFT TOPOLOGICAL SPACES

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ABSTRACT

The main aim of this paper is to introduce some properties in soft Jc closed sets. In this paper we have discussed the features of Soft Jc Interior, Soft Jc Closure, Soft Jc Border, Soft Jc Frontier, and Soft Jc Exterior and studied them in detail.

Keywords: Soft Jc Closed, Soft Jc Interior, Soft Jc Closure, Soft Jc Border, Soft Jc Frontier, Soft Jc Exterior.

1. INTRODUCTION

In 1999, Molodtsov [7] proposed soft set theory as a new mathematical tool for dealing with uncertainty. He has demonstrated multiple applications of this theory in the solution of several practical issues in economics, engineering, social science, and medicine, among other fields. Later, scholars such as Maji et al [5,6] expanded on the notion of soft sets and applied it to tackle specific decision-making difficulties. Following that, numerous writers defined various structures on soft sets and shown multiple uses. Soft groups were created by H Aktas and N.Cagman [1] in 2007. Several other writers further expanded on various aspects of soft set theory. Kharal and Ahmed [4] first suggested the concept of mapping on soft classes in 2011. Recently in 2011, Shabir and Naz [8] introduced soft topological spaces. The authors of this study explored the features of a new type of Soft generalised closed set called Soft Jc closed set [3]. In this paper we have discussed the features of Soft Jc Interior, Soft Jc Closure, Soft Jc Border, Soft Jc Frontier, and Soft Jc Exterior and studied them in detail. The reconfiguration of the extrinsic nature through which the functionality of organisation is undergoing incorporates the enforcement in the contracts, property rights, and rule of laws. Intrinsically, the organisations be able to undergo corporate governance besides the rules for the setting of strategical company in progressing the decisions that met with day-to-day scheme. The ethical principles will be capable of working as key function when extrinsic organisations are vulnerable, to enableimitation in business transactions. So as there would be enhancement in the economic expansion andadvancement.

2. PRELIMINARIES

In this section, we discuss the basic definitions and results of Soft set theory that can be considered from previous studies. Throughout this work, X refers to an initial universe, $P(X)$ is the power set of X, E denote the set of parameter and (X, τ, E) denote Soft topological spaces where no Soft separation axioms are assumed until it is explicated.

Definition 2.1: Let (X, τ, E) be a Soft topological space. A Soft set (F, E) is called Soft Jc Closed set if $S\alpha Cl(F, E) \widetilde{\subseteq} Sint(U, E)$ whenever $(F, E) \widetilde{\subseteq} (U, E)$ and (U, E) is Soft $\hat{g}$ open. The set of all Soft Jc Closed sets is denoted by SJcC (X, τ, E)

Definition 2.2: [2,8] Let (X, τ, E) be a Soft Topological Space over X.

1. The **Soft interior** of (F, E) denoted by $Sint(F, E)$ is the union of all Soft open subsets contained in (F, E). Clearly (F, E) is the largest Soft open set over X which is contained in (F, E). $Sint(F, E) = \widetilde{U} \{(O, E): (O, E)$ is Soft open and $(O, E) \widetilde{\subseteq} (F, E)\}$.

2. The **Soft Closure** of (F, E) denoted by $Cl(F, E)$ is the Sintersection of Soft Closed sets containing (F, E). Clearly (F, E) is the smallest Soft Closed set containing (F, E). $Cl(F, E) = \widetilde{\cap} \{(O, E): (O, E)$ is Soft Closed and $(F, E) \widetilde{\subseteq} (O, E)\}$.

3. The **Soft Border** of (F, E) denoted by $SBr(F, E) = (F, E) - SSint(F, E)$.

4. The **Soft Frontier** of (F, E) denoted by $SFr(F, E) = Cl(F, E) - Sint(F, E)$.

5. The **Soft Exterior** of (F, E) denoted by $SExt(F, E) = Sint(X - (F, E))$.

Definition 2.3: [8] Let $(A,)$ be a Soft subset of the Soft topological space $(X, , E)$. Then the Soft set $\widetilde{\cap} \{(U,) \widetilde{\in} \tau : (A, E) \widetilde{\subseteq} (U, E)\}$ is known as the **Soft kernel** of the Soft subset (A, E) and it is symbolized as $SKer(A, E)$.

3 ON SOFT JC CLOSED SET

Definition 3.1: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. The union of all Soft Jc open subsets of (F, E) is the **Soft Jc interior** of (F, E) symbolized as $SJc - int(F, E)$. Precisely $SJcint(F, E)$ is the largest Soft Jc open set over $\tilde{X}$ which is contained in (F, E).

$SJc - int(F, E) = \tilde{\cup} \{(O. E): (O, E) \text{ is Soft Jc open and } (O, E) \tilde{\subseteq} (F, E)\}$.

Definition 3.2: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. The intersection of Soft Jc Closed sets containing (F, E) is the **Soft Jc Closure** of (F, E) symbolized as $SJcCl(F, E)$. Precisely $SJcCl(F, E)$ is the smallest Soft Jc Closed set containing (F, E).

$SJcCl(F, E) = \tilde{\cap} \{(O, E): (O, E) \text{ is Soft Jc Closed and } (F, E) \tilde{\subseteq} (O, E)\}$.

Definition 3.3: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. The **Soft Jc Border** of (F, E) symbolized as $SJcBd(F, E)$ is defined as $SJcBd(F, E) = (F, E) - SJcint(F, E)$.

Definition 3.4: Consider (X, τ, E) which is a Soft topological space over X. The **Soft Jc Frontier** of (F, E) symbolized as $SJcFr(F, E)$ is defined as $SJcFr(F, E) = SJcCl(F, E) - SJcint(F, E)$.

Definition 3.5: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. The **Soft Jc Exterior** of (F, E) symbolized as $SJcExt(F, E)$ is defined as $SJcExt(F, E) = SJcint((F, E)^C)$.

Theorem 3.6: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. For any two subsets (A, E) and (B, E) of (X, τ, E),

(i) $SJcCl(\tilde{\phi}) = \tilde{\phi}$.

(ii) $SJcCl(\tilde{X}) = \tilde{X}$.

(iii) $(A, E) \tilde{\subseteq} SJcCl(A, E) \tilde{\subseteq} Cl(A, E)$.

(iv) If $(A, E) \tilde{\subseteq} (B, E)$ then $SJcCl(A, E) \tilde{\subseteq} SJcCl(B, E)$.

(v) If (A, E) is Soft Jc Closed then $SJcCl(A, E) = (A, E)$.

(vi) $SJcCl(SJcCl(A, E)) = SJcCl(A, E)$.

Proof:

(i)   And (ii) are evident.

(iii) Since each one of the Soft Closed set is Soft Jc Closed, the argument proceeds.

(iv) And (v) proceeds from the Definition 3.2.

(vi) Proceeds from the Definition 3.2 and (v).

Theorem 3.7: Consider (X, τ, E) which is a Soft topological space over X. For any two subsets (A, E) and (B, E) of (X, τ, E),

1. $SJcint(\tilde{\phi}) = \tilde{\phi}$.

2. $SJcint(\tilde{X}) = \tilde{X}$.

3. $Sint(A, E) \tilde{\subseteq} SJcint(A, E)$

4. (A, E) is Soft Jc open then $(A, E) = SJcint(A, E)$.

5. If $(A, E) \tilde{\subseteq} (B, E)$, then $SJcint(A, E) \tilde{\subseteq} SJcint(B, E)$.

6. If (B, E) is any Soft Jc open set contained in (A, E), then $(B, E) \tilde{\subseteq} SJcint(A, E)$.

7. $SJcint(A, E) \tilde{\cup} SJcint(B, E) \tilde{\subseteq} SJcint((A, E) \tilde{\cup} (B, E))$.

8. $SJcint(SJcint(A, E)) = SJcint(A, E)$.

Proof:

(1) And (2) are evident.

(3) Since each one of the Soft open set is Soft Jc open, the argument proceeds.

(4) And (5) follows from the Definition 3.1.

(6) Let$(x, e) \widetilde{\in} (B, E)$. By (5) $(x, e) \widetilde{\in} SJcint(A, E)$. Hence the argument.

(7) Proceeds from (5).

(8) Proceeds from Definition 3.1 and (4).

Theorem 3.8: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$ and (A, E) be a Soft subset of (X, τ, E). Then for any $(x, e) \widetilde{\in} \tilde{X}$, $(x, e) \widetilde{\in} SJcCl(A, E)$ if and only if $(U, E) \widetilde{\cap} (A, E) \neq \tilde{\phi}$ for every Soft Jc open set (U, E) containing (x, e).

Proof:

Necessity: Suppose that $(x, e) \widetilde{\in} SJcCl(A, E)$. Let (U, E) be a Soft Jc open set containing (x, e) such that $(U, E) \widetilde{\cap} (A, E) = \tilde{\phi}$. Then, $(A, E) \widetilde{\subseteq} (U, E)^C$. But $(U, E)^C$ is Soft Jc Closed and hence $SJcCl(A, E) \widetilde{\subseteq} (U, E)^C$.

Since$(x, e) \widetilde{\notin} (U, E)^C$. Then$(x, e) \widetilde{\notin} SJcCl(A, E)$, which is conflicting the hypothesis. Hence the argument.

Sufficiency: Suppose that every Soft Jc open set (U, E) containing (x, e) intersects (A, E). If $(x, e) \widetilde{\notin} SJcCl(A, E)$, there exists a Soft Jc Closed set (F, E) in (X, τ, E) such that $(A, E) \widetilde{\subseteq} (F, E)$ and $(x, e) \widetilde{\notin} (F, E)$. Then $(x, e) \widetilde{\in} (F, E)^C$ and $(F, E)^C$ is a Soft Jc open set containing (x, e). But$(F, E)^C \widetilde{\cap} (A, E) = \tilde{\phi}$, which is conflicting the hypothesis. Hence the argument.

Theorem 3.9: For any subset (A, E) of the Soft topological space (X, τ, E),

1. $(SJcint(A, E))^C = SJcCl((A, E)^C)$.

2. $SJcint(A, E) = (SJcCl((A, E)^C))^C$.

3. $SJcCl(A, E)) = (SJcint((A, E)^C))^C$.

Proof:
1. Let $(x, e) \widetilde{\in} (SJcint(A, E))^C$.Then$(x, e) \widetilde{\notin} SJcint(A, E)$. That is every Soft Jc open set (U, E) containing (x, e) is such that$(U, E) \widetilde{\subseteq} (A, E)$. Then$(U, E) \widetilde{\cap} (A, E) \neq \tilde{\phi}$. By Theorem 3.6(iii), $(x, e) \widetilde{\in} SJcCl((A, E)^C)$. And therefore, $(SJcint(A, E))^C \widetilde{\subseteq} SJcCl((A, E)^C)$.Conversely, suppose, $(x, e) \widetilde{\in} SJcCl((A, E)^C)$. By Theorem 3.8, every Soft Jc open set (U, E) containing (x, e) is such that$(U, E) \widetilde{\cap} (A, E) \neq \tilde{\phi}$. Then by Theorem 3.7(4), $(x, e) \widetilde{\notin} SJcint(A, E)$. Therefore, $(x, e) \widetilde{\in} (SJcint(A, E))^C$.

2. It proceeds by taking complements in (1).

3. It proceeds by replacing (A, E) by $(A, E)^C$ in (1).

Theorem 3.10: For any subset (A, E) of the Soft topological space(X, τ, E),

1. $SJcBd(\tilde{\phi}) = \tilde{\phi}$.

2. $SJcBd(\tilde{X}) = \tilde{X}$.

3. $SJcBd(A, E) \widetilde{\subseteq} (A, E)$.

4. $SJcint(A, E) \widetilde{\cup} SJcBd(A, E) = (A, E)$.

5. $SJcint(A, E) \widetilde{\cap} SJcBd(A, E) = \tilde{\phi}$.

6. $SJcBd(A, E) \widetilde{\subseteq} SBd(A, E)$.

7. $SJcBd(SJcint(A, E)) = \tilde{\phi}$.

8. $SJcBd(SJcBd(A, E)) = SJcBd(A, E)$.

9. $SJcBd(A, E) = (A, E) \widetilde{\cap} SJcCl((A, E)^C)$.

Proof:
(1), (2), (3), (4), (5) are evident from the Definition 3.3.

(6) Proceeds from Theorem 3.7(3).

(7) Let$(x, e) \widetilde{\in} SJcBd(SJcint(A, E))$. Then $(x, e) \widetilde{\in} SJcBd(A, E)$.

Since $SJcBd(A, E) \widetilde{\subseteq} (A, E)$, $(x, e) \widetilde{\in} SJcint(SJcBd(A, E)) \widetilde{\subseteq} SJcint(A, E)$.

There on $(x, e) \widetilde{\in} SJcint(A, E) \widetilde{\cap} SJcBd(A, E)$, which conflicts (5).

Then $SJcBd(SJcint(A, E)) = \tilde{\phi}$.

(8) Proceeds from (7).

(9) Proceeds from Definition 3.3 and Theorem 3.9(1).

Theorem 3.11: For any subset (A, E) of the Soft topological space (X, τ, E),

1. $SJcFr(\tilde{\phi}) = \tilde{\phi}$.

2. $SJcFr(\tilde{X}) = \tilde{X}$.

3. $SJcint(A, E) \widetilde{\cup} SJcFr(A, E) = SJcCl(A, E)$.

4. $SJcint(A, E) \widetilde{\cap} SJcFr(A, E) = \tilde{\phi}$.

5. $SJcBd(A, E) \widetilde{\subseteq} SJcFr(A, E) \widetilde{\subseteq} SJcCl(A, E)$.

6. $SJcFr(A, E) \widetilde{\subseteq} SFr(A, E)$.

7. $SJcFr(SJcint(A, E)) \widetilde{\subseteq} SJcFr(A, E)$.

8. $SJcFr(SJcCl(A, E)) \widetilde{\subseteq} SJcFr(A, E)$.

9. $SJcFr(SJcFr(A, E)) \widetilde{\subseteq} SJcFr(A, E)$.

10. $SJcFr(A, E) = SJcCl(A, E) \widetilde{\cap} SJcCl((A, E)^C)$.

11. (A, E) is Soft Jc Closed iff $(A, E) = SJcint(A, E) \widetilde{\cap} SJcFr(A, E)$.

12. (A, E) is Soft Jc Closed iff $SJcBd(A, E) = SJcFr(A, E)$.

13. $X = SJcint(A, E) \widetilde{\cup} SJcint((A, E)^C) \widetilde{\cup} SJcFr(A, E)$.

Proof:

(1), (2), (3), (4), (5) are evident from the Definition 3.4.

(6) Proceeds from Theorem 3.6(iii) and Theorem 3.8(3).

(7) Proceeds from Definition 3.4 and Theorem 3.8(8).

(8) Proceeds from Definition 3.4 and Theorem 3.6(vi).

(9) Proceeds from Definition 3.4 and the fact $SJcFr(A, E)$ is Soft Jc Closed.

(10) Proceeds from Definition 3.4 and Theorem 3.9(i).

(11) Proceeds from (3) and Theorem 3.6(v).

(12) Proceeds from Theorem 3.6(v).

(13) Proceeds from (3) and Theorem 3.9(3).

Theorem 3.12: For any subset (A, E) of the Soft topological space (X, τ, E),

1. $SJcExt(\tilde{\phi}) = \tilde{\phi}$.

2. $SJcExt(\tilde{X}) = \tilde{X}$.

3. If $(A, E) \widetilde{\subseteq} (B, E)$ then $SJcExt(B, E) \widetilde{\subseteq} SJcExt(A, E)$.

4. $SJcExt(A, E)$ is Soft Jc open.

5. $SExt(A, E) \widetilde{\subseteq} SJcExt(A, E) \widetilde{\subseteq} (A, E)^C$.

6. $SJcExt(A, E) = \tilde{X} - SJcCl(A, E)$.

7. $\tilde{X} = SJcint(A, E) \widetilde{\cup} SJcFr(A, E) \widetilde{\cup} SJcExt(A, E)$.

8. $SJcExt((A, E) \widetilde{\cup} (B, E)) \widetilde{\subseteq} SJcExt(A, E) \widetilde{\cap} SJcExt(B, E)$.

9. $SJcExt(A,E) \tilde{\cap} SJcExt(B,E) \tilde{\subseteq} SJcExt((A,E) \tilde{\cup} (B,E))$.

Proof:

(1), (2), (3) are evident from Definition 3.5.

(4) Proceeds from Definition 3.1 and Definition 3.5.

(5) Proceeds from Theorem 3.7 (8).

(6) Proceeds from Theorem 3.9 (3).

(7) Proceeds from Definition 3.5 and Theorem 3.11 (13).

(8) Proceeds from (3) and set theoretic properties.

Definition 3.13: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. The intersection of all Soft Jc open sets containing (F, E) is the **Soft Jc Kernal** of (F, E) symbolized as $SJcKer(F, E)$. $SJcKer(F, E) = \tilde{\cap} \{(O, E) : (O, E) \text{ is Soft Jc open and } (F, E) \tilde{\subseteq} (O, E)\}$.

Theorem 3.14: Consider (X, τ, E) which is a Soft topological space over $\tilde{X}$. For any two subsets (A, E) and (B, E) of (X, τ, E),

1. $(A, E) \tilde{\subseteq} SJcKer(A, E)$.

2. If $(A, E) \tilde{\subseteq} (B, E)$ then $SJcKer(A, E) \tilde{\subseteq} SJcKer(B, E)$.

3. $SJcKer(SJcKer(A, E)) = SJcKer(A, E)$.

4. If (A, E) is Soft Jc open then $SJcKer(A, E) = (A, E)$.

Proof:

(i) Proceeds from Definition 3.13.

(ii) Suppose $(x, e) \tilde{\notin} SJcKer((B, E))$, then there exists a Soft Jc open set (U, E) such that $(B, E) \tilde{\subseteq} (U, E)$ and $(x, e) \tilde{\notin} (U, E)$.

Since $(A, E) \tilde{\subseteq} (B, E), (x, e) \tilde{\notin} SJcKer((A, E))$.

Then $SJcKer(A, E) \tilde{\subseteq} SJcKer(B, E)$.

(iii) Follows from Definition 3.13 and Theorem 3.14 (1).

(iv) By the Definition 3.13, $(A, E) \tilde{\in} SJcO(X, \tau, E)$, then $SJcKer(A, E) \tilde{\subseteq} (A, E)$ and by (1), $(A, E) \tilde{\subseteq} SJcKer(A, E)$. Then $SJcKer(A, E) = (A, E)$.

4 CONCLUSION

We study some extensions of soft topology, which are defined by reducing the stipulations of soft topology, for various purposes such as obtaining appropriate models to handle some real life issues, or building some paradigms that demonstrate the relations among some topological notions and ideas, or keeping certain properties under fewer conditions of those given on soft topology. To this end we have recently defined a new class of Soft Closed set namely soft Jc closed set and studied some of their properties

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A NEW APPROACH ON FUZZY ℓ_1 PENALTY METHOD SPARSE REGULARIZATION WITH FUZZY LINEAR PROGRAMMING PROBLEM

DR. A. NAGOOR GANI AND R. YOGARANI

ABSTRACT

This article highlights a new technic of the fuzzy regularization least square with a nonconvex, nonsmooth of the fuzzy Huber function to solve the ill-posed fuzzy linear programming problem. Further, we focus on the fuzzy existence and stability of the fuzzy sparse regularization solution. A fuzzy ℓ_1 penalty function algorithm is used in this method to reach an optimal solution for the considered problem. This work, in particular, focuses on applying an algorithmic strategy to solve fuzzy numerical problems.

Keywords: Fuzzy $\boldsymbol{\ell_1}$ penalty function, Least-square regularization, Fuzzy optimal solution, Fuzzy basic feasible solution, Fuzzy $\boldsymbol{\ell_2}$ norm.

1. INTRODUCTION

Fuzzy optimization is a widely recognized problem in theory and applications in artificial intelligence, production, and management; it is essential to build general and operable fuzzy optimization algorithms. Fuzziness is a broad-based occurrence in the actual world, and many practice areas are inescapable. The relaxing strategy involves replacing the ℓ_0 norm with a sparsity continuous fuzzy penalty function. A fuzzy convex relaxation indicates fuzzy penalty function as the ℓ_1 norm in a unique way. The ℓ_1 algorithms Bregman split Bregman methods and yallare developed by yin [19] et al., Goldstein [10] et al. and Yang [20] et al.

In 1965, Zadeh [21] was provided with a fuzzy set theory, whereas Tanaka and Asai [17] initially developed the concept of the fuzzy problem of linear programming in general. Introducing the notion of fuzzy numbers, D. Dubois and H. Prade [5]. The feature to address fuzzy arithmetic, Hsieh and Chen [10] established the principle of operation. The optimization of the Bellman and Zadeh seminal was initiated in 1970. Xiangyu Chang et al. [4] is further developed by high dimensional fuzzy c means data clustering using sparse regularization. A. Nagoor Gani and R. Yogarani [7] introduce the polynomial penalty approach to solving fuzzy linear programming problems. The fuzzy polynomial barrier procedures are further investigated.

This article concentrates on solving the form's ill-posed operator fuzzy equation

$$\widetilde{M}\tilde{p} = \widetilde{N} \tag{1}$$

Fuzzy Sparsity regularisation is the most widely adopted approach of solving the ill-posed operator's equation (1).

$$arg\ min \frac{1}{z}\left\|\widetilde{N}_l - \widetilde{M}_l\tilde{p}\right\|_x^z + \frac{1}{\tau}\left\|\left(\widetilde{f_1}, \widetilde{f_2}, \widetilde{f_3}\right)\right\|_y \tag{2}$$

Fuzzy objective value as the ℓ_1 norm and then constraints consider the ℓ_2 norm of the problem. fuzzy ℓ_1 norm regularised least squares is a traditional method for obtaining fuzzy sparse approximation solutions to linear equations of the fuzzy variable, but this method frequently underestimates the proper answer. This study introduces fuzzy non-convex penalty functions as an another way to approach to the ℓ_1 norm, the fuzzy convexity of the least-squares function to be minimize while avoiding systematic optimization. For regularization, utilize the ℓ_1 norm and then a sparse solution can be found. We have the minimizing ℓ_2 *the norm* in the case of residuals, the Euclidean standard and the ℓ_1 norm is applied regularly.

Fuzzy Convex optimization means a minimum of the convex objective function over a series of convex constraints (or a maximum of a concave objective function). Fuzzy Linear programming means an instance of fuzzy convex optimization the fuzzy objective function is linear, and the fuzzy constraints consist of linear equality and inequality of the fuzzy variable, the fuzzy convex problem revolution in optimizing imperfect structured models. Compressed sensing work reveals that many non-precise linear actions to the signal sparing factor can be reconstructed if the vector is sparse.

2. PRELIMINARIES

a. Fuzzy Spark
The fuzzy spark is a nonlinearly independent subset of column entries in a matrix.

b. Fuzzy Generalized Huber Function\
The generalized fuzzy Huber is a lower semicontinuous function defined as $H_q: R^N \to R, q \in R^{i \times j}, H_q(\tilde{P}) = inf\{\|\widetilde{s_1}, \widetilde{s_2}, \widetilde{s_3}\|_y + \frac{1}{2}\|q(\tilde{p} - \tilde{s})\|_x^z\}$.

$$H_s(\tilde{P}) = \begin{cases} \frac{1}{2}q^2\tilde{P}^2, & |\tilde{P}| \leq {1}/{q^2} \\ |\tilde{P}| - \frac{1}{2q^2}, & |\tilde{P}| \geq {1}/{q^2} \end{cases}$$

c. Convex Fuzzy Set
Let any $\tilde{P}, \tilde{Q} \in l$ and $\vartheta \in (0,1)$ is referred to as a convex fuzzy set is defined as follows

$\theta(\vartheta\tilde{P} + (1 - \vartheta)\tilde{Q}) \in Min(\theta(\tilde{P}), \theta(\tilde{Q}))$.

d. Fuzzy Convex Optimization Problem
If a problem can be described in the form, it's a fuzzy convex optimization

Minimize $(\tilde{f_1}, \tilde{f_2}, \tilde{f_3})\tilde{p}_1 + (\tilde{f_1}, \tilde{f_2}, \tilde{f_3})^t\tilde{p}_2$

Subject to the constraints

$\widetilde{M}_{11}\tilde{p}_1 + \widetilde{M}_{12}\tilde{p}_2 \leq (\tilde{n}_1, \tilde{n}_2, \tilde{n}_3)$,

$\widetilde{M}_{21}\tilde{p}_1 + \widetilde{M}_{22}\tilde{p}_2 \leq (\tilde{n}_1, \tilde{n}_2, \tilde{n}_3)^t$.

Where $\tilde{f_k}, \widetilde{M}_{ij}, \widetilde{N}$ are convex.

3. FUZZY ℓ_1 PENALTY METHOD SPARSE REGULARIZATION
Let us consider the following the primal fuzzy linear programming problem (PFLPP)

Minimize $\tilde{V} = \left\|(\tilde{f_1}, \tilde{f_2}, \tilde{f_3})\tilde{p}_1 + (\tilde{f_1}, \tilde{f_2}, \tilde{f_3})^t\tilde{p}_2\right\|$

Subject to $\widetilde{M}_{11}\tilde{p}_1 + \widetilde{M}_{12}\tilde{p}_2 = (\tilde{n}_1, \tilde{n}_2, \tilde{n}_3)$,

$\widetilde{M}_{21}\tilde{p}_1 + \widetilde{M}_{22}\tilde{p}_2 = (\tilde{n}_1, \tilde{n}_2, \tilde{n}_3)^t$.

where $\quad \widetilde{M}_l = \begin{bmatrix} \widetilde{M}_{11} & \widetilde{M}_{12} \\ \widetilde{M}_{21} & \widetilde{M}_{22} \end{bmatrix} \in R^{m \times n}, \tilde{f}, \tilde{f}^t, \tilde{p}_i \in R^m, \widetilde{N}, \widetilde{N}^t \in R^n, \tilde{f} = (\tilde{f_1}, \tilde{f_2}, \tilde{f_3}), \widetilde{N}_l = (\tilde{n}_1, \tilde{n}_2, \tilde{n}_3), i = 1,2$

(3)

Without loss of generality we may assume that the rank of $\widetilde{M}_l$ is maximum say m. Suppose that the PFLPP possess atleast one possible solution. We introduce the fuzzy ℓ_1 penalty method is denoted by $\tilde{L}_1(\tilde{p}, \tau), \tau > 0$

Define $\tilde{L}_1(\tilde{p}, \tau): R^n \to R$ by the fuzzy ℓ_1 Penalty Huber function of the sparse recovery is defined by

$\tilde{L}_1(\tilde{p}_1, \tilde{p}_2, \tau) =$
$\frac{1}{z}\left\|\widetilde{N}_l - \widetilde{M}_l\tilde{p}\right\|_x^z + \frac{1}{\tau}\left\|(\tilde{f_1}, \tilde{f_2}, \tilde{f_3})\tilde{p}_1 + (\tilde{f_1}, \tilde{f_2}, \tilde{f_3})^t\tilde{p}_2\right\|_y$ (4)

Where x, z are the smallest even number, y=1.

The problem has a convex fuzzy ℓ_1 penalty Huber function (4). As a result, $\tilde{L}_1(\tilde{p}, \tau)$ is a global minimum, and the parameter has a positive increasing value.

The fuzzy generalized penalty satisfies

$\rho_q(\tilde{p}) = \left\|(\tilde{f_1}, \tilde{f_2}, \tilde{f_3})\tilde{p}_1 + (\tilde{f_1}, \tilde{f_2}, \tilde{f_3})^t\tilde{p}_2\right\|_y - \frac{1}{2}\|q(\tilde{p})\|_x^z$
(5)

$$\rho_q(\tilde{p}) \approx \left\| (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3) \tilde{p}_1 + (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)^t \tilde{p}_2 \right\|_y, \tilde{p} \approx 0$$

(6)

$$G(\tilde{p}) = \frac{1}{2}(\tilde{N}_l - \tilde{M}_l \tilde{p})^2 - \frac{1}{\tau} H_s(\tilde{P})$$

In general, only considerable improvements can result from a sparable penalty restricted to the convexity of a cost function.

Transform the fuzzy ℓ_1 penalty of the equation into the problems of two weak and fuzzy inequalities.

In general, a sparable penalty limited to retaining the convexity of a cost function can only significantly improve the ℓ_1 norm.

The interior of its boundary region was represented by a fuzzy ℓ_1 penalty Huber function, and hence

(i) A fuzzy ℓ_1 Penalty regularization cannot be separated

(ii) The convexity of the Huber function is represented by the fuzzy ℓ_1 norm.

Theorem: 3.1. Existence and uniqueness of the fuzzy projection onto convex set. Consider $\tilde{L} \subseteq R^n \neq \emptyset$ is a closed fuzzy convex set. The projection of any fuzzy vector $\tilde{p} \in R^n$ onto fuzzy set $\mathcal{P}_L(\tilde{p}) = arg\ min\ \|\tilde{p} - \tilde{q}\|_2$. A unique concept of the fuzzy projection onto a convex set exists.

Proof:
Let us consider an arbitrary point $\tilde{q} \in \tilde{L}$

$Min\|\tilde{p} - \tilde{q}\|_2$ over $\tilde{L} \cap \{\tilde{q}/\|\tilde{p} - \tilde{q}\|_2 \le \|\tilde{p} - \acute{q}\|_2\}$(7)

A site that is farther from $\tilde{p}$ than $\acute{q}$ Cannot be the fuzzy solution that exists.

$Min\ \|\tilde{p} - \tilde{q}\|_x^z$

$l \in \left\{ \tilde{L} \cap \{\tilde{q}/\|\tilde{p} - \tilde{q}\|_2 \le \|\tilde{p} - \acute{q}\|_2\} \right\}$
(8)

There is a solution since $\|\tilde{p} - \tilde{q}\|_x^z$ is a continuous fuzzy function, the fuzzy set is bounded & closed, and fuzzy compact. Even if s is not convex, this holds.

Fuzzy uniqueness

Let us consider

$\acute{q} = \frac{\tilde{q}_1 + \tilde{q}_2}{2}, \tilde{q}_1 \neq \tilde{q}_2 \in \tilde{L}.$
(9)

$$\langle \tilde{p} - \acute{q}, \tilde{q} - \acute{q} \rangle = 0, \tag{10}$$

As a result, the orthogonal vectors are $\tilde{p} - \acute{q}$ and $\tilde{q} - \acute{q}$.

$$\|\tilde{p} - \tilde{q}_1\| = \|\tilde{p} - \tilde{q}_2\|$$

(11)

$$\|\tilde{p} - \tilde{q}_1\|_x^z \ge \|\tilde{p} - \acute{q}\|_x^z$$

This contradicts our assumption that the resulting fuzzy projection is unique.

Theorem: 3.2. Let $\tilde{L}_1(\tilde{p}, \tau): R^n \to R, \tilde{p} \in R^m, \tilde{M}_l, \tilde{p} \in R^{m \times n}, \tau > 0,\ \tilde{L}_1(\tilde{p}_1, \tilde{p}_2, \tau) = \frac{1}{z}\left\|\tilde{N}_l - \tilde{M}_l \tilde{p}\right\|_x^z + \frac{1}{\tau}\rho_q(\tilde{p})$.

If $q^T q \preccurlyeq \frac{1}{\tau} M^T M$ then the fuzzy ℓ_1 penalty of the Huber function is convex.

Proof:
$$\tilde{L}_1(\tilde{p}_1, \tilde{p}_2, \tau) = \frac{1}{z}\left\|\tilde{N}_l - \tilde{M}_l \tilde{p}\right\|_x^z + \frac{1}{\tau}\left(\|\tilde{p}\|_1 - H_q(\tilde{P})\right)$$

$$= \frac{1}{z}\left\|\tilde{N}_l - \tilde{M}_l \tilde{p}\right\|_x^z + \frac{1}{\tau}\|\tilde{p}\|_1 - min\left\{\frac{1}{\tau}\|\tilde{s}\| + \frac{2}{\tau}\|q(\tilde{P} - \tilde{s})\|_2^2\right\}$$

$$= \frac{1}{z} \tilde{p}^T \left(M^T M - \frac{1}{\tau} q^T q \right) \tilde{p} + \frac{1}{\tau} \|\tilde{p}\|_1 + max\, G(\tilde{p}, s), \tag{12}$$

Hence $\tilde{L}_1(\tilde{p}, \tau)$ is convex.

Theorem: **3.3.** A fuzzy linear programming problem is assumed to be an increasing sequence of fuzzy ℓ_1 penalty parameter$\{\tau^s\}$, $where\ \tau^s \geq 1, s \to \infty$. Suppose $\tilde{f}(\tilde{p}), M_{ij}\tilde{p} - \widetilde{N}_l\ \&\ \tilde{L}_p$ is a semi continuous function, and there exists an optimal solution. Then every $\tilde{p}$ is a limit point of $\{\tilde{p}^s\}$.

Proof:
Suppose $\tilde{p}$ is boundary point of $\{\tilde{p}^s\}$.

$$\tilde{L}_1(\tilde{p}_1, \tilde{p}_2, \tau) = \frac{1}{z} \left\| \widetilde{M}_l \tilde{p} - \widetilde{N}_l \right\|_x^z + \frac{1}{\tau} \left\| (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)\tilde{p}_1 + (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)^t \tilde{p}_2 \right\|_y$$

$$\tilde{L}_p(\tilde{p}_1, \tilde{p}_2, \tau) \leq \tilde{f}(p^*)$$
(13)

From the continuity of $\tilde{f}(\tilde{p})$, we get,

$$\underset{\tau \to \infty}{Lim}\, \tilde{f}(\tilde{p}^s) = \tilde{f}(\tilde{p}),$$

$$\tilde{f}(p^*) \geq \tilde{L}_1(\tilde{p}^s, \tau^s) \geq \tilde{f}(\tilde{p}^s)$$

From the fuzzy ℓ_1 penalty we get,

$$\underset{\tau \to \infty}{Lim}\tilde{L}_1(\tilde{p}^s, \tau^s) = \tilde{f}(p^*)$$

$\tilde{p}$ is feasible**.**

3.4. Fuzzy ℓ_1 Penalty Sparse Regularization Algorithm:
1. Determine the problem's fuzzy objective function and constraints and then express it in standard formats to represent them. Min $\tilde{Z} = \tilde{f}(\tilde{p})$ should be written $\left(\tilde{p}^k - \widetilde{N}_l \right) \leq 0$.

2. Convert the fuzzy linear programming problem to the regularized least square approach of the fuzzy ℓ_1 norm penalty.

3. $\tilde{L}_1(\tilde{p}_1, \tilde{p}_2, \tau) = \frac{1}{z} \left\| \widetilde{N}_l - \widetilde{M}_l \tilde{p} \right\|_x^z + \frac{1}{\tau} \left\| (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)\tilde{p}_1 + (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)^t \tilde{p}_2 \right\|_y$

4. Minimize the fuzzy ℓ_1 penalty Huber function with the given fuzzy inequality constraints, $Min\tilde{L}_1(\tilde{p}_1, \tilde{p}_2, \tau) = \frac{1}{z} \left\| \widetilde{N}_l - \widetilde{M}_l \tilde{p} \right\|_x^z + \frac{1}{\tau} \left\| (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)\tilde{p}_1 + (\tilde{f}_1, \tilde{f}_2, \tilde{f}_3)^t \tilde{p}_2 \right\|_y$ as $\tau \to \infty$

5. The optimum value of the provided fuzzy linear programming issue can be found by adding the first-order condition of optimality by applying the limit $\tau \to \infty$.

6. Calculate $\tilde{L}_1\left(\tilde{p}_{1,}^s \tilde{p}_{2,}^s \tau^s \right) = min_{\tilde{p} \geq 0}\, \tilde{L}_1(\tilde{p}_{1,}^s \tilde{p}_{2,}^s \tau^s)$, then minimize $\tilde{p}_{1,}^s \tilde{p}_{2,}^s \& \tau^{s+1} = 10\tau^s, s = 1,2, \dots s = I$ then stop. If not so return to step 5.

The dual fuzzy linear programming problem should be applied in a fuzzy ℓ_1 norm penalty sparse regularization strategy based on the Huber function of the problem with this same technique.

4.   NUMERICAL EXAMPLE
Example: 4.1. Let us take the following primal fuzzy linear programming problem

$$Min\, \tilde{V} = (3.75,4,4.25)\tilde{p}_1 + (2.75,3,3.25)\tilde{p}_2$$

$$(1.75,2,2.25)\tilde{p}_1 + (2.75,3,3.25)\tilde{p}_2 \geq (5.75,6,6.25),$$

$$(3.75,4,4.25)\tilde{p}_1 + (0.75,1,1.25)\tilde{p}_2 \geq (3.75,4,4.25).$$

Solution:
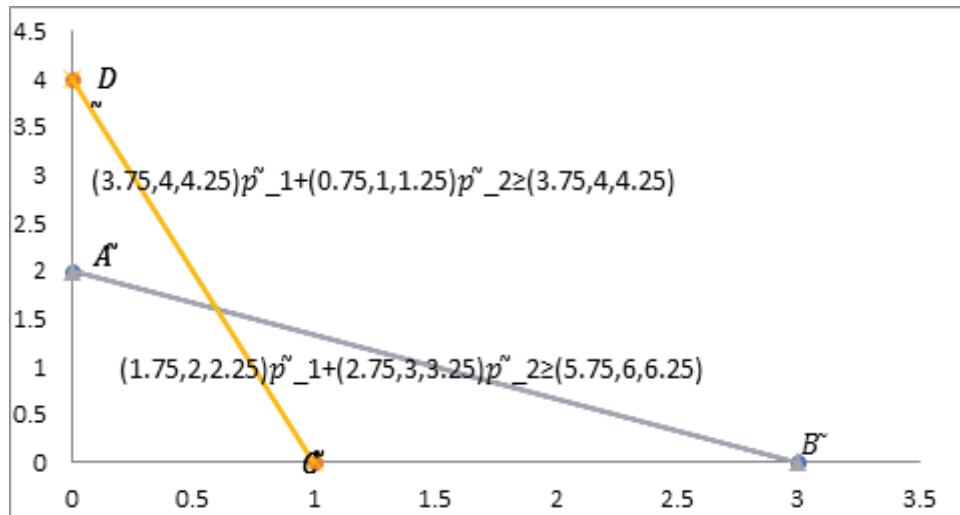In this example this graph of the given FLPP can be described as in the following figure(i).

Figure (i):

Using the fuzzy ℓ_1 penalty sparse regularization algorithm, we obtain

This approach can be used to turn FLPP into a conventional form of unconstrained problems.

$$\mathrm{Min}\tilde{L}_1(\tilde{p}_1,\tilde{p}_2,\tau) = \frac{1}{z}\left\|\tilde{N}_l - \tilde{M}_l\tilde{p}\right\|_x^z + \frac{1}{\tau}\left\|(\tilde{f}_1,\tilde{f}_2,\tilde{f}_3)\tilde{p}_1 + (\tilde{f}_1,\tilde{f}_2,\tilde{f}_3)^t\tilde{p}_2\right\|_y$$

Step (iv) of the primal-dual fuzzy ℓ_1 penalty sparse regularization algorithm yields

$$\tilde{p}_1 = (0.15,0.6,1.35) - \frac{1}{\tau}(0.05,0.05,0.10), \tilde{p}_2 = (-0.29,1.6,3.5) - \frac{1}{\tau}(0.19,0.20,0.21).$$

For the given primal and dual FLPP we fuzzy optimial values can be calculated as list in tables(i),(ii).

Table: (i)

No.	τ^s	$\tilde{p}_1$	$\tilde{p}_2$
1	10	(-0.15500,0.59500,1.34000)	(-0.30900,1.58000,3.48900)
2	10^2	(-0.15050,0.59950,1.34900)	(-0.29190,1.59800,3.50790)
3	10^3	(-0.15005,0.59950,1.34990)	(-0.29019,1.59980,3.50979)
4	10^4	(-0.15001,0.599951.34999)	(-0.29002,1.59998,3.50998)
5	10^5	(-0.15000,0.60000,1.35000)	(-0.29000,1.60000,3.51000)

Table: (ii)

No.	τ^s	$\tilde{q}_1$	$\tilde{q}_2$
1	10	(-0.6930,0.0460,0.8050)	(-0.1240,0.5930,1.3100)
2	10^2	(-0.0963,0.7246,1.5655)	(-0.1204,0.5933,1.3190)
3	10^3	(-0.0307,0.7925,1.6416)	(-0.1200,0.5999,1.3199)
4	10^4	(-0.0301,0.7999,1.6499)	(-0.1200,0.6000,1.3200)
5	10^5	(-0.0300,0.8000,1.6500)	(-0.1200,0.6000,1.3200)

The fuzzy ℓ_1 penalty sparse regularization of the Huber functions has the optimum solution value to the given primal-dual problems.

$$\tilde{p}_1 = (-0.1500,0.6000,1.3500), \tilde{p}_2 = (-0.2900,1.600,3.5100),$$

$$\mathrm{Min}\,\tilde{V} = (-1.58,7.2,17.15)$$

$$\tilde{q}_1 = (-0.03,0.8,1.65), \tilde{q}_2 = (-0.12,0.6,1.32),$$

$$\mathrm{Max}\,\tilde{V} = (-0.66,7.2,15.18).$$

5. CONCLUSION

In this paper, the solving fuzzy sparse regularized linear least-squares of the problem using a non-convex version of the ℓ_1 norm which preserves the fuzzy convex property of the Huber function needs to be minimum. Furthermore, we concentrate on the fuzzy existence and stability of the sparse regularization solution to be obtained.

An algorithm explained the overall situation of the problem to be fuzzy optimal solution exists. Increase the parameterτ, since it helps us to optimize the level of the presented problem. Tables indicate that the method describes the primal and dual fuzzy optimal solution clearly explains the problem computation procedure in the graph. A successful numerical example to be attached in this paper and specific work to optimize the problem to be convex.

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DYNAMIC PROGRAMMING APPROACH FOR AGRICULTURE PRODUCTION PLANNING

K. VINOTHA AND S. TAMILSELVAN

ABSTRACT
Agriculture plays a critical part in the economy and is regarded as the backbone of the economic system in India. This paper deals with the application of optimization technique in agricultural planning particularly for farmers of Thanjavur district, Tamil Nadu, India. Generally the crop planning problem is formulated as linear programming problem and then solved by LPP techniques. In this paper the dynamic programming techniques is incorporated to formulate a model for agriculture planning to improve production and profit in Thanjavur district.

Keywords: Production planning, profit, multi objective linear programming, dynamic programming.

1. INTRODUCTION
Agriculture is extremely important to the Indian economy. The geographical location of India is ideal for agriculture since it offers a variety of favourable meteorological conditions. Plain lands, a lengthy growing season, rich soil, and a broad range of weather conditions exist. Apart from its geographical location, India has continually made inventive attempts to improve output via the use of science and technology. The main goal of agricultural production planning is to maximise profit with the least amount of investment while keeping other constraints in mind. The optimization of objectives using one or multi-objective optimization approaches is a key topic in these challenges.

Maximization of crop production can't guarantee the maximization of profit. Profit or loss is also depending on fluctuating demand and cost for the particular crop. Also agriculture is a process that, at any moment of time associated with the issue of risk and there is no certainty. Several operations research techniques have been used in agricultural planning to optimize the objectives. Linear programming (LP) models have been used for maximization of production of crops [1]. But linear Programme is a single objective optimization technique and most of the farm planning problems are multi objective in nature. Multi objective optimization problem and Goal programming (GP) are the useful tool for dealing with problems having multiple and conflicting objective functions and for obtaining a satisfactory solution. Dynamic programming [4] is a mathematical optimization technique for formulating and numerically solving multi-stage decision problems [2]. Many researchers used the dynamic programming and optimal control techniques in several studies regarding agro ecosystem modelling ([3], [6], [8]). Several researchers used fuzzy goal programming techniques for farm planning problems ([7], [9]). Later the procedure to solve multi objective linear programming (MOLP) using max. min. approach to construct the member ship function and also it provides optimal results to problem. The paper has been organized as follows: Section – 2 provides the fundamental concepts and algorithms of the proposed problem. In Section – 3 the main optimization problem have been constructed for the adopted area. In the following section – 4, the solutions are obtained. Finally, the conclusion is also included.

2. PRELIMINIRIES
In this section, we introduce some basic terms and definitions related to the paper and the construction of the problem.

Linear Programming Problem
The general form of a linear programming problem with n variables and m constraints can expressed as

$$Maximize \ \ Z = p_1 z_1 + p_2 z_2 + \ldots + p_n z_n$$

Subject to the following constraints

$$q_{i1} z_1 + q_{i2} z_2 + \ldots + q_{in} z_n \leq r_i; \ \ i = 1, 2, \ldots, m$$

$$z_j \geq 0; \ \ j = 1, 2, \ldots, n$$

Multi Objective Linear Programming Problem
The general form of a multi objective linear programming problem with l objectives, n variables and m constraints can expressed as

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Maximize $\{Z_1, Z_2, ..., Z_l\}$

Where $Z_k = p_{k1}z_1 + p_{k2}z_2 + ... + p_{kn}z_n$; $k = 1, 2, ..., l$

Subject to the following constraints

$q_{i1}z_1 + q_{i2}z_2 + ... + q_{in}z_n \le r_i$; $i = 1, 2, ..., m$

$z_j \ge 0$; $j = 1, 2, ..., n$

Construction of the Dynamic Programming Problem

Consider the general linear programming problem with n variables and m constraints as

Maximize $Z = p_1z_1 + p_2z_2 + ... + p_nz_n$

Subject to the following constraints

$q_{i1}z_1 + q_{i2}z_2 + ... + q_{in}z_n \le r_i$; $i = 1, 2, ..., m$

$z_j \ge 0$; $j = 1, 2, ..., n$.

The following is how this problem might be expressed as a dynamic programming problem:

Consider the general linear programming problem as a multi-stage problem, with each activity $j = 1, 2, ..., n$ acting as a separate stage. This is an n-stage problem with the decision variables (possibilities) are the levels of activities $z_j (\ge 0)$ at stage j. Each activity has an endless array of possibilities within the feasible region since z_j is continuous.

Allocation problems are known to be a variety of linear programming problems. These problems necessitate allocating available resources to the various activities. Each restriction indicates a resource limitation and $r_1, r_2, ..., r_m$ denoting the quantity of accessible resources. Due to the fact that there are m resources, the state must be represented by an m-component vector $s = (r_1, r_2, ..., r_m)$.

Let $f_n(r_1, r_2, ..., r_m)$ be the optimal (maximal)value of the general linear programming problem for the stages $z_1, z_2, ..., z_m$ for the states $r_1, r_2, ..., r_m$.

By applying the forward computational algorithm, the recursive equation is given by

$$f_j(r_1, r_2, ..., r_m) = \max_{0 \le z_j \le r}\{p_1z_1 + f_{j-1}(r_1 - q_{1j}z_j, r_2 - q_{2j}z_j, ..., r_m - q_{mj}z_j)\}$$

The optimal value of r that z_j can assume is

$$r = min\left\{\frac{r_1}{a_{1j}}, \frac{r_2}{a_{2j}}, ..., \frac{r_m}{a_{mj}}\right\}$$

Because the minimum value satisfies the set of constraints simultaneously.

d. Algorithm to Solve Multi Objective Linear Programming Problem

Step 1:
Solve the optimization problem by considering one objective function at a time with given constraints, using optimization techniques (LPP or DPP) to find the optimal solutions.

Step 2:
Construct the new linear programming problem by incorporating new constraints to the previous linear programming problem. The new constraints can be formed by using the first objective function with the optimal solution obtained in step 1.

Step 3:
Solve the new objective function with constraints proposed in step 2, using optimization techniques(LPP or DPP) to find the optimal solutions. Continue the procedure until all the objective functions are considered.

If the optimal objective solution is obtained in each stage, the final optimal solution is an efficient optimal solution the original multi objective optimization problem.

3. DYNAMIC PROGRAMMING APPROACH FOR AGRICULTURE PRODUCTION PLANNING
In this section, we construct the mathematical model from the statistical data relevant to the agriculture production planning.

This study was taken up in Thanjavur district of the Tamil Nadu state. Thanjavur district lies between 9º 50'and 11º 25' North latitude and 78º 45' and 79º 25' East longitude. Total geographical area of the district is 3,602.86sq.km. This constitutes just 2.77% of the area of the State.

There are three important seasons namely Kharif, Rabi and Summer. Kharif starting from June ending with October-November. Rabi season starting from November ending with February-March and Summer season starting March ending with May. The data for the planning year 2019–2020 were collected from different sources of agricultural planning units. The data on current total land area under cultivation, production and productivity of major crops from several issues of Season and crop report. The market prices of all the study crops were collected from agmark website.

In this district farmer mainly grows paddy, maize, blackgram, redgram and greengram in Kharif season, paddy(kuruvai) and jowar in summer season. Paddy and groundnut in Rabi season and they also cultivate annuals like sugarcane. The land available is 229710 hectare with given labour hours constrains. A small farm holder needs at least 600 kg of paddy and 200 kg of sorghum to meet out his annual food grains requirement.

a. Mathematical Modelling of the Agriculture Production Problem
The main objective of this problem is to maximize the profit and production. The optimal solution of the problem of crop production for Thanjavur district, Tamil Nadu can be obtained by using the computational algorithm proposed in the above section.

The different types of crops as decision variables are named as follows:

z_{11} - Paddy(Kharif), z_{12} - Maize, z_{13} -Black Gram, z_{14} - Red Gram, z_{15} - Green Gram, z_{21} - Paddy(Rabi), z_{22} - Groundnut, z_{31} -Jowar (Cholam), z_{32} - Paddy(Summer), z_4 - Sugar Cane.

Table 1: The Statistical Data Description of Production and Profit in Thanjavur District

Particulars	Production (Kg/Ha)	Man Days	Profit(Rs)
Paddy(Kharif)	3660.52	106.67	31480
Maize	8409.27	105.4	140465.9
Black Gram	981.45	23.66	31568.35
Red Gram	459.11	20	6053.48
Green Gram	1272.73	21.11	66508.11
Paddy(Rabi)	3755.13	150.21	31543
Groundnut	5275.04	132.15	190205
Jowar (Cholam)	1176.47	6.88	9077.04
Paddy(Summer)	4056.58	160	33665
Sugar Cane	106498.3	275.13	181828.2

The objective functions are

Profit:

$$Maximize \ Z_1 = \begin{cases} 31480z_{11} + 140465.9z_{12} + 31568.35z_{13} + 6053.48z_{14} + 66508.11z_{15} \\ +31543z_{21} + 190205z_{22} + 9077.04z_{31} + 33665z_{32} + 181828.2z_4 \end{cases}$$

PRODUCTION

$$Maximize \ Z_2 = \begin{cases} 3660.52z_{11} + 8409.27z_{12} + 981.45z_{13} + 459.11z_{14} + 1272.73z_{15} \\ +3755.13z_{21} + 5275.04z_{22} + 1176.47z_{31} + 4056.58z_{32} + 106498.3z_4 \end{cases}$$

Subject to the constraints

Labour:

$$\left.\begin{array}{l}106.67z_{11}+105.4z_{12}+23.66z_{13}+20z_{14}+21.11z_{15}\\+150.21z_{21}+132.15z_{22}+6.88z_{31}+160z_{32}+275.13z_4\end{array}\right\}\leq 450$$

Land:

$$z_{11}+z_{12}+z_{13}+z_{14}+z_{15}\leq 229710$$

$$z_{21}+z_{22}\leq 229710$$

$$z_{31}+z_{32}\leq 229710$$

Food requirement:

$$3660.52z_{11}+3755.13z_{21}+4056.58z_{32}\geq 600$$

$$1176.47z_{31}\geq 200$$

4. SOLUTIONS AND DISCUSSIONS

In this section, the respective solutions of the proposed problem have been obtained in two stages.

Table 2: The Optimal Solutions of Profit Maximization Problem

Optimal Solution $Z_1 = 619293.4$	
Paddy(Kharif)	0.163911 ha land
Maize	1.259813 ha land
Black Gram	0.118339 ha land
Red Gram	0.28341 ha land
Paddy(Rabi)	0.887859 ha land
Jowar (Cholam)	1.812887 ha land
Paddy(Summer)	0.312725 ha land

Table 3: The Optimal Solutions of Profit and Production Maximization Problem

Optimal Solution $Z_1 = 519338.5$, $Z_2 = 73955.41$	
Paddy(Kharif)	0.1639 ha land
Maize	0.9219 ha land
Black Gram	0.5436 ha land
Red Gram	0.2073 ha land
Paddy(Rabi)	0.5261 ha land
Paddy(Rabi)	1.2812 ha land
Jowar (Cholam)	0.0698 ha land
Sugar Cane	0.1639 ha land

The values in table 2 and table 3 are the optimal solutions of the problems in two stages. In stage 1 the optimal solution obtained for the profit maximization problem. Then in stage 2 the optimal values are obtained for the production and profit maximization problem.

OPTIMAL VALUES OF DECISION VARIABLES
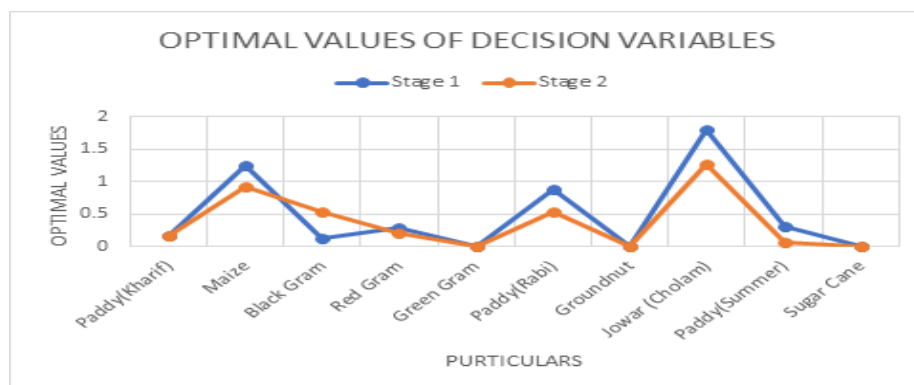
Figure 1: Optimal Values of Decision Variables

5. CONCLUSION

In the development of agriculture production planning, the main objectives to be maximized are production and profit. In this paper, we have presented the algorithm to find the optimal solutions of the multi objective linear programming problem. The multi objective linear programming problem is constructed according to statistical report of agriculture production in Thanjavur district. Then the problem has been solved by using the presented algorithm. The final optimal solutions the problems are, the maximum profit of Rs. 519338.5 and maximum production of 73955.41 Kg. By using this methodology, the multi objective linear programming problem to maximize production, profit and to minimize the cost of production may be utilized in future.

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PROBING THE MAGNETO TRANSPORT PHENOMENA AND SPIN TRANSPORT PROPERTIES IN TIS

ADITIKALSH[*] AND DR. V. K. LAMBA

ABSTRACT

Due to their excellent electronic and optical properties, TI-based materials are used in optical storage, quantum computing, thermoelectric, laser photonics, broadband photo detectors, and high-speed optoelectronics. Researchers are currently working on Bi_2Se_3 photo detectors near-infrared wavelengths because of their wide range of surgery, telecommunications, medical imaging, and gas sensing applications. As a result, determining the electronic and optical properties of bismuth selenide, such as train edge of reflection, photocurrent sensitivity, and light abstraction is important for a deeper understanding of optoelectronic properties. In its crystal structure, Bi2Se3 rhombohedral has five atoms with three Et (Se) atoms per unit cell. Two atoms are differentiated as Se-1 and Se-2, all of which belong to the (R-3M) space group, although two atoms are identical. In this paper we have analyzed total force, total energy of TI. We have chosen Bi_2Se_3 and Bi_2Te_3 for our research.

Keywords: Topological Insulators (TIs), Spintronics

1. INTRODUCTION

The existence of heavy spin-orbit (SO) interactions, which reverse the orbital, conduction character, and validity bands, distinguish TI from other narrow-band gap semiconducting materials. TIs are mostly Bi_2Te_3 and Bi_2Se_3 compound narrow-band gap semiconductor materials with linear dispersion with surface speed k, appealing properties for light detection at long wavelengths. Due to a combination of time – reciprocal symmetry and spin-orbit pairing, spin polarization varies with k, distinguishing it from every other 2D surface state. Bi_2Te_3 and Bi_2Se_3 TIs have recently become an emerging topic in materials science due to their single diac cones, which allow for tunable surface band gaps, which are important for many optoelectronic devices [1]. Van der Waals used a vertical axis to tie the quintuple layers together. On the other hand, density functional theory (DFT) techniques minimize band differences and are useful for measuring realistic surfaces using LDA or GGA [2].

2. INTRODUCTION TO BI$_2$SE$_3$

Bi_2Se_3 single crystal is a rhombohedral lattice system with the space group $D3d$ 5 ($R\overline{3}m$). It has a layer-stacked structure. As shown in Figure 1, the red square, for each layer of Bi2Se3, consists of 5 layers of atoms in the order of Se1-Bi1-Se2-Bi1'-Se1' (Figure 1a and c, red square region), which is called a quintuple layer. These quintuple layers are bonded together with the Van der Waals force, which forms the Bi_2Se_3 single crystal. Compared to other 3D topological insulators, Bi_2Se_3 is an ideal material to study the properties of topological insulators because it has only one single Dirac cone in the bulk band gap, simple band structures near the Dirac point, and a relatively large bulk bandgap17 Eg~ 300 meV. Figure 1is the band structure of Bi_2Se_3.

Moreover, Bi_2Se_3 is a stoichiometric compound, which means fewer defects in the single crystal (compared to BixSb1-x alloys).Due to the large band gap in Bi_2Se_3, the thermal excitations, even at room temperature, are suppressed, indicating the possible application of topological surface states. Although Bi_2Se_3 has many superior properties among other binary compounds in this group (Bi_2Te_3, Sb_2Te_3), as-grown Bi_2Se_3 single crystals always have defects. A major source of the defects comes from the selenium (Se) vacancies. Se atoms, leaving the materials, create Se vacancies and introduce excess electrons. Thus Bi_2Se_3 single crystals are turned to heavily n-doped materials [3].

$$Se_{Se} \rightarrow V_{se+} Se (g)_+ 2e' \ldots\ldots\ldots(1)$$

Figure 1: Lattice structure of Bi_2Se_3
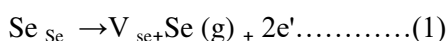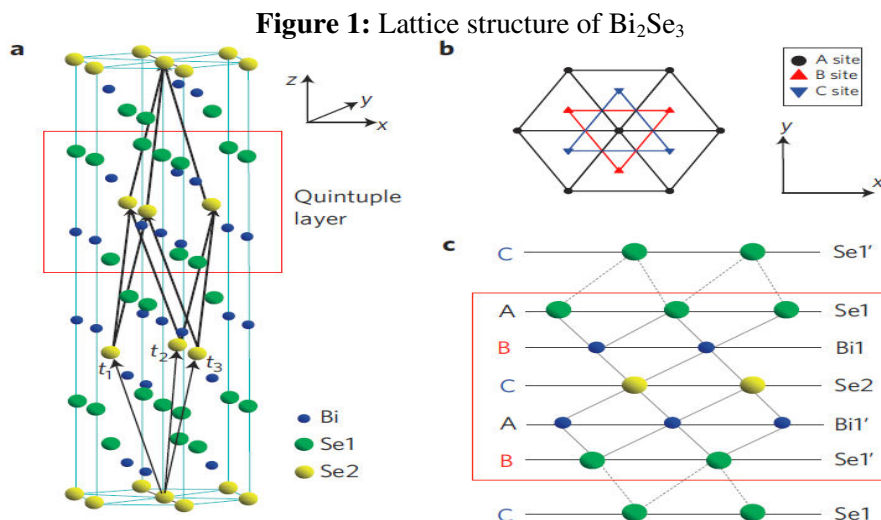
a. Crystal structure of Bi_2Se_3.

b. Top view of Bi_2Se_3 crystal lattice along the z-direction.

c. Side view of Bi_2Se_3 crystal lattice.

To reduce this type of defects, either high Se vapour pressure needs to be precisely controlled during the growth of single crystals, or p-type dopants need to be incorporated.

$$2Ca \rightarrow 2\ Ca'_{Bi+} 2h \ldots\ldots\ldots (2)$$
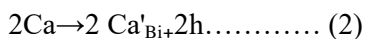
After the introduction of Ca dopants, Bi atoms are replaced by Ca atoms. The Ca atom has only two electrons in the outermost shell, while the bismuth atom has three. The Ca_{Bi} site will have a negative charge and then create one hole. The holes created by Ca dopants can compensate for the excess electrons generated by Se vacancies. As the Ca doping level increases, most carriers will change from electrons to holes, realizing an n- to p-type transition in the materials. At a certain intermediate point, the holes created by Ca dopants could exactly compensate for the electrons generated by Se vacancies. No free carriers exist in the bulk channels of Bi_2Se_3 crystals, and a bulk insulating state can be achieved.

$$Ca \rightarrow Ca_+ 2e' \ldots\ldots\ldots (3)$$
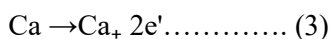
Each Ca atom will introduce two more electrons in the materials and thus increase the electron density. To avoid this mechanism, the exact stoichiometric elements should be precisely controlled in the growth process. Either less Bi or more Se needs to be added together with Ca dopants.

3. STRUCTURAL PROPERTIES

The optimized lattice constant is shown inTable-1. Since the relation in the z-direction is the van der Waals power, it was discovered that the approximate C is the greatest source of errors for any XC functional. The internal atomic coordinates of Bi_2Se_3 in a hexagonal configuration, as well as experimental and previous ab initio results, are shown in Table 1. GGA (PBE) is made up of the lattice parameter c and the interlayer gap deqm, according to first-principles calculations. With the addition of vdW correction for Cd atoms, it is found that v, internal atoms and atomic atoms are in strong accordance with experimental findings. Consequently, first-principles calculations indicate that, in the case of BTW3, the vdW correction is important for predicting lattice parameters and interlayer distances because it better matches experimental findings [4].

Table 1: Calculated lattice parameter of Bi_2Se_3 compared with previous theoretical and experimental

| Structure	References	Method	Lattice parameters	
			a(Å)	c (Å)
Hexagonal unit cell	Our work	PBE	4.183	31.336
		PBE+vdW	4.134	28.758
	(Brinkman et al., 2007)	LDA	4.140	27.610
	(Qin et al., 2015)	PBE+SOC	4.195	31.010
	(Qin et al., 2015)	PBE	4.178	31.860
	(Thiel et al., 2006)	Exp	4.143	28.630

4. TOTAL ENERGY OF BI₂SE3 AND BI₂TE₂SE

The variations in total energy for iteration are seen in Fig.2; the SCF is not converged. In iteration1, the cumulative energy is -344.33270955Ry. There is no attempt at convergence. As a result, no electrons are shifted.

Figure 2: The total energy of Bi_2Se_3
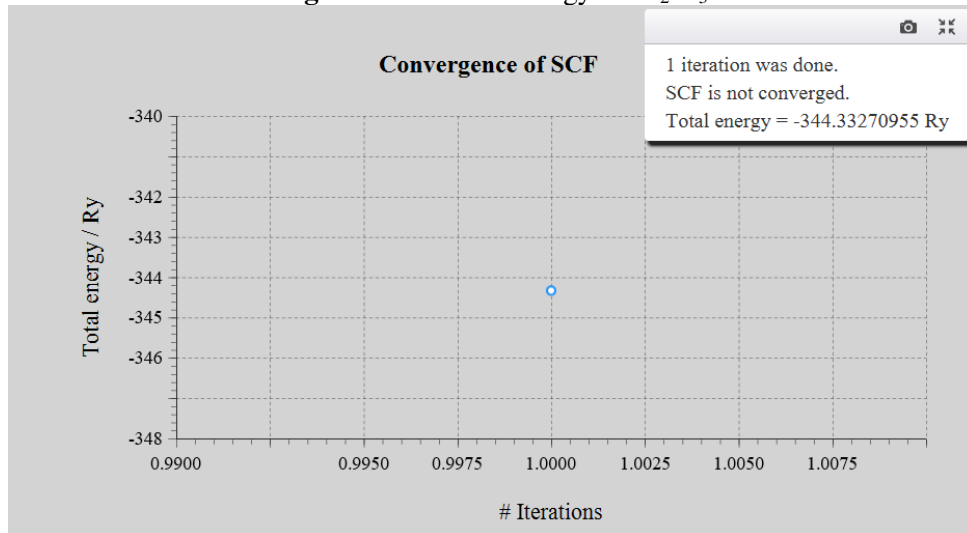
After 21 iterations, the structure was consistent, as seen in Figure 3. After the 3.625^{th} iteration, the energy of the equilibrium state is -327.552 eV. SCF is converged between the 0.95^{th} iteration to 3.625^{th} iterations. It should be mentioned that the forces converge quicker than the energy.

Figure 3: The total energy of Bi_2Te_2Se
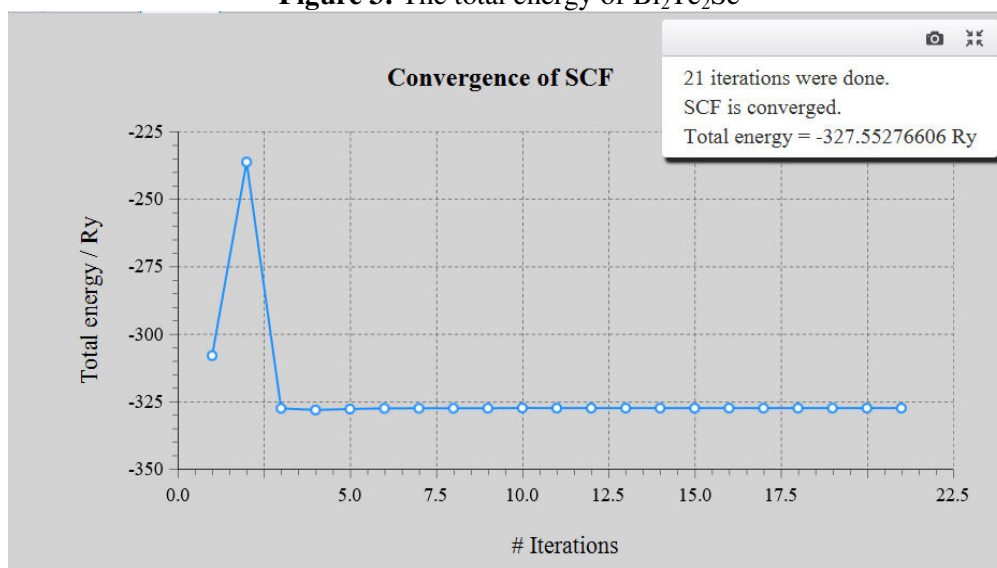
The total energy convergence tolerances are -25eV. This involves the development of the original configuration as well as the subsequent configuration updating procedure. There is a sudden increase in overall capacity in the first iteration, and a slight plateau appears for -233Ry in the 1.875^{th} iteration. The declining rate immediately slows down without major adjustments after about 3.25 iterations. The total energy becomes much more stable; it will continue to decrease but at a much slower rate. Small variations in the area near the interface cause certain small variability in total energy.

5. TOTAL FORCE OF BI₂SE₃ AND BI₂TE₂SE

Figure 4 shows the force on the atom as a function of the number of iterations. Here the 2 iterations were taken. The optimization is not converged. In fig 4, the black line represents the total force of **Bi2Se3, and**the orange line is Bi and violet lines Se, respectively. The total force is 250.513069 Ry/Bohr. When increasing the number of iterations, the force of on atom is minutely increasing smoothly. The force on Bi is 182.5Ry when increasing the iterations; the force is decreasing smoothly. The force of the Se atom is 162.5 Ry in the 1st iteration, and on increasing iteration, the force is increasing smoothly.

Figure 4: The total force **Bi_2Se_3**
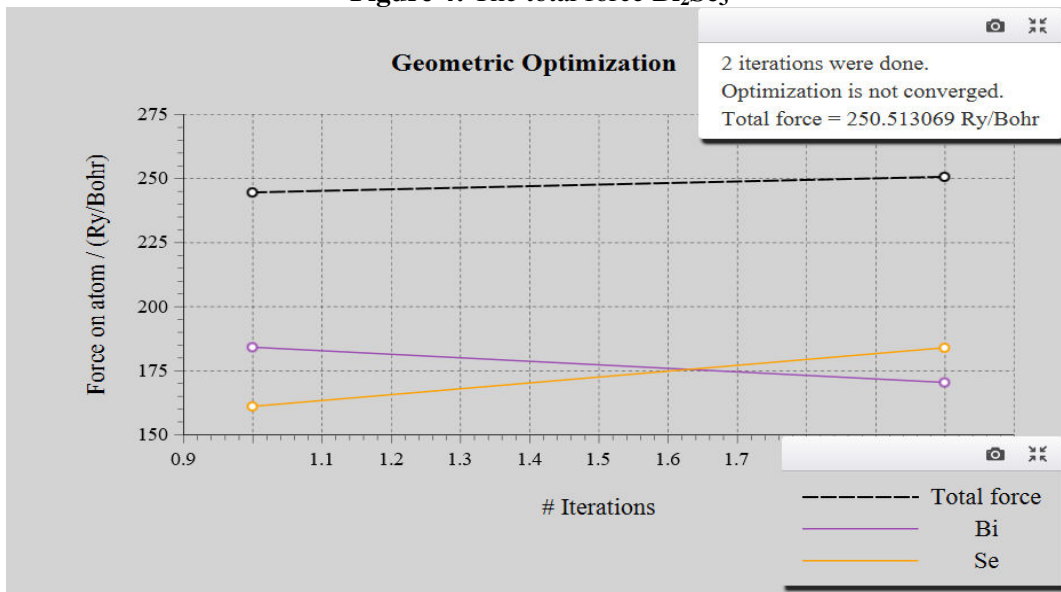
In figure 5, there are three small peaks and steps in this plot mark of the iterations are appeared. Atoms are moved in the forces appearing in this fig. the force at this peak is 0.74375, 0.0375 and 0.04 **Ry/Bohr,** respectively. **The value of the total force is 0.001732 Ry/Bohr.**

Figure 5: Force on an atom plotted against iteration number in geometry optimisation.
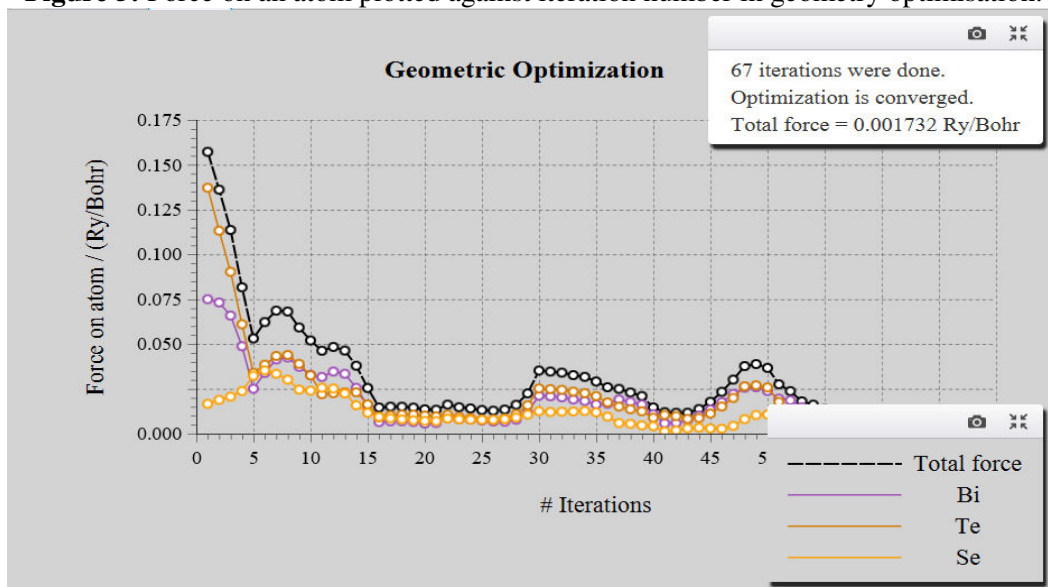
For finite temperature KS functionals, the force is easily obtained and is given in principle by

$$F_N = \frac{\partial F}{\partial R} \quad \dots\dots\dots\dots (4)$$

F_N is the F system's free energy, and Orthonormality restrictions are paired with large multipliers suitable for the situation. This formula is right and helps both Hellman-Feynman and Pulay. Instead of using the exact Kohn sham, it is possible to obtain force correction formulas by closely studying the Harris – Foulkes functional. Since the input charge density for the Harris – Foulkes functional is dependent on the atomic coordinates, an additional term such as the pulleys is produced when the input charge density ρ is determined from the atomic charge density of the components. The equilibrium of forces for various algorithms for a long cell with B atoms is contrasted in Fig. 5. The optimized scheme outlined here achieves the best results. Ensure that calculating the local contribution for powers using mixed charge density will yield a uniform convergence rate. The monk horst-pack scheme was used to build k-point grids for the Brillouin zone (BZ) study. For a k-point mesh of 7x 7x 2, the convergence values for structure optimization and energy estimation were found to be ultra-fine. Convergence thresholds of 5×10^{-7} eV /Å atom for maximum energy 0.02 GPa and 0.5×10^{-3} eV / Å atom for maximum displacement were used to optimize geometry.

6. MOLECULAR DYNAMICS:

6.1 Total Energy of Bi_2Se_3 and Bi_2Te2Se

Fig 6 shows the total energy of $Bi_2Se_3$is shown to be stable for time steps up to 0.09 Ps, so it is well suited to use in production simulations. When the time is increasing, the energy of this element is decreasing gradually up to 0.0074th iterations. After that, the total energy occurs in the equilibrium state.

Figure 6: Total energy for Bi_2Se_3 as a result of time (ps) in Molecular Dynamics

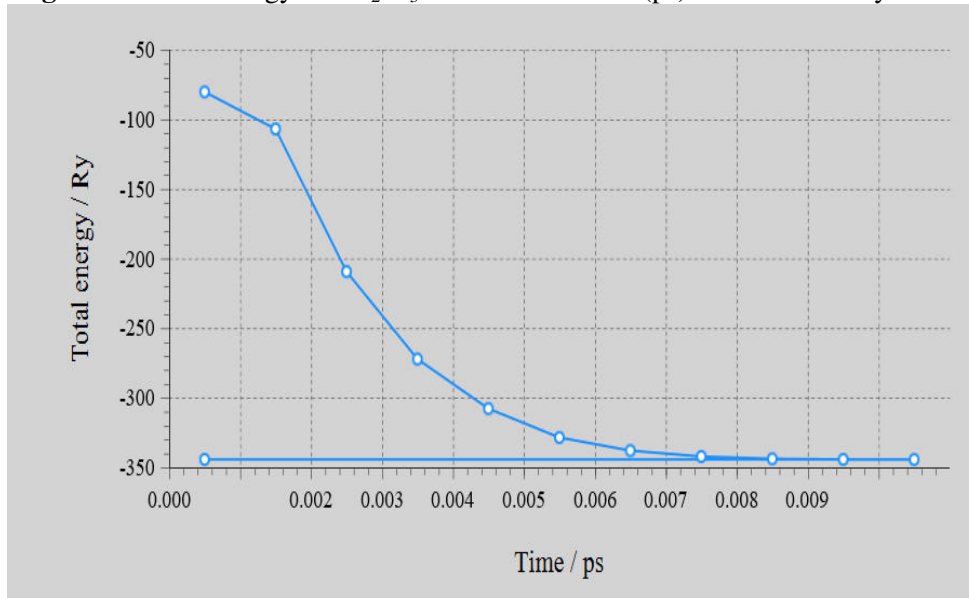**Figure 7:** Total energy as a function of time (ps) for Bi_2Te_2Se
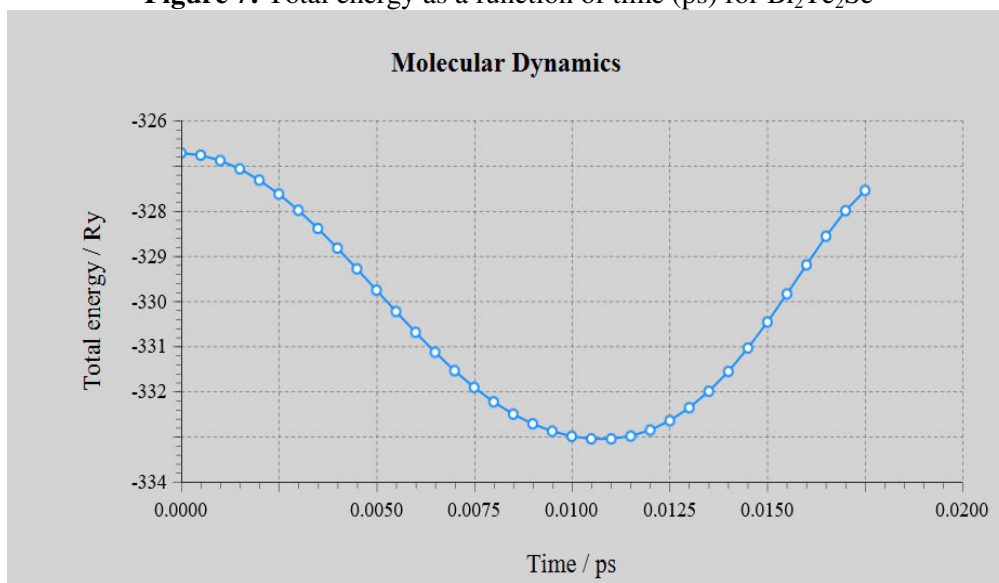

Fig. 7 Plots of total energy versus time for the molecular dynamics simulation of the **Bi_2Te_2Se**. The lowest energy of this element is -326.6Ry. When increasing the time, the total energy decreases the total energy gradually and occurs the total energy. When further increasing the time, the total energy is also increasing. The total energy of this element is -333Ry. The electronic orbitals used to achieve validity and conduction bands for Bi, Te, and Se atoms are Bi $[6s^2 6p^3]$, Te $[5s^2 5p^4]$, and Se $[4s^2 4p^4]$. The total energy of each cell was calculated using periodic boundary conditions. The test wave functions were extended using the plane-wave basis. For structure optimization, plane-wave cut-off energy of 400 eV was used.
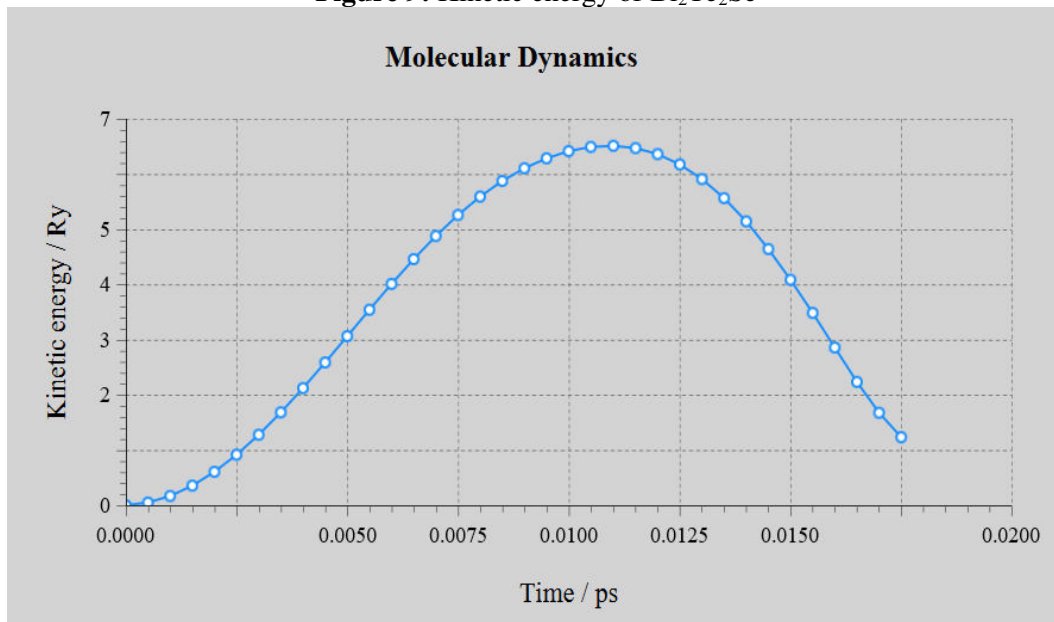
6.2 Kinetic Energy Bi_2Se_3 and Bi_2Te_2Se

Fig 8 and 9 shows the kinetic energy of the Bi_2Se_3 and Bi_2Te_2Se as a function of time. This figure explains that on increasing the time, the kinetic energy is also increased gradually. This graph is the inverse of total energy in molecular dynamics.

Figure 8: Kinetic Energy of Bi$_2$Se$_3$
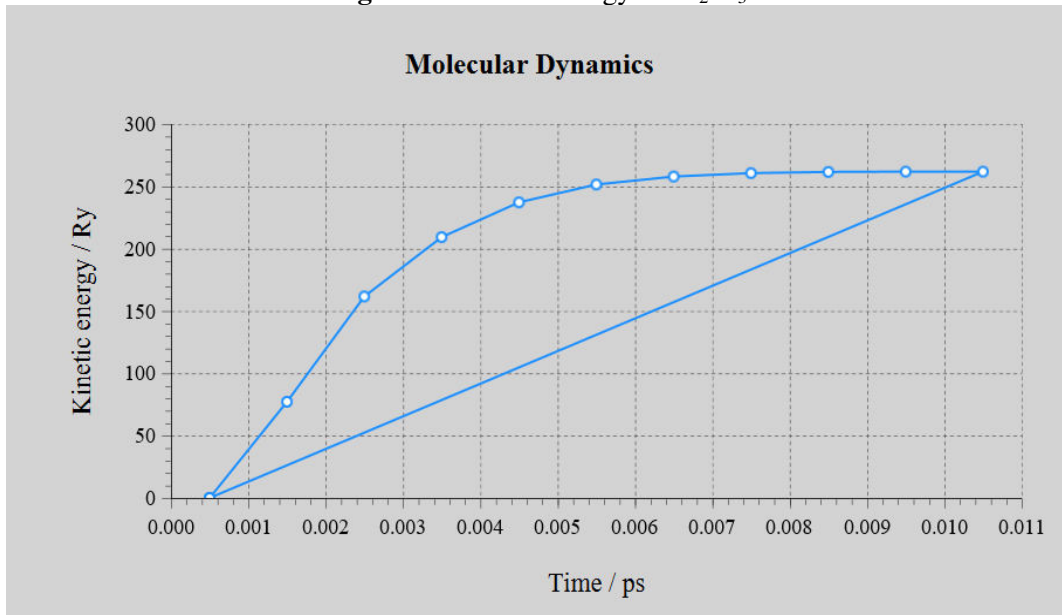

Figure 9: Kinetic energy of Bi$_2$Te$_2$Se

7. ELECTRICAL TRANSPORT PROPERTIES

Using GGA to calculate the band structures of Bi$_2$Se$_3$ while accounting for spin-orbit coupling and high-symmetry points, $\Gamma \rightarrow M \rightarrow K \rightarrow \Gamma \rightarrow A$, $\Gamma(0.00000.0000\ 0.0000)$, M(0.3333 0.0000 0.0000), K(0.50000.0000 0.0000) and A(0.0000 0.0000 0.5000) of the first Brillouin region are plotted in the band structure and DOS plots, as seen in Figures 10 and 11. Conduction happens at the bottom 14 of the band and the top 14 of the valence band, suggesting a direct band difference of about 0.14eV. This value is lower than the 0.32 to 0.35 eV experimental band interval. Because of the approximation used for the exchange differential functional, the DFT solution has a drawback in lowering the band difference. As seen in the diagram, the effects of the absolute and partial density of states (DOS and PDOS) help extend the band difference structure. The PDOS provides background on the band's origin. The PDOS of Bi$_2$Se$_3$ states is shown in Fig. 12. Orbital states from Bi and Se atoms are found below the Fermi standard. The p orbitals from Se atoms are caused by states -1 eV close to the Fermi stage. The valance from Bi 2p and Se 3p atoms is related to the states about 1 eV. Compared to previous experiments, the theoretical evidence contains the 5d10 orbital states, which improves the present work.
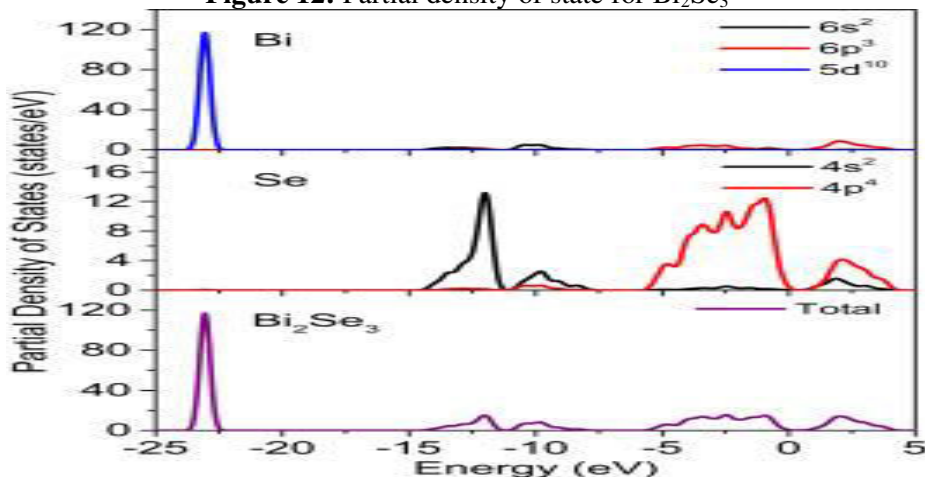
Figure 10: Band structure of bulk Bi_2Se_3 with SOC.
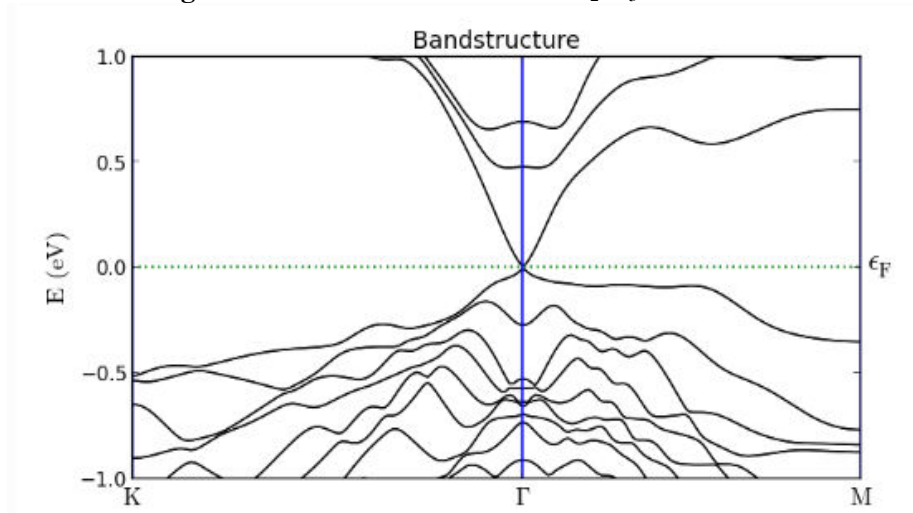
Figure 11: Total density of state DOS for Bi_2Se_3
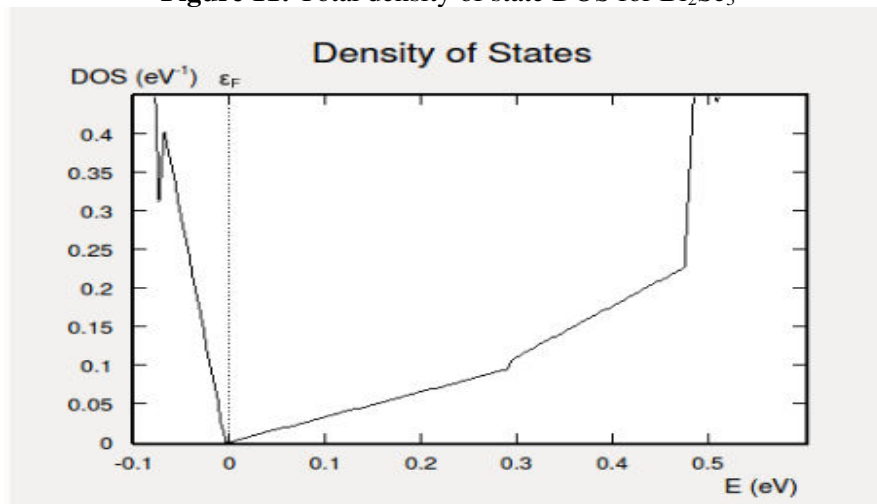
Figure 12: Partial density of state for Bi_2Se_3

8. INTRODUCTION TO BI₂TE₂SE

Although binary 3D topological insulator Bi_2Se_3 and Bi_2Te_3 have ideal single Dirac cone and relatively large bulk band gap, the as-grown single crystals tend to have high bulk carrier density due to defects and impurities in both as-grown Bi_2Se_3 and Bi_2Te_3 single crystals. For Bi_2Se_3, the large density of Se vacancies leads to excess electrons and change Bi_2Se_3 to a heavily n-type doped degenerate semiconductor. And for Bi_2Te_3, the impurities come mainly from Bi-Teantisite defects and hence introduce excess holes, making Bi_2Te_3 a heavily p-type doped material. The high bulk carrier density due to defects and impurities dominates the overall conductance, making the topological surface states extremely difficult to be detected by transport[5].

Figure 13: Lattice and band structure of Bi_2Te_2Se a, Bi_2Te_2Se has the same tetradymite structure as Bi_2Se3 and Bi2Te3. And it is also a layered structure with a basic quintuple layer in the order of Te-Bi-Se-Bi-Te. Bi_2Te_2Se in two different samples. Dirac point is buried in the valence band.
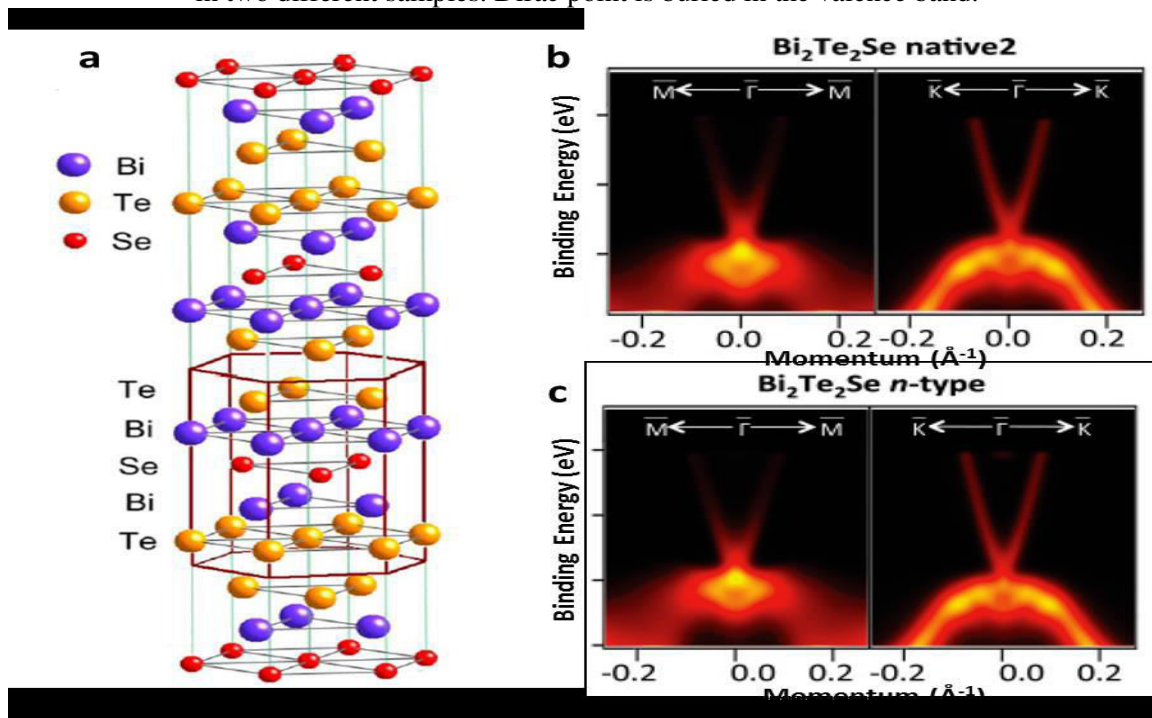
As seen in Figure 13 (b &c), Neupane et al. suggested a new ternary compound, Bi_2Te_2Se, as a new candidate for 3D TIs, which was proven to have topological surface states by ARPES calculation. And later, this new candidate was proven to achieve insulating states with high resistivity at the lowest temperature. Bi_2Te_2Se has the same tetradymite crystal structure as Bi_2Se_3 and Bi_2Te_3. It is also a layered structure with a basic quintuple layer in the order of Te-Bi-Se-Bi-Te, as shown in figure 13a. In this material, the Se layer is sandwiched in the middle and protected by the outer layers. So Se vacancy formation is expected to be greatly suppressed.

Moreover, Se is more electronegative than tellurium (Te) and can bind Bi atoms more tightly. Then the Bi-Teantisite defect formation is also expected to be greatly suppressed. With the presence of Se and Te in the same material, not only Se vacancies but Bi-Teantisite defects are theoretically reduced tremendously. The total defect density in Bi_2Te_2Se is expected to be greatly reduced. And high resistivity bulk insulating states can be more easily realised in Bi_2Te_2Se than in binary compounds. Hence, it is possible to probe topological surface states in this new topological insulator candidate material.

9. ELECTRICAL TRANSPORT PROPERTIES

4-terminal resistance R4T and Hall Effect are both measured at different temperatures. It is necessary to point out that there is inhomogeneity in the as-grown single crystals mentioned previously in $Ca_xBi_2-xSe_3$ single crystals. This is somehow unavoidable in the single crystal growth. Even flakes from the same batch have sample-to-sample variations. And within the same crystal, flakes from different regions exhibit fluctuations. But, flakes from the same region always have similar resistivity temperature dependence. The insulating states can be easily found after the test of several flakes. The 2D resistivity ρ2D can be calculated with R4T and aspect ratio (AR), which is

ρ2D = R4T /AR………. (5)

And the 3D resistivity ρ3D can then be calculated by equation ρ3D = ρ2D t, where tis the flake thickness. The y-axis in the figure is plotted in a semi-log form to show the full shift in insulating and metallic samples. Different insulating states are observed in the samples, among which the bulk insulating state is achieved. At room temperature, the bulk insulating samples have a much higher ρ3D (~ 45 mΩ·cm), which is more than one order higher in magnitude than that of the metallic state (~ 4 mΩ·cm). When the temperature is lowered, weak insulating samples and metallic sample have only slight changes from 300 K to 20 K. But for the insulating samples, ρ3D increases nearly two orders in magnitude and reaches 2 Ω·cm, ~ 45 times bigger than that at room temperature! Compared with the ρ3D at 20 K for the most insulating Ca-doped Bi_2Se_3 bulk flake, which is ~ 100 mΩ·cm, it is 20 times larger. This demonstrates that the realisation of a highly insulating bulk state in the

Bi_2Te_2Se flakes and confirms the theory, which predicts the suppression of Se vacancies and Bi-Teantisite defects in this material [6].

At different temperatures, the Hall Effect is recorded for the most insulating samples. At room temperature, the Hall coefficient is small and positive, meaning hole carriers with a high density. It increases gradually as the temperature is cooled down, indicating the decrease in the carrier density. At T ~ 110 K, the Hall coefficient reaches a maximum and starts to decrease. It then crosses zero at T ~ 60 K and turns negative at even lower temperatures. This sign change of Hall coefficient indicates that the dominating carriers change from holes to electrons during the cool-down process. In the intermediate temperature range, both holes and electrons exist in the sample. Two different channels of carriers with different mobilities result in a nonlinear curvature in the Hall resistance. The Hall resistance at temperatures from 100 K to 10 K shows a clear nonlinear feature. Due to the existence of two carriers' channels, the simple carrier density calculation is derived from the Hall Effect measurement is no longer applicable[7]. More complex calculations can be used to derive the carrier densities and mobilities from the two networks. In the lowest temperature T = 4.3 K, a relatively straight line is obtained for this sample which gives a 3D carrier density n3D ~ $6.9{\times}10^{17}$ cm^{-3}. This is comparable with the carrier density of the most insulating Ca-doped Bi_2Se_3 flakes, showing the success of the decrease of carrier density in Bi_2Te_2Se samples. For samples with bulk insulating states and low carrier density, the signal from the topological surface states takes a larger fraction of the overall transport signal, which is more likely to show the properties of surface states. Surface states have large-scale Fermions with linear energy dispersion to speed k, compared to bulk states. Due to strong spin-orbit pairing, they are also covered by time-reversal symmetry. The backscattering is believed to be greatly suppressed. Subsequently, it leads to high mobility in the surface states, while the mobility is relatively low in the bulk channels. One technique that can track the high mobility channels is the Shubnikov-de Haas effect measurement. At low temperature and high magnetic field, high mobility carriers are more likely to show an oscillating behaviour in resistance due to the split of the Landau levels. The oscillations are periodic with the change in a magnetic field. The periodicity in the magnetic field should be 1/B is inversely proportional to the channel's carrier density.

10. SPIN AND MAGNETIC TRANSPORT IN BI_2SE_3
Surface states are found in bands about the Fermi level at the Γ-point. Four such surface states cross the Fermi threshold (shown by red spots); groups 142 and 143 form a single ruffian band easily under the Fermi vitality, while groups 144 and 145 form a ruffian band above EF. The mass valence groups are found under the surface states (showed by blue spot). As such, the dirac cone is located inside the mass band hole. There is a 7 meV gap between the valence and conduction surface groups.

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GAP ANALYSIS OF PMJDY SCHEME AND ITS IMPACTS ON FORMULATION OF RESEARCH METHODOLOGY: AN EXERCISE FROM RESEARCHERS PERSPECTIVE

MS. NAVSIN MISTRY AND PROF. (DR.) ARVIND S. LUHAR

ABSTRACT
This article is a by product of doctoral research study written with a aim to bring in one sequence the logic of carrying out gap analysis from review of literature leading to formulation of statement of problems, objectives, hypothesis and impact of all on questionnaire forming for the study. This article will be very helpful to the research students in writing their thesis to understand the connection between research title, ROL and Gap, how statement of problems is framed in support of objectives of the study. The creative aspects of this article are connection of hypothesis with Gap and questionnaire, and also sub questions of the questionnaire with the appraisal of the study.

Keywords: Thesis Writing, Gap Analysis, PMJDY, Research Methodology.

INTRODUCTION

Review of literature is detailed and in-depth study of available literature pertaining to a particular area of knowledge. It tries to put study in the present context by relating it to the past literatures available in the field of knowledge in the form of conference research papers, scholarly research articles, chapters from books, reports published by government and non-government organisations, statistical reports, past historical records, reports published by commercial agencies, legal documents, manuscripts, thesis's and dissertations.

While writing review of literature chapter in the thesis researcher has studied the research area gradually and extensively to find out what is known about PMJDY Scheme, link it to what is not yet known, which was important for narrating the relativeness of the ongoing research and to ultimately identifying the gaps in the research area under the study.

A range of literatures are available on PMJDY scheme at both national and international levels where researchers have viewed, examined, analysed and compared the schemes from various angles. The review of literature conducted for the research study has been conducted in the field of PMJDY scheme proving to be the banking solution for the unbanked and related literatures are reviewed to find the gap in the previous literature and accordingly frame the problems, objectives and hypotheses for the research study.

The Focus of This Article is to understand the Process Literature Reviews Related to Only One Aspects of the Study, Viz.
Providing the background studies focusing on the aims and objectives of PMJDY scheme and establishing a link as how aims and objectives of the scheme has helped in providing access of banking facilities to all.

Studies Focused on Providing Access of Banking Facilities to all Through Pmjdy Scheme
Inclusion of all individual in banking system is important as this financial inclusion of the population in banking system will help the country to reduce poverty and which will in turn lead to break the vicious circle of poverty, illiteracy and unemployment in our nation. Financial inclusion will lead to transfer of the benefits of the economy to all the strata of the population including the lowest strata in it. Limited accessibility of financial services and no financial literacy amongst the citizen leads to obstructing the economic growth and development. India has been focusing on financial inclusion programmes in past under different names but were not much effective as the coverage was limited. A large number of populations in our country belongs to people working in unorganised sector and households categorised under below poverty line are not having any bank accounts which resulted in no access to various government schemes extending basic financial support. Hence, the PMJDY scheme for financial inclusion of the unbanked was launched in 2014 and then carried forward with the renewed aims and objectives and ensuring maximum reach. The key objectives of the scheme were to provide access of financial services to all the households at an affordable rate. The financial services such as savings account, insurance, pension, remittance and credit were to be provided to all citizen through a focal point that is bank account under the scheme. This section gives summary of the various initiatives of the government for providing access of banking facilities to all sections of the society.

1. **Chinnamuthuetal and Gabriel John (2015)[1]** according to this study it is provided that it is not only important to open accounts for achieving the financial inclusion aim but it is equally important for making the

disadvantaged group to take the benefit of all the deliverable financial services provided by PMJDY scheme. In a populous and vast country like India even achieving the target of linking all to organised financial set up is truly challenging and there will be other problems associated with opened account which will pose another bigger challenge for making the account holder to take the benefit of credit facilities provided by the government. However, it is mentioned in the paper that PMJDY is a financial inclusion programmes by government have proved to be producing positive results. Along with Pradhan Mantri Jan Dhan Yojana (PMDJY), Financial Literacy and Credit Counselling (FLCC) centres had played a participatory role in striving hard for attaining financial inclusion and in providing a better means for availing credit facilities especially in rural India. The real inclusion is possible only when all the hurdles are minimised and the layman is able to reap the benefits of the scheme.

2. **Chakrabarty (2013)**[2] has mentioned in his keynote address that financial inclusion is the process which can be successful only by ensuring that the basic financial services needed are accessible by all sections present in the society including unprivileged groups consisting of the weaker sections, lower income groups and people living in backward areas. PMJDY scheme was launched with a national mission of providing one bank account to every household so that all the section of the society is linked to the banking system and can take the advantage of various financial products and services at an economical and affordable cost in a fair and transparent manner through the main institutional players. In order to combat financial exclusion, PMJDY scheme was initiated for bringing in financial inclusion. The basic objective of this financial inclusion scheme was to provide the banking services to all the people of the society and making the availability of these services to the public in abetter way without discrimination so that no household will be left without a bank account.

3. **Rani S (2016)**[3] has carried out the study in Sonipat district of Haryana on level of awareness about PMJDY. The study was conducted as a conglomerate study consisting of both primary and secondary data. Primary data was collected through questionnaire being the data collection tool. As per the responses received from the respondents belonging to this rural area of Haryana state reveals that even though 100% accounts were opened under PMJDY scheme but the frequency of the accountholder being aware about the facilities provided through this scheme was around 44%. So, it has been observed that even though the scheme is covering a good number of people under its banner but the level of awareness of the financial services offered under the scheme is not at par with the account opening and so various programmes must be organised to increase the level of awareness amongst the account holders of the scheme. If the awareness about the scheme is not increased the moto of reducing poverty and economic growth and development will suffer.

4. **Ram Prakash et al. (2014)** [4] has explained in his study conducted in Chennai Metropolitan city that majority of the section of urban area belongs to street vendors and other workers. These sections of urban economies are mostly not literate and have measly incomes. They operate their business amidst insecurity and uncertainties. The scope of study has special reference to accident policy taken by individuals and how the street vendors perceive its coverage provided by the service provider of insurance. Personal accident policy is usually taken for it covers accidental death, permanent total or partial disability happened due to accident, accidental temporary or permanent disability and such other few more features offered by the service provider. The study tried to cover its objective of finding the perception of risk, awareness and uptake of accident insurance. It was seen in the findings that the level of awareness about accident insurance being provided at micro and general level was very low, vendors were not aware that there is some insurance other than life insurance which can help them to cover their risk and it was seen that even after advertising the insurance scheme nothing much was achieved.

5. **Bhola Sarang (2014)** [5] stated that as the penetration of life insurance in India as on 2012 was very low. The indicator of growth of insurance in India was just 3.17 percentage compared to Japan was 9.2 percentage, Taiwan was 15.0 percentage and South Korea was 6.9 percentage. (IRDA Annual Report 2012-13).The paper is an attempt for studying the level of awareness about life insurance policy, why the penetration of life insurance is low and the needs for taking the life insurance. It was revealed by the researcher that the major reason for low penetration is that people are unaware of the need of life insurance policy. With the establishment of IRDA and entry of private players into insurance sector have increased the products being offered and have also improved the level of awareness about life insurance. But Indian people are yet not giving the required importance to a life insurance policy they either remains uninsured or under insured and the ones who are opting for life insurance are taking the policy not for risk coverage but for saving or exemption of taxes.

6. **Fang Wang and Haitao Zheng (2020)** [6] has examined the causal relationship between public health and mental wellbeing of the elderly people belonging to lower- income and middle-income group. The paper first coined a theoretical framework on the impact of new rural society wellbeing on mental health of elderly in

China. The results of the paper are no different from the other countries where the research listed that there is a relationship between the pension income and the mental health of the people. The effect of wellbeing differs from region to region but there is a visible impact that when the person has a security of pension he gets a little relieve from stress and depression for they feel that they can survive independently.

7. **Dr. N. Rajasekaran (2018)** [7]states that the term financial inclusion has real meaning only if all the sections of the society are included in the formal financial system of the economy. It is a major challenge for both developed and developing countries to financially include the underprivileged section, weaker section, low - income group, vulnerable group and others who are financially excluded. At the same time financial inclusion is important for the growth and development of a country's economy. The study has made an attempt to outline the barriers faced by India towards its goal of financial inclusion. The secondary data from various sources is used to get the results where it has been found that various attempts of financial inclusions were made by government and Reserve bank of India but still nothing much was achieved and the reason highlighted are low financial literacy, low or no regular income, lack of documentation, no proper awareness and mindset of the people.

8. **Chinmay Tumbe (2011)** [8]the research paper provides a sheet listing the facts about domestic remittances and international remittances at different State level, across households and also takes about the extent of dependency on remittance, growth since the 1990's, the varied uses of remittances for interstate transactions, the probable impact of remittances on source region inequality and its significance in enhancing financial inclusion. Data of 49th and 64th round migration related to National Sample Surveys, Reserve Bank of India and the Census 2001are used for the analysis and finding are as follows:

(i) The domestic remittance market is forecasted to be at an estimated value of $10 billion in 2007-08, 60% of which is comprised of Inter-State transfers and from which 80% are directed towards rural households

(ii) Domestic remittances are used to finance over 30% of household consumption expenditure, the remittance is being received by the households that formed around 10% of rural India.

(iii) The states of Bihar, Uttar Pradesh and Rajasthan showed high dependency on domestic remittance and which has generally grown since the 1990s, most notable growth is seen in Orissa.

(iv) The first top 25% households received almost around 50% of domestic remittances showing that remittances could be the increasing source region inequality.

(v) 70% of the domestic remittances transaction had estimated to be channelled in not formal but in informal sector as against 25% of international remittance being in China uncovering a huge opportunity for financial institutions to attend and serve the migrant workers.

(vi) The states of Kerala, Punjab and Goa accounted for approximately 40% of international remittance and are amongst the top remittance dependent economies of the world.

9. **Singhal Parmod (2016)** [9] explored through his research paper the awareness and the impact of PMJDY scheme on poor population of India. The study has made use of questionnaire for collecting the primary data by means of interview that is meeting people face to face for filling the responses. The key highlight of the paper is that the research has provided the insight on the reasons for which poor people have opened the PMJDY accounts. The major reasons for which the scheme was successful in opening accounts were zero balance account maintenance, ATM provided and so on. Like other studies even this study states that there is need for creating awareness so that the scheme benefits can be harvested.

10. **Akshatha B. G. (2018)** [10]discussed in the paper on how PMJDY has helped in boosting and uplifting the public wealth. This scheme has proved to be a boon in providing financial inclusiveness and access of banking facilities to millions of household in our country and along with account facilities it also provided insurance cover which invoked a sense of security in millions of household in our country. The government by linking this scheme accounts as a base for various other government schemes started to transfer money directly into the accounts of the beneficiaries, which in turn proved beneficial in eliminating the intermediaries and so helped in curbing the leakages of fund. This scheme has a potential of acting as a game changer for the economic face of the country.

11. **Prasad Rajendra Byakod et al. (2019)** [11]states in his study being conducted in a rural region of Karnataka named Nelamangala and Bidadi regions that the economic progress of any region depends on its rural regions too taken together, where use of ICT is limited. The researcher further states that the emerging changes in ICT

penetration and the impact of demonetization taken together along with the digital initiative of the government increases the need for improved Digital Payment System. Such required improvements are attainable with in rural India by providing an increased emphasis on adoption of the Digital Payment System, whereas the difficulties are the trust and providing enhances security for usage of User Payment Interface and portable mobile wallets.

APPRAISAL

At the time of carrying out review of literature in the area of how the aims and objectives of PMJDY scheme has helped in creating access of banking facilities for all, the researcher has noted down the following key observations:

1. The study revealed that in a populous and vast country like India even achieving the target of linking all to organised financial set up for availing all the financial services is truly challenging. Along with PMJDY, FLCC centres had played a participatory role in striving hard for attaining financial inclusion and in providing a better means for availing credit facilities especially in rural India.

2. It was mentioned in a keynote address that financial inclusion is the process whichcan be achieved, if PMJDY scheme initiative is successful in achieving its national mission of one account for every household.

3. It has been observed through the research that even though the scheme is covering a good number of people under its banner but the level of awareness of the financial services offered under the scheme is not at par with the account opening and so various programmes must be organised to increase the level of awareness amongst the account holder of the scheme.

4. The study highlighted the findings that the level of awareness about accident insurance being provided at micro and general level was very low and so they are unable to cover their risk.

5. The study states that Indian people are yet not giving the required importance to a life insurance policy they either remains uninsured or under insured and the ones who are opting for life insurance are taking the policy not for risk coverage but for saving or exemption of taxes.

6. The research listed that there is a relationship between the pension income and the mental health of the people, as and when the person has a security of pension, he gets a little relieve from stress and depression for they feel that they can survive independently.

7. The study highlighted that low financial literacy, low or no regular income, lack of documentation, no proper awareness and mindset of the people are the major reason why people are financial excluded from the formal financial system.

8. The study provides the insight that remittances are largely carried out by people and it also states that these remittances as an impact on source region inequality and its significance in enhancing financial inclusion.

9. The study explored the major reasons for PMJDY scheme to be successful in opening accounts. The credit for the scheme being successful is given to zero balance account maintenance facility, ATM facility, economical and affordable services and so on.

10. The study explained that government by using PMJDY account as a base for various other government schemes started to transfer money directly into the accounts of the beneficiaries, thus eliminating the intermediaries which in turn helped in curbing the leakages of fund and boosting the public wealth.

11. It has been stated in the paper that as per the new dream of going digital it is attainable in rural India by providing an increased emphasis on adoption of the Digital Payment System and overcoming the difficulties of trust and providing enhances security for usage of User Payment Interface and portable mobile wallets.

Thus, it is concluded from the observations made that no concrete work is carried out in the area of how the PMJDY scheme's objectives will be successful in creating access of banking facilities for all. Hence for bringing the authenticity to the present research work, researcher has framed following problem, objective and hypothesis.

1) **Problem No. 1 of the Study:** Poor universal access of the banking facilities to the people of the country is the biggest hindrance in the economic development.

2) **Objective No. 1 of the Study:** To study the aims and objectives of PMJDY scheme to expand and make affordable access of the banking facilities to the people of the country.

3) **Hypothesis No. 1 of the Study:**

(H0): PMJDY scheme is not significantly successful in creating access of the banking facilities to the account holder of the sample area under the research study.

(H1): PMJDY scheme is significantly successful in creating access of the banking facilities to the account holders of the sample area under the research study.

Accordingly, the efforts undertaken on review of literature are worthwhile, as the researcher has justified the linkages between the title, problem, objective and hypothesis of the study. The gist of all the above 11 points mentioned in the appraisal has been reflected in the questionnaire.

One will see the fantastic connection of all appraisals written with the questionnaire of the study, which is as follows:

Qestionnaire for the Account Holders under Pmjdy Scheme
The following statements are to collect responses on whether if, PMJDY scheme was successful in **creating access** of banking facilities for all the people in the selected sample area. Respondents are requested to read thoroughly and select the most appropriate alternative options given in the below table. **[Codes: VD: Very Dissatisfied, SD: Somewhat Dissatisfied, NSND: Neither Satisfied Nor Dissatisfied, SS: Somewhat Satisfied, VS: Very Satisfied]**

Access created by PMJDY Scheme	VD [1]	SD [2]	NSND [3]	SS [4]	VS [5]
1. PMJDY scheme has given access to better credit facilities.					
2. PMJDY scheme has provided the facility of one basic account to every household.					
3. PMJDY scheme has created an awareness of financial services amongst the underprivileged people.					
4. Accidental insurance is accessible through PMJDY scheme.					
5. Life insurance cover is accessible through PMJDY scheme.					
6. PMJDY scheme has made the needy to get access to pension facilities.					
7. Lesser hassles of documentation laid to better access of banking facilities through PMJDY scheme.					
8. PMJDY scheme have made remittance of fund easier and affordable.					
9. PMJDY scheme provided every accountholder an access to ATM services through RuPay debit card.					
10. Easy access and direct transfer of government subsidies is an admirable outcome of PMJDY scheme.					
11. PMJDY account has opened the new vistas of online banking access in under privileged area.					

SUMMARY
It is one of the novel articles in the area of writing M.Phil/PhD/MRP research work. New researchers are often confused in connecting the idea between topic, gap, ROL, objectives, problems, hypothesis and writing questionnaire. Researcher by taking the base of PMJDY scheme and its first problems, first objectives first hypothesis nicely explained the connectivity. Generally this connectivity is not seen in thesis writing, researcher and her mentor tried their level best to provide the glimpse of their work, which will definitely help future researcher in understanding the sequence of the chapter writing and methodology adopted.

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ECOFEMINISTIC STUDY OF TONI MORRISON'S A MERCY

PIYALI GOPE AND DEEPALI SHARMA

Literature has two qualities that have always facilitated in the increase in its followers and adherents both. Firstly, it is an unique discipline which endures to be connected with all other disciplines of humanism, and secondly, due to the consequence of first, it has always been closer to the issues relevant to human beings. With the advent of Literary theories these two qualities are being more deeply rooted in literature because they have brought a huge change in perspective by which Literature is studied. Before the occurrence of literary theories, 'Liberal Humanism' sought a non-political, clear stand of Literature thereby claiming it to be 'self-sufficient' and 'organic'. But now the trend has changed remarkably and literary theories have been successful in showing text having an extensive interest in socio-political characteristic of life.

Theories of Literature started making its presence felt with full sway only after post second world war. Since 1960's each decade has observed a wave in 'theories.' A number of theories were born and inborn one after another broadening away the linguistic perspective of liberal humanism and took their turns in taking over the ruling throne of Literary Theory and Criticism. William Ruckbert in 1978 has written an essay: "Literature and Ecology: An experiment in Ecocriticism." In 1974 Francois d' Eaubonne, a French feminist, wrote the book Le Feminisme ou La Mort and brought out the term Ecofeminism in that. This is a movement which seeks a huge connection between the suppression of women and the exploitation of our natural environment. According to Mary Mellor, "It takes from the green movement a concern about the impact of human activities on the non-human world and from feminism the view of humanity as gendered in ways that subordinate, exploit and oppress women."(Mellor, 2007) This two terms remained passive until 1980's till the environmental concerns started to become a major part of universal concern.

Ecofeminism sees a comprehensible relation between women and nature as both are the breeder, nurturer and feeder. Indian Ecofeminist Dr. Vandana Shiva sees 'development' as a form of subordination of women. The war of this subordination can be won through Prakriti, which is, the feminine basis for development which both conserves as well as is ecological. Feminism as like as ecology, and ecology as the restoration of Prakriti- the root of all life. (Shiva, 1989) In the words of Priyanka Chanda, "The disruption and transformation of the static dualism of nature/culture into a more dynamic and dialectical relationship between the two sides of the binary is pivotal to gender inclusiveness in terms of women's material position as (ecological) citizens and valuing women's (care) work which "naturally"links women to caring for the earth."(Chanda, 2014)

Before attempting a study of ecofeminism of Toni Morrison's novel, it is essential to understand the concept of ecofeminism. Recently, in the form of ecofeminism, the ecofeminists have started seeing the relation between the domination of nature and sexism. Both, women and nature are termed as feminine and therefore are in dual opposition to 'Masculinity.' The belief of similarity as well as proximity between nature and women arrives from the presumption of radical feminists that women are nurturing just like nature is nurturing itself.

Swarnlatha Rangarajan mentions about ecocriticism that it "articulates the symbiotic relationship between land and landscape, text and terrain, and recognizes that language is not separate from the world of nature." (Rangarajan, 2009) Jeremy Hawthorn, Paul Goring and Domhnall Michell define ecocriticism in simple terms which is, "an earth centered approach to literary works, especially works that share the critic's interest in the physical environment." (Goring et al, 2010) In English Literature, the devastating effects of urbanization and the concern with nature dates back to the time of *Lyrical Ballads* (1798).

Ecofeminists depict women and environment being equally subordinated for use of man. Carolyn Merchant writes that, "Social and socialist ecofeminism ground their analysis in capitalist patriarchy. They ask how patriarchal relations of reproduction reveal the domination of women by men and how capitalist relations of productions reveal the domination of nature by men." (Merchant, 1992)

Issues regarding environment are of grave concern in the present scenario. To be concerned about environmental issue or to save environment is not only the duty of environmentalists or government but of each and every citizen of this world. Because of environmental issues we are facing many problems like climate change, global warming and many other disasters. This had affected the entire humanity and therefore now people are very much upset about the issues of environment. And as everywhere in all fields, people are concerned about it, so the literary world is not apart from this. In the past we have witnessed a huge love for

nature in the works of poets like Coleridge, Wordsworth, Keats and many other poets and novelists. Contemporary writers are expressing their agitation about environment in their writings which are in the form of memoirs, prose-work, novels and also in the poems.

There are many writers not only in India but the world over, who have reacted their concern for the environment in their literary works. Toni Morrison is also one such writer, who is from Afro-America. She was the first black women who received the Nobel prize in the year 1993. Toni Morrison has written nine novels. Morrison was a black feminist writer who has mention about the intersection of class, race and gender in her novels.

Morrison's latest novel, A Mercy (2008) depicts the rising of ecofeminism in the novelist. The Bluest Eye (1970), Morrison's first novel contained the events which showed her interest in ecology in the species and equally beings oppressed as well as ignored as women: environment and animals. In this novel she tried to attract attention of readers towards a cat which is poorly tortured by a boy and ultimately, he killed him. As a novelist when Morrison grows, we as a reader can discover a growing appetite for all those things in the nature that are being exploited by the humans.

In Morrison's fourth novel, Tar Baby, the story is set in the lap of beauty of nature. Morrison successfully shows us the benefit of being close to nature instead of damaging it. Morrison's another novel, in A Mercy, there is a direct intimation of the exploitation of animals, women and nature by men.

But Morrison's earlier novels were not so concern towards plants and animals as she manifested in this novel. A Mercy can be studied as an ecofeminist novel because Morrison has shown in a most apparent way the crisis of environment that the world is living through. Here she shows how animals are used unemotively, she depicts at several places how mankind is disturbing the ecological balances.

The story of A Mercy involves multiple open ending of several characters. It tells about the story of a businessman, Jacob Vaark who goes to meet the portugese plantation worker, D'Ortega in the new world. Vark possess two women slaves. Lina is the first one who is a native American girl and second one is Sorrow. Both of them are orphan. The novel opens with Floren, who is a sixteen years old black girl. Florens remembers her past that how her master had given her to Jacob Vark in settlement of a debt. She recounts how her mother offered her instead of herself because she had a baby boy whom she had to nurse. Florens was in love with a black blacksmith who was never enslaved. She narrates about her journey to meet her love that ends in only despair.

Morrison in this story, has indicated her deep concerns at several instances which go beyond her specialization of black feminism. She has shown the complete abuse of plants and animals, nature both, in the hands of man.

When Jacob Vark goes to meet D'Ortega at latter's house she borrows a horse named Regina. Virginia's newly developed path is still not in sound condition. Jacob senses danger around him all the time. On his way he witnesses a young raccoon stuck in a beak of a tree. He dismounts the horse to set free raccoon. He tries to be, "as gentle as possible, avoiding the claws and jaws of the frightened animal. Once he succeeded, the raccoon limped off, perhaps to the mother forced to abandon it or more likely into other claws." (Morrison, 2008) Morrison here draws the attention of readers towards two things. First is the agony and pain of that young raccoon which was badly caught in a tree. Being an animal there is no worth of its pain. Nor it could beg and cry like human beings. Only a true human like Jacob could bring it relief of liberation. Secondly, it is already known that being young and alone the raccoon could effortlessly fall prey to some other man or animal. The novelist has subtly compared raccoon with Florens. The mothers of both the species, one a black girl and other a helpless animal, could do nothing to save them.

At one point Morrison depicts the savage like behavior of man towards animal. When Jacob was coming back to Pursey's tavern from house of D'Ortega he sees a man beating a horse to its knees. Some men took the man away from there but the episode of beating the horse pains Jacob Vark. Through this incident Morrison showed us that Jacob felt bad, "not only because of the pain it incited on the horse, but because of the mute, unprotesting surrender glazing its eyes." (Morrison, 2008) Morrison herself proves to be on a significant mission of listening to the unspeakable voices of animals.

Morrison strengthens the work by advocating the cause of nature, animal and women. At one instance she juxtaposes the condition of Florens and Leena and an eagle to show how they all are the same, one, the hopeless, the helpless and the exploited ones. Lina narrates a story of an eagle to Florens. The eagle lays eggs far off from the reach of hunters and snakes. She ferociously protects her eggs. But one day a man reaches the place and decides to take the eggs. By this eagle gets frightened. Still, she tries to protect her eggs but the man

raises his stick and beats the eagle with his full energy. It falls leaving the eggs all alone. Here Florens asks Lina, "Do they live?"Lina replies, "We Have."(Morrison, 2008) Morrison shows how the plight of animals and birds and humans are same in the hands of man.

Same way through the work of Morrison the cause of plants and trees also find a cause and a voice. At many places in the novel, she has mentioned about the exploitation of plants, of trees and of nature. She writes that Jacob Vark's new house building "required the death of fifty trees." (Morrison, 2008) She writes and really means that the cutting down of trees means the death of trees and nothing less. And that the trees life is as precious and important as that of a human being.

A Mercy has indicated a new means of bringing the cause of nature, animal and women all together in a novel. This is an ecofeminist novel which attracts the attention towards the importance of ecofeminist movement in today's where both women, animal and nature need a voice to speak. Morrison writes that, "to be given dominion over another is a hard thing; to wrest dominion over another is a wrong thing; to give dominion of yourself to another is a wicked thing." (Morrison, 2008)

It is quite obvious for Morrison to represent the suffering whether it is animal or women because being a black woman she herself has witnessed pains, sufferings and mal-treatments. So, her voice can be called the voice of a subaltern.

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LUCY MAUD MONTGOMERY'S PSYCHOLOGICAL REFLECTIONS IN "ANNE OF GREEN GABLES"

SANCHNA CHOPRA AND DR. VINAYA KUMARI

ABSTRACT
Stories speak of the characters in all aspects of everyday life and nature, and every character has different issues. The problem usually explained in the story is the writer's experience. Many of the workers (under construction) are influenced by their personal lives. From time to time, even the characters in the work reflected their own personal characteristics. The purpose of this study is to analyze Lucy Maud Montgomery's psychology as a script reflected in her novel Anne of Green Gables. The documentation contains the content of Montgomery's novels and biographies. The approach to analyzing a novel is psychological. As a result, writer Lucy Maud Montgomery and the novel's protagonist Anne have an imaginary personality that belongs to a practical type of imagination, a desire to be grateful, and loneliness. In addition, loneliness empowers Lucy Maud Montgomery to create her personality when writing her work. Despite the immense popularity of her books, especially the Anne of Green Gables, L.M. Montgomery is often not discussed by literary historians in the development of Canadian national culture. This is interesting because some of Canada's leading writers, such as Margaret Atwood, Alice Munro, and Jane Urquhart, have acknowledged their attachment to Montgomery's fiction. This collection complements the fact that scholars did not unearth the "Canadianness" of Montgomery's writings. This is the first systematic attempt to investigate and investigate Montgomery's active involvement in Canadian nationalism and identity, including regionalism, norm-building, and Canadian-American cultural relationships. It examines their work in connection with many dramatic changes in their time, such as the movement of women and the emergence of new technologies. It then examines the domestic and international consumption of the Anne of Green Gables, both in the form of "high culture" and in the form of cultural tourism. A wide range of contributors represent cross-disciplinary and cross-border views, including feminists, biographies, psychoanalysis, history and cultural approaches. Scientific considerations are effectively accompanied by creative contributions, personal considerations and interviews. This groundbreaking collection appeals to all fans of Montgomery's work and students of Canadian literature. It puts Montgomery and her work directly in the mainstream of Canadian literary history, emphasizing its importance for the cultural development of our country.

Keywords: Psychology, Author, Anne of Green Gables Novel, Psychoanalytic, Imagination.

INTRODUCTION
The purpose of this study is to analyze Lucy Maud Montgomery's psychology as a script reflected in her novel Anne of Green Gables. The documentation contains the content of Montgomery's novels and biographies. The approach to analyzing a novel is psychological. As a result, writer Lucy Maud Montgomery and the novel's protagonist Anne have an imaginary personality that belongs to a practical type of imagination, a desire to be grateful, and loneliness. In addition, loneliness empowers Lucy Maud Montgomery to create her personality when writing her work.

L.M. Montgomery's Psychological Reflections:
Stories speak of the characters in all aspects of everyday life and nature, and every character has different issues. The problem usually explained in the story is the writer's experience. Many of the workers (under construction) are influenced by their personal lives. From time to time, even the characters in the work reflected their own personal characteristics. In line with Siswant's opinion in Dwitantyanov (2013), he said that literary works are a reflection of the true reality, but the reflection of reality is reinforced by the author's imagination. The literary work itself is related to human life. Therefore, it is appropriate to use psychology as an approach to understanding humans from the symptoms of the soul and processing them into texts to complete them in the mind (Endraswara, 2003). The choice of words is characteristic of the individual author. Anne of Green Gables' novel was written by Canadian author L.M. Montgomery in 1908. This novel was her first work to make her name known to many. A novel about an orphan girl named Anne Shirley who unexpectedly arrives in Avonlea in a confused manner to live with elderly siblings named Matthew Chutbert and Marilla. They wanted to give custody to little boys, not girls. Boys can help take care of green gables more than girls. But who can guess, this is the best fallacy for them. In fact, this little girl used her imagination to make both adorable. When she decided to take care of her, they tried to do their best, but neither had seen the care of the child. It's the first time for

them, so they don't make it meaningless. They sent her to her school and gave her motivation and advice like her parents. Anne, who has her romantic soul, was always impressed by her kindness. It's been a while since she hasn't been treated this way. Because of all the kindness she received, she tried to do her best for her in the form of her affectionate parenting. She is proud of both of them. The author of this novel, Lucy Maud Montgomery, really attracted readers to love Anne as the protagonist of the novel. Anne's story, which has never felt the affection of her parents from an early age, has increased the number of patients facing her life. She used to be a little girl who took care of her brothers Mashu and Marilla and eventually lived in the Green Gables, until eventually her family didn't want to accept her and settled in an orphanage, which changed her residence. Anne's story as the main character in this novel is similar to Montgomery's life story.

Anne then imagines that her body is plump and full, with candy ridges that resemble elbow pits. Anne was presented out of the facility in a terrible old Wincy dress and she felt very embarrassed in the dress. She talks about what people think when they see her. She sympathizes with people. Then Anne began to imagine that she wore the most beautiful light blue silk dress, and she wore a big hat with flowers and nods plums and a gold watch and velvet gloves and boots. In addition to the previous three dates, date 05 also shows that Anne loves trees. Here Anne is talking about her exiled tree. She imagines the trees in the facility like an orphan. You have to live outside the facility to get a better life. She uses her imagination to overcome difficulties. Anne was healed. She broke her leg, she couldn't go to play, and she had to stay home until she was healed. It can be concluded that the main character of this novel "Ann of Green Gables" always has an imaginative psychological nature. And it reflects the author Lucy Maud Montgomery. The imaginative Montgomery can be found in the encyclopedia (2010) biography "Young Mode is a lonely child and imaginative ...". She lived with her maternal grandparents' house at the time. In another source of Montgomery's life in the diary by Jillen (1976), "Her childhood was in the United Kingdom, lonely, spending time in an old man's house. "The couple, however, she found comfort in the natural beauty of her fertile fantasy world landscape. Because it is explained here that Montgomery experienced several refugees in her life. Because her mother died and her mother's grandparents grew up unforgiving. In this case, Montgomery becomes an imaginative individual. As a feature of this practical imaginary type, these all meet the practical needs of their lives (Panchal, 2016). Gratitude, everyone needs to want to value what they are, their contributions and their performance in order to know that they have changed something in the lives of others. I have. Gratitude means recognizing the value and importance of something. A sense of events, people, behaviors, things, and their positive emotional connections (Adler and Fagley, 2005, p.81). By expressing gratitude, you can build your spirit, your passion, and your purpose (Smith, 2010). In Lucy Maud Montgomery‟s novel entitled Anne of Green Gables presented several expressions about appreciation to the main character, Anne. It can be seen that Anne got an appreciation from the doctor of her ability in handle a baby who got cough. Appreciation in this did not come to her directly, but this is enough to make people know that Anne a little girl who they thought is a stranger with her head that full of imagination have hidden ability. She was invited by Mrs. Barry to drink tea with her family at home as Mrs. Barry's greeting led Anne to help her child. At that time, Mrs. Barry used her special cup for tea, and Anne was the first girl to use this cup. This gratitude gives her the energy and motivation to work harder and do more, knowing she has never let go of the problem, but she always strives. Compare the life of Montgomery with Anne Shirley. Montgomery's was taught through her childhood that she must follow the role of grandparents. She was not a naughty girl, but an obedient girl. But everything she did was never appreciated. I feel like no one cares. Then she tried her new things and wanted her family to be proud of her. She wrote poetry, wrote as an essay, and participated in an essay contest. But they did not support her between her grandparents and her stepmother to her family. But it didn't bother her. She started a big ambition for it. When she was 16, Montgomery wanted to do a teacher training course in Charlottetown. The same thing happened to her grandfather, but not to her grandmother and her father. Her grandfather McNeil didn't want to pay Montgomery. But this still made them purposeless. In her diary, she hints at a willing struggle with her sharp-tongue grandfather. At the end of the year, Montgomery's grandmother and her father raised enough money to send to the Prince of Wales University in Charlottetown. And she learned hard for it. She was very successful in her final exam and was honored to read an essay on Shakespeare's Posha in her spring introductory exercises. Montgomery has postponed the two-year curriculum at the University of Prince of Wales to one year. She focuses on finding paid jobs as a school teacher. Grandpa McNeil never changes his mind about Montgomery. She did not receive such encouragement from her grandfather. She could only apply to a nearby school or a nearby school. If enough money rewarded her efforts, she could plan a year in college despite her grandfather's dissatisfaction. Her grandmother offered to spend half a year at Dalhousie University in Halifax, Nova Scotia. Montgomery has a strong soul. Thanks from her grandfather didn't let her do anything better.

Her grandfather has passed away, which makes her sad. But she loves her grandfather. She returns to the island with half-hearted hope. In her diary, she writes, she became more and more absorbed in her writing. "Almost everything I think, do, or say is subordinate to my desire to improve my work." English Literature, We can conclude that Anne Shirley was recognized as the protagonist who did her best, but Montgomery was not. But that doesn't mean that Anne Shirley wasn't a mirror image of Montgomery who founded her perception. Montgomery has evolved to do the best of her life and gain recognition because she has no support and must be valued by her family. Loneliness Farooqi (2015) stated 'Loneliness is the discomfort of not being able to build a satisfying relationship or being dissatisfied with the quality of one's relationship'. Being alone does not mean that she / he is lonely. Conversely, one can feel lonely when being with her / his friends. That is Anne's feelings. Prior to her stay in the Green Gables, she lived in custody of her parents, after which she lived in a mental hospital. There were a lot of people around her. She can build relationships with them if she so desires. But she doesn't. She wasn't because she couldn't communicate with them, but they weren't the ones who wanted a better social relationship with Anne. The dating sensation of being obsessed with the Anne of Green Gables in this novel can be seen, Anne was very kind because someone wanted her, and she would join it. There were a lot of people in the facility, but she felt lonely. We can see that her loneliness made her uncomfortable in a satisfying relationship with others. There were a lot of people in her facility and she just made friends with her. In addition, her loneliness that Anne explained on Date 10. On those dates she got a better relationship as she wanted. She has a lot of friends and some of her best friends. She called it a "soulmate." This gives her a sense of satisfaction. Her feelings of loneliness were also rooted in Date 11. She felt she was away from her friend because Anne was no longer her best friend with Diana. She has many friends, but she felt that no one could understand and love her like her best friend Diana. Also, none of her friends have similarities between Diana and her. The loneliness of these dates is a sense of social separation that Anne wants for a better social relationship. In addition to her loneliness, she also had to feel like parental controls. Factions of relationships and it causes loneliness to appear. Now, on date 10, Anne needs to confess that she belongs to her so that she can feel part of this her family. She wants to call Marilla an "aunt," but Marilla doesn't. She thought she could really belong to Marilla, at least with her facial expression. Anne's loneliness as a mirror image of Montgomery can also be seen in her biography. Montgomery's childhood was very lonely. She has a family, but she felt they weren't for themselves. After her mother died, he left his father, Montgomery, with his separated mother's grandparents. She only became friends with her cousin (Rubio and Waterson, 1995, p. 18), but they were not intimate. Her loneliness caused the treatment and attitude of her family. Montgomery has lost love from his family. But Montgomery was able to use her loneliness with her imagination. She creates their ideal world and writing. "In the face of immense challenges, Montgomery stuck to this thread. She once combined all mysterious experiences to create an unforgettable, adorable story with sunny surfaces and dark shadows. Whatever happened to her, whatever she read or protected, she was caught in a net of words "(Rubio and Waterston, 1995, p. 11). In addition, the discovery that Montgomery was a lonely girl. Montgomery's family life with her dear father and her little stepmother was a nuisance. Her stepmother, named her Marriage Anne, was far from her affectionate and protective mother Maud had longed for. Individual loneliness is caused by discomfort or inadequacy in relationships with others. You have difficulty communicating with others. This is a way to know what they are feeling. Usually, they write in their diary what they feel. The next day, some people have this as a hobby. Montgomery not only showed Anne's imaginative personality, loneliness, and possession, but also a desire to be grateful, and made Anne love to write. The depictions Anne likes to write reflect Montgomery. Based on the search for writing, it's really just Anne's passion. On the other hand, her writing became Montgomery's way of controlling her loneliness and later her passion, which is different in this novel. Anne loves to write. Anne's enthusiasm for her writing was demonstrated when she stayed at the Green Gables and was mentored by Marilla and Matthew. Explain on these dates that Anne was praised for her best composition. By the time she started, she liked writing essays. She loves to be a noteworthy person when she is asked by her teacher to write an essay about a noteworthy person.

Here she imagines how much fun it would be if she were a remarkable person. Her personality with a practical imagination makes it easy for her to write her composition. She often influenced her imagination. She imagined a sad story and cried for it. The last date to describe Anne's seriousness in writing. She asked her best friend to start a story club. This club helps her and her friends develop their writing skills by relying on their imagination. And she will be the tutor of this club. Writing was the most important part of Montgomery's life. Whatever happened to her, what she read and heard locked her in a net of words for the rest of her life (Rubio and Waterston, 1995). Montgomery's passion for writing was born in her childhood. At that time, her passion was watching over their loneliness. She trained herself to write down the events of her daily life in the form of a story and write it down in her diary. Writing her secret diary has become an exercise in her storytelling skills.

She recorded a particular experience in her life. In addition, Montgomery is a church clan who learned her storyteller skills from the traditional storytellers of men and women. She learned other trade tricks from her English Literature Favorite novelist. Know that their lives were uncomfortable and painful. The content of her diary avoids her grandfather. Not only that, many poems and novels contain hidden rebellions, whose diaries pulsate with open resistance, resentment, and depression (Rubio and Waterston, 1995).

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URMILA PAWAR'S AAYDAN AND MOTHER WIT: A NARRATIVE OF SOCIAL REJECTION, EXCLUSION, LANGUAGE, RESISTANCE, VOICING AND EMPOWERMENT THROUGH EDUCATION

ULKA TEWARI AND DR. VINAYA KUMARI

ABSTRACT

Many Dalit literary works have expressed the experience of social rejection in their works. This paper deals with the implications of the idea about the language, existence of social rejection, exclusion, sufferings, social experiences, trauma within their community and also the darker side of how women are treated in their households by the people of their own community. Also how they overcome the situation with the passage of time being self-determined keeping a positive distinction and maintaining individuality using education as a tool to empower them taking reference of famous Dalit women autobiography Aaydan and short story collection Motherwit by Urmila Pawar.

Key words: Social rejection, experience, exclusion, dalit, women, language.

INTRODUCTION

The significance of gender in relation to caste is explained in many of the texts. Life narratives of Dalit's have established themselves as a distinct genre, which has emerged from self- interpretation, exploring society and the conflict within these .(Jadhav 1991; Lokhande 1994). There are all types of utopias that many people have imagined and written about. But the most common type is a society which is completely based on equality. Here equality not only refers to no division between rich and poor but also giving same respect to men and women. The text deals with the experiences of social rejection and search for the correlation between 'Social experiences' and 'creativity' if any. It also deals with the psychological processes that might help in comprehending this connection. Although a much has been done on social rejection which points out the various harmful and injurious effects of social rejection on one's performance. It also focuses on how language has been playing a central role in defining and constructing the meaning for everything and anything in their world.

Urmila Pawar, a literary figure in the world of Dalit writings, a Maharashtrian native, a short story writer, has portrayed several incidents of social rejection due to casteism. Her autobiography' *Aaydan*' (2003), translated by Maya Pandit as '*The Weave of My Life*' is replete with such accounts. The 'Preface' highlights the theme of social rejection and the need to transcend it as it is a complex narration of an individual. Pawar portrays her desire to transcend the caste identity and need for the individualization of self which seems to be very motivating for her to take the creative nature of literary writing to next level instead of suppressing it. She has given special emphasis on social rejection and its consequences on the women of her community. She states, "What the writer writes about is social reality and not her/his individual life" (342). Social rejection is a common social reality and traumatic experience for Dalit women. Narrating one such experience where she was asked to carry the baskets made by her mother to the members of the Upper caste and forced to stand outside the house. She recalls how the baskets were washed when she put them down by sprinkling "*water on them to wash away the pollution, and only then would they touch them*" (65). In another incident when coins were dropped, "*in my hands from above, avoiding contact if their hands would have burnt if they touched me*" (65).

She also faced social rejection after her marriage also, she recalls, she went to Ratnagiri and was forced to vacate the house and the reason was "*one point: caste*" (206). The negative outcome experienced by her seems to have long lasting effects and she explains how that rejection was enough to produce negative consequences. Williams and Zardo state, "*Rejection evokes a strong immediate warning*" (22).

Pawar observed the differences between herself and other girls and was conscious to learn about it. She explains the realization as, "We were aware, without anybody telling us, that we were born in a particular caste and in poverty, and that we had to live accordingly" (96). There was another aspect to it wherein she observed that the degree of social rejection was different for male members and female members of her community and the fact that Dalit women also suffer rejection from the male members of their own community. Even separate dishes are prepared for male and female members. According to Baumeister and Leary (1995). "A need to belong, that is, a need to form and maintain at least a minimum quantity of interpersonal relationships, is innately prepared (and hence nearly universal) among human beings" (499). The end result is frustration only to look for the

belongingness. Even the children remain untouched from this humiliation. She depicts the humiliation and embarrassment suffered by the female children and women of the community who occupy the periphery of the society and are compelled to live on the fringes. She explains this with an example, when she along with her two nieces sat down to eat and began asking rice time after time. She recalls the humiliation. "The cook returned with more rice but being called monster was not easy to digest and we politely declined" (117).

She talks about rejection she faced during her school days wherein her classmates in school decides to prepare a meal. Everybody discussed what they should bring, rice, lentils etc. but she was instructed not to bring anything. Instead she was told. "*You must bring some money*" (107). She was not allowed to touch anything. And her eating habit "*had become the hottest topic for juicy gossip*" (110).James, W. in *The Principles of Psychology* describes the feeling of being ostracised as "*every person we met cut us dead*" (293).

Pawar has portrayed the images of social rejection not only to what she has undergone but also those who belong to her community with the same realism. She describes about her elder sister Sushi who died after her marriage in utmost pain and misery. Likewise, Parvati, brother's wife, who has no voice of her own, everybody has faced the same or some other form of social rejection by one or the other person of their own community or upper caste people. Talking about one more incident in her school where she was put in an embarrassed situation by her English teacher who used to abuse her for poor language skills but the worst experience was at home only where in her uncle tried to exploit her sexually to play dolls with her imagining being her husband, dragging her and pressing her hard (125). All this resulted in anxiety, depression, unhappiness and a deep wrong effect on her young mind. The feeling of getting suppressed and humiliated and exploited by someone who is very close instead by someone who is not so very close has intensified the negative outcomes. And in continuation, she narrates the experiences of her wedding night when she felt the groping hands of her husband and was called 'frigid', which made her feel even more negative about herself. If she wouldn't have been there, her husband might have some other suspicions in his mind for her may be her being virgin! So she chose to remain silent and not show her disagreement or displeasure and surrendered completely. Similarly she had many more such examples from her community. This continued even in other matters also like when she received her first salary. She remarks,

"When I got my first salary, I could not believe that all money was mine; that I could spend it the way I liked. Before my marriage, I used to hand over my salary to my mother; now I started handling it over to my husband. If this is not like deliberately offering head for the butcher's knife, what else is it?" (14)

Similarly, Dalit woman's personal narratives not only challenged their absence in Dalit men's narratives, but also voice the concerns shared by women across all strata. These alternative accounts criticises the patriarchal structure in their society thus reflecting on women's problems with specific issues in a Dalit society. Dalit women's autobiographies are very candid about all kinds of exploitation and oppression that these women had to face within and outside their society. This has been observed in Dalit men's autobiographies that hardly there is any mention of domestic violence or any kind of emotional abuse but this fact is very evident in Dalit women autobiographies that domestic violence has always been a very major issue in their households. The absence of such narratives from Dalit men's writings shows the dismissal of the fact and denial from their end also. Whereas the women narratives have clearly shown the darker side of their daily routine life which again is a kind of social rejection from men's writings. This is stated in Bama's *Sangati* (1994) also as,

"It is not the same for women of other castes and communities. Our women cannot bear the treatment of upper-caste masters in the fields, and at home, they cannot bear the violence of their husbands" (65).

Urmila Pawar has written about one more custom prevalent in Maharashtra that is at the death ceremony of a man, his wife has to break her 'Mangalsutra' and her bangles. She has to remove all the signs of a 'Suhagan' or wifehood. She has to remove her 'Kumkum' from her forehead with the left toe of the husband. Urmila disliked this death ritual and raised her voice against this. According to Sonali rode, "Urmila Pawar's Aaydan describes her long journey from Konkan to Mumbai bringing the struggle of three generations for a Dalit modernity about which readers have hitherto heard so little". (International Research Journal, Vols.3 and 4, 2008)

Urmila Pawar, herself not just a woman, but also a Dalit is no stranger to dejection or disregard. Her personal experiences perhaps bring the relevance to her stories. In fact we can find the woman of her stories all around us who does not belong to a specific community but all the castes and communities. She has shown through her writings that language has an immense power, and its impact is totally dependent on how we use it. She uses the short story to a great effect, in not only setting the stage for her woman, but also allowing them to be faces in the crowd, to play their role and pass the baton to many more other women for the similar and another tale of

struggle, to bring out the parts left yet unexplored. The same platform is used over, and over again, yet each story leaves the reader questioning his knowledge of female oppression, otherwise, mostly confined to physical assaults. As we all are aware that it is difficult to separate literature from life and keeping in view the same dalit women are using literature and language as one of the strongest medium to express their lives in syncing society as well as in raising their identity which is sinking under the triple burden of class, caste and gender discrimination. She has handed over a very important role to each one of her protagonists who are representatives of all those thousands and lakhs of women who refused to accept the patriarchal system, or at times have broken the stereotypical mind-sets. These stories offer a deep insight into the themes that somehow redefines women's roles. Her language contains those distinctive elements like the earthen touch of Marathi language. Also the English translations of these stories have given access to a wider audience across the globe and let people know about the wit, agency, strength these women possesses and exercise when faced with difficult situations. Women in her stories unlike other writings do not write slogans and march in movements but has their own share of struggles and fight everyday discrimination which at times beget within the circumstances they find themselves in. And the writing skills or language they have used to write in and later on English translations of their work have become one of the most important tools to empower them. As the emotions with which the original story was written somehow the same emotions were either translated or transformed in the English version. One of the most striking occurrences in majority of dalit writings is the invocation of the communication idea of "we" with which they constantly identify their selves without fail.

Paik argues that, "most social reformers: sought to make efforts towards improving women's status and strengthening the Hindu community (as well as the nation), yet they failed to concern themselves with women's issues in their own right. They argued for the necessity of education and simultaneously set limits to it. In the process they articulated a public culture of domesticity and at the same time entrenched separate gendered spheres, reinforced Brahman caste power and constructed caste differentiation. (p. 120)

While upper-caste women could benefit from this type of schooling by constructing their own venues and authoring their own stories, Dalit women did not have the same chances. Dalit women's diaries, stories, and other writings are scarce. Consequently, their experiences are usually unreported and unacknowledged. Women's voices are silenced even inside the Dalit movement. In a context where Dalit women's autonomy and participation are limited, because sexuality was and still is frowned upon, gaining self-esteem has been difficult.

CONCLUSION

Urmila Pawar and almost all the Dalit writers had lived their lives under extremely bad conditions and they have been through worst of the circumstances but there was a positive aspect to it that it has given some motivation to people to do better and never stop working hard not only for themselves but for the whole community. It has also shown the path of unity to them and that is the reason they are united always in giving voice to all the silent sufferers. Urmila Pawar rejected the age old traditional set of rules designed by patriarchal society. She not only emerged as a strong woman amidst all the social rejection and exclusion but she was determined to liberate other Dalit women also. And the concluding paragraph of her autobiography states:

"Life has taught me many things, showed me so much. It has also lashed at me till I bled, I don't know how much longer I am going to live, nor do I know how much life is going to confront me let it came in any form; I am ready to face it stoically. This is what my life has taught me. This is my life and that is me". (320)

All such social stratification, exclusions and rejections has given a stronger reason and ways to empower Dalit women and men not only within but outside their community also. And Dalit women certainly writes differently. Urmila Pawar has also invented words and has tried to show the different mode and moods first in regional language and then in English language. The English translations of her works represents the hopes and ambitions of a new society and new people. This has given a power to dalit women to tread on a path which has empowered them to emerge as an individual with selfhood, agency and a better vision.

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SOCIAL HOUSING FINANCE MODEL OF NETHERLANDS

NISAR KHAN

ABSTRACT

As per the Mckinsey report by 2025, about 440 million urban households around the world comprising of at least 1.6 billion people would occupy crowded, inadequate, and unsafe housing or will be financially stretched.(McKinseyGlobalInstitute, 2014) This situation will be more pronounced in the developing countries where prevalence of slums and sub standard housing conditions in more pronounced. This situation is largely attributed to the huge financial requirements in producing housing in any country, more so in the developing ones. Countries have adopted various financial models to supply housing for the people, however only a few have sustained the complex dynamics of availability and affordability. After the independence, Indian government has taken up the role of housing producer and provider, where numerous development authorities are functioning across the country and providing housing of plots, independent houses and flats typologies. However, only a fraction of the population is benefited out of these. Netherlands is one of the countries which has been successful in meeting her housing demands. The credit to this goes to the multifaceted housing finance model that the country has adopted. In this article the Author intends to discuss the salient aspects of the housing finance model of the Netherlands which he learnt during his post graduate studies at the Institute for Housing and Urban Development Studies (IHS) Rotterdam under the OKP scholarship.

INTRODUCTION

Netherlands is a small country in Europe known for its low topography, in fact the name of the country Netherlands literally mean 'low lands'. Almost 25% of the land is below sea level and another 50% is under 1 m of mean sea level. This topographical situation puts the country at a constant risk of flooding which is mitigated by various remarkable technological solutions like surge barriers, dams, dikes, windmills, channels and lakes etc. The Dutch flood mitigation methods are used globally. The difficult landscape of Netherlands has made the Dutch peopleindustrious and innovative in finding solutions to the problems. It is this innovativeness that has resulted in the remarkable achievement of sufficiency and adequacy in the housing sector as discussed in the following sections.

The country has produced a sturdy and effective social housing model meeting the demand of the people, especially the needy ones. In the present about 31 percent of the housing in the Netherlands is social housing category.(ABF Research, 2011) The social housing in Netherlands is entirely rental housing provided mostly by the housing associations.[i] (Gerrichhauzen, 1990) The housing associations are private entities mandated by the Housing Act of 1901[ii] to provide decent quality social rental housing to the people in return of subsidised land, subsidised loan and tax benefits.[iii](Elsinga, 2014; Priemus, 1997) As per 2015 data there are about 350 housing associations collectively owning about 2.4 million housing units spread across the country.[iv] The social housing in Netherlands accommodate about 4 million people. Another remarkable aspect of the social housing of Netherlands is the spatial distribution within the cities. The social housing is located everywhere in the cities, from the very city centres to the sprawl and suburbs. This makes the social housing more integrated with the socio-economic functioning of the city and provides multiple locational opportunities to the dwellers. (Ayala, 2019) Further, the social housing is mixed use type where ground floor on the street edge is often provided with the commercial and retail space. The rent from these commercial and retail space augment the income of the housing associations and make up for the loss if any in the housing. As per the mandate it is the responsibility of the housing associations to maintain the housings on regular basis.

The eligibility of social housing depends on the income threshold of the 37500 euros per annum of a house hold. This income threshold of 37500 euros per annum is wide enough to cover the middle income section along with the lower income section of the society making the social rental housing inclusive and bridging the housing ladder. The allocation of the social housing is through a website for transparency with provision for preference to the senior citizens and immigrants. To make social housing more accessible for lower income section of the society the rent is augmented by the government, if the income of the household is insufficient. Further, in a separate scheme youth and students are provided with housing in lieu of social service like attending old age homes, teaching in local schools etc. This scheme facilitates the youth to continue their studies or occupation without spending on the housing. (Elsinga, 2014)

The success of social housing of Netherlands can largely be attributed to the uniquely secured financial model where government acted as a catalyst rather than an actor in providing housing. The financial model is discussed in the following sections.

Social Housing Finance Model of Netherlands

The requirement of finance in the social housing sector in the Netherlands emerge with the housing associations which borrow loans for the production or buying of housing stock. This loan is provided by the banks at reduced interest rates. The reason for the reduced rates of interest is the presence of a mutual guarantee fund which guarantees the bank against any default on the loan by the housing associations. (Ouwehand 2002) This mutual guarantee fund reduces the risk of loss for the banks in the event of default on the part of borrower and thus results in the reduced rate of interests for the housing associations. What is more intriguing is to know that this mutual guarantee fund which acts as the backbone of housing finance in the Netherlands is a corpus created by the same housing associations through mutual contributions.[v] Since, this mutual guarantee fund is their own money, the chances of defaulting on the loans by the housing associations is further kept on a check. The lower rates of interest reduces the input cost of housing production for the housing associations making the social housing cheaper and affordable for the consumer. (Central Fund for Housing, 2012)

There are two sources of income for the housing associations, first is the rent they receive from the housing units and second is the rent they receive from the commercial space. The rent of the housing units is regulated by the government and is 512 euros. For the lower income households the rental subsidy is provided by the government. This subsidy is provided as per the household income and supplements the rent. The provision of rental subsidy by the government makes housing accessible to the lower income section of the society and also ensures the regular income of the housing associations.

Table 1: Netherlands Rental Housing Value Chain (Author)			
	Supply Side		***Demand Side***
Component of HVC	Planning and Regulations, Land Acquisition and Infrastructure development	Procuring Land, Securing Title and Obtaining building permits	Construction (Design, Material and Labour)	Disposal of Housing Stock
Actor	**Government**	**Housing Associations**		**Allocation Agency**
Finance	Compensation for Land Acquisition	Loan from Banks		Rental
Provision		Subsidised land cost + Low interest on bank loan due to Mutual Guarantee Fund	Low interest on bank loan due to Mutual Guarantee Fund	Rent regulated by the government + Rental Subsidy for low income household.
Benefit		Low input costs for the housing associations	Low input costs for the housing associations	Affordable rent. No maintenance cost. No additional cost towards stamp duty, tax etc as in the ownership model.

As mentioned earlier social housings are planned as mixed use development with commercial spaces on the ground floors and street edges. (Pic 1) These commercial spaces are rented out to the retail stores, grocery stores, salons, eateries and restaurants. On one hand these commercial spaces act as amenities for the residents of the housings and also people of the city, on the other hand they augment the income of the housing associations. Since, the social housings in Netherlands are located prominently in the city, the rental of these commercial spaces is significant.

Pic 1. Typical Built Character of Social Housing in Netherlands (Author 2019)

The increased income of the housing associations make them financially healthy and they are able to run the housings in a maintained state. Also, with additional income at their disposal, housing associations are able to payback the loan, pay applicable taxes and contribute to the mutual guarantee fund with ease. The taxes that the housing associations pay to the government is used to provide the rental subsidy and also fund the municipalities which provide infrastructure to the city enhancing the liveability of the social housings.

DISCUSSION

In Netherlands government plays the role of the facilitator in social housing finance. Contrary to many welfare states where governments act as the investor, producer and provider of the social housing, Netherlands government acts as an external agency. (Chiodelli, 2016)In this very distinctive arrangement the housing associations act as the service provider where they produce, provide and maintainthe social housing stock in return for the rental income. This model is similar to any service provider like mobile service providers where the company generates regular revenue by making one time capital investment. The social housing business benefits from the economy of scale where housing associations own thousands of units similar to large consumer base of mobile service providers. (Olsen, 1987)

In such positioning the housing associations function almost independently of the government. They procure finance from the banks for producing housing stock and then recover their investment through the rental income. As the housing associations are the owners of the properties and residents are tenants the social housing becomes an asset with a source of perpetual income for the housing associations. This income from the rent is regular and is not a one time return on the investment as it happens in the ownership model. For the housing associations their social housing stock is a source of income for indefinite period where the return on investment can be multiple times. To add to this the housing stock can be sold to another housing association or a private owner at any stage and capital investment can be recovered with a premium. (Fingleton, 2008)

There are many other benefits of this rental model of social housing. First, the housing associations produce good quality of housing for the reason that they own it and have to maintain it for long period to recover their investment. This is unlike the situation in countries where social housing is produced as a low cost construction and provided to the consumers, who experience the multiple quality related problems. Secondly, the price rise due to speculation as seen in the ownership model does not arise at all as the housing is not owned but rented by the consumers. The rent is regulated by the government preventing any arbitrary increase by the housing associations due to market forces. Further, the rental subsidy makes the housing accessible for the low income section of the society and also ensures recovery of investment for the housing associations.

The allotment of social housing is through an independent online system imparting transparency. Since the allotment is though a centralised system the chances of multiple occupancy or vacant units is eliminated. The allotment system also has gives preference to old age, immigrants and other needy sections of the society.

CONCLUSION

The general situation of social housing in the world is identified with low cost, low quality constructions usually on the outskirts of the city. Contrary to this the social housing of Netherlands is neither a low cost typology nor it is located on the fringe of the cities. So, the question arises how does the Netherlands achieved affordability of social housing by maintaining the quality. The answer lies in the housing finance model. (Hoek-Smit, 2015)
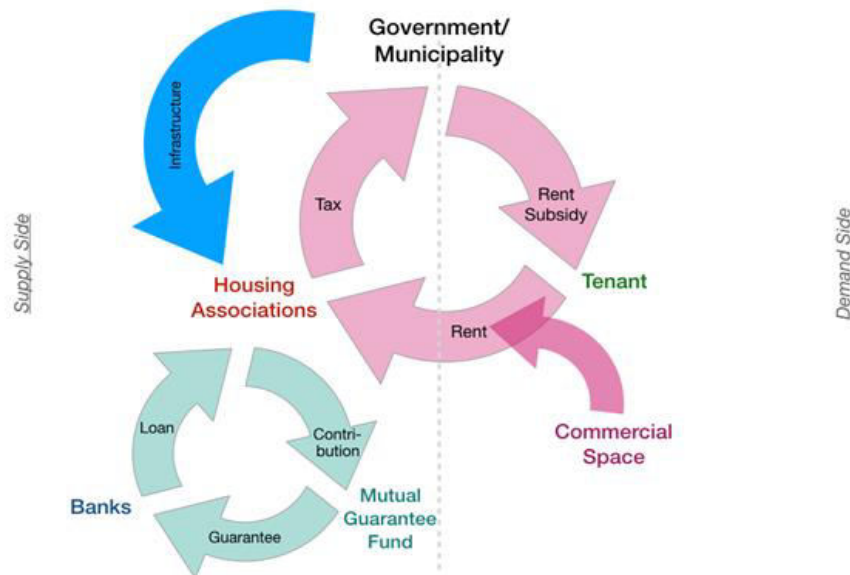
Pic 2. Diagram representing Housing Finance Model in Netherlands (Author)

The social housing finance model of the Netherlands is designed like a machine where several components works in tandem. (See Pic 2) Moreover, the overall system is financially secure where the investment are returned and loans are recovered in a cyclic manner. Since affordability of the housing is largely an economic function, a secure financial model reduces the chances of loss, consequently resulting in the overall affordability of the housing.

The good quality of social housing is also a bye-product of this financial model where the housing associations produce and maintain housings as per good standards since they own them and also generate rental revenue for an extended period of time. The housing finance model of the Netherlands has multiple benefits and has been time tested for more than a century, as a result the model should be adopted in the developing countries with major housing shortage.

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NOTES

[i] A very few units are also owned by the municipalities.

[ii] Netherlands was one of the few countries to enact law for providing housing.

[iii] These subsidised land, subsidised loan and tax benefits were discontinued in 2015 in return for writing off of housing associations debts, the housing associations.

[iv] The numbers of housing associations have come down in past decades due to mergers mainly. Housing associations with smaller number of units were acquired by the bigger housing associations making economy of scale. The numbers of social housings units are although remained constant, where the demolished housing units are replenished by newly constructed housings.

[v] In the initial phase of social housing in Netherlands the guarantee fund was a government fund which was discontinued in 1995 reforms. So, between 1901 to 1995 the government promoted the production of social housing by providing guarantee to the loans that the housing associations borrowed from the banks. By the year 1995 social housing stock was sufficiently produced and the housing associations were financially independent, so they were able to contribute to the creation of mutual guarantee fund.