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Editorial

Skill based education is the need of the hour. Students graduating from the educational institutions are in possession of qualifying certificates with less skills. The education system rather a classroom teaching practice in most of the educational institutions in India is to deliver the content available in the local books and making the students to learn. Many educational institutions follow the practice of giving a priority to theoretical knowledge than the practical knowledge with an objective to secure higher ranking to the institution. This is the same scenario in technical and other professional institutions too. A meritorious graduate may get an employment and sometimes not able to fare well in processional career due to lack of required skills in the domain.

It is a fact that there is a drastic increase in literacy rate in India, but the recent reports saying 20% of the technical graduates in India only are employable. This implies that there is a lack of the necessary skills and a huge gap between the skills required by the industry and the person in possession. In a highly competitive world, employers look for the candidates who possess the required skills rather than the candidates having more degrees with higher grades. In this context, the educational institutions need to get connected with various industries and create the opportunities to the students to acquire practical knowledge at every stage of their education to strengthen necessary skills so as to grow well in a chosen area. Lot many new technologies are emerging across the world, and there is a need that a person inculcates the required skills to use these technologies for a successful life. If one is failed to acquire such skills to use the latest technologies will remain as a back bencher.

There is a need to have a skill-based education system that helps the employers to easily absorb the suitable trained candidates. Hence, there is a need to bring up the students by educating them with more thrust or atleast equal weightage to practical knowledge than theoretical at every stage of their college level education.

The S. B. Jain Institute of Technology, Management & Research, Nagpur (Maharashtra) has organized a 2day International Conference on Advancement in Science, Technology and Management 2023 (ICASTM- 2023) and created a platform to invite the authors to share advances in technologies and their applications.

The editorial board of IJTE has shortlisted 51 papers of ICASTM- 2023 covering engineering, management and basic sciences to publish as September 2023 special issue. We believe that Vol. 46, September 2023 special issue of IJTE is interesting to the readers to enhance or update their knowledge.

New Delhi — Editor

30th September 2023

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Behavioural Analysis of Infectious Diseases in Two Main Age Groups using a Mathematical Approach

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ABSTRACT

In this study, we modify the S-I-R-M model for two major age groups of the total population: the aged group (which includes old adults ranging from 60 and above) and the youth group (this comprises young adults aged 18 to 25 years old, adults aged 26 to 44 years old, and middle-aged individuals aged 45 to 59 years old) and discussed the frequency of infection, rapidity of healing, mortality, and susceptibility in the case of infectious diseases like plague, flu, cholera, coronavirus, etc. For the various parameters and functions, computations have been suggested and given graphically. The specific S-I-R-M model scenarios for both age groups have been discussed.

KEYWORDS: *Infectious diseases, Susceptible, Infective,recovery, Mortality Mathematical Modelling.*

INTRODUCTION

For many years, the whole world has faced so many pandemic and epidemic conditions due to the spread of infectious diseases like plague, flu, cholera, tuberculosis, malaria, coronavirus, etc. According to the data collected by the World Health Organization, people with a high risk of developing severe cases of infectious diseases are found to be over the age of 60, and the highest mortality rate is found in people over the age of 80. In addition to older age groups, young people with chronic illnesses including diabetes, high blood pressure, kidney disease, or cancer are at increased risk of contracting infectious infections. From the available literature survey, it is found that around 9 % of diabetic patients died after contracting the virus, which spreads infection in many diseases. Also, around 8 % of people are victims of high blood pressure. Hence, from the available data, we believed that the age distribution of the population plays a pivotal role in describing disease behaviour and characteristics. Now there is a need to study the impact of infectious diseases on the two major age groups, namely young (those who are below and equal to 60 years) and old (those who are above 60 years), across the globe. Consequently, in order to avoid and limit the spread of infections, recovery, and mortality in the above-mentioned age range, it is necessary to prepare a mathematical model category-wise due to the suitability conditions.

Morens et al. [1] state that many infectious illnesses, such as cholera, malaria, and tuberculosis, have spread across large geographic areas, posing health problems for a sizeable section of the population. Oliveira [2] suggested that infectious organisms, such as the variola virus and Yersinia pestis, have the potential to be utilized as bioweapons and pose a threat to civilization. The flea-borne bacteria Yersinia pestis, which caused the Black Death, the third plague, and the Justinian plague, was discussed by Zietz and Dunkelberg [3]. According to Faruque et al. [4], Vibrio cholerae causes the acute, frequently deadly disease of the gastrointestinal tract known as cholera. Three years ago, early December 2019 in the Chinese city of Wuhan saw a rapid rise in the reports of numerous inexplicable symptoms including cough, weariness, fever, and pneumonia [5, 6]. The pathogen of these cases was determined by the World Health Organisation (W.H.O.) and Chinese health officials to be a group of a new type of virus known as Coronavirus on January 10, 2020 [7]. Numerous researchers examined the coronavirus's transmission dynamics and came to sound conclusions [8, 9].

In order to explore the impact of the S-I-R-M (young and old) model owing to the influence of conditions like immunity power, weather conditions, etc., the current research works with a general mathematical model of infectious diseases. By using Mathematica Software, the numerical calculations for young and old people have been examined in terms for infection pace, recovery pace, and death rate. Additionally, a few comparisons are depicted in the image to illustrate the specific S-I-R-M model situations, including the elderly and younger generations, and to estimate the influence of susceptible conditions.

Proposed Mathematical Model

Assume that represents the population of a certain nation, and that and represent the susceptible and infectious populations, respectively, at each point in time .

i.e. $S(t)+I(t)=N$

Furthermore, there is a chance that each sick person will spread the virus to a susceptible individual. The likelihood of contracting an illness varies from person to person, from society to society, as well as from country to country, based on their surroundings, culture, way of life, immune function, lack of knowledge about virus infection, and capacity for their age group. The frequency of new infections rises steadily as time (measured in days) changes and rises as well. In order to study the physical impact of infectious diseases on two major age groups, the numbers of susceptible and infectious diseases are further divided into two parts as follows:

$S(t)=S_y(t)+S_o(t),\ I(t)=I_y(t)+I_o(t),$

where $S_y(t)$ stands for the number of young susceptible whose age is less than and equal to 60 years and $S_o(t)$ for the number of young susceptible whose age is above than 60 years. Similarly $I_y(t)$ and $I_o(t)$ refers to young and old infective as the age taken in the case of susceptible respectively.

The S-I-S model (Young and Old)

One of the simplest epidemic models and one of the most realistic ways to simulate the spread of disease is the S-I-S model. As alreadydescribed, the overall population is split into those who are infectious and those who have exposure at any one time.

$$S(t)+I(t)=N \quad (1)$$

On differentiating equation (1) on both sides with respect to *t*, we get

$$\frac{dS}{dt}=-\frac{dI}{dt} \quad (2)$$

Further we have

$$S(t)=S_y(t)+S_o(t) \text{ and } I(t)=I_y(t)+I_o(t) \quad (3)$$

But with the consideration of the comparison purpose of two major age categories, equation (2) can be rewritten for the young and old populations as

$$\frac{dS_y}{dt}=-\frac{dI_y}{dt} \quad (4)$$

$$\frac{dS_o}{dt}=-\frac{dI_o}{dt} \quad (5)$$

The above equations (4) and (5) give the relationship between how the numbers of susceptible and infected people are changing over time according to age category, both young and old.

To make sense of the study, rather than considering raw numbers, proportions of infected and susceptible people are taken.

So, let the proportion of the young population that is infected be given as: $i_y(t)=\frac{I_y}{N}$

and the proportion of the young population who are susceptible is: $s_y(t)=\frac{S_y}{N}$

Similarly, the proportion of the old population thatis infected is given as: $i_o(t)=\frac{I_0}{N}$

and the proportion of the old population who are susceptible is: $s_o(t)=\frac{S_0}{N}$

here $i_y+s_y+i_o+s_o=1$

In the S-I-S model the rate of infection is defined as

Rate of infection in young =

c × (Proportion of young susceptible) × (Proportion of infected)

$$= c\, s_y(t)\, i(t) = c\, s_y\, i \qquad (6)$$

Similarly Rate of infection in old =

c × (Proportion of old susceptible) × (Proportion of infected)

$$= c\, s_o(t)\, i(t) = c\, s_o\, i \qquad (7)$$

The constant 'c' in equations (6) and (7) denotes the transmission rate, which is the average number of persons each infectious person (young or elderly) transfers the disease to each day.

So the equation can be written solely for every person (young or old) as

$$\frac{di_y}{dt} = c\, s_y\, i \qquad (8)$$

$$\frac{ds_y}{dt} = -c\, s_y\, i \qquad (9)$$

$$\frac{di_o}{dt} = c\, s_o\, i \qquad (10)$$

$$\frac{ds_o}{dt} = -c\, s_o\, i \qquad (11)$$

The S-I-R Model

The fundamental SIR-Model for the equations of a differential system is provided by the following, adopting Barnes and Fulford [10]:

$$\dot{I} = cSI - rI \qquad (12)$$

$$\dot{S} = -cSI \qquad (13)$$

$$\dot{R} = rI \qquad (14)$$

where "dot" stands for a time function derivative.

Here, the population can be further divided into three basic categories:

$I(t)$– Infective, $S(t)$– Susceptible, $R(t)$– Recovered,

clearly, $I(t) + S(t) + R(t) = N$.

The S-I-R model is altered by the addition of the age category as majorly young and old. Hence, the proposed **S-I-R model (young and old)** is given as:

Case 1: with uniform recovery rate

$$\left.\begin{aligned} \frac{dI_y}{dt} &= cS_yI - rI_y \\ \frac{dS_y}{dt} &= -cS_yI \\ \frac{dR_y}{dt} &= rI_y \end{aligned}\right\} \qquad (15)$$

$$\left.\begin{aligned} \frac{dI_o}{dt} &= cS_0I - rI_0 \\ \frac{dS_0}{dt} &= -cS_0I \\ \frac{dR_o}{dt} &= rI_o \end{aligned}\right\} \qquad (16)$$

Case II: with different recovery rate r_y in young's and r_o in old's

$$\left.\begin{aligned} \frac{dI_y}{dt} &= cS_yI - r_yI_y \\ \frac{dS_y}{dt} &= -cS_yI \\ \frac{dR_y}{dt} &= r_yI_y \end{aligned}\right\} \qquad (17)$$

$$\left.\begin{aligned} \frac{dI_o}{dt} &= cS_0I - r_oI_o \\ \frac{dS_0}{dt} &= -cS_0I \\ \frac{dR_o}{dt} &= r_oI_o \end{aligned}\right\} \qquad (18)$$

The S-I-R-M Model:

We rewrite the S-I-R model by considering mortality. The equations (12 to 14) can be written as

$$\dot{I} = cSI - rI - mI \qquad (19)$$

$$\dot{S} = -cSI \quad (20)$$

$$\dot{R} = rI \quad (21)$$

$$\dot{M} = mI \quad (22)$$

where "dot" stands for a time function derivative.

Here Population N can be further classified into major four broad classes as:

$I(t)$– Infective, $S(t)$– Susceptible, $R(t)$– Recovered, $M(t)$– Mortality

Clearly, $I(t) + S(t) + R(t) + M(t) = N$

S-I-R-M Model (Young and Old):

So with the consideration of age category, the S-I-R-M model is now proposed as the S-I-R-M model (young and old). Therefore, equations (19)–(22) can now be rewritten as

Case I: with different recovery (r_y in young's and r_o in old's) and mortality rate (m_y in young's and m_o in old's)

$$\left.\begin{aligned} \frac{dI_y}{dt} &= cS_yI - r_yI_y - m_yI_y \\ \frac{dS_y}{dt} &= -cS_yI \\ \frac{dR_y}{dt} &= r_yI_y \\ \frac{dM_y}{dt} &= m_yI_y \end{aligned}\right\} \quad (23)$$

$$\left.\begin{aligned} \frac{dI_o}{dt} &= cS_0I - r_oI_o - m_oI_o \\ \frac{dS_0}{dt} &= -cS_0I \\ \frac{dR_o}{dt} &= r_oI_o \\ \frac{dM_o}{dt} &= m_oI_o \end{aligned}\right\} \quad (24)$$

Case II: with different recovery rate (r_y in young's and r_o in old's) but mortality is only in old. For this case the above equations (23) and (24) can be rewritten by taking $M_y = 0$.

Numerical Analysis and Graphical Representation

As a case study, we constructed a mathematical model S-I-R-M for young and old people with infectious diseases under different parameters and functions. Using Mathematica software, the findings for the infective, recovered, and death rates for young as well as old age groups have been shown graphically.

Hypothetical Data: $N = 1000$, $c = 0.01$, $S_y = 749$, $S_o = 240$, $I_y(t=0) = 1$, $I_o(t=0) = 10$, $r_y = 0.90$, $r_O = 0.30$ $m_y = 0.001$ and $m_o = 0.010$.

The assumed data is based on the capacity of the infectious disease-spreading virus and subjected to its rate of transmission, recovery, and mortality.

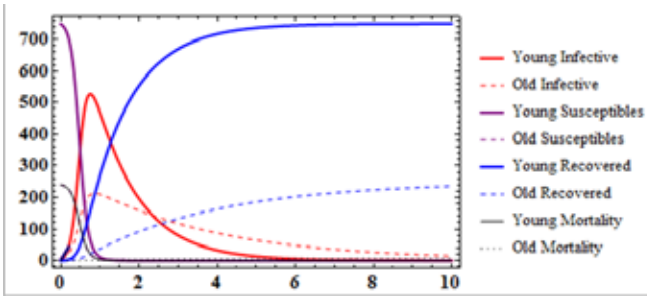

Fig. 1. Distribution of S-I-R-M model (Young & Old Age Groups)

OBSERVATION AND DISCUSSION

The above figure shows the variation of infective, susceptible, recovered, and mortality versus time in the older and younger groups. The following observations have been discussed:

- For young people, the rate of transmission of disease from person to another person goes on decreasing as compared to old people.
- •Younger people heal more quickly than older people do.
- The rate of mortality in young people is found to be lower than in old people.

Additionally, we noted the following from the graphic representation of the S-I-R-M (young and old) model:

- There is no recovery and no fatality rates in the

earliest stages of infection because of the slow infection rate.At this specific instance of the S-I-R-M (young and old) reduces to S-I-S (young and old).

- The chain of infection from one person to another fluctuates gradually over time, which causes the infection rate to rise with periodic probable recovery. In this case above model is a particular case of the S-I-R (young and old) model.

CONCLUSION

An infection, recovery, and death rates are quite low in young people. as compared to the elderly, whereas the mortality rate is a little higher in the elderly population because of low immunity and chronic diseases. It is also concluded that if the transmission rate is less than one, the rate of infection, recovery, and death rates in both age categories is under control to minimize the influence of infection in society. The results of our study's mathematical modelling indicate that the pandemic's path may rapidly shift in both the elderly and the young if adequate precautions are not taken or are done insufficiently.

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A New Prospective to Undamped Force of Vibration System Problems using Some Integral Transforms

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ABSTRACT

A new way of approaching to solve the physical system problems such as undamped force of vibration equation on a simple pendulum problem. In this paper we have revisited these problems by applying some integral transforms such as Ezaki transforms method (ETM) and Differential transforms method (DTM) demonstrating how effectively they are in the determination of the solutions.

KEYWORDS: *Physical system, Ezaki transform, Differential transform, Simple pendulum.*

INTRODUCTION

Since from last few decades the efforts have been made in the field of mathematics and physical sciences to apply some techniques to find the possible solutions for some physical system problems, further the development had made to analyse the such linear differential equations which we can apply in different areas of science and engineering. Some of the analysis was made and studied in the field of physical sciences and their applications. here some of the appropriate methods are adopted to get the different solutions such as Ezaki transform method (ETM) and Differential Transform method (DTM).These transform methods have been inspired towards researchers of physical and mathematical sciences and many research works have been taken places and research article were published in these fields.

Undamped force of vibrations

Whenever an external force is applied on a particular system continuously the vibration of that system never stop. This type of vibration also can be called as undamped force of vibration.

Examples: movement of laundry machine due to asymmetry, vibration of a moving transport due to its engine. movements of strings in guitar.

Consider undamped forced vibrations of spring given by the differential equation is.

Undamped force vibration of spring

Consider the undamped force vibrations of spring given by the differential equation is,

$$m\frac{d^2y}{dt^2}+k\,y(t)=f(t) \qquad (1)$$

In this paper we will consider our choice the forcing function as $f(t) = (1\text{-}\sin t)$, m=1kg, k=1N/m, with initial values y(0) = y'(0) = 0 then equation (1) and it gives us,

$$\frac{d^2y}{dt^2}+y(t)=(1-\sin t) \qquad (2)$$

Basics definition

The Ezaki transform of the function f(t) for t > 0 , can be defined as

$$E[f(t)]=v\int_0^\infty e^{-\frac{t}{v}}\,f(t)\,dt=T(v).$$

The Differential transform of a function f(t) is given by

$$F(k)=\frac{1}{k!}\left[\frac{d^k}{dt^k}f(t)\right]_{t=0}$$

Main results

Applying both sides Ezaki transform method (ETM)

Consider the equation (2) and applying both sides Ezaki Transform

$$E[y''(t)]+E[y(t)]=E[1]-E[\sin t]$$

$$\left[\frac{Y(v)}{v^2}-y(0)-v\,y'(0)\right]+Y(v)=v^2-\frac{v^3}{1+v^2}$$

Since y(0)=y'(0)=0. And applying both sides Ezaki inverse transform.

We get

$$y(t)=1-\cos t-\frac{1}{2}[\sin t-t\cos t] \qquad (4)$$

Now applying the Differential transform method (DTM) both the side for equation (2)

$$(k+1)((k+2)y(k+2)+y(k)=1-\frac{1}{k!}\sin\left(\frac{k\pi}{2}\right)$$

$$y(k+2)=\frac{1-\frac{1}{k!}\sin\left(\frac{k\pi}{2}\right)-y(k)}{(k+1)(k+2)}$$

$$\text{Put k=0}\quad y(2)=\frac{1-\frac{1}{0!}\sin(0)-y(0)}{(1)(2)}=\frac{1}{2}$$

$$\text{Put k=1}\quad y(3)=\frac{1-\frac{1}{1!}\sin(\pi/2)-y(1)}{(2)(3)}=\frac{1}{6}$$

$$\text{Put k=2}\quad y(4)=\frac{1-\frac{1}{2!}\sin(\pi)-y(2)}{(3)(4)}=\frac{1}{24}$$

$$\text{Put k=3}\quad y(5)=\frac{1-\frac{1}{3!}\sin(\frac{3\pi}{2})-y(3)}{(4)(5)}=\frac{1}{20}$$

$$\text{Put k=4}\quad y(6)=\frac{1-\frac{1}{4!}\sin\left(\frac{4\pi}{2}\right)-y(4)}{(5)(6)}=\frac{23}{480}\ \text{and so on}$$

Let us consider the solution is of the form

$$y(t)=\sum_{k=0}^{\infty}y(k)t^k$$

$$y(t)=y(0)t^0+y(1)t+y(2)t^2+y(3)t^3+y(4)t^4+y(5)t^5+ \qquad (6)$$

Substituting the different values of y we get

$$y(t)=t+\frac{t^2}{2}+\frac{t^3}{6}+\frac{t^4}{24}+\frac{t^5}{20}+\frac{23}{480}t^6+ \qquad (7)$$

Table 1 : The value different values of y(t) using Differential transform method and Ezaki Transform method

t	DTM	ETM	Absolute Error
0	0	0.5	0.5
0.1	0.1053380021	0.1252658210	-0.0203202079
0.2	0.2227494667	0.2585658212	-0.0358163545
0.3	0.3544605181	0.2853691211	0.0690911397
0.4	0.5029205333	0.4582025833	0.0447179512
0.5	0.6705658854	0.5268425123	0.1421407621
0.6	0.8613852012	0.8212550121	0.0792597101
0.7	1.0779861021	1.0526158412	0.0253702609
0.8	1.324663471	1.2512368401	0.0734266306
0.9	1.605969169	1.4581252584	0.1478433291
1	1.927083333	1.9202581223	0.00068525077

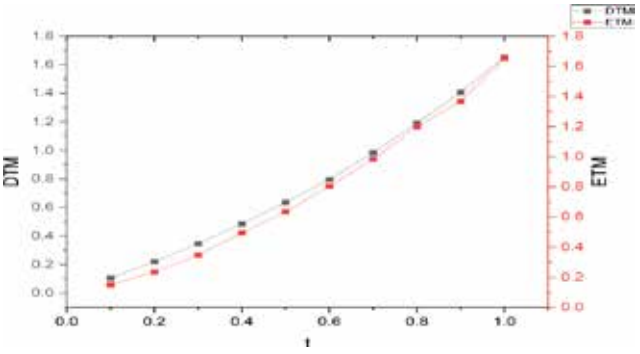

Figure 1: Comparisons for DTM, and ETM for different mesh points for undamped force of vibration problem

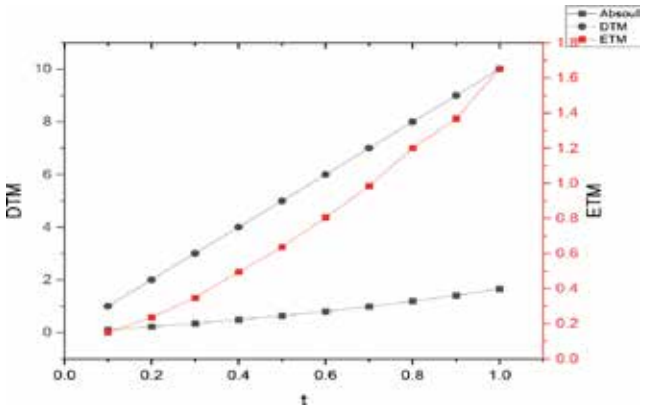

Figure 2: Comparisons for DTM, and ETM for different mesh points with respect to absolute error for undamped force of vibration problem

Conclusion: The main basic motive of this work is to implement the given transformations to linear non homogeneous differential equations which are occurring in the field of engineering, applied sciences and other physical systems .The methods which are proposed here are two transformations they are ETM and DTM and comparative study has been shown graphically.

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Modified Differential Evolution Algorithm for Engineering Design Optimization

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ABSTRACT

Differential evolution (DE) is broadly used for various optimization issues, amongst a lot of evolutionary methods (EMs). But, it has few weaknesses like untimely convergence, maintenance of diversity etc. Similarly, mutation and its control factor choice for DE are extremely inspiring for enhanced optimization. To increase the DE exploration competence, a modified DE (mDE) is projected in this paper. It implemented a new mutation system, thru the perception of particle swarm optimization, to balance population diversity. Meanwhile, focused on time-varying structure, new mutant control parameters incorporated with the suggested mutation scheme, to escaping local optima. Using the features of retention and robustly altered control parameters, exploitation and exploration ability of mDE is well-adjusted. Finally, six engineering optimization problem solved, to verify effectiveness of the mDE. Performance of mDE compared with different peer algorithms. According the investigational results, efficiency of suggested mDE technique has been confirmed.

KEYWORDS: *Evolutionary algorithm, Differential evolution, Engineering optimization, Mutation.*

INTRODUCTION

Presently, huge amounts of evolutionary methods (EMs) are offered to solve engineering design optimization problems [1]. Between several EMs, differential evolution (DE) is ultimate widespread optimizers since its initiation in 1995 [2]. It has competence to solve multifaceted optimization issues, due to its easy implementation. Equally, it attained evident improvement in the past two years, owing to its search capacity and proficiency [3]. Besides, the DE effectively applied in several real-life problems, for example power system [4], neural system [5], image analysis [6], chemical manufacturing [7] etc. Conversely, at the time of solving multifaceted optimization problem, the DE faces certain disadvantages for instance stagnation i.e. to escape from local minima [8]. Respectively, DE has no possibility to solve all optimization problems efficiently [9].

Henceforth, various innovative DE reforms have been advocated in the literature to increase the DE presentation [10, 11, 12, 13]. But, most of the DE variants still face the stagnation problem and provide poor results for complex optimization issues [14, 15, 16]. It happens due to selection of DE mutation and control factors schemes. Hence, various mutation and control factors for DE projected by scholars [17, 18]. Furthermore, synergy of DE and PSO (particle swarm optimization) [19] techniques improves the search performance of the DE [20, 21, 22, 23]. Up-to-date various DE and its hybrids variants suggested for solving complex optimization issues. But they are unable to provide best outcome and falls into local minima; due to unable to used earlier best outcomes [24, 25, 26].

Stimulated by the above literature study and PSO method, in this article a modified DE (mDE) is suggested. It has an innovative mutation scheme, using the perception

of PSO, to trade off the exploration and exploitation. Also, novel time-varying mutant control parameters incorporated with the suggested mutation scheme, to escaping local optima. Using the features of retention and robustly altered control parameters, exploitation and exploration ability of mDE is well-adjusted. Also, admitted features of mDE algorithm follows better convergence speed. Finally, to verify the effectiveness of mDE, six engineering design optimization issues are solved. Presentation of mDE equated with different methods. The experimental results of mDE are better than other compared methods which confirm its efficiency and ability to solve engineering design optimization issues.

The article rest part is prepared as - Section 2 delivers elementary DE outline. Facts of the offered mDE are demonstrated in Section 3. Results and discussions displays in Section 4. And Section 5 present conclusion of the whole article and future plans.

ELEMENTARY DE OUTLINE

DE is a population established stochastic optimizer. It has similar steps with other evolution methods (EMs), namely initialization, mutation, crossover & selection. In each cycle mutation, crossover to selection operator used in the evolution process and form new solution vectors. Mutation, crossover and selection cycles are repeated up-to predefined stopping conditions. Following are the implementation steps of the classic DE.

1st Step: Initialization

Aimed at -dimensional problem optimization, a group of random sampling points (target vectors) $x_{i,j}^t = (x_{i,1}, x_{i,2}, \dots, x_{i,D}) \quad i = 1, 2, \dots, NP$ and $j = 1, 2, \dots, D$ called the population initialization population size and - dimension) is generated randomly in specified limits, at 't^{th}' iteration.

2nd step: Mutation

$v_{i,j}^t = (v_{i,1}, v_{i,2}, \dots, v_{i,D})$ called mutant vector is formed as

$$v_{i,j}^t = x_{r_1}^t + F \times (x_{r_2}^t - x_{r_3}^t) \quad (1)$$

where

x_{r_1}, x_{r_2} and $x_{r_3} \in [1, NP], r_1 \neq r_2 \neq r_3 \neq i$ and $F \in [0, 1]$ is specified as mutant factor.

3rd step: Crossover

$u_{i,j}^t = (u_{i,1}, u_{i,2}, \dots, u_{i,D})$ called trial vector is formed as -

$$u_{i,j}^t = \begin{cases} v_{i,j}^t; \text{ if } rnd \leq CR \\ x_{i,j}^t; \text{ Otherwise} \end{cases} \quad (2)$$

where = uniformly random number spread among 0 and CR ∈ [0,1] is indicated as crossover constant.

4th step: Selection

It is formed as -

$$x_{i,j}^{t+1} = \begin{cases} u_{i,j}^t; \text{ if } f(u_{i,j}^t) \leq f(x_{i,j}^t) \\ x_{i,j}^t; \text{ Otherwise} \end{cases} \quad (3)$$

5th step: Stopping

Repeats II-V else stopped as per criteria of termination.

OFFERED MODIFIED DE (MDE)

Following are observation from the literature survey (research gaps).

(i). $v_{i,j}^t = x_{r_1}^t + F \times (x_{r_2}^t - x_{r_3}^t)$ is extensively used mutation scheme and effectively balanced population diversity [2, 27]. In contrast, it has slow convergence rate [27].

(ii) $v_{i,j}^t = x_{r_1}^t + F \times (x_{r_2}^t - x_{r_3}^t) + F \times (x_{r_4}^t - x_{r_5}^t)$ has enhanced perturbation than $v_{i,j}^t = x_{r_1}^t + F \times (x_{r_2}^t - x_{r_3}^t)$. But, it may fail to provide exploitation facility during the search evolution [28].

(iii) $v_{i,j}^t = x_{best} + F \times (x_{r_1}^t - x_{r_2}^t) + F \times (x_{r_3}^t - x_{r_4}^t)$, $v_{i,j}^t = x_{i,j}^t + F \times (x_{r_1}^t - x_{r_2}^t)$ and $v_{i,j}^t = x_{i,j}^t + F \times (x_{best} - x_{i,j}^t) + F \times (x_{r_1}^t - x_{r_2}^t)$ has better exploitation ability. But, they have low exploration capability when solving multimodal optimization problems [28].

exploration capability when solving multimodal optimization problems [28].

(iv). Various mutation schemes presented in the literature [29], to decrease the DE disadvantages. Bur,

want essential refinement to enhance the DE search capability [30].

(v). DE might be not stanching the previous best memory/vector information in the evolution process. Hence, it may loss of the best vectors and leads to premature convergence [31].

Encouraged by above stated and literature investigation, a modified DE (mDE) presented in this article, to overcome DE disadvantages. Advised mDE steps are presented as follows.

1st step: Initialization

NP size initial poputational generated randomly by using following equations in mDE.

$$x_{i,j}^{t} = x_i^{min} + rnd(0,1)\left(x_i^{max} - x_i^{min}\right) \quad (4)$$

where i = 1,..., NP, j = 1, ..., D, t iteration number, x_i^{min} & x_i^{max} = minimum and maximum value of i^{th} variable.

2nd step: Mutation

Using the concept of PSO [29], $v_{i,j}^{t}$ i.e. mutation vector created as follows.

$$v_{i,j}^{t} = x_{i,j}^{t} + F_1 \times \left(xbest_{i,j}^{t} - x_{i,j}^{t}\right) + F_2 \times \left(xbetter_j^{t} - x_{i,j}^{t}\right) + F_3 \times \left(xworst_j^{t} - x_{i,j}^{t}\right) \quad (5)$$

where $xbest_{i,j}^{t}$ = best vectors, $xbetter_j^{t}$ = better vectors, and $xworst_j^{t}$ = worst vectors. These vectors are restructured as follows.

$$xbest_{i,j}^{t} = \begin{cases} x_{i,j}^{t} & ;\text{if } f\left(x_{i,j}^{t}\right) < f\left(xbest_{i,j}^{t-1}\right) \\ xbest_{i,j}^{t-1} & ;\text{if } f\left(x_{i,j}^{t}\right) \geq f\left(xbest_{i,j}^{t-1}\right) \end{cases}$$

$$xbetter_j^{t} = \text{minimum}\left\{xbest_{i,j}^{t}\right\} \;\&\; xworst_j^{t} = \text{maximum}\left\{xbest_{i,j}^{t}\right\}$$

Moreover, F_1, F_2, & F_3 are the novel control parameters defined as follows.

$$F_1 = \left(t - 1/t_{max} - 1\right) \times F_{1,\text{initial}} - \left(F_{1,\text{final}} - F_{1,\text{initial}}\right)$$
$$F_2 = \left(t - 1/t_{max} - 1\right) \times F_{2,\text{initial}} - \left(F_{2,\text{final}} - F_{2,\text{initial}}\right)$$
$$F_3 = \left(1 - \exp(F_2 \times t)\right) \times F_1$$

where t_{max} and t = maximum and current iteration/ generation number.

Moreover, mutant factors (F_1, F_2, & F_3) have the subsequent quality, throughout the search procedure.

(i). initiate with big value and gradually falls to a small value, while initiate with small value and gradually upturns to a large value. In earlier period, large and small values are allowed vectors to travel freely over search space, instead of affecting to the population's finest. Likewise, small and large values are endorsed vectors to touch the overall best, in later period.

(ii). quickly upsurge in earlier period then gradually shrinkage in latter period. It supports the vectors to find suitable direction and better movement position.

After an wide study, $F_{1,\text{initial}} = F_{2,\text{final}} = F_{2,\text{initial}} = 0.5$, are fixed for mDE for entire experiments. Variation of F_1, F_2, & F_3 and according to iteration number are depicted in Fig. 1.

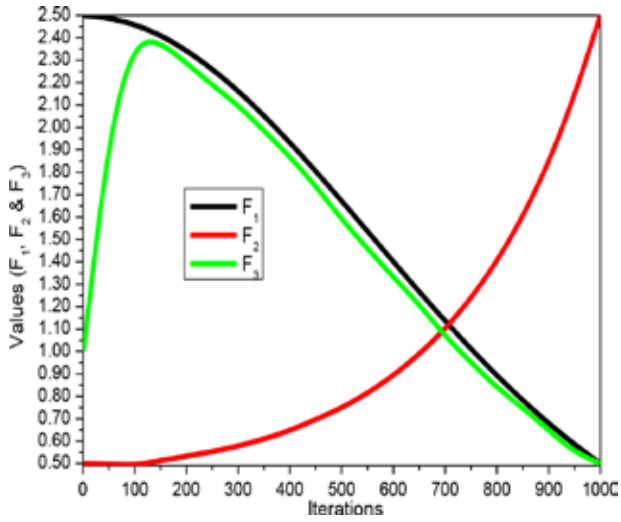

Fig. 1. Variation of F_1, F_2, & F_3 as per iteration number

3rd step: Crossover

Recombines mutant ($v_{i,j}^{t}$) and target ($x_{i,j}^{t}$) vector to create trail ($u_{i,j}^{t}$) vector as follows.

$$u_{i,j}^{t} = \begin{cases} v_{i,j}^{t}; \text{if } rnd(0,1) \leq CR \\ x_{i,j}^{t}; \text{if } rnd(0,1) > CR \end{cases} \quad (6)$$

where ( ) = random number among 0 & 1, = crossover rate.

4th step: Selection

A greedy selection scheme used in mDE i.e. if $u_{i,j}^{t}$ has better or equal function values than it used for next iteration otherwise $x_{i,j}^{t}$ will used for the next iteration. It works as follows mathematically.

$$x_{i,j}^{t+1} = \begin{cases} u_{i,j}^{t}\ ; \text{ if } f(u_{i,j}^{t}) \le f(x_{i,j}^{t}) \\ x_{i,j}^{t}\ ; \text{ if } f(u_{i,j}^{t}) > f(x_{i,j}^{t}) \end{cases} \quad (7)$$

5th step: Stopping

Repeat step II – V, else stop as per specified stopping criteria such as t_{max} (maximum iterations)

RESULT AND DISCUSSION

Competence of developed mDE is thoroughly checked in 6 engineering design optimization issues (EDOIs). Particulars of these EDOIs with objective minimization/ maximization (Min/Max)specified as below.

EDOI -1: Gas transmission design [32]

$$\text{Min } F(x) = 8.61 * 10^5 \times x_1^{1/2} * x_2 * x_3^{-2/3}(x_2^2 - 1)^{-1/2} + 3.69 * 10^4 * x_3 + 7.72 * 10^8 * x_1^{-1} * x_2^{0.219} - 765.43 * 10^6 \times x_1$$
$$\text{s.t. - } 55 \ge x_1 \ge 10, 2 \ge x_2 \ge 1.1, 40 \ge x_3 \ge 10$$

EDOI -2: Optimal capacity of gas production facilities [32]

$$\text{Min } F(x) = 61.8 + 5.72 * x_1 + 0.2623[(40 - x_1)ln(x_2/200)]^{-0.85} + 0.087(40 - x_1)ln(x_2/200) + 700.23 * x_2^{-0.75}$$
$$\text{s.t. - } 40 \ge x_1 \ge 17.5, 600 \ge x_2 \ge 300$$

EDOI -3: Gear train design [33]

$$\text{Min } F(x) = (1/6.931 - T_d T_b / T_a T_f)^2 = (1/6.931 - x_1 x_2 / x_3 x_4)^2$$
$$\text{s.t. - } 60 \ge x_1, x_2, x_3, x_4 \ge 12$$

EDOI -4: Optimal thermohydraulic performance of an artificially roughened air heater [34]

$$\text{Max } F(x) = 5.5 - 0.1RM - GH + 2.51 * ln e^+$$
$$\text{where } RM = 0.95 * x_2^{0.53}, GH = 4.5(e^+)^{0.28}(0.7)^{0.57}, e^+ = x_1 * x_3(\bar{f}/2)^{1/2},$$
$$\bar{f} = [0.079x_3^{-0.25} + 2(0.95x_3^{0.53} + 2.5 * ln(1/2x_1)^2 - 3.75)^{-2}]/2$$
$$\text{s.t. - } 0.8 \ge x_1 \ge 0.02, 40 \ge x_2 \ge 10, 20000 \ge x_3 \ge 3000.$$

EDOI -5: Frequency modulation sound parameter identification [35]

$$\text{Min } F(x) = \sum_{t=0}^{100}(y(t) - y_0(t))^2$$
$$\text{where } y(t) = a_1 \sin(\omega_1 t\theta + a_2 \sin(\omega_2 t\theta + a_3 \sin(\omega_3 t\theta)))$$
$$y_0(t) = 1.0 \sin(5t\theta + 1.5 \sin(4.8t\theta + 2 \sin(4.9t\theta))), \theta = 2\pi/100$$
$$\text{s.t. - } 6.35 \ge a_i, \omega_i \ge -6.4, i = 1, 2, 3.$$

EDOI -6: Spread spectrum radar poly-phase code [36]

$$\text{Min } F(x) = \max\{f_1(x), \dots, f_{2m}(x)\}$$
$$\text{where } x = \{(x_1, \dots, x_n) \in R^n : 0 \le x_j \le 2\pi, j = 1, 2, \dots, n\} \text{ and } m = 2n - 1,$$
$$f_{2i-1}(x) = \sum_{j=1}^{n} \cos\left(\sum_{k=|2i-j-1|+1}^{j} x_k\right), i = 1, 2, \dots, n;$$
$$f_{2i}(x) = 0.5 + \sum_{j=i+1}^{n} \cos\left(\sum_{k=|2i-j|+1}^{j} x_k\right), i = 1, 2, \dots, n-1;$$
$$f_{m+i}(X) = -f_i(x), i = 1, 2, \dots, m.$$

Simulation outcomes experimented on Core(TM) Intel(R) i7-7200U CPU, 2.50GHz, 16GB RAM, MATLAB R2021a software with Windows 10 (64-bit) operating system. To conduct a fair evaluation- 30 population size, 240000 maximum numbers of function evaluations and 30 trail runs set for developed mDE on EDOIs which is same as comparative methods. The other parameter settings of mDE mentioned in above section and other methods can be found in the respective papers. The boldface in each table reveals the best results. The experimental results of developed mDE with the other methods presented as follows.

The experimental results of developed mDE on 6 EDOIs equated with DE [2], PSO [23] and PSODE [37]. Mean (mn) and standard deviation (std) over 30 trail runs of these methods describedin Table 1. It could be noticed that from table 1 – for EDOI-1 and EDOI-2 proposed mDE produce same results with others, but for the rest three EDOIs suggested mDE yield best optimal solutions compared with other methods. Hence, it can be said that projected mDE reaches the best solution in all EDOIs. Also, it should be noticed that from this table, most of the std of mDE is less compared to others, which illustrate that its solution stability.

Table 1. Comparisons results on 6 EDOIs

EDOIs	Ideals	mDE	PSODE	PSO	DE
EDOI-1	mn	**2.9610E+06**	**2.9610E+06**	**2.9610E+06**	**2.9610E+06**
	std	**0**	2.20E-09	4.61E-02	2.60E-10
EDOI-2	mn	**1.6924E+02**	**1.6924E+02**	**1.6924E+02**	**1.6924E+02**
	std	**0**	1.11E-13	1.14E-10	2.11E-12
EDOI-3	mn	**1.3968E-12**	1.4021E-10	1.4321E-06	1.1609E-08
	std	**1.02E-12**	2.30E-12	2.01E-02	3.52E-08
EDOI-4	mn	**2.1709E-06**	2.3102E-06	4.2647Ee-01	3.2101E-02
	std	**1.04E-10**	1.21E-06	2.62E-01	5.01E-06
EDOI-5	mn	**2.045471**	2.58574	9.75124	3.0152
	std	**3.01E-02**	3.30	6.61	4.61E-01
EDOI-6	mn	**0.3**	0.35021	0.6	0.42042
	std	**1.02E-02**	1.16E-02	1.61E-01	1.20E-01

Furthermore, to measure the significance of experimental results of mDE with others CPU time (s) and nFEs (function evaluations numbers) considered on 6 EDOIs and reported in Table 2. This table shows that proposed mDE has less CPU time (s) and number of function evaluations on each EDOI compared to others. It illustrates that mDE has best convergence ability and higher reliability with others. Finally, the Friedman's ranking test [26] testified on all associated algorithms

on 6 EDOIs and results designated in Table 3. It shows that, projected mDE reaches the top ranking.

Table 2. The statistical results for mDE vs other algorithms in terms of CPU time (s) (nFEs)

EDOIs	mDE	PSODE	PSO	DE
EDOI-1	**10.2 (12000)**	15.2 (21000)	28.2 (26000)	25.2 (24000)
EDOI-2	**10.2 (8000)**	10.5 (10000)	21.1 (18000)	10.2 (16000)
EDOI-3	**10.1 (20000)**	11.2 (28000)	27.8 (34000)	28.0 (32000)
EDOI-4	**10 (18000)**	13.2 (20000)	18.5 (28000)	15.2 (24000)
EDOI-5	**15.8 (80000)**	16.2 (100000)	30.2 (115000)	28.0 (104000)
EDOI-6	**16.04 (180000)**	19.2 (200000)	30.5 (240000)	28.1 (204000)

Table 3. Average ranking of different algorithms

Ranking	Algorithms
1.19	**mDE**
1.42	PSODE
5.53	PSO
3.76	DE

Moreover, to analyse the convergence results of mDE, convergence curve is used in this section. It reflects the speed and convergence accuracy of projected and other methods. The convergence curves of developed mDE with other methods on 6 EDOIs displayed in Fig. 2, Fig. 3, Fig. 4, Fig. 5, Fig. 6, and Fig. 7 separately. In these figures, number of iterations is applied in x- axis and objective function values gained from each method on same population/seed are used in y- axis. From these figures, it can be supposed that mDE has quicker convergence with better accuracy in most cases. Hence, it can be said that projected mDE has capability to jump out from the local optima effectively.

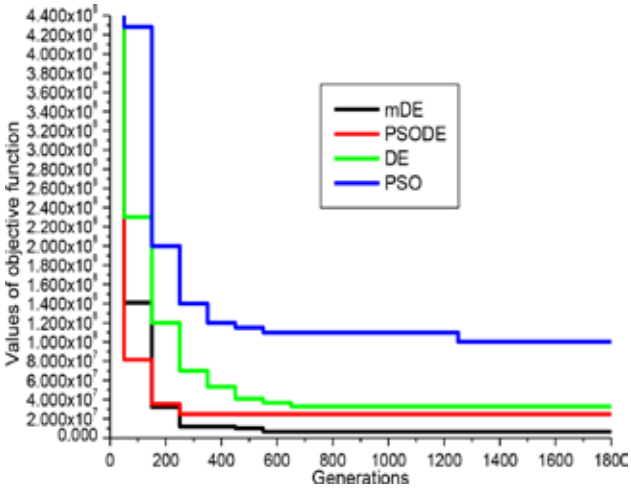

Fig. 2. EDOI-1 convergence graph

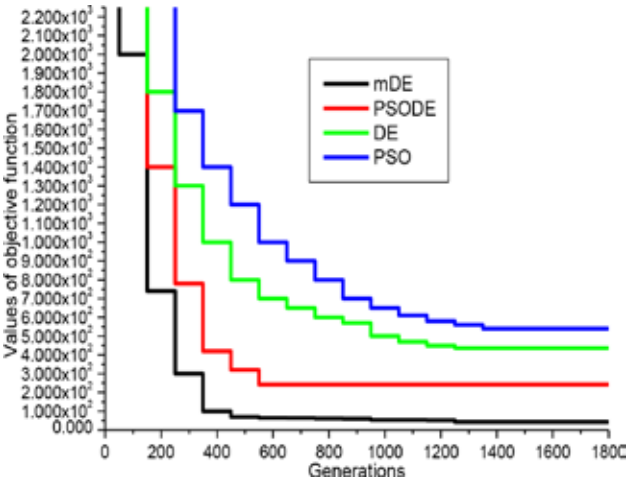

Fig. 3. EDOI-2 convergence graph

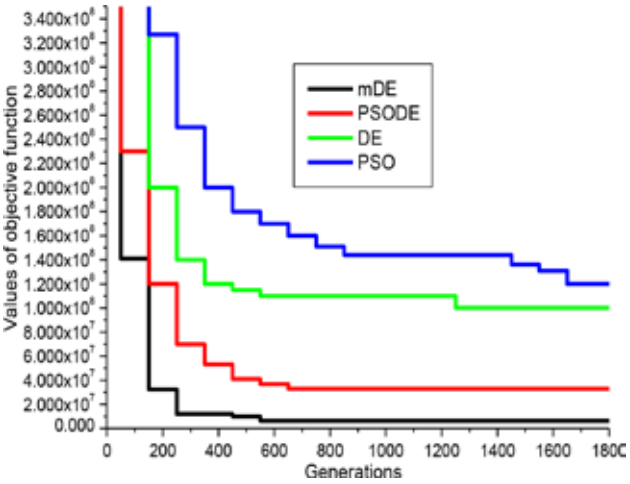

Fig. 4. EDOI-3 convergence graph

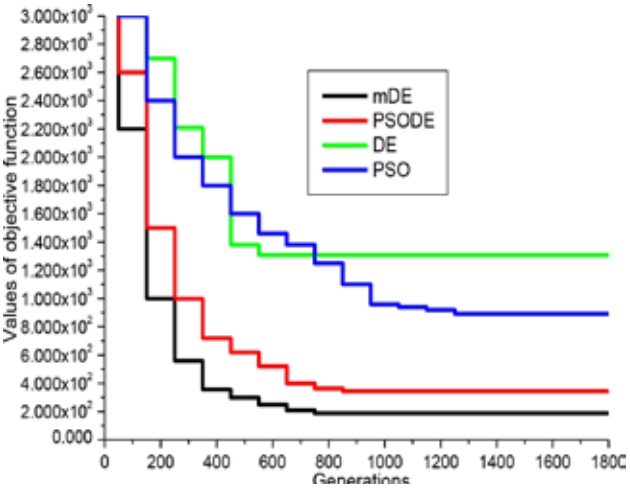

Fig. 5. EDOI-4 convergence graph

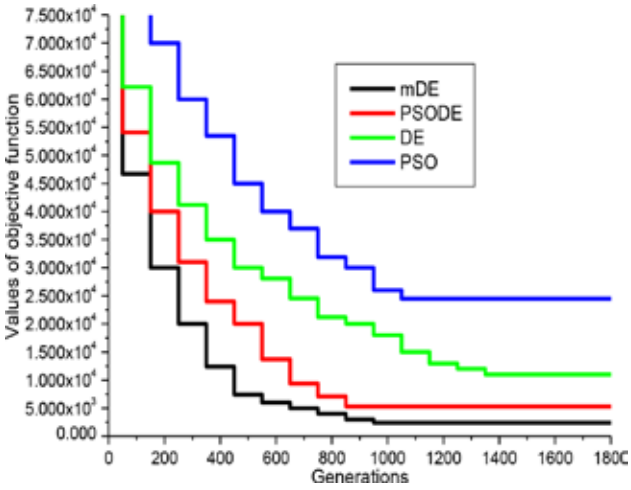

Fig. 6. EDOI-5 convergence graph

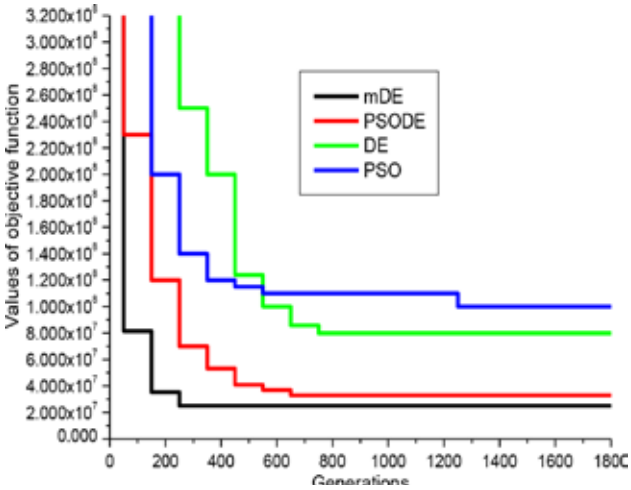

Fig.7. EDOI-6 convergence graph

CONCLUSION AND FUTURE PLANS

In this article, a modified differential evolution (mDE) is projected for solving engineering optimization issues. It implemented a new mutation scheme, based on the perception of PSO, which balance population diversity. Also, new time-varying mutant control parameters incorporated with suggested mutation scheme, which helps individuals to escaping from local optima. Using the features of new mutation and robustly altered control parameters, exploitation and exploration ability of mDE is well-adjusted. Also, admitted features of mDE algorithm follows to speeding up convergence efficiently.

The mDE performance has been tested on six engineering design optimization problems. The experimental outcomes achieved by mDE equated with DE, PSO, and PSODE. Suggested mDE obtained better results on all engineering design optimization issues, due to its new mutation and controlling factors strategies. Hence, advised mDE is an active alternative of DE for solving engineering design optimization issues. Suggested mDE may be used for complex real-world optimization issues, in future.

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A Study of Fractional Heat Transfer in A Generalized Two-Dimensional Thermally Elastic Problem

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ABSTRACT

In this article, an attempt has been made to analyse the exact thermoelastic response of a generalised infinite-length problem in two dimensions, which is under the action of a periodic varying source of heat with one relaxation time. The basic heat equation involves a fractional Caputo-like temporal derivative. Initially, the medium is assumed to be quiescent and subjected to traction-free boundary conditions. The entire solution of temperature distribution, displacement function and stress is evaluated in the Laplace transformation domain, and its numerical inversion is performed using the Gaver-Stehfast algorithm. For A numerical investigation is done by considering copper material properties and showing them graphically with discussion.

KEYWORDS: *Fractional response, Infinite space, Source of heat, Integral transformation.*

INTRODUCTION

Physical processes taking place at the microscopic level should be taken into account because the conventional Fourier law and parabolic heat conduction equations are no longer accurate enough. As a result, nonclassical theories are developed, replacing the Fourier law and the parabolic heat conduction equation with more comprehensive equations. Fractional thermoelasticity, or thermoelasticity based on the heat conduction equation with differential operators of fractional order, is the primary objective of this article. Memorization effects are described by a heat equation with time-fractional differential operators. The fractional calculus has been applied effectively in fields such as physics, geology, chemistry, rheology, engineering, bioengineering, robotics, etc.

Maxwell [1] in the dynamic study of gases first investigated the finite velocities of heat distribution, i.e., hyperbolic form. Lord and Shulman [2] expressed the waveform thermal heat equation with relaxation time as well as presented the standard heat law by replacing the modified Fourier law. Povstenko [3-5] studied the equation of heat conduction with derivatives of fractional order and calculated the corresponding thermal stresses. Zenkour [6–9] discussed generalised thermoelastic problems under thermal shock with various boundary conditions and explained multi-phase lag theory for plane wave propagation. Lamba [10] determines the stress function in a temperature-dependent FGM cylinder by the integral transform method. Green and Lindsay [11] presented an alternative generalization of existing classical thermoelastic theory, and this theory allows a second sound effect. Green and Naghdi [12] study the thermoelastic behaviour of materials without energy dissipation for both linear and nonlinear theories; they also prove the uniqueness theorem, which is appropriate for linear thermoelasticity. Ezzat [13] investigated bio-thermo-mechanics behaviour in living tissue based on fractional thermo-viscoelasticity with two types of thermal loading by utilizing Kirchhoff and Laplace transformation techniques. Kamdi et al. [14] studied the thermoelastic problem on a thin rectangular plate with known boundary conditions and used integral transform methods to obtain the temperature and stress functions, which are depicted graphically. Kumar et

al. [15] discuss problems that depend on the concept of generalised thermal stresses in the case of a thick circular plate with the consideration of dual phase lag and two temperature functions. Abbas and Youssef [16] studied a 2D thermal problem for a porous material with one relaxation time under the consideration of fraction order derivatives and used the eigenvalue approach to simplify the coupled thermoelastic equations.

Santra et al. [17] considered a half-space three-dimensional thermoelastic problem with fractional derivative subjected to a heat source and evaluated thermal stresses by using the normal mode and eigenvalue approaches, as well as illustrating all the obtained results graphically. Gupta and Das [18] considered an unbounded transversely isotropic medium with a fractional derivative subjected to an instantaneous heat source and evaluated the general solution for the thermoelastic deformation using the eigenvalue approach and Laplace transform, as well as showing the result graphically. Gaurav and Kulkarni [19] investigated the bounded spherical region for generalised two-temperature fractional theory, obtained an analytical solution of thermal variations in the Laplace domain, and discussed the stability of the assumed problem. Gaikwad and Naner [20] studied the thermoelastic temperature and thermal distribution of a thin circular plate for uniform internal heat generation, and the results were evaluated using the integral transform method. Povstenko and Kyrylych [21] studied the fractional thermoelasticity in an infinite isotropic plane with a line crack exposed to heat flux loading and obtained the solution of the heat equation using the integral transform technique. Youssef and Eman [22] successfully studied the Fractional Order Generalized Thermoelastic Half-space Subjected to Ramp-type Heating. Lamba and Deshmukh [27, 28] and Verma et al. [29] Studied the hygrothermal effect in cylindrical body in both coupling and decoupling cases.

The present work is devoted to determining the thermal behaviour of a generalised infinite-length problem in two dimensions that is under the action of a periodic varying source of heat with one relaxation time. The basic heat equation assumes a Caputo order fractional time derivative. At first, the medium is considered to be at rest and subject to limiting conditions without traction. The entire solution of temperature distribution, displacement function, and stresses is evaluated in the Laplace transform domain, and its numerical inversion is done using the Gaver-Stehfast algorithm. For A numerical investigation is done by considering copper material properties and showing them graphically with discussion.

PROBLEM FORMULATION

Let us consider a generalized thermoelastic problem of an axisymmetric homogeneous, isotropic solid of height 2h , defined in the range $0 \le r \le \infty$, $-h \le z \le h$ under the influence of a heat source. Further, it is considered that z-axis, as an axis of symmetry and coordinate system, lies in the middle of the plane in between the upper and lower plate faces. Cylindrical coordinates (r,φ,z) are used to express the system of equations under consideration. All the quantities in this problem are independent of coordinate φ, it is because of the assumption that rotation is symmetric about the z axis.

Thus, displacement function becomes $\vec{u} = (u,0,w)$ and equations of motion becomes

$$\mu\nabla^2 u - \frac{\mu u}{r^2} + (\lambda+\mu)\frac{\partial e}{\partial r} - \gamma\frac{\partial T}{\partial r} = \rho\frac{\partial^2 u}{\partial t^2} \tag{1}$$

$$\mu\nabla^2 w + (\lambda+\mu)\frac{\partial e}{\partial z} - \gamma\frac{\partial T}{\partial z} = \rho\frac{\partial^2 w}{\partial t^2} \tag{2}$$

The conduction of heat under the Caputo fractional derivative of order $0 < \alpha \le 2$written as [24]

$$k I^{\alpha-1}\nabla^2 T = \left(\frac{\partial}{\partial t} + \tau_0\frac{\partial^2}{\partial t^2}\right)(\rho C_E T + \gamma T_0 e) - \rho\left(1+\tau_0\frac{\partial}{\partial t}\right)Q \tag{3}$$

where, I^{α} denotes the fractional integral of R–L (Riemann–Liouville) type as

$$I^{\alpha} g(t) = \int_0^t \frac{(t-s)^{\alpha-1}}{\Gamma(\alpha)} g(s)\,ds; \qquad \alpha > 0 \tag{4}$$

where, g(t) is the integrable function of Lebesgue type and Gamma function as denoted by Γ(α) for

absolutely continuity of g(t), one have $\lim_{\Omega\to 1}\frac{d^{\alpha}}{dt^{\alpha}} g(t) = g'(t)$

in which,

k - Thermal conductivity,

τ_0 - Relaxation time,

C_E - Specific heat at constant strain,

T - Absolute temperature distribution function,

T - Medium temperature with $(|T - T_0) / T| <<$, and e_{ij} -Components of the strain tensor.

Caputo time derivative of a function $T(t)$with fractional order α is denoted by $D^{\alpha}_{0,t} T(t)$ and defined as

$$D_{0,t}^{-(r-\alpha)} \frac{d^r}{dt^r} T(t) = \int_0^t \frac{(t-\tau)^{r-\alpha-1}}{\Gamma(r-\alpha)} T^r(\tau) d\tau, \quad r-1 < \alpha < r \tag{6}$$

The relation for Cubical dilatation e is

$$e = \frac{1}{r}\frac{\partial}{\partial r}(ru) + \frac{\partial w}{\partial z} \tag{7}$$

For $\alpha \to 1$, the Eq. (3), transformed as

$$k\nabla^2 T = -\rho\left(1+\tau_0\frac{\partial}{\partial t}\right)Q + \left(\frac{\partial}{\partial t} + \tau_0\frac{\partial^2}{\partial t^2}\right)(\rho C_E T + \gamma T_0 e) \tag{8}$$

Equation (8) is the generalized heat equation with one relaxation parameter and subjected to heat Q.

Further, when $\alpha \to 1$ with $\tau_0 \to 0$, Eq. (3) is written as

$$k\nabla^2 T = \left(\rho C_E \frac{\partial T}{\partial t} + \gamma T_0 \frac{\partial e}{\partial t}\right) - \rho Q \tag{9}$$

Which the exactly same heat conduction as noted in the coupled thermoelastic theory. The other constitutive relations are as follows

$$\nabla^2 = \frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r} + \frac{\partial}{\partial z} \tag{10}$$

$$\sigma_{rr} = 2\mu\frac{\partial u}{\partial r} + \lambda e - (T - T_0)\gamma \tag{11}$$

$$\sigma_{rz} = \mu\left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial r}\right) \tag{12}$$

$$\sigma_{rz} = \mu\left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial r}\right) \tag{13}$$

Introducing the non-dimensional variables as follows

$$r' = c_1\xi r \; z' = c_1\xi z, \; u' = c_1\xi u, \; w' = c_1\xi w, \; t' = c_1^2\xi t,$$

$$\tau_0' = c_1^2\xi\tau_0, \; \sigma_{ij}' = \frac{\sigma_{ij}}{\mu}, \; \theta = \frac{\gamma(T-T_0)}{(\lambda+2\mu)}, \; Q' = \frac{\rho\gamma Q}{k c_1^2 \psi^2 (\lambda+2\mu)},$$

$$\xi = \frac{\rho c_E}{k}, \; c_1 = \sqrt{\frac{\lambda+2\mu}{\rho}}, \; \beta^2 = \frac{\lambda+2\mu}{\mu}$$

c_1 denotes the elastic waves propagation speed.

The system of governing equations in non-dimensional variables, after dropping the primes written as

$$\nabla^2 u - \frac{u}{r^2} + (\beta^2 - 1)e - \beta^2\frac{\partial\theta}{\partial r} = \beta^2\frac{\partial^2 u}{\partial t^2} \tag{14}$$

$$\nabla^2 w + (\beta^2 - 1)\frac{\partial e}{\partial z} - \beta^2\frac{\partial\theta}{\partial z} = \beta^2\frac{\partial^2 w}{\partial t^2} \tag{15}$$

$$I^{\alpha-1}\nabla^2\theta = -\left(1+\tau_0\frac{\partial}{\partial t}\right)\beta^2 Q + \left(\frac{\partial}{\partial t} + \tau_0\frac{\partial^2}{\partial t^2}\right)(\theta + \varepsilon e) \tag{16}$$

Also, the relations (11)-(13) written as

$$\sigma_{rr} = 2\frac{\partial u}{\partial r} + (\beta^2 - 2)e - \beta^2\theta \tag{17}$$

$$\sigma_{zz} = 2\frac{\partial w}{\partial z} + (\beta^2 - 2)e - \beta^2\theta \tag{18}$$

$$\sigma_{rz} = \left(\frac{\partial u}{\partial z} + \frac{\partial w}{\partial r}\right) \tag{19}$$

Utilizing eqns. (14) and (15), by using eqn. (5) we get

$$\nabla^2 e - \nabla^2\theta = \frac{\partial^2 e}{\partial t^2} \tag{20}$$

All the assumed conditions at initial time are homogeneous since medium is quiescent. The corresponding boundaries are fixed as

$$\theta = f(r,t) \quad at \quad z = \pm h \tag{21}$$

$$\left.\begin{matrix}\sigma_{zz}\\ \sigma_{rz}\end{matrix}\right\} = 0 \, at \quad z = \pm h \tag{22}$$

Solution of the problem

Laplace transform of θ is

$$L[\theta] = \bar{\theta} = \int_0^{\infty} e^{-st}\theta(r,z,t)\,dt \tag{23}$$

Also following Povstenko [3], Laplace transform of the R–L integral is as below

$$L\left[I^n\theta(t)\right]=\frac{1}{s^n}L[\theta(t)]] \qquad n>0 \tag{24}$$

Equations (14–20) under Laplace transformation utilizing equation (24), written as

$$\nabla^2\bar{U}-\frac{\bar{U}}{r^2}+\left(\beta^2-1\right)\bar{e}-\beta^2\frac{\partial\bar{\theta}}{\partial r}=\beta^2s^2\bar{U} \tag{25}$$

$$\nabla^2\bar{W}+\left(\beta^2-1\right)\frac{\partial\bar{e}}{\partial z}-\beta^2\frac{\partial\bar{\theta}}{\partial z}=\beta^2s^2\bar{W} \tag{26}$$

$$\left(\nabla^2-s^{\alpha-1}(s+\tau_0s^2)\right)\bar{\theta}=s^{\alpha-1}(1+\tau_0s)\left(-\bar{Q}+s\varepsilon\bar{e}\right) \tag{27}$$

$$\nabla^2\bar{\theta}=(\nabla^2-s^2)\bar{e} \tag{28}$$

$$\bar{\sigma}_{rr}=2\frac{\partial\bar{u}}{\partial r}+\left(\beta^2-2\right)\bar{e}-\beta^2\bar{\theta} \tag{29}$$

$$\bar{\sigma}_{zz}=2\frac{\partial\bar{w}}{\partial z}+\left(\beta^2-2\right)\bar{e}-\beta^2\bar{\theta} \tag{30}$$

$$\bar{\sigma}_{rz}=\left(\frac{\partial\bar{u}}{\partial z}+\frac{\partial\bar{w}}{\partial r}\right) \tag{31}$$

Also conditions (21) and (22) becomes

$$\bar{\theta}(r,z,s)=\bar{f}(r,z,s) \qquad , \quad z=\pm h \tag{32}$$

$$\bar{\sigma}_{zz}(r,z,s)=\bar{\sigma}_{rz}(r,z,s)=0 \qquad , \quad z=\pm h \tag{33}$$

On removing $\bar{e}$ from the eqns. (27) & (28) we obtain

$$\left\{\nabla^4-\nabla^2\left[s^2+s^{\alpha-1}(s+\tau_0s^2)(1+\varepsilon)\right]+s^{\alpha+1}\right.$$
$$\left.(s+\tau_0s^2)\right\}\bar{\theta}=-s^{\alpha-1}(1+\tau_0s)\left(\nabla^2-s^2\right)\bar{Q} \tag{34}$$

The above eqn. (34) can be written in factorized form as

$$\left\{(\nabla^2-k_1^2)(\nabla^2-k_2^2)\right\}\bar{\theta}=-s^{\alpha-1}(1+\tau_0s)(\nabla^2-s^2)\bar{Q} \tag{35}$$

where k^2_1 and k^2_2 denotes for the roots of

$$\left\{k^4-\left[s^{\alpha-1}(s+\tau_0s^2)(1+\varepsilon)+s^2\right]k^2+s^{\alpha+1}(s+\tau_0s^2)\right\}=0 \tag{36}$$

Complete solution of eqn. (35) can be expressed as,

$$\bar{\theta}=\bar{\theta}_1+\bar{\theta}_2+\bar{\theta}_p \tag{37}$$

here $\bar{\theta}_i$ denotes the solution of,

$$(\nabla^2-k_1^2)\bar{\theta}_i=0 \quad ; \quad i=1,2 \tag{38}$$

and $\bar{\theta}_p$ is the particular integral.

To find the solution of eqn. (35), we define the Hankel transformation and its inversion of order zero w.r.t. variable *r* as follows

$$\bar{\theta}^*=H\left[\bar{\theta}\right]=\int_{r'=0}^{\infty}\bar{\theta}\,r'\,J_0(\eta r')\,dr' \tag{39}$$

First kind Bessel's function with zero order is denoted by J_0

$$\bar{\theta}=H^{-1}\left[\bar{\theta}^*\right]=\int_{\eta'=0}^{\infty}\bar{\theta}^*\eta'\,J_0(\eta' r)\,d\eta' \tag{40}$$

Using the transform defined in eqn. (39) to eqn. (38), we get

$$\left\{-(k_1^2+\eta^2)+D^2\right\}\bar{\theta}_i^*=0 \quad ;i=1,2 \ , \ D=\frac{\partial}{\partial z} \tag{41}$$

Complete integral of eqn. (41) can be expressed as,

$$\bar{\theta}_i^*=\cosh(l_i\,z)A_i(\eta,s)\left(k_i^2-s^2\right) \tag{42}$$

Where $l_i=\sqrt{\eta^2+k_i^2}$

Applying the transform defined in eqn. (39) to both parts of eqn. (35)

$$\left\{(D^2-l_1^2)(D^2-l_2^2)\right\}\bar{\theta}_p^*+s^{\alpha-1}(1+\tau_0s)\left(D^2-l^2\right)\bar{Q}=0 \tag{43}$$

$$l=\sqrt{\eta^2+s^2}$$

For sake of convenience, heat source is of cylindrical shell type is considered at r = 0 and releases heat instantaneously at t = 0 is

$$Q=\cosh z/2\pi r\,\delta(t)\,\delta(r) \tag{44}$$

On above equation taking Laplace and Hankel transformation, implies

$$\bar{Q}^*(\eta,z,s)=\cosh z \tag{45}$$

On simplifying eqn. (43), we obtain the solution as,

$$\bar{\theta}_p^*=\frac{-s^{\alpha-1}(1+\tau_0s)\left(1-l^2\right)\cosh z}{(1-l_1^2)\left(1-l_2^2\right)} \tag{46}$$

Then on substituting (42) and (46) in (37) the temperature distribution function is obtained as

$$\bar{\theta}^* = \sum_{i=1}^{2}\left(k_i^2 - s^2\right)A_i(\eta,s)\cosh(l_i z) - \frac{s^{\alpha-1}\left(1-l^2\right)(1+\tau_0 s)\cosh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)} \quad (47)$$

Using (40), the transformation inverse of eqn. (47) becomes,

$$\bar{\theta} = \int_0^\infty \left\{\sum_{i=1}^{2}\left(k_i^2 - s^2\right)A_i(\eta,s)\cosh(l_i z) - \frac{s^{\alpha-1}\left(1-l^2\right)(1+\tau_0 s)\cosh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)}\right\}\eta' J_0(\eta' r)d\eta' \quad (48)$$

On the same way equations (27) and (28), after removing $\bar{\theta}$ implies

$$\left\{(\nabla^2 - k_1^2)(\nabla^2 - k_2^2)\right\}\bar{e} = -s^{\alpha-1}(1+\tau_0 s)\nabla^2 \bar{Q} \quad (49)$$

Using transform defined in (39) to above eqn. (49), we get,

$$\left\{(D^2 - l_2^2)(D^2 - l_1^2)\right\}\bar{e}^* + s^{\alpha-1}(1+\tau_0 s)(D^2 - \eta^2)\bar{Q}^* = 0 \quad (50)$$

On simplifying eqn. (50) one obtains,

$$\bar{e}^* = \sum_{i=1}^{2} k_i^2 A_i(\eta,s)\cosh(l_i z) - \frac{s^{\alpha-1}\left(1-\eta^2\right)(1+\tau_0 s)\cosh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)} \quad (51)$$

On taking transform inversion of eqn. (51) by using (40), we get,

$$\bar{e} = \int_0^\infty \left\{\sum_{i=1}^{2} k_i^2 A_i(\eta,s)\cosh(l_i z) - \frac{s^{\alpha-1}\left(1-\eta^2\right)(1+\tau_0 s)\cosh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)}\right\}\eta' J_0(\eta' r)d\eta' \quad (52)$$

Similarly applying the integral defined in eqn. (39) to the eqn. (26) and using (47) and (51), we obtain

$$\bar{W}^* = \sinh q_3 z\, B(\eta,s) + \sum_{i=1}^{2} q_i A_i(\eta,s)\sinh(l_i z) - \frac{(1+\tau_0 s)s^{\alpha-1}\sinh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)} \quad (53)$$

$$l_3 = \sqrt{\eta^2 + \beta^2 s^2}$$

On Taking Hankel transform inverse of above eqn. we get,

$$\bar{w} = \int_0^\infty \left\{\sinh l_3 z\, B(\eta,s) + \sum_{i=1}^{2} l_i A_i(\eta,s)\sinh(l_i z) - \frac{(1+\tau_0 s)s^{\alpha-1}\sinh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)}\right\}\eta' J_0(\eta' r)d\eta' \quad (54)$$

Next, applying Hankel and Laplace transformation respectively to equation (7) and using eqns. (51) & (53)

$$H\left(\frac{1}{r}\frac{\partial}{\partial r}(r\bar{u})\right) = -B(\eta,s)l_3\cosh l_3 z - \eta^2\left[\sum_{i=1}^{2} A_i(\eta,s)\cosh(l_i z) - \frac{s^{\alpha-1}(1+\tau_0 s)\cosh z}{\left(1-l_1^2\right)\left(1-l_2^2\right)}\right] \quad (55)$$

On employing the Inversion of Hankel transform eqn. (55) becomes

$$\bar{u} = -\int_0^\infty \left\{l_3 B(\eta,s)\cosh l_3 z + \eta^2\left[\sum_{i=1}^{2}\cosh(l_i z)\right.\right.$$

$$\bar{u} = -\int_0^\infty \left\{l_3 B(\eta,s)\cosh l_3 z + \eta^2\left[\sum_{i=1}^{2}\cosh(l_i z)\right.\right. \quad (56)$$

On substituting (48), (52) and (54) in (29) to (31) stress tensor components becomes

$$\bar{\sigma}_{zz} = \int_0^\infty \left\{2l_3 B(\eta,s)\cosh l_3 z + (\eta^2 + l_3^2)\left[\sum_{i=1}^{2}\cosh(l_i z)A_i(\eta,s) - \frac{(1+\tau_0 s)s^{\alpha-1}\cosh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)}\right]\right\} \times \eta' J_0(\eta' r)d\eta' \quad (57)$$

$$\bar{\sigma}_{rz} = \int_0^\infty \left\{-B(\eta,s)(\eta^2 + l_3^2)\cosh l_3 z - 2\alpha^2\left[\sum_{i=1}^{2} l_i A_i(\eta,s)\sinh(l_i z) - \frac{(1+\tau_0 s)s^{\alpha-1}\sinh z}{\left(1-l_2^2\right)\left(1-l_1^2\right)}\right]\right\} \times J_1(\eta' r)d\eta' \quad (58)$$

The conditions defined in eqn. (21) and (22) under Hankel transform written as

$$\bar{\theta}^* = \bar{f}^* \quad , \quad z = \pm h \tag{59}$$

$$\bar{\sigma}^*_{rz} = \bar{\sigma}^*_{zz} = 0 \quad , \quad z = \pm h \tag{60}$$

Utilizing equations (59) and (60) to find the values of unknown parameters, as

$$\sum_{i=1}^{2}\left(k_i^2 - s^2\right)A_i(\eta,s)\cosh(l_i\,h) - \frac{(1+\tau_0 s)s^{\alpha-1}\left(1-l^2\right)\cosh(h)}{\left(1-l_2^2\right)\left(1-l_1^2\right)} = \bar{f}^* \tag{61}$$

$$\left(\eta^2 + l_3^2\right)\sum_{i=1}^{2}\cosh(l_i\,h)A_i(\eta,s) - 2l_3\,B(\eta,s)$$

$$\cosh l_3 z = \frac{(1+\tau_0 s)s^{\alpha-1}\left(\eta^2+l_3^2\right)\cosh(h)}{\left(1-l_2^2\right)\left(1-l_1^2\right)} \tag{62}$$

$$2\eta^2\left[\sum_{i=1}^{2} l_i\,A_i(\eta,s)\,\sinh(l_i\,h) + B(\eta,s)\left(\eta^2+q_3^2\right)\right.$$

$$\left.\cosh l_3 h = \frac{2s^{\alpha-1}\eta^2(1+\tau_0 s)\sinh(h)}{\left(1-l_2^2\right)\left(1-l_1^2\right)}\right] \tag{63}$$

To evaluate the solution of the problem we use numerical technique using equations (61) to (63).

Inversion Method for Double Transformation

The physical solution of the supposed problem under study is based on the inversion of the Laplace method, but it is not analytically possible because of the complex mathematical analysis. So, inversion of the numerical computation method is adopted by employing the well-known Gaver-Stehfast algorithm [23, 24]. A detailed explanation of the processor can be seen in Knight and Rich [25]. Gaver and Stehfast's modified formula is as

$$F(t) = \frac{\ln 2}{t}\sum_{i=1}^{L} D(i,L)\,G\left(i\frac{\ln 2}{t}\right) \tag{64}$$

with

$$D(i,L) = (-1)^{i+M}\sum_{n=m}^{\min(i,M)}\frac{n^M(2n)!}{(M-n)!(n-1)!(i-n)!(2n-i)!}$$

Here, the value of L (even integer) is dependent of computer programme word length. M = L / 2, m denotes the integer part of the (i+1)/ 2 .

The value of L is taken from the Stehfast algorithm which converges faster and with desired accuracy.

Also, to find the integrals involved in calculating Romberg's numerical integration technique [26] is used subject to variable pitch size. These parts of programs are made by using MATLAB mathematical software.

NUMERICAL EVALUATION OF RESULTS

The physical properties for numerical computation are assumed as for copper material as:

$k = 386\,J\,K^{-1}m^{-1}s^{-1}$,	$\alpha_t = 1.78\times10^{-5}\,K^{-1}$,	$\mu = 3.86\times10^{10}\,N\,m^{-2}$,	$\lambda = 7.76\times10^{10}\,N\,m^{-2}$,
$C_E = 383.1\,J\,Kg^{-1}K^{-1}$,	$\rho = 8954\,Kg\,m^{-3}$,	$c_1 = 4.158\times10^{3}\,m\,s^{-1}$,	$\psi = 8886.73\,s\,m^{-2}$,
$\mu = 3.86\times10^{10}\,N\,m^{-2}$,	$\tau_0 = 0.5s$,	$\varepsilon = 0.0168\,N\,m\,J^{-1}$,	$T_0 = 293\,K$,
$a = 1$,	$b = 1$,	$\theta_0 = 1$	$\beta^2 = 4$,

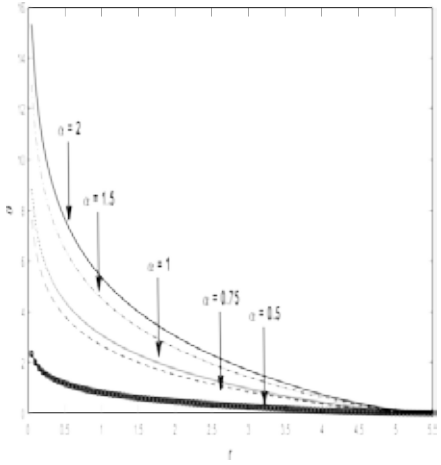

Figure 1. Temperature function along radius

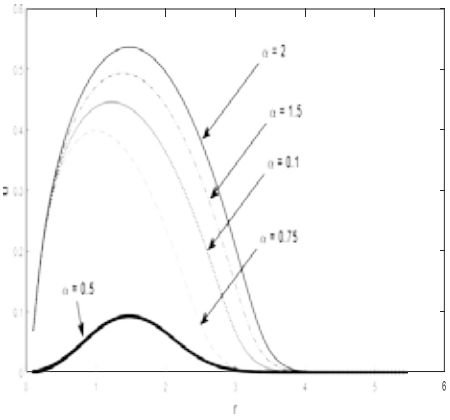

Figure 2. Displacement function along radius

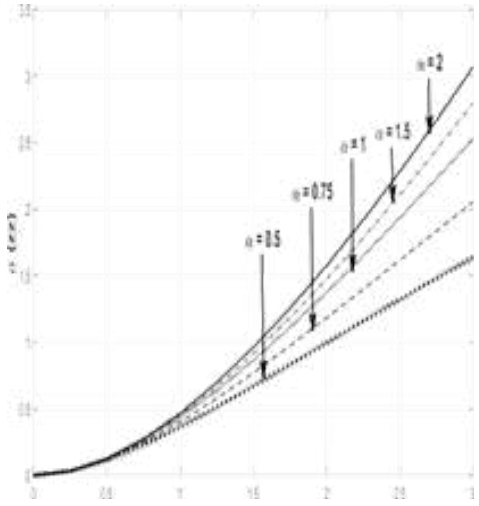

Figure 3. Axial Stress function along radius

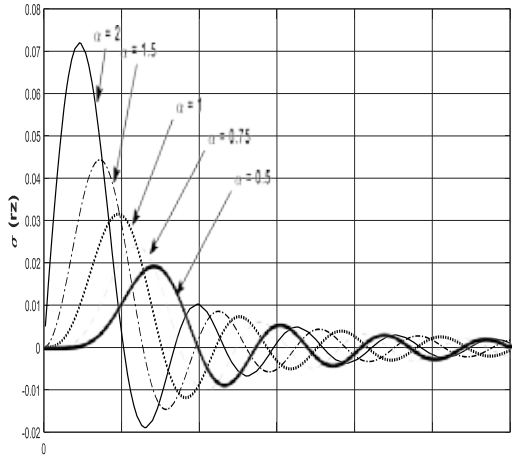

Figure 4. Shear stress function along radius

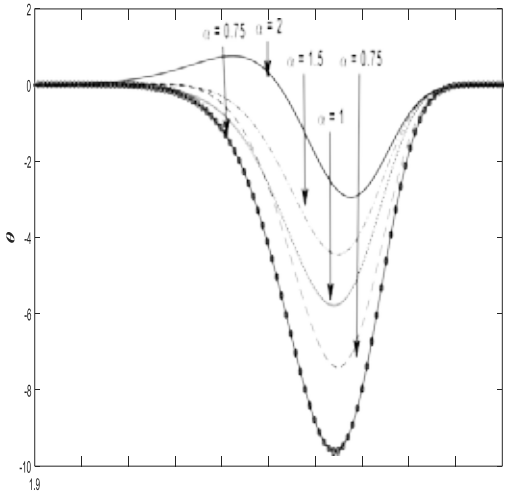

Figure 5. Temperature function along thickness

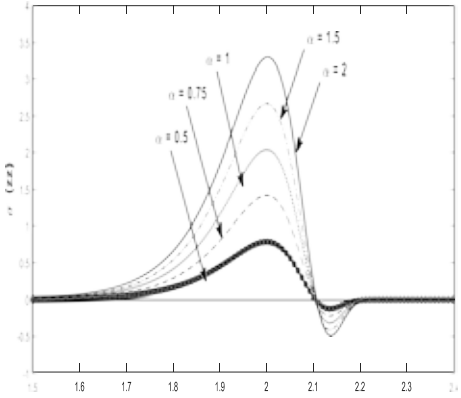

Figure 6. Axial stress along thickness

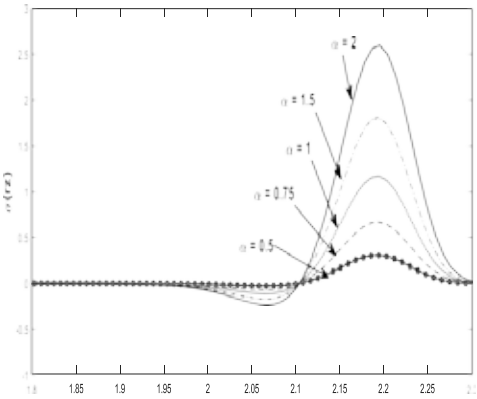

Figure 7. Shear stress along thickness

Graphical plotting for the resultant temperature, displacement, and stress distribution is shown in Figs. 1 to 7 along the radial and thickness directions for various fractional parameters i.e.,α = 0.5, 0.75, 1 ,1.5, 2.

From the numerical analysis, following important points are noted:

- The wave propagation speed in the case of temperature, displacement, and stress distribution is found to be dependent and vary directly proportional to the fractional order value of α in both radial and axial directions. For the higher value of α, large distribution in above plotting is noted for temperature variation, displacement function and the thermal stresses.
- Physical quantities are significant affected by the fractional derivatives for weak $0 < \alpha < 1$, normal $\alpha = 1$ and superconductivity $1 < \alpha < 2$ cases. Large fluctuation in distribution is observed in the range $1 < \alpha < 2$.

- Also, variation of field variables is also affected by various values of the fractional derivatives.
- Numerical analysis indicates that materials ability of conducting heat is as according to value of fractional parameter.
- Variation of steady waves are also depending on the fractional parameters.

CONCLUSION

The work done in this paper provides a better understanding of the thermoelastic behaviour of a 2D half space of infinite length subjected to periodic varying heat sources with time under generalised thermoelasticity. The fractional derivative is involved in the heat equation of Caputo type order α. Analytical variation of the resulting temperature function, displacement function, and stress functions are obtained in the Laplace transform domain. Numerical inversion is used to obtain solutions in Laplace domain by the well-known Gaver-Stehfast method, and all the obtained results are illustrated graphically by taking copper material properties. From the study, it is found that fractional order significantly affects the thermal quantities. All the plotted curves show smooth behavior in the range $0 < \alpha \leq 1$, also when $1 < \alpha \leq 2$ distributed curves are strongly dependent on various fractional values. As a case study, limiting cases for coupled and generalized thermoelastic theory are successfully derived with one relaxation time. Hence, the obtained results of the study may be useful in the design of conducting materials that are used in thermoelastic modelling, which is a new class of applicable materials that helps in the various designs of new structures.

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Deflection Behaviour Due to the Response of the Caputo-Fabrizio Fractional Derivative in a Thermoelastic Disc with Heat Generation

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ABSTRACT

Analytical analysis is performed to study the distortion produced by thermal variation in a fixed, clamped annular disc that is exposed to an internal source of heat. The bottom and top faces of the annular disc, as well as both its inner and external curved surfaces, maintain the boundaries of convective interchange of heat. The fundamental equation with the time fraction is solved using the analytical approach of integral transformation. The temperature and heat deviation measurements that were made are calculated numerically considering the material properties of a copper metal disc and are presented graphically.

KEYWORDS: *Annular disc, Caputo-Fabrizio, Fractional operator, Heat generation, Deflection, Temperature.*

INTRODUCTION

Since the last decade, the study of fractional order thermoelasticity has been in great demand due to its ability to predict the delayed response, which is important in many physical processes and applicable to real-world problems. Many researchers, engineers, mathematicians, and scientists are working hard to understand the exact phenomenon of physical observations occurring at the microscopic level and its application in developing structural designs. Using fractal theory, Povstenko [6] studied one- and two-dimensional temperature equations and discovered the stress functions. Povstenko [7] used spatiotemporal fractal derivatives and determined their influence on various solids. Youssef [8] considered a modified heat transfer equation and described a new thermoelastic theory with fractal parameters and proved its uniqueness. Povstenko [9, 10] determined the thermal stress distributions in a medium with infinite range by considering the effect of a radial heat conduction equation with a cylindrical cavity under fractal theory.

Ezzat [11] described the modelling of magneto-thermoelasticity by considering the concept of fractional approach. Ezzat [12] solved a 1D thermoelectric problem using the analytical transformation technique within the range of fractional elasticity. Ezzat and Ezzat [14] explained the applications of porous materials using fractional order thermoelasticity. In recent years, many other researchers [18, 20 and 21] have also made an important contribution to the study of thermal behaviour in the development of thermoelasticity. Shaikh et al [15] proved the existence and uniqueness criteria and discussed the effects of Caputo- Fabrizio reaction with nonlinear differential equations. Yepez and Gomez [16] determined the behaviour of the nonlinear fractional heat equation using the Caputo-Fabrizio operator. Amal

et al [17] studied the behaviour of the Caputo-Fabrizio differential operator for trigonometric and exponential functions considering the nonsingular kernel. Recently, Elhagary [19] determined the concentration effects of the Caputo-Fabrizio differential operator in an infinite hollow cylinder using the analytical transformation method.

In this work, the authors are motivated to understand the behaviour of thermal deflection in a two-dimensional annular disc by considering the Caputo-Fabrizio fractional differential operator. Constraints of convective heat exchange type and the impact of an internal heat source are applied to the assumed disc. The theoretical formula for the transmission of heat is resolved using integral transformations. Numerical calculation and graphical representation of temperature and deflection distribution along radial directions are carried out for material properties based on copper. Such work has not been published before and is beneficial for the creation of structures with new material designs used in physical problems.

Formulation of thermal equation

In this section we consider a thermoelastic disc of thickness 2h, defined in the domain a ≤ r ≤ b and ≤ h ≤ z ≤ h , under the influence of the fractional differential parameter $\gamma \in (0,1)$ of Caputo-Fabrizio. Heat is generated inside the disc during period at a rate of t > 0. It is believed that the disc's initial temperature is arbitrary and boundary conditions for convective heat exchange are applied to the top, bottom, and curved surfaces.

The response of thermal deformations in the disc caused by heat generation must be estimated under the influence of the derivatives of the fractions and the assumed conditions.

The differential equation of deflection function W (r,t) in terms of thermal moment N_T is written as in [3]

$$\nabla^4 W = \frac{\nabla^2 N_T}{D(1-v)} \tag{1}$$

where

$$N_T = a_t E \int_{-h}^{h} T(r,z,t) z\, dz\,, \tag{2}$$

D is the disc's flexural stiffness indicated as

$$D = \frac{Eh^3}{12(1-v^2)} \tag{3}$$

v, E and a_t are the disc material's Poisson's ratio, Young's modules, and linear thermal expansion coefficients, respectively.

$$\nabla^2 = \frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r} \tag{4}$$

The edge of an annular disc has been fixed and clamped.

$$W(r=a,\ b) = \frac{\partial W(r=a,\ b)}{\partial r} = 0\,, \tag{5}$$

also, T (t = 0) = W (t = 0) = 0

The formula for heat with the Caputo-Fabrizio fractional differentiation and the heat source of the disc is

$$d\left(\nabla^2 T + \frac{\hbar(r,z,t)}{k}\right) = {}^{CF}_{0}D^{(\gamma)}T \quad ; \quad \gamma \in (0,1) \tag{6}$$

where, d is thermal diffusivity and ${}^{CF}_{0}D^{(\gamma)}T$ is the Caputo-Fabrizio fractional differentiation in range $\gamma \in (0,1)$ stated as [13]

$${}^{CF}_{0}D^{(\gamma)}T(t) = (1-\gamma)^{-1}\int_0^t T'(t)\exp\left(-\gamma(t-\tau)(1-\gamma)^{-1}\right)d\tau, \qquad 0 \le \gamma \le 1 \tag{7}$$

For simplicity of use, the number of variables is listed in non-dimensional form as:

$$r' = \frac{r}{b},\ z' = \frac{r}{b},\ t' = \frac{t\,d}{b^2}, T' = \frac{T}{T_0}$$

Equation (6) has the following form (omitting the prime numbers for simplicity), using the above dimensionless variables.

$$\frac{\partial^2 T}{\partial r^2} + \frac{1}{r}\frac{\partial T}{\partial r} + \frac{\partial^2 T}{\partial z^2} + \frac{\hbar(r,z,t)}{k} = \frac{1}{d}\,{}^{CF}_{0}D^{(\gamma)}T \quad ; \quad \gamma \in (0,1) \tag{8}$$

The Laplace integral formula for above time derivative is defined as

$$L.T.\left[{}^{CF}_{0}D^{(\gamma)}T(t) = \frac{\partial^\gamma T}{\partial t^\gamma}\right] = \frac{sL\left[T(t)\right] - T(0)}{s + \gamma(1-s)} \tag{9}$$

Here s is the Laplace transform parameter

Boundary constraints

The following convective heat exchange constraints are applied to the faces of the assumed disc:

$$\left\{T + k_1 \frac{\partial T}{\partial r}\right\} = \square_1(z,t) \quad ; \quad at \;\; r = a, \quad t > 0 \tag{10}$$

$$\left\{T + k_2 \frac{\partial T}{\partial r}\right\} = \square_2(z,t) \quad ; \quad at\, r = b,\, t > 0 \tag{11}$$

$$\left\{T + k_3 \frac{\partial T}{\partial r}\right\} = \square_3(r,t) \quad ; \quad at\, z = -h,\, t > 0 \tag{12}$$

$$\left\{T + k_4 \frac{\partial T}{\partial r}\right\} = \square_4(r,t) \quad ; \quad at\, z = h,\, t > 0 \tag{13}$$

$$T(r,z,t) = 0, \;\; at\, t = 0 \tag{14}$$

where k_1, k_2, k_3 and k_4 are radiation constants of the disc's material. Further 1 (z,t), 2 (z,t), 3 (r,t) and 4 (r,t) are the time dependent heat flux.

The problem under investigation is expressed mathematically in Equations (1) to (14).

Analytical solution by integral transformation

To find an analytical solution, we first apply the Marchi-Zgrablich transformation with respect to r as in [4, 5] to equation (8), then we apply the Marchi-Fasulo integral transformation in relation the variables z as in [2] and use the corresponding transformed boundary conditions, obtaining

$$\frac{\partial^{\gamma} \bar{\bar{T}}(m,n,t)}{\partial t^{\gamma}} + d\, p^2 \bar{\bar{T}}(m,n,t) = \bar{\bar{\Psi}}(m,n,t) \tag{15}$$

where $\mu_m^2 + a_n^2 = p^2$

If we now apply the Laplace transformation defined in (9) for the fractional derivative of Caputo-Fabrizio to equation (15) by using the transformed constraints and performing their inversion, we obtain

$$\bar{\bar{T}} = \frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right) \int_0^t e^{-l_5 u}\, \bar{\bar{\psi}}(t-u)\, du \tag{16}$$

where, $(1-\gamma) = l_1$, $\frac{\gamma}{(1-\gamma)} = l_2$, $l_1 l_2 = \gamma$, $1 + d\, l_1 p^2 = l_3$, $d\,\gamma\, p^2 = l_4$ and $l_5 = \frac{l_4}{l_3}$

Finally, by reversing the integral transformation in equation (16), we obtain

$$T = \sum_{m=1}^{\infty} \frac{1}{\mu_m^2} X_0(k_1, k_2, \mu_m r) \left[\sum_{n=1}^{\infty} \frac{1}{\lambda_n^2} I_n(z) \left\{\frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right) \int_0^t e^{-l_5 u}\, \bar{\bar{\psi}}(t-u)\, du\right\}\right] \tag{17}$$

Where $\bar{\Psi} = \frac{b}{k_2} X_0(\alpha, \beta, \mu_m b) \square_2(n,t) - \frac{a}{k_1} X_0(\alpha, \beta, \mu_m a) \square_1(n,t)$,

$\bar{\Psi}_1 = \bar{\Psi} + \phi$, $\phi = \frac{P_n(h)}{k_4} \square_4(\mu_m, t) - \frac{P_n(-h)}{k_3} \square_3(\mu_m, t)$, $\bar{\bar{\psi}} = d\left(\frac{1}{k}\bar{\bar{h}} + \bar{\Psi}_1\right)$

where

$$I_n(z) = \cos(a_n z)\left\{a_n(\alpha_1 + \alpha_2)\cos(a_n h) + (\beta_1 - \beta_2)\sin(a_n h)\right\} - \sin(a_n z)\left\{(\beta_1 + \beta_2)\cos(a_n h) + (\alpha_2 - \alpha_1) a_n \sin(a_n h)\right\}$$

$$\lambda_n = \int_{-h}^{h} I_n^2(z)\, dz$$

here α_1, α_2 and β_1, β_2 are constants.

Equation (17) is the desired solution to the given problem.

Analysis of thermal deflection

Equation (2) yields the following value when the temperature distribution value from equation (17) is used.

$$N_T = a_t E \left[\sum_{m=1}^{\infty}\sum_{n=1}^{\infty} \frac{1}{\mu_m^2} X_0(k_1, k_2, \mu_m r) \frac{1}{\lambda_n^2} \left\{\frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right) \int_0^t e^{-l_5 u}\, \bar{\bar{\psi}}(t-u)\, du\right\} (z-1) \int_{-h}^{h} I_n(z)\, dz\right] \tag{18}$$

Assuming that the response to equation (1) satisfies (5),

$$W(r,t) = \sum_{m=1}^{\infty} C_m(t)\left[X_0(k_1, k_2, \mu_m r) - X_0(k_1, k_2, \mu_m b)\right] \tag{19}$$

where μ_m are the roots of

$$X_0(k_1, k_2, \mu_m a) - X_0(k_1, k_2, \mu_m b) = 0 \tag{20}$$

Now

$$\nabla^4 W = \left(\frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r}\right)^2 \sum_{m=1}^{\infty} c_m\left[X_0(k_1, k_2, \mu_m r) - X_0(k_1, k_2, \mu_m b)\right] \tag{21}$$

By using the well-known result,

$$\left(\frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r}\right) X_0(k_1, k_2, \mu_m r) = -\mu_m^2\, X_0(k_1, k_2, \mu_m r) \tag{22}$$

in equation (21), we get

$$\nabla^4 W = \sum_{m=1}^{\infty} c_m \mu_m^4 \, X_0(k_1, k_2, \mu_m r) \tag{23}$$

Also

$$\nabla^2 N_T = -a_t E \sum_{m=1}^{\infty}\sum_{n=1}^{\infty}[X_0(k_1,k_2,\mu_m r)\frac{1}{\lambda_n^2}\left\{\frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right)\int_0^t e^{-l_5 u}\bar{\bar{\psi}}(t-u)\,du\right\}(z-1)\int_{-h}^{h} I_n(z)\,dz] \tag{24}$$

Equations (23) and (24) are used in equation (1) to get

$$\sum_{m=1}^{\infty} c_m \, \mu_m^4 \, X_0(k_1,k_2,\mu_m r) = -\frac{a_t E}{D(1-\nu)}\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}[X_0(k_1,k_2,\mu_m r)\frac{1}{\lambda^2}\left\{\frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right)\int_0^t e^{-l_5 u}\bar{\bar{\psi}}(t-u)\,du\right\}(z-1)\int_{-h}^{h} I_n(z)\,dz] \tag{25}$$

When we solve equation (25) we obtain

$$c_m(t) = -\frac{a_t E}{D(1-\nu)}\sum_{n=1}^{\infty}\left[\frac{1}{\lambda_n^2 \mu_m^4}\left\{\frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right)\int_0^t e^{-l_5 u}\bar{\bar{\psi}}(t-u)\,du\right\}(z-1)\int_{-h}^{h} I_n(z)\,dz\right] \tag{26}$$

Substituting equation (26) into equation (19), we obtain

$$W = -\frac{a_t E}{D(1-\nu)}\sum_{m=1}^{\infty}\sum_{n=1}^{\infty}\left[\frac{1}{\lambda_n^2 \mu_m^4}\left\{\frac{l_1}{l_3}\bar{\bar{\psi}} + \left(\frac{\gamma}{l_3} - \frac{l_1}{l_3} l_5\right)\int_0^t e^{-l_5 u}\bar{\bar{\psi}}(t-u)\,du\right\}(z-1)\int_{-h}^{h} I_n(z)\,dz\right] \times [X_0(k_1,k_2,\mu_m r) - X_0(k_1,k_2,\mu_m b)] \tag{27}$$

Numerical analysis

For numerical computation, disc is assumed to have radius between r =1 to r = 2 and thickness z = h = 0.1. Further it is considered that thin hollow disc is made up of copper metal whose material properties are as:-

Thermal diffusivity, d = 112.34 $\times 10^{-6}$ m^2 s, Factor of thermal expansion, a_t = 16.5 $\times$ 10^{-6}/ K, Poisson ratio, ν = 0.35, Density, ρ = 8954kg/m^3, Specific heat, C_p = 383J/(kgK).

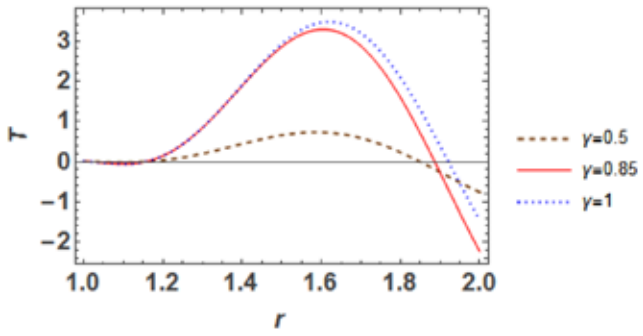

Fig. 1. Deflection T versus radius r for differential fractional parameter of γ

Fig. 1 depicts the temperature change for various order of fractions values γ = 0.5, 0.85, 1in the radial dimension. Temperature variation has non-zero values in the bounded region and zero values at the inner curved disc's surface. Along the radial direction, temperature increases on going towards the outer radii, and maximum distribution is noted near the midpoint due to the action of internal heat generation. For γ = 0.5 the infinite speed of thermal waves, propogation is obtained, and solutions behave like coupled thermoelastic theory of diffusion. For γ = 1 the solution behaved as predicted by the thermoelastic diffusion model. Also, for γ = 0.85 the curve appears to function in accordance with the thermoelastic diffusion theory.

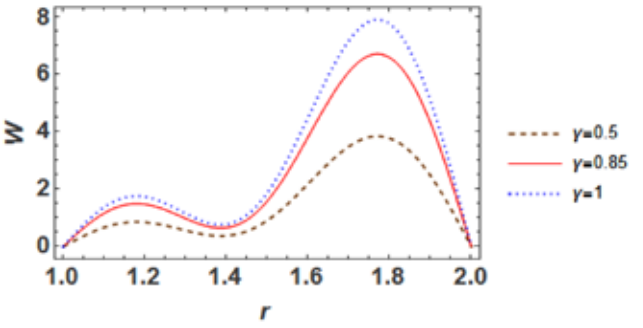

Fig. 2. Deflection W versus radius r for differential fractional parameter of γ

Fig. 2 shows the variation of deflection in the radial dimension for different fractional order values γ = 0.5,0.85,1. Deflection variation has non-zero values in the bounded region and zero values at both internal and external surfaces of the disc, which matches the prescribed mathematical conditions for fixed and clamped disc conditions defined in equation (5).

From graphical analysis, it can be seen that deflection increases for various fractional values across the radius dimension. The highest distribution of deflection is observed near the exterior curved surface, this could be a result of the effect of internal heat generating. Further, it is noticed that variations in thermal deflection are affected by changing values of the parameters of order of fractions. Consequently, it may be implied that the fractional parameters γ play an important part in the development of innovative structural materials that can be used to solve physical concerns.

CONCLUSION

Fractional thermoelastic modelling in different solids under boundary conditions of convective heat exchange and heat sources is found to be more suitable for physical observations as compared to classical heat exchange models. The main reason for suitability is the prediction of a retarded response, which more clearly describes the physical phenomenon. In this investigation, the temperature flow and thermal deflection based on thermal moments in an annular disc have been investigated analytically by the integral transformation technique due to the impact of the Caputo-Fabrizio fractional differentiation. Graphical investigations show the strong dependency of temperature and deflection function on the different fractional order parameters. Thus, it can be deduced that the results attained have a significant impact on material sciences and the development of novel materials.

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Design and Study of the Load Behavior of a Steel Angle and Tube-based Three Dimensional Roof Truss. Comparison of the Angel and Tabular Portions

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ABSTRACT

The five main goals utility, economy, efficiency, safety, and aesthetic must all be met in a structural design and analysis of a three-dimensional roof truss. This paper compares the economics, weight, and efficiency of tubular and angle section structures Using STAA- PRO software, the analysis and design are carried out step-by-step for a 30 m straight truss and curved section while taking into account all loads and load combinations. Since the weight of the angle section is greater than that of the tubular section, In order to show that the tubular structure is more economical than the steel structure, the findings are compared and verified.

KEYWORDS: *Purlin, Space truss, Geometry, Tubular section, Angular section.*

INTRODUCTION

Space trusses structures are a useful resource for architects and engineers looking for innovative forms due to their wide variation and flexibility. Over the past decades, the popularity of this style of construction has increased because space trusses can combine light weight and easy assembly with a beautiful appearance. It should be simple to build and maintain. As a consequence, constructions end up being large or unsuccessful because of heavy cost of material, time duration of construction, and durability for the structure. To overcome this problem in the space trusses we study on the space truss member and also if space truss shape is take as inverted what are the most possible outcomes for this?. The three dimensional inverted truss shape not only provides excellent results while saving money and adding the least amount of weight, but it is also a straightforward geometry for analyses and designs. For effectiveness, utility, and aesthetics, different three-dimensional geometries can be made for roof trusses in today's modern world. In an addition to inverted shape truss to reduce tonnage (weight) tabular section is used in exception of angle section, a tubular structure is lighter and more aesthetically pleasing, economical than steel angular section. As a result, it is more affordable than options. In this, as sheets are stacked on top of members, weight is transferred from the members to the joints.

To Identifying a square-based inverted pyramid in all three dimensions for the top structure will help to analyze and design for angle section and tubular section regarding weight and expenses. Discovering the ideal span while keeping the building's number of supports as low as possible was necessary. Hence the length 30m is selected for study.

RESEARCH GAP

In this study, we use an inverted shape for the space truss. The impact of removing the roof truss purline was taken into account in the analysis and design of a three-dimensional geometry square-based inverted pyramid. In addition, we used ball bearing connections for better stability and flexibility. To lower more costs tabular sections are used as a material.

Aim and Objective of Project

The primary goal of this review is to investigate inverted pyramid-shaped roof trusses in both straight and curved forms for a range of spans:

1. Analysis of inverted pyramid shape for roof truss.
2. Analysis of Design members for angle and tubular section.
3. Finding out actual cost saving.
4. Comparison for weight and cost for both sections.

METHODOLOGY

1. Identifying a shape and dimensions of inverted truss structure with the help of 3D VIEW.
2. Analysis of truss by manual calculation of different forces, behavior of forces compression.
3. Software validation for static loading (For known results): Software calculation Analysis of trusses using STAAD-PRO software by Finite Element Method. STAAD-PRO software is chosen for the further analysis of the truss.
4. Wind Analysis of this truss carried out by using the STAAD-PRO software by the considering all loading, wind loading and load combination of these.
5. Weight comparison for the both the trusses.

METHODS OF ANALYSIS

Following are the various methods used for analysis in general

1. Finite Element Method
2. Moment Distribution Method
3. Displacement or Stiffness Method
4. Force Flexibility Method.

Finite Element Method

The finite element method (FEM) or finite element analysis (FEA), is a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The analytical solutions of these problems generally require the solution to boundary value problems for partial differential equations. The finite element method formulation of the problem results in a system of algebraic equations. The method yields approximate values of the unknowns at discrete number of points over the domain. To solve the problem, it subdivides a large problem into smaller, simpler parts that are called finite elements. The simple equations that model these finite elements are then assembled into a larger system of equations that models the entire problem. FEM then uses variation methods from the calculus of variations to approximate a solution by minimizing an associated error function. Various types of finite element methods: - Applied Element Method, Generalized finite element method, mixed finite element method, Spectral element method, etc. Application: - A variety of specializations under the umbrella of the mechanical engineering discipline (such as aeronautical, biomechanical, and automotive industries) commonly use integrated FEM in design and development of their products. Several modern FEM packages include specific components such as thermal, electromagnetic, fluid, and structural working environments. In a structural simulation, FEM helps tremendously in producing stiffness and strength visualizations and also in minimizing weight, materials, and costs. Here we used FEM based software stadd pro software validation and analyze the inverted roof truss for straight and curved shape.

Geometry

This is three dimensional inverted geometry in X, Y, Z direction. As a result of the elimination of the purlin, the design is a pyramid that has been inverted. This STADD- PRO application is employed to carry out this. The impact of removing the roof truss purlin was taken into account in the analysis and design of a three-dimensional geometry square-based inverted pyramid.

Dimensions for 30m curved Geometry

- Height:- 5m
- Length :- 30m (clear span)

These Square based pyramid of 1 X1 squares with height 5m are design and analyzed for 30m. A curved and straight truss of square based inverted three dimensional (pyramid) shape analysis and design for

angle and tubular section is done in following way using STAAD-Pro V8i. the geometry for the shape is shown in the Fig 1, 2.

Material

- Angle Section :-Angle sections are used in the inverted roof truss as followed 1. ISA 75X75X10, 2. ISA 130X130X12, 3. ISA 150X150X15
- Tubular Section :- Tubular sections are used in the street inverted roof truss as followed

  1. TUB 75754.9

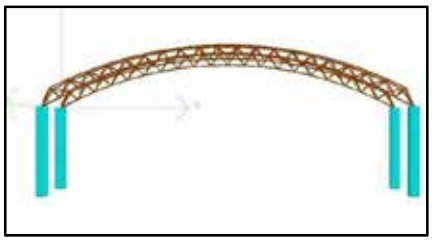


Figure 1: Front View for 30m curved roof truss

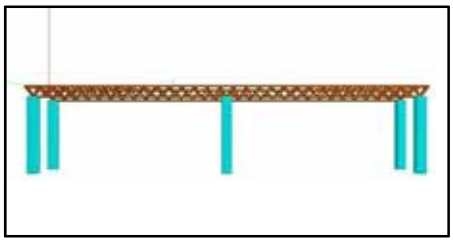


Figure 2: Front View for 30m straight roof truss

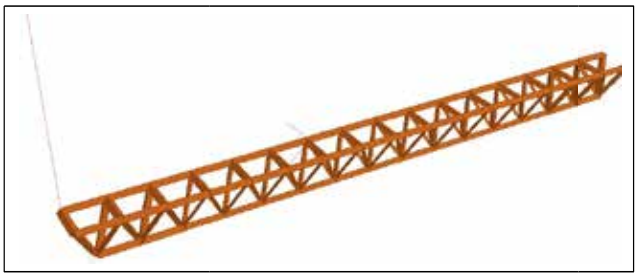


Figure 3: 3D View for invented truss having tabular section as material used

Loading calculation

i) For 30 m straight (inverted truss)

Loading Calculations

This includes three types of loading live weight, wind load, and dead load

Dead Load

Weight for sheeting including laps and connectors = 100 N/m^2 Projected area = 5 X 30 = 150 m^2, Dead Load = Projected Area X Weight of sheeting = 150 X 100 = 15000 kN

D. L. at each point = 0.234 KN

Live Load

Rise (h) = 1.12m, Length / Span (l) = 30 m Tan θ = 1.12 / 30 θ = 2.13

According to IS 875 Part II Live Load = 750- (θ– 10) X 20 = 0.907kN

Live Load = 136.05kN, L.L. at each point = 2.12 KN

Wind Load

IS 875 Part III Basic wind velocity data in the vicinity of Pune Vb = 39m/s k1= 1.0, k2 = 1.0 for category 2, class B , k3= 1.0 Intended wind speed Vz = Vb x k1 x k2 x k3 = 39x1x1x1 = 39 m/s. Planned wind speed Pd = 0.6 X (Vz)2 = 0.6 X (39)2 = 912.6 N/m2 Total wind pressure = Pd X (Pe + Pi) = 912.6 X (- 0.8-0.5) = -1.186 kN/m2 Wind Load = 177.8 kN, W.L. at each point = 2.77 KN, Loading of truss on each joint is tabulated in Annexure C

ii) For 30 m Curved (inverted truss)

Dead Load

Weight for sheeting including laps and connectors = 100 N/m^2 Projected area = 5 X 30 = 150 m^2, Dead Load = Projected Area X Weight of sheeting = 150 X 100 = 15000, D.L. at each point = 0.375 KN

Live Load

Rise (h) = 4.78m Length / Span (l) = 30 m According to IS 875 Part II Live Load = 0.75 – (0.52X γ2)= 0.75 – (0.52 X (h/l)2) = 0.75 – (0.52 X (4.78/30)2) = 0.746kN/m2 = 111.9 kN, Live Load = 111.9 kN,L.L. at each point = 2.79 KN

Wind Load

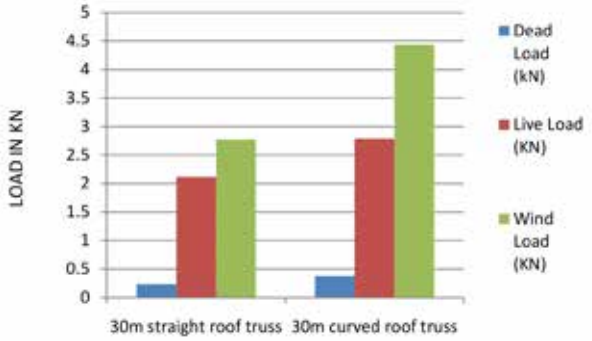
According to IS 875 Part III, Basic wind Velocity near Pune city Vb = 39m/s k1 = 1.0, k2 = 1.0 for category 2, class Bk3 = 1.0 Design wind speed Vz = Vb x k1 x k2 x k3 = 39x1x1x1 = 39 m/s Design wind pressure Pd = 0.6 X (Vz)2 = 0.6 X (39)2= 912.6 N/m^2.

Total wind pressure = Pd X (Pe + Pi) = 912.6 X (-0.8-0.5) = -1.186 kN/m2, Wind Load = 177.9 kN, W.L. at each point = 4.44 KN Loading of truss on each joint is tabulated in Annexure C.

Loading at each point for 30m straight and curved roof truss

Table 1:- Loading At Each Node for Angle and Tubular Section

Type of Truss	Dead Load (kN)	Live Load (kN)	Wind Load (kN)
30m straight roof truss	0.234	2.12	2.77
30m curved roof truss	0.375	2.79	4.44



Graph 1:- Loading At Each Node for Angle and Tubular Section

Design of members

Support:- These are fixed at node 112, 113, 114, 210, 211, 212. Taken in the straight inverted ruff truss this member is act as fixed support in the truss. The sectional properties for angle and tubular section are given below.

POST PROCESSING RESULT

Node Displacement

Table 1:- Nodes and Displacement for 30m Straight and curved for (Tubular Section material) Inverted roof truss

	30m Straight tubular truss Nodes	30m Straight tubular truss Displacement (mm)	30m curved tubular truss Nodes	30m curved tubular truss Displacement (mm)
Max X	108	3.849	130	38.391
Min X	10	-3.849	1	-38.391
Max Y	27	6.259	31	113.504
Min Y	27	-14.408	31	-117.432
Max Z	40	12.625	75	453.271
Min Z	39	-12.625	75	-453.272
Max rX	35	0.006	108	0.105
Min rX	36	-0.006	75	-0.105
Max rY	104	0.001	22	0.028
Min rY	103	-0.001	22	-0.028
Max rZ	108	0.004	131	0.015
Min rZ	10	-0.004	22	-0.015

Table 2:- Nodes and Displacement for 30m Straight and curved for (Angle Section material) Inverted roof truss

	Node	Displacement (mm)	Node	Displacement (mm)
Max X	108	3.984	130	43.300
Min X	10	-3.984	1	-43.300
Max Y	27	5.361	31	50.529
Min Y	27	-13.221	31	-122.040
Max Z	40	10.978	108	283.588
Min Z	39	-10.978	75	-283.588
Max rX	82	0.004	108	0.066
Min rX	83	-0.004	75	-0.066
Max rY	104	0.001	22	0.018
Min rY	103	-0.001	22	-0.018
Max rZ	109	0.003	158	0.014
Min rZ	1	-0.003	110	-0.014

Beam End Forces

Table 3:- 30m Straight and curved Angle truss beam end forces

	Beam	Node	Max Axial Force (kN)/Max Shear Force /Max Bending Moment(kNm) (for curved Angle section)	Max Axial Force (kN)/ Max Shear Force / Max Bending Moment (kNm) (for Straight Angle section)
Max Fx	337	178	242.060	455.590
Min Fx	248	31	-279.455	-274.116
Max Fy	338	130	166.707	19.514
Min Fy	337	1	-166.707	-19.514
Max Fz	31	1	18.351	21.488
Min Fz	31	1	-18.351	-21.488
Max Mx	337	1	32.352	5.086
Min Mx	337	1	-32.352	-5.086
Max My	337	178	88.131	166.369
Min My	337	178	-88.131	-166.369
Max Mz	337	178	1151.636	114.187
Min Mz	338	179	-1151.636	-114.187

Table 4:- 30m Straight and curved Angle truss beam end forces

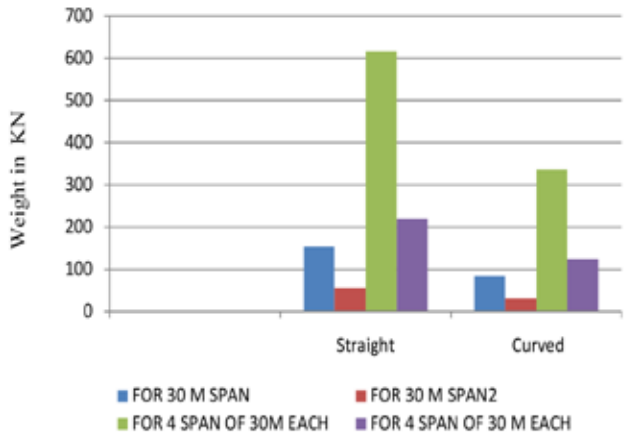
	Beam	Node	Max Axial Force(kN)/ Max Shear Force / Max Bending Moment (kNm) (for 30m curved tabular section)	Max Axial Force (kN)/ Max Shear Force / Max Bending Moment (kNm) (for 30m straight tabular section)
Max Fx	337	178	240.076	442.694
Min Fx	40	31	-153.965	-277.336
Max Fy	338	130	149.976	33.761
Min Fy	337	1	-149.976	-33.761
Max Fz	31	1	26.183	21.660
Min Fz	31	1	-26.183	-21.660
Max Mx	337	1	32.426	3.722
Min Mx	337	1	-32.426	-3.722
Max My	337	178	83.612	167.232
Min My	337	178	-83.612	-167.232
Max Mz	337	178	1026.068	109.476
Min Mz	338	179	-1026.068	-109.476

RESULTS

Comparison of total weight of angle and tubular section for straight and curved inverted pyramid shape geometry is done with the influence of removing purline. The inverted pyramid for roof truss is analyzed and design for 30m span, for straight and curved geometry. The total weight is compared of angle and tubular section for straight and curved geometry for the given span. It is found that tubular section has less weight compare to angle for all spans and the actual saving of material is about 25-30% by weight. Total weight for angular and tubular section for different is as follows.

Table 6: Weight for different span

Span (m)	Weight (Kg) For one span of 30 m		Weight (Kg) for Complete structure of 4span	
	Angle section ISA 75X75X10 ISA 130X130X10 ISA150X150X15	Tubular SECTION	Angle SECTION ISA 75X75X10 ISA130X130X10 ISA150X150X15	Tubular SECTION
30m Straight	154	55	616	220
30m Curved	84	31	336	124



Graph 1:- Graph of Weight different

CONCLUSION

After analysis and design following conclusion are obtained.

1. As we use the inverted pyramid shape geometry for roof truss with the influence of removing purline decreases the weight of structure.
2. This is designed for angle and tubular section to get light weight structure with its pleasant appearance, safety and minimum maintenance.
3. These are analyzed and design for straight and curved geometry of which straight geometry required more members for their minimum deflection than curved roof truss.
4. It also proves from the graph that the inverted pyramid geometry with removal of purline gives good result for long span structure.
5. It also proves that tubular structure is lighter than angle section.
6. Saving in steel by 35-40% by using tubular section for curved roof truss.
7. Hence this inverted pyramid shape is designed with tubular section for long span of curved roof truss gives better result and can be used.
8. Wind load is critical for the trusses so here seismic forces is negligible and not in consideration.

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Comparative Analysis and Costing of a Multi-story Steel Building

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ABSTRACT

One of the most frequently utilized building materials worldwide is steel. Steel's inherent hardness, ductility, and strength make it the perfect material for earthquake design. The design engineer must be aware of the pertinent in order to take advantage of these benefits for seismic application. Based on IS 1893: 2002, IS 875 and IS 800:2007, the building frame's seismic and wind depth sign is offered in this project. The current work's objective is to design a multi-story, wind force in accordance with IS 1893:2002 and IS 875 before constructing it in accordance with IS 800:2007. The frame has eight pieces. There are four horizontal bays and five lateral bays on this building's four stories. Using these methods of analysis, a steel moment- resisting frame was created in accordance with IS 800:2007. The section underwent multiple design iterations to ensure that it met all the requirements outlined in IS 800:2007. The proposed frame was once more examined, and the outcomes in terms of the bracings used were compared. Both the RCC and the Steel building's cost-effectiveness have been compared., Finally, the calculations for the depth sign of connection between a joint's interior and exterior have been completed. In addition, the foundation's design, which comprises the base plate, there are four horizontal bays and five lateral bays on this building's four stories. Using these methods of analysis, a steel moment resisting frame was created in accordance with IS 800:2007. In the procedure, IS 800:2007 was followed. The statistics have been drawn, and pertinent calculations have been displayed.

KEYWORDS: *Lateral displacement, Base shear, Response spectrum analysis, Steel building, Bracing, lateral displacement, Wind load.*

INTRODUCTION

Seismic analysis and design refer to assessing a building structure's response to earthquakes and designing it to withstand seismic forces [14]. Multi-storey buildings are particularly susceptible to seismic hazards, and designing them requires careful consideration of structural stability, strength, and ductility. Involves evaluating the building's strength and stability under static loads, while the dynamic analysis method involves assessing its response to earthquake-induced loads. In the case of a G+8 steel building, the analysis and design process will typically involve a combination of static and dynamic analysis methods [2]. The static analysis method During the design process, engineers will consider various factors such as the building's location, soil characteristics, seismic hazard levels, and building codes and regulations The aim is to ensure that the building can withstand the maximum anticipated seismic forces while minimizing damage and ensuring occupant safety [2].

The design process also involves selecting appropriate building materials, structural components, and connections such as steel moment-resisting frames, braced frames, and steel plates. These elements are designed to dissipate energy during an earthquake, which helps to minimize damage and reduce the

likelihood of collapse [22]. Overall, seismic analysis and design of multi-story G+8 steel buildings require careful planning, analysis, and design to ensure that the building can withstand the forces of earthquakes and keep occupants safe.

According to past experience, steel buildings that are susceptible to earthquakes respond well. The majority of catastrophic failures and significant casualties are related to structures composed of other materials. This might be explained by a few distinctive qualities of steel construction [19].

Figure 1 : Steel building with bracing

There are two ways to fight back against the earthquake:[28]

1. Structures with enough big sections that are only exposed to elastic stresses
2. Composed of smaller pieces, structures intended to create a variety of plastic zones.

Need for steel buildings in India

Without a doubt, due to the high population density, particularly in metro areas, horizontal construction has been restricted, and it is difficult to find real estate that is sufficiently spacious. Due to a lack of available space brought on by the exponential population growth in urban areas, higher structures with more floors are now the norm, which emphasizes the need for quicker construction. High- rise buildings are increasingly being constructed out of steel. There are not many high-rise or multi-story buildings in India that are made entirely of steel or largely of steel; in fact, they might even be considered a "novel concept in the construction business."

Objective 1. To determine and assess the responses of the compression and flexural members to seismic loading.

Using spreadsheets for compression members, flexural members, and bolted connections as well as the software's analysis outcomes, design, and analysis of steel buildings.

Comparison of costs In-depth comparison of the cost per square meter of reinforced concrete and steel-framed buildings.

LITERATURE REVIEW

Seena S.K., Vasugi D.A. (2017) In this paper was studied mostly due to their capacity to produce large-span space at reasonable prices. The pre-designing and pre-fabrication quality, as well as the lightweight result and economically sensible component, all contribute to the extremely complex process used in PEB. The truss chord members in this study are created using SAP 2000-18 for a variety of sections, including ISLC/ ISA, UB/UC, and SHS. For the purpose of designing industrial buildings, the most cost- effective truss chord sections are used. As a result, industrial buildings are built with various bracings, including X-, diagonal-, and k-bracing, to carry out wind analysis. The PEB structure for the same parameter is then compared to the best optimal structure. When PEB is the desired design for a project, it is discovered that PEB with K-bracing is most suited when both economic and technical analyses are considered simultaneously. This includes diagonal bracing and k-bracing.

Sangle B.K., Mhalungkar M.V. (2012) In this paper studied Bracing can significantly alter the overall seismic behavior of a steel-framed building, as was explored in this research. In this study, various bracing system configurations for the Northridge earthquake are done. A new pattern of bracing system is used to determine below the permitted limit, further optimization study was conducted to choose the appropriate sort of bracing arrangement. The study's structures had various bracing system layouts and those that didn't Balaji U.A., Salvarsan M.E. (2016) residential building studied while taking earthquake effects into account. Analysis that is linear, static, and dynamic is done. The authors looked at deflection, displacement base shear plots, etc.

The three approaches used by the authors to design the earthquake, EQ (Earthquake), The authors also adhere to a step-by-step process. Definitions, design seismic base shear, load combinations, material qualities, and definitions like M25, M30, Fe 415, column size, slab thickness, LL (Live load), DL (Dead load), and the number of stories is just a few. f) Design and analysis. Max. Deflection displayed in fig., the author's conclusion.

Gaikwad P.S., Prof. Tolani K.K. (2015) The basic goal minimizes structural during an earthquake. It is decided on factors like story drift, story shear, and story torsion. Dynamic analysis should be carried out for both symmetrical and unsymmetrical buildings, depending on whether the response spectra, technique, or time history approach is being employed. The mathematical model of a building is being developed in dynamic analysis, and strength and stiffness are being determined. Additionally, it exhibits a greater reaction to structures under dynamic loads.

Sasaki M.K., Michio Y.S. (2004) The loss of vertical structural members caused by explosions and crashes has an impact on the redundancy of steel frame structures, according to this paper's analytical analysis. Because the vertical loads can be spread among the remaining vertical structural members, it was discovered that steel structural frames constructed with joints with load-carrying capability will stay standing even when multiple vertical load-carrying components are destroyed. This study examined how actual Japanese high-rise steel buildings responded to unexpected external forces (Loss of Members). For the experimental investigation, it is conceivable to shift the loads that failed columns bore and to inhabit the space left by the missing column when the remaining frame components have a stiff joint structure. even if some columns are gone, there is progressive collapse.

Bayan A.A., Sariffudin S.M., Hanim O.M. (2010) An experimental study of cold-formed steel frames is presented in this work. were joined back-to-back at the joints. The author used 10 frames, and experiments were conducted with CFSS and bolted moment connections of varying stiffnesses under lateral loads (cold-formed steel structure). The stiffness and performance of the connections at the base of the columns had a considerable impact on the structural behavior of the frames, according to the authors. The two independent modes of failure that he notes are: (a) the column twisting under a heavy load; and (b) bearing failure in the section web near the bolt hole.

Cher S.T., Mahmood M.T. (2015) The behavior of joints for cold-formed steel frames, especially the connection between the beam and the column, has not been well investigated, according to the author's research. The isolated joints test for three deference is presented in this study. experimenting with bolted angle joints with angles ranging in thickness from 2 to 6 millimeters WC (web cleat connection), FC (flange cleat connection), and FWC are the connections the author has utilized (flange web cleat connection). The author looked at how to angle connections affected strength and stiffness in a steel structure.

Prof. Kulkarni B.K., Jirage S.R. (2011) This essay compared the working state method (WSM) to the local state method (LSM) (limit state method). Linear members known as tension members experience axial stresses that result in a crucial area, leading to failure. Angle tension member for both equal and odd angles. In comparison to the operating stress approach, the limit state method produces greater values. It is more cost-effective to design tension members utilizing the Angles by Limit state approach

Milind B.K., Milind. D.S. (2014) Learn the most cost-effective tool that makes the best use of steel by studying this paper. We are familiar with the structural elements and parts utilized in pre-engineered buildings. There are several different kinds of components, including primary, secondary, and sheeting. For low-rise buildings, preengineering is more cost-effective than CSB (conventional steel construction). The roof structure of a PEB (preengineered building) is nearly 26% lighter than a CSB. The price of a PEB building is 30% less than that of a CSB construction. Neha Pawar, Kuldeep Dabhekar, P.B. Patil, Isha Khedikar (2021) In this paper was one of the studies reviewed in this paper suggested that the inclusion of triangular plates beneath floating columns can result in increased base shear and decreased storey drift and displacement. However, there is scope for further research to explore the impact of stiffness irregularities and torsional irregularities on the

behavior of floating columns. Additionally, most of the literature reviewed in this study focused on rigid floor diaphragm action, so it would be valuable to analyze the same buildings with flexible floor diaphragms. Finally, the use of fiber Reinforced Polymer (FRP) could also be examined to evaluate the structural response of buildings with floating columns.

Yogesh Dhamge, Dr. Sanket Sanghai. (2021) In this paper study, Analytical time history is used to determine the structural response of RC structures with an unusual G+10 floor that lacks the cross- bracing integration system, which is an effective way of concentrating forces. TABS 2016 is the program employed for analysis, examining the impacts of various model configurations, including narrative shifts, multi-story shear, and multi-storey rigidity.

Ambadkar S.D., Prof.Pajgade (2012) In this Indian study, the analysis, of a structure's whole life cost (WLC) is calculated, which considers both current and future costs. This provides a more thorough and accurate assessment of the price tag attached to owning any structure. As a result, there is a general trend toward utilizing LCC as a metric for choosing the optimal option and a rise in awareness of the durability component of buildings on a global scale. The decks are compared to the LCC of RCC industrial structures in this study.

Khaleel M.T., Kumar U.D. (2016), Using the computer program ETABS 2015, the steel braced frame's response to equivalent static analysis and response spectrum analysis was studied in this work. A bracing system is a practical approach to improving lateral strength. regularly and irregularly distributed systems are attempted. To determine the best bracing system for steel-framed high-rise structures, various bracing systems were tested. ETABS is used to simulate and analyze the structure, and sections are chosen depending on how well they can limit lateral story displacements. Zone V, according to IS 1893-2002, has been chosen for the investigation. Numerous variables, including Because of the higher stiffness. When compared to a building without lateral load bracing structures. Utilizing a bracing system makes the structure stiffer and draws in more lateral force.

METHODOLOGY

The compression and flexural member's behaviors when subjected to earthquake loading.

Using an Excel spreadsheet for reinforcement bars, flexural representatives, and bolted connections as well as the results of the analysis from the software, design a steel structure.

Cost analysis: Order to accurately determine the comparison between reinforced concrete and steel bay frame buildings.

CONNECTION DETAILS

Various connections of steel buildings are connected by welds, bolts, rivets, or a combination of these. In the MSB structure, a bolted connection is used. For connection high strength structural bolts are used as per IS 3357:1985 high strength structural bolts - specification, IS 6623:2004 high strength structural nuts – specification, IS 4000:1992 High strength bolts in steel structure – code of practice, and for anchorage bolts connection as per IS 5624:1993 for foundation bolts – specification.

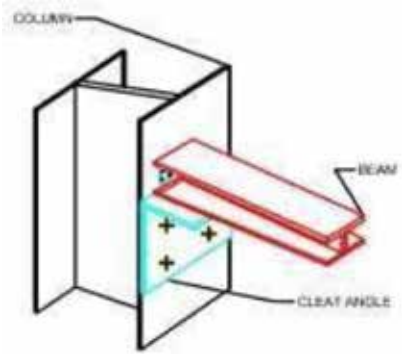


Figure 2. Column to Beam connection

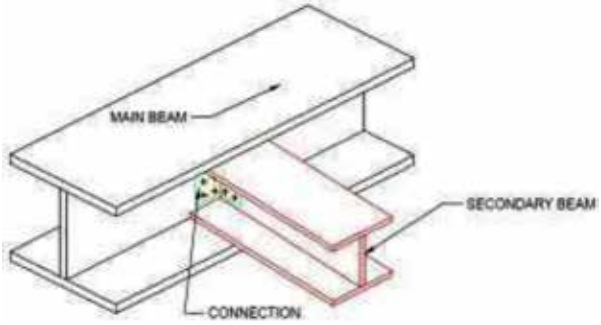


Figure 3. Beam to Beam connection

THE LAYOUT THE OF FLOOR WITH MEMBER PROPERTY

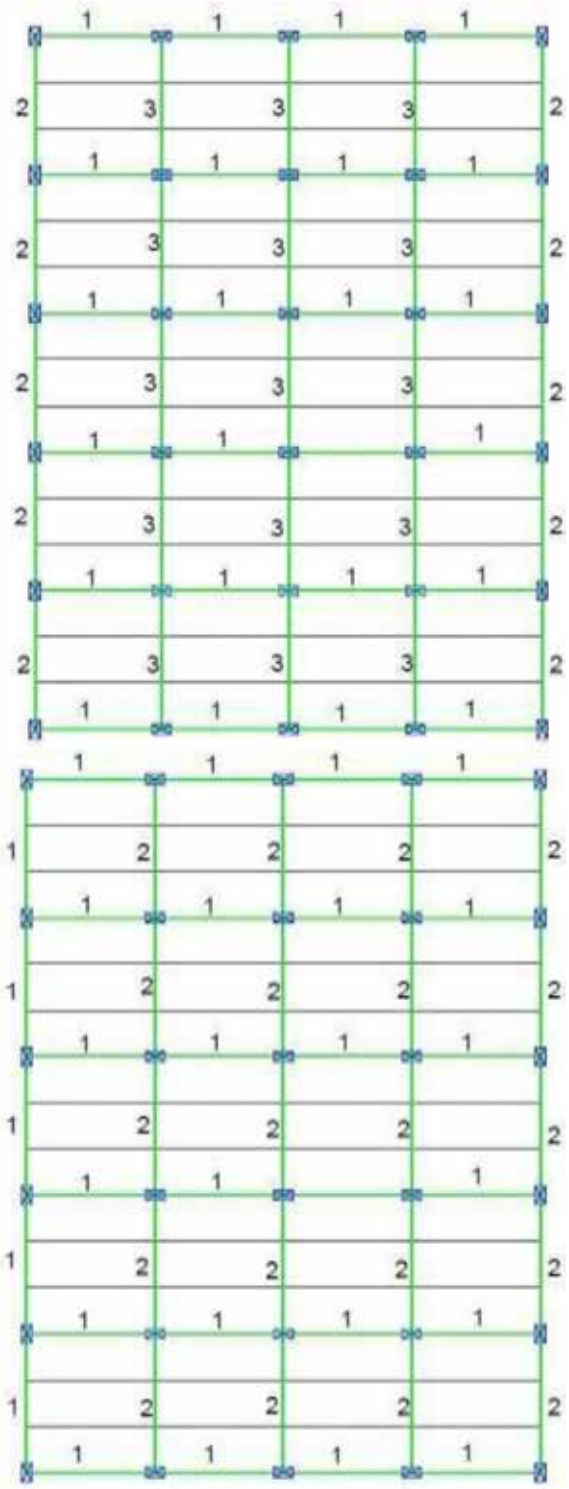


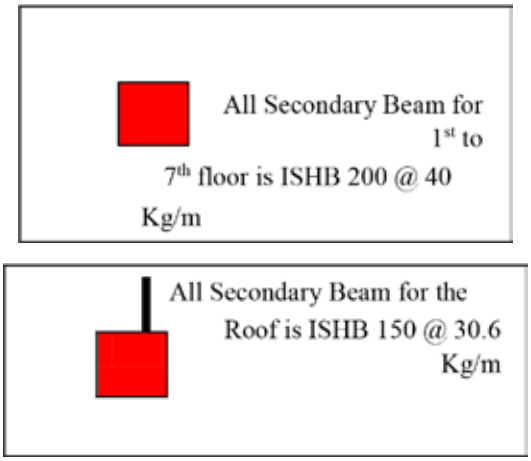
Figure 4- Main Beam for Roof

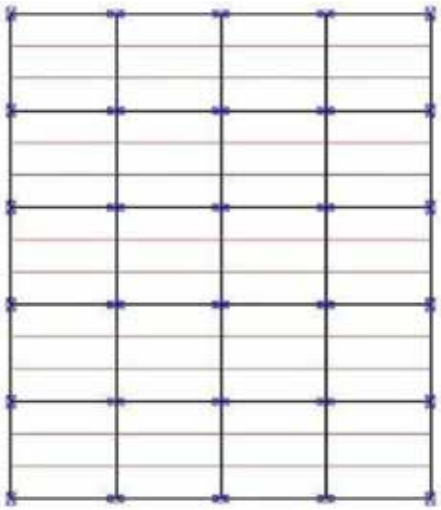
Nos	Sections
1	ISHB 150 @34.
2	ISHB 225 @ 46
3	ISHB 300 @ 63

Figure - Secondary Beam 1st to 7th-floor

Nos	Sections
1	ISHB 200 @ 40 Kg/m
2	ISHB 250 @ 54.7 Kg/m

Figure - All Secondary Beam for





Height (each floor ht. 3m)	Sections
PL to 3rd floor	Built-up
3rd to 6th floor	ISHB 350 @ 72.4 Kg/m
6th to Roof	ISHB 250 @ 51 Kg/m
Bracing	ISB 172x92x4.8 @ 18.71kg

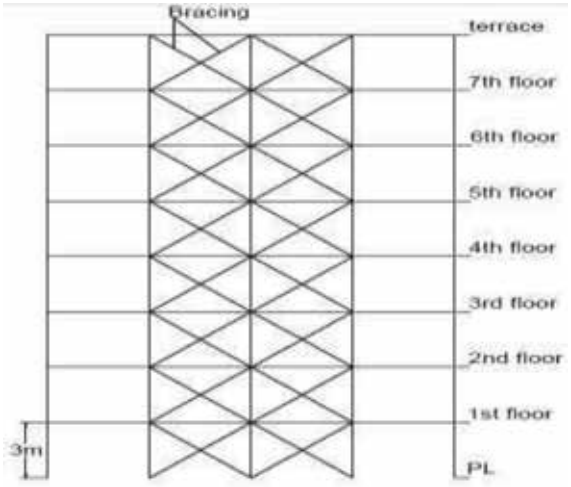


Figure - Elevational view a

Built-up Section property

- Total depth = 520mm
- Top and bottom flange width = 280mm
- Web thickness = 12mm
- Top and bottom flange thickness = 12mm

DESIGN OF G+8 STOREY STEEL BUILDING

Compression Member Design

Grouping	Height	Required Load	Section	Provide Load
C1 to C30	0-6m	2250	Built-up section	2570.33
C1 to C30	6-15m	1670.74	ISHB 400-2	1786.63
C1 to C30	15-24m	849.71	ISHB 250-1	1142.52

Flexural Member Design-

a) Main beam and secondary beam

	Grouping	Beam no	Section
	FLOOR MB		
A	B = 6, 7,8,9,10,11,12,13,14,15,16,17,18,19,20	15	ISHB 300@63 kg
B	B = 1, 2, 3, 4, 5, 21, 22, 23, 24 ,25	10	ISHB 225@46.8kg
C	B = 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49	24	ISHB 150@34.6kg
2	FLOOR SB SB 1 to 40	40	ISHB 200 @ 40kg
3	ROOF MB		
A	B = 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	15	ISHB 250@54.7kg
B	B = 1, 2, 3, 4, 5, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49	34	ISHB 200@40kg
4	ROOF SB 1 to 40	40	ISHB 150@34.6kg

Bracing System Design:

For both seismic and wind models the tubular bracing system is used of size = ISB 172x92x4.8 @ 18.71 kg

Bolted Connection

"Black bolts" to connect the column to the beam and beam to column and "J" type anchor bolt to connect the column to the two bases.

Deck Sheet Details

- Slab depth, (concrete thickness of M20) tc = 80mm
- Rib depth, hr = 50 – 52mm
- Rib width top, wrt = 180mm
- Rib width bottom, wrb = 90mm
- Rib spacing, sr = 270
- Deck shear thickness =1.5mm (thickness varies from 0.8 to 1.5mm)
- Shear stud diameter = 19mm
- Deck unit weight = 0.11 KN/m2
- Shear stud Height, hs = 100mm
- Oneway is contribution of all slabs; provision of Secondary beam with perpendicular to the 4 meterss span at ters, respectively.
- The slab's placement is parallel to the 3.5 meters.
- Maximum deck sheet laps in vertical and horizontal directions are 150mm and 90mm, respectively. The Rebar lap distance is 50 times the bar diameter.

- The minimum cover is 100mm and the maximum cover is 300mm for the rebar main and distribution.

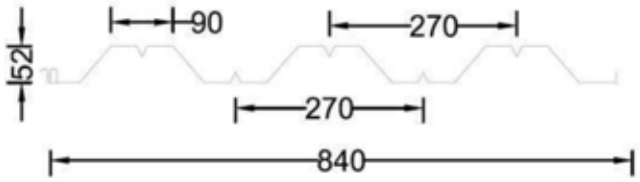


Figure 7.1 - Deck sheet dimensions

QUANTITY ESTIMATION

Sr. no.	Member	Property	No.	Length	Weight	Total length	Total Quantity
				m	Kg/m	m	kg
1	Column	BUILTUP	30	6	99.475	180	17905.5
		ISHB4002	30	9	82.2	270	22194
		ISHB 2501	30	9	51	270	13770
							63869.5
2	BEAM at Roof						
	a. Main beam	ISHB 2002	10	4	40	40	1600
		ISHB 2002	24	3.5	40	84	3360
		ISHB 2502	15	4	54.7	60	3282
	b. Secondary beam	ISHB 1503	40	3.5	34.6	140	4844
							23086
3	Floors 1 to 7						
	a. Main beam	ISHB 1503	24	3.5	34.6	84	2906.4
		ISHB 2252	10	4	46.8	40	1872
		ISHB 3002	15	4	63	60	3780
	b. Secondary beam						
		ISHB 200-2	40	3.5	40	140	5600
							89108.8
4	Brace	ISB172X92X 4.8	96	5	18.71	480	8980.8 5508.224
			64	4.6	18.71	294.4	
	Overall, the Weight Of steel (K ;)						*1760563.32*

- Building's total built-up area is 280 square meters or 3014 square feet.
- According to the price of structural steelwork per kg, which is 56.344 Rs, the total weight of steel is 180553.324 kg. The total cost of the steel is Rs. 1,01,73,100. The required amount of steel is 6.656 kg/square foot.
- Deck sheet slab for PIL52/271 per m2 and 450 Rs., according to recent market rates. In this building, the total slab area is 2240 m2 (280 m2 x 8 floors). 10,08,000 Rs. total will be spent on the deck sheet slab.
- The amount of PCC over the deck sheet slab is 22.4 m3, and the cost per m3 as stated in the DSR is 4466 Rs. 8,00,310 Rs. is the total cost of filling a PCC.

CONCLUSION

The Angle form bracing and Tube shape bracing in the structure lessen lateral displacement or joint displacement brought on by wind load effects as compared to multi-story steel buildings without any bracing. This study demonstrates that the Type 3 type of angle bracing offers the least amount of lateral movement when compared to other angle bracing models. Additionally, the Type 3 Tube Bracing Model offers the least degree of lateral movement in comparison to other tube bracing system models. Furthermore, it has been observed that steel-framed structures with tube bracing display less joint displacement than traditional structures. A further benefit of tube bracing over angle bracing is that it makes steel structures lighter. Joint displacement and dead load are greatly improved in a steel structure with tube bracing, the entire structure.

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31. IS 875 – Wind load on building and structures

32. IS 3757:1985 High-strength structural bolts

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Friction Dampers Effects on Seismic Response Control of Irregular Building

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ABSTRACT

This research investigates the impact of friction dampers on the management of uneven building seismic response. The study's main goal is to comprehend how well friction dampers can reduce the dynamic response of irregular structures to earthquakes. Through a literature review and numerical simulations, the behaviour and performance of friction dampers in various irregular building configurations are analysed. The evaluation includes majorly interstory drifts, base shear forces, and floor accelerations. The findings contribute to the knowledge of seismic response control in irregular buildings and provide insights into the potential benefits and limitations of friction dampers in enhancing their seismic resilience. The research aims to improve design practices for irregular buildings in seismic-prone regions, promoting their safety and reliability.

KEYWORDS: *Inter-story drift, Friction dampers, Story acceleration, Base shear, Time history analysis, Seismic zone.*

INTRODUCTION

An earthquake is a natural phenomenon characterized by sudden, intense vibrations in the Earth's crust, caused by the release of accumulated energy along faults. Its impact on the built environment and human lives can be devastating. Earthquakes result in ground shaking that damages structures, infrastructure, and lifelines like roads and bridges. They can trigger secondary hazards such as landslides, tsunamis, fires, and aftershocks, compounding the destruction. In recent years, there has been an increased focus on the behaviour of unsymmetrical buildings under dynamic loads in structural engineering.

These structures, with varying geometries or masses on either side of the centreline, exhibit unique responses, posing challenges for analysis and design. To mitigate the adverse effects of dynamic loads, including seismic forces, incorporating friction dampers into the structural system has proven effective. Friction dampers are devices that reduce seismic movement and protect structures. They absorb and dissipate seismic energy, enhancing the building's stability. These dampers are particularly useful for unsymmetrical buildings, as they can counteract the uneven forces generated during an earthquake. By providing additional strength and stability, friction dampers help minimize damage, increase the likelihood of structural integrity, and safeguard occupants' safety. The integration of friction dampers in building design has become crucial in regions prone to earthquakes. Their implementation reduces repair costs, increases resilience, and safeguards against escalating seismic activity. Growing in popularity in the field of structural engineering as a result of their efficiency in regulating structural reactions to dynamic loads. By mitigating the detrimental effects of earthquakes, friction dampers contribute to safer and more sustainable built environments

FRICTION DAMPERS

Friction dampers are devices widely used to dissipate

energy and reduce vibrations in various engineering applications, including wind turbines, bridges, and buildings. These dampers rely on the principle of frictional resistance to control the seismic response of structures. By dissipating energy through controlled slip between surfaces, friction dampers can effectively mitigate the damaging effects of seismic events, improving the overall performance and safety of building. The use of friction damper for irregular building responses management has grown in popularity in recent years. By creating friction between two surfaces that are in contact, these dampers are intended to lessen the amount of seismic movement that a building experiences during an earthquake. Friction aids in absorbing and dissipating the energy of the seismic waves.

Fig. 1.

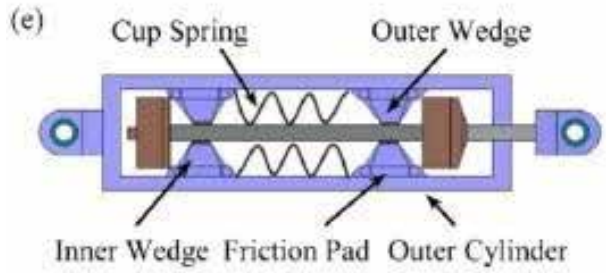


Fig. 2.

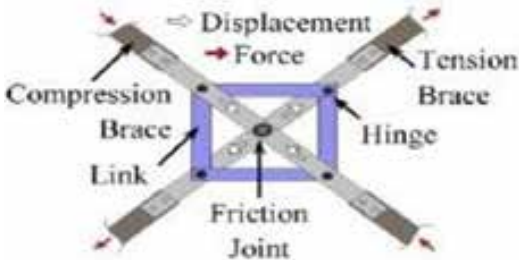


Fig. 3

OBJECTIVES & SCOPE OF THE WORK.

1) To assess the effectiveness of friction dampers in reducing the earthquake-induced response of structural systems.
2) To compare the outcomes of an irregular building with friction dampers alone with an irregular building with friction dampers in terms of base shear, storey drift and storey acceleration.

LITERATURE REVIEW

R.B. Ghodke et al. [1] focused on the torsional behavior of asymmetrical reinforced concrete (R.C.) frames under earthquake loads. They found significant torsional moments in these frames, suggesting design recommendations such as shear walls and symmetrical column placement.

Gennaro Maggiolo et al. [2] reviewed seismic code guidelines for vertically irregular frames, highlighting the inadequacy of current regulations and proposing recommendations for improved seismic design.

M. DeStefano and Pintucchi [3] conducted a comprehensive review of research on structural irregularities and seismic performance, emphasizing the importance of seismic retrofitting and suggesting future research directions.

Sujit Jaisee et al. [10] provided an overview of passive friction dampers, discussing their suitability, slip load, seismic control, influencing parameters, limitations, and the need for further research in creating more effective and reliable dampers.

J.H. Griffin et al. [11] focused on incorporating bench test data into the design of friction dampers for fast speeds turbo machines, using finite elements analysis. and analytical models to enhance design reliability. Their study presented a design procedure that predicts engine behavior and ensures accuracy without conducting engine tests.

M. Novak and L. El Hffnawy [12] explained the interactions between soil and structure that affect damping, emphasising the need of flexible foundations. They gave ways for assessing this effect and talked about how to determine how the foundation will affect damping.

RESEARCH METHODOLOGY.

This study aims to assess the impact of friction dampers on irregular building seismic behaviour. ETAB software is used for the design and analysis. Two RCC structures have been modelled for this. The construction of Model 1 is devoid of friction dampers, while Model 2 has friction dampers.

The study of time is thought to be undertaken in order to comprehend the seismic behaviour of the building. Data on recorded ground motion has been taken into consideration for the analysis. After modelling is finished, it automatically assigns code-based loading conditions for seismic and gravity. Dynamic loading is indicated for the two load situations TIMEX and TIMEY.

ANALYTICAL DATA

Basic Parameters for Building Analysis Data

DIMENSION OF PLAN	L SHAPE 6 X 30, 6 X 30
BUILDING TOTAL HEIGHT	17 M
EACH STOREY HEIGHT	3.0 M
SIZES OF BEAM	300MM X 300MM
SIZES OF COLUM	500MM X 500 MM
SLAB THICKNESS	130
EXTERNAL WALL'S THICKNESS	230
INTERNAL WALL'S THICKNESS	150
SEISMIC ZONE	V
CONDITION OF SOIL	Medium
REDUCTION FACTOR OF RESPONSE	5
FACTOR OF IMPORTANCE	1.2
FLOOR FINISH	2
LIVE LOAD ON ALL FLOORS	3
CONCRETE'S GRADE	M25
STEEL GRADE	Fe500 and Fe415
CONCRETE'S DENSITY	25 KN/M³
BRICK MASONRY DENSITY	19 N/M³

Seismic Data

SR. NO	MODEL DESCRIPTION	
1	Zone	V
2.	Zone factor	0.36
3.	Type of building	Commercial
4.	Reponses reduction factor	5(SMRF)
5.	Importance factor	1.2
6.	Building height	17
7.	Soil condition	Medium
8.	Damping ratio	5 %

Models in ETAB

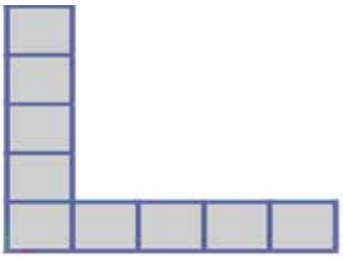


Fig:4 building's floor plan

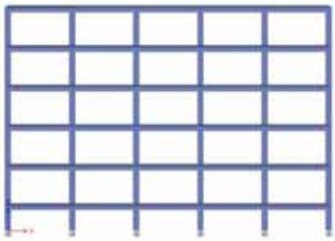


Fig. 5 side view of the structure

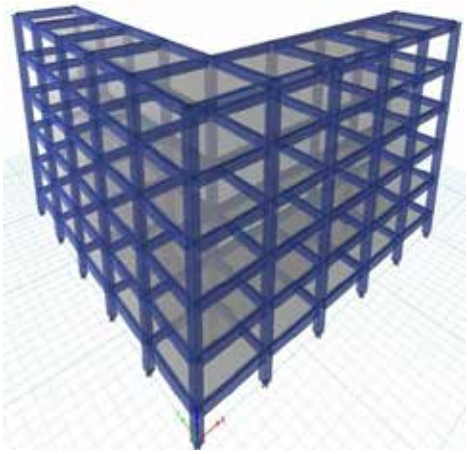


Fig. 6. 3D rendering of an building

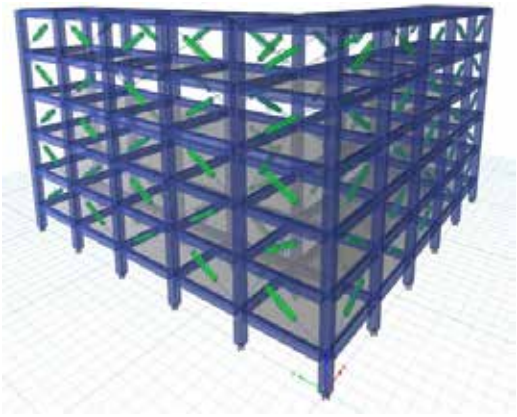


Fig. 7. 3D rendering of an atypical building with dampers

RESULTS AND DISCUSSION

Modal Participation Mass Ratio.

Table1: Modal participating mass ratio for model 1

		Modal Participating Mass Ratios (MODEL 1)				
Mode	Period/ sec	Sum UX	Sum UY	Sum RX	Sum RY	Sum RZ
1	1.025	0.2354	0.2354	0.0846	0.0846	0.2664
2	0.976	0.6079	0.6079	0.2143	0.2143	0.2664
3	0.904	0.7448	0.7448	0.2597	0.2597	0.7422
4	0.297	0.7851	0.7851	0.4001	0.4001	0.7767
5	0.288	0.8405	0.8405	0.6014	0.6014	0.7767
6	0.27	0.8557	0.8557	0.6623	0.6623	0.8547
7	0.145	0.8787	0.8787	0.702	0.702	0.8606
8	0.144	0.904	0.904	0.7455	0.7455	0.8606
9	0.136	0.9064	0.9064	0.7494	0.7494	0.9061
10	0.086	0.9219	0.9219	0.7919	0.7919	0.9061
11	0.086	0.9374	0.9374	0.8344	0.8344	0.9062
12	0.081	0.9374	0.9374	0.8344	0.8344	0.9374
13	0.059	0.9477	0.9477	0.8603	0.8603	0.938
14	0.059	0.9584	0.9584	0.8872	0.8872	0.938
15	0.056	0.9588	0.9588	0.8882	0.8882	0.9589
16	0.047	0.9781	0.9781	0.9406	0.9406	0.9617
17	0.047	0.9987	0.9987	0.9965	0.9965	0.9617
18	0.044	1	1	1	1	1

Table 2: Model 2's modality participation mass ratio.

Ratios of Modal Participating Masses (MODEL 2)						
Mode	**Period/ sec**	**Sum UX**	**Sum UY**	**Sum RX**	**Sum RY**	**Sum RZ**
1	1.001	0.1676	0.1634	0.0582	0.0599	0.4074
2	0.81	0.5526	0.5385	0.1776	0.1827	0.4075
3	0.714	0.7594	0.7604	0.2425	0.2435	0.7511
4	0.292	0.786	0.7867	0.3357	0.3376	0.813
5	0.266	0.7894	0.7902	0.3412	0.3428	0.813
6	0.255	0.8367	0.8366	0.5391	0.5425	0.813
7	0.225	0.8635	0.8634	0.6636	0.6652	0.8606
8	0.186	0.8665	0.8664	0.6787	0.6796	0.8606
9	0.143	0.8803	0.88	0.7024	0.7034	0.8852
10	0.134	0.901	0.9007	0.7385	0.7393	0.8852
11	0.122	0.9109	0.9105	0.7559	0.7563	0.9101
12	0.116	0.9131	0.9133	0.761	0.7602	0.9101
13	0.091	0.9131	0.9133	0.761	0.7602	0.9101
14	0.086	0.9132	0.9133	0.7612	0.7603	0.9101
15	0.085	0.9234	0.9234	0.7892	0.789	0.9202
16	0.082	0.9373	0.9372	0.8287	0.8286	0.9202
17	0.077	0.9416	0.9415	0.8419	0.842	0.9396
18	0.075	0.9423	0.9423	0.8446	0.8445	0.9396
19	0.075	0.9423	0.9423	0.8446	0.8445	0.9402
20	0.065	0.9423	0.9423	0.8446	0.8445	0.9402

Comparison of Time Period.

Comparison of the time period of two different models

Table 3: Time period.

Modal Direction Factors

Modal Direction Factors			
Case	Mode	Period/ SEC	Period/SEC
		MODEL 1	MODEL 2
Modal	1	1.025	1.001
Modal	2	0.976	0.81
Modal	3	0.904	0.714

Base Shear

Comparing the base reaction output cases for base shear for model 1 and model 2

Table 4: Base shear (model-1)

Output Case	Case Type	FX-1	FY-1
		KN	KN
EQ x	Lin-Static	-2977.9508	0
EQ +y	Lin-Static	0	-2977.9508
THX	Non-Mod Hist	11475.2797	1789.5287
THX	Non-Mod Hist	-10670.6117	-1788.4476
THX-Y	Non-Mod Hist	1789.5287	11475.2797
THX-Y	Non-Mod Hist	-1788.4476	-10670.6117

Table 5: Base shear (model-2)

Output Case	Case Type	FX-2	FY-2
		KN	KN
EQ x	Lin-Static	-2000.2782	0
EQ y	Lin-Static	0	-2000.2782
THX	Non-Mod Hist	12960.3618	1689.2579
THX	Non-Mod Hist	-11697.408	-1661.016
THX-Y	Non-Mod Hist	1691.5722	12927.5921
THX-Y	Non-Mod-Hist	-1664.4606	-11661.8319

Graph 1: Comparative study of base forces in x and y direction in model 1 vs model 2

Storey Acceleration

Table 6: Storey acceleration (Model-1)

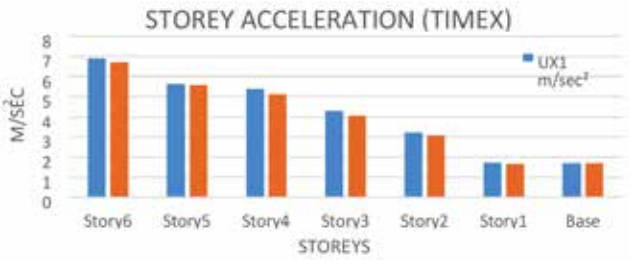
Storey Accelerations (MODEL1)			
Story	**Output Case**	**Step Type**	**UX1**
			m/sec²
Story6	THX	Max	6.91
Story5	THX	Max	5.63
Story4	THX	Max	5.4
Story3	THX	Max	4.28
Story2	THX	Max	3.21
Story1	THX	Max	1.72
Base	THX	Max	1.69

Storey speed for model 1 in the X direction Case of load: TIMEX.

Table 7: Storey acceleration (Model-2)

Story Accelerations (MODEL 2)			
Story	**Output Case**	**Step Type**	**UX1**
			m/sec²
Story6	THX	Max	6.71
Story5	THX	Max	5.58
Story4	THX	Max	5.12
Story3	THX	Max	4.06
Story2	THX	Max	3.07
Story1	THX	Max	1.66
Base	THX	Max	1.69

Storey accelerate for model 1 in the X direction Typical load: TIMEX



Graph 2: Correlation of Storey accelerated for the load scenario in the x direction TIMEX for models 1 and 2 separately

Table 8: Storey acceleration (Model-1)
Story Accelerations (MODEL 1)

Story Accelerations (MODEL 1)			
Story	**Output Case**	**Step Type**	**UY1**
			m/sec²
Story6	THX-Y	Max	6.91
Story5	THX-Y	Max	5.63
Story4	THX-Y	Max	5.4
Story3	THX-Y	Max	4.28
Story2	THX-Y	Max	3.21
Story1	THX-Y	Max	1.72
Base	THX-Y	Max	1.69

For model 1, storey acceleration in the Y direction TIMEY is a load case

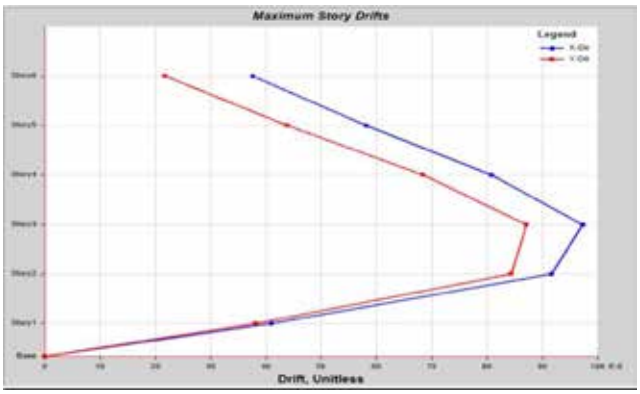
Table 9: Storey acceleration (Model-1)

Story Accelerations (MODEL 2)			
Story	**Output Case**	**Step Type**	**UY2**
			m/sec²
Story6	THX-Y	Max	6.7
Story5	THX-Y	Max	5.58
Story4	THX-Y	Max	5.11
Story3	THX-Y	Max	4.05
Story2	THX-Y	Max	3.06
Story1	THX-Y	Max	1.66
Base	THX-Y	Max	1.69

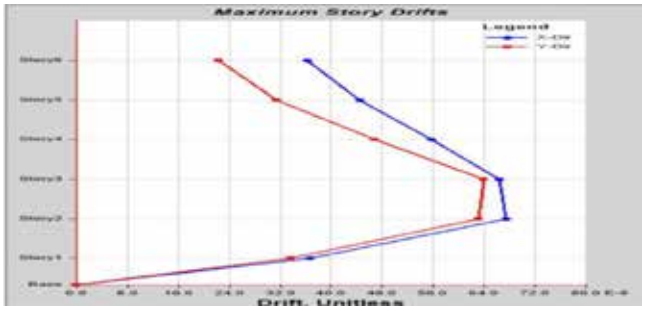
Storey acceleration in the Y direction for load case TIMEY in model 1

Graph 3: Storey acceleration in the Y direction is compared for the load case TIMEY for models 1 and 2, respectively

Storey Drift



Graph 4: For the load scenario, storey drift is measured as Timex and Timey, respectively



Graph 5: For the load example, storey wander in the x and y directions: The two terms are Timex and Timey

CONCLUSION

Friction dampers have been demonstrated to be a successful method for managing the response of irregular buildings to seismic loads. The findings of thisinquiry demonstrate that friction dampers can be used to lessen the structural reaction, including time period, storey displacement, storey drift, and storey acceleration.

When friction dampers were added to the structure, it was discovered that the time period was reduced.

The maximum base shear can be reduced by dampers in buildings, however this effect has been proven to be minor because buildings with dampers, such as model 2, have higher base shear than model 1.

The inclusion of dampers also resulted in a decrease in maximum storey displacement.

Buildings equipped with friction dampers have been seen to reduce story drifts. Base shears, storey shears are likewise higher for buildings with dampers than for buildings without dampers.

The addition of dampers increased the mass of the structure, which is why the base shear and storey shear increased.

The maximum storey acceleration will not be lowered by adding too many dampers, but it will decrease with their addition.

The addition of friction dampers has boosted the building's percentage of input energy dissipation.

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Performance of Steel Structure on Various Earthquake Zones

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ABSTRACT

Earthquakes are a natural occurrence that can occur abruptly and result in significant destruction. The majority of Indian soil is unstable due to earthquake-induced vibrations. In contrast, while it is impossible to stop earthquakes from happening, the damage can be reduced with the help of efficient seismic designs. By taking into account several limit states outlined by the rules and using the affordable ones, the design can be completed. Semi-elastic design of the structure is more cost-effective than elastic design because whole elastic response design of the structure is highly expensive. In the codal method of design, steel building are constructed from structural steel section and are created using the code basis prescriptive guidelines. The Performance of the buildings cannot be controlled during such a design process. In steel Constructions, the desired performance can be attained by selecting the appropriate section. Now days steel structure are a popular type of structure in many nations and its financial as well. It is essential to research seismic behavior of structure in different zone which are designed by code guidelines. This technique employs an algorithm based on computer programming ETAB-19. In this we considered spectral computational ground motion data (sgm)The Building operations are carried out in accordance with historical precedent. analysis (direct numerical integration method (DNI)) and pushover analysis.

KEYWORDS: *Performance of steel section, Different zone, Seismic analysis, ETABS, Steel structure.*

INTRODUCTION

Among the most frequently utilised building materials worldwide is steel. Its inherent toughness, strength, and high ductility are the qualities that make it perfect for use in building construction. Current earthquake research shows that steel is the most resilient material for structures against seismic loads when compared to other materials. Its comparative analysis looks at factors like structural performance, construction time, durability, etc. to determine whether steel structures are practical. The huge destruction of engineered systems and facilities caused by an earthquake is a natural occurrence. Currently, scientists are particularly interested in earthquake engineering because this is an occurrence that is difficult to forecast and occurs for a variety of reasons, including;

1. the shifting of tectonic plates
2. Sudden slips at the faults.
3. Construction of dams and huge structure
4. Quakes caused by volcanoes.
5. Due to the increased in use of explosives material like dynamite and other
6. Because of an increase in mining work

This topic has been the focus of much research, and more are still being conducted since the more we learn, the more we can do to lessen the harm and save lives. According to seismology studies, tectonic activity is the primary source of 90% of earthquakes. An engineer's duty in civil engineering is to maintain the economy while ensuring the highest level of safety in the structures they construct. Steel structure buildings are a popular form of construction in many countries due to their cost-effectiveness. These buildings are constructed using structural sections and designed using IS codal

methods to achieve the target performance in steel structural building.

The performance level of a steel structural building indicates its potential damage. There are 3- primary performance levels: Earthquake Prevention, Life Security, and Quick Occupancy, Performance Point. Choosing the appropriate PP is critical to ensuring the safety of the structure and its occupants

To cheek the point: -

If , $\Delta_{pp} < \Delta_{IO}$, it implies **IO** level of building.

$\Delta_{pp} > \Delta_{IO}$ & $< \Delta_{LS}$, **LS** level of building.

$\Delta_{pp} > \Delta_{LS}$ & $< \Delta_{CP}$, **CP** level of building.

TIME HISTORY ANALYSIS

The structural reaction is computed via time history analysis at various later time instants. In other words, the consequence is the acquisition of time histories of the structural response to a particular input. The behaviour of a structure throughout time, both before and after the installation of a load, can be determined from a full-time history. The structure's equation of motion must be solved to determine the response's complete time history to determine the complete time history of the response.

PUSHOVER ANALYSIS

Nonlinear static analysis the analysis produces a plot of total base shear verses top displacement in the structure, which would identify any early failure or weakness under constant vertical loads and gradually increasing lateral pressures. The study is done all the way to failure, making it possible to calculate the collapse load and ductility capacity. On a building frame, load and displacement are applied progressively, the development of plastic hinges, stiffness deterioration, and plastic rotation are watched, and the response of the entire structure to lateral inelastic force and displacement is calculated.

OBJECTIVE

1. To study the performance level of steel section used in building to know the performance of the steel members.
2. To identify the behaviour of steel structure in different zone (III, IV, V).
3. To evaluate the performance of steel buildings in zone III, IV, V by using pushover analysis, nonlinear time history analysis by using ETAB-19.

ANALYTICAL MODELLING

In this work, a G+6 storey steel structure is subjected to systematic investigation. Analysis of this structure is carried out by using ETAB 19 software. In this study, structure is analysed for zone III, IV, V according to IS 1893 (Part-1)2016, IS 13920-2015 with analysis of pushovers and non-linear temporal histories (Direct Numerical integration.)

GEOMETRY OF STRUCTURE

- Building schematic – 8.5 m x 9 m
- Each story's Dimensions – 3m

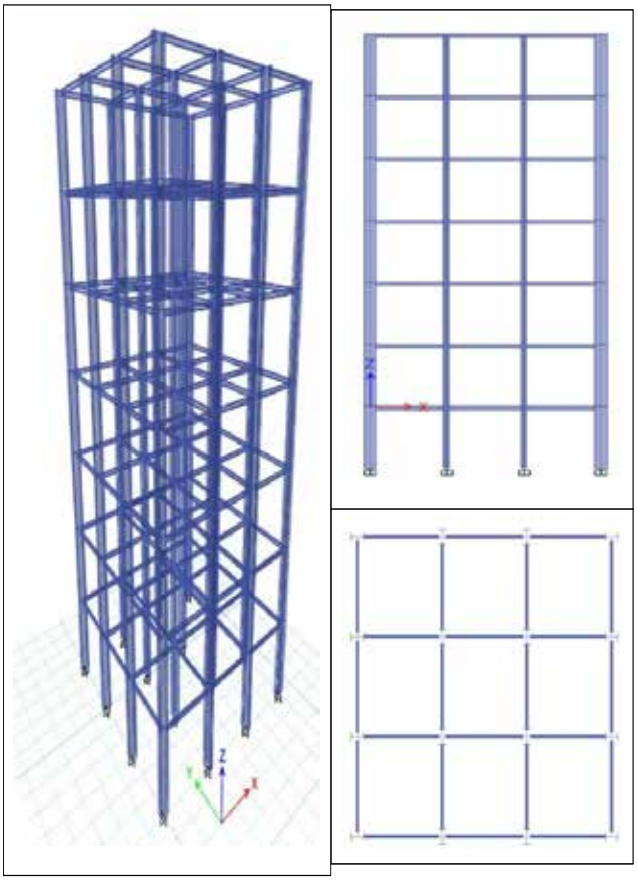

Figure 1. Geometry of Structure 3D View, Top View and Front View

Structure Properties The following qualities are taken into account when analysing a structure.	
Site Properties of Structure	
Thickness of the outer wall of a wall	150mm
Story Height	3m
Total height of building	18m
Size of Members Beam, Column	□ Beam ISMB 150mm. □ Column ISHB-450mm
Loading on Structure	□ Dead load □ Self-weight □ Wall-load 8kN/m
characteristics of brick masonry	
Young's (E)	2457.03 N / mm^2
Poisson's Ratio (nu)	0.2
Density	19 kN / m^3
Modulus of Shear	1023.76 N / mm^2
Seismic Properties of Structure	
seismic area	III, IV, V
Important aspect	1
Response reduction factor	5
Soil condition	Small Damping 2%

Load Combination for Analysis

1.5 (DL + LL + SIDL)

1.5 (DL + SIDL +- EQ-x)

1.5 (DL + SDL +- EQY) (Dl + SDL + LL)

(Dl + SDL + Live +- EQX) (Dl + SDL + Live +- EQY)

1.2 (Dl + SDL + Live +- EQX)

1.2 (Dl + SDL + LL +- EQY)

SECTION

ISMB- Indian Standard Medium Beam ISHB- Indian Standard Heavy Beam.

Rolling mills create rolled steel sections, which are structural elements distinguished by the patterns of their cross sections. They are cast in continuous, seamless casting moulds. Depending on the manufactured member types and the erection process, different section forms are selected. Some examples of rolled steel sections are I-sections, channel sections, T-sections, angle sections, bars, tubes, flats, sheets, and strips.

EARTHQUAKE GROUND MOTIONS

The ground motion in nonlinear seismic analysis must be modelled across time. histories three earthquake ground motion data have been considered with the name of 2ndfile, RSN4, RSN7. The design of the spectrum at Indian code-1893-part-1-2016 is referred to as the "spectrum.". Each of ground motion data refers to real earthquake data. The earthquake data have been generated using software Seismomatch.

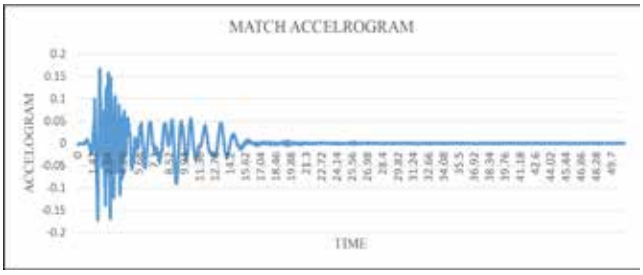

Figure 2: - Ground motion data consider for zone 5

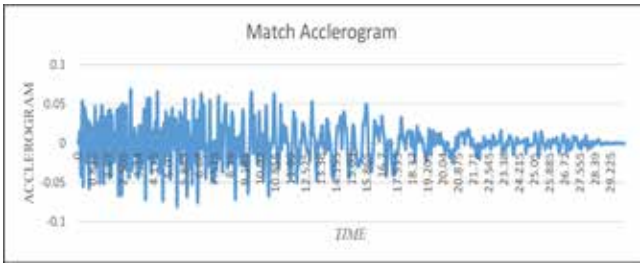

Figure 3:- Ground motion data consider for Zone-3

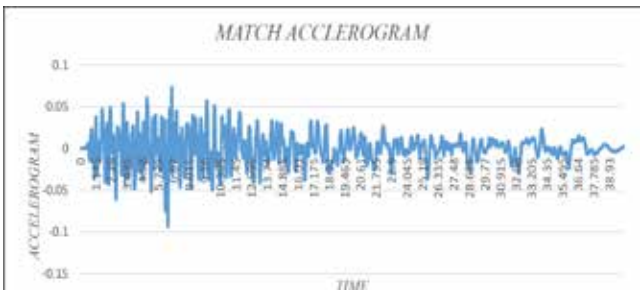

Figure 4: - Ground motion data consider for zone -4

RESULT

The building shows the performance levels. Fig- show the performance of steel building under push over analysis.

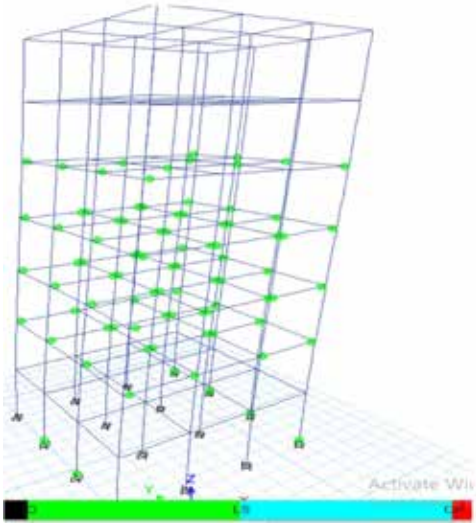

Figure 5: - Push over examination of steel building performance for ZONE III

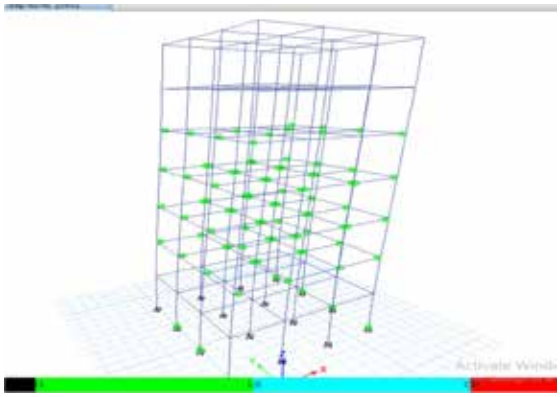

Figure 6: - Push over examination of steel building performance for ZONE IV

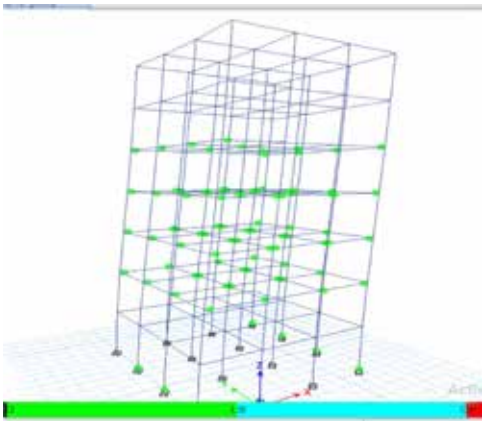

Figure 7: - Pushover examination of steel building performance for ZONE V

NON-LINEAR TIME HISTORY ANALYSES

It is determined using a time history study that displays the results through inter-story drift.It has been acknowledged that inter-storey drift is a crucial sign of a building's performance. The inter-story displacements change over time during an earthquake as various modes predominate the response.

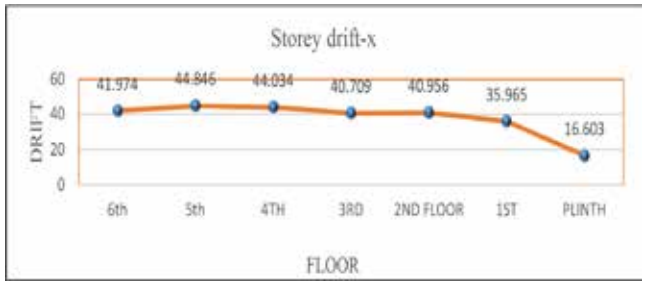

Figure 8: - Story Drift in X direction for zone III

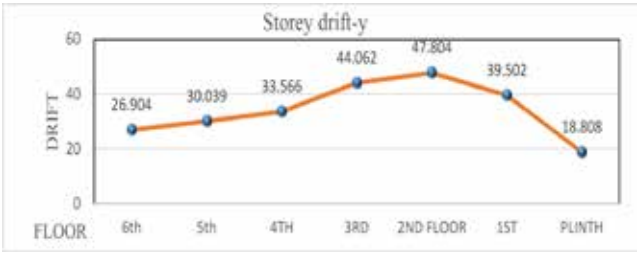

Figure 9: - Story Drift in Y direction for zone III

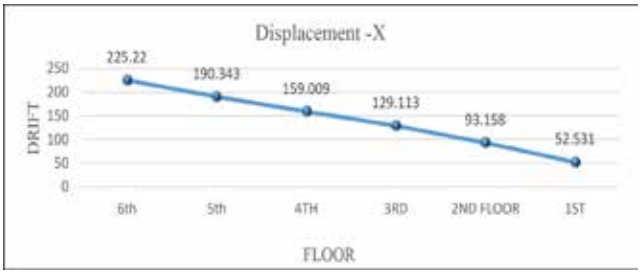

Figure 10: - Displacement in X direction for zone III

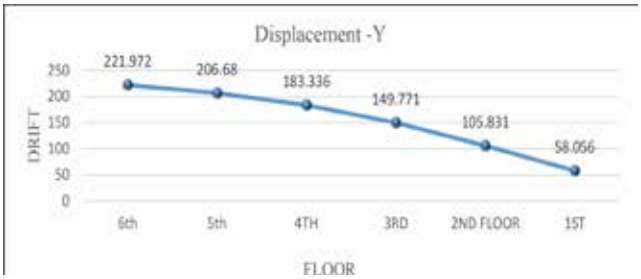

Figure 11: - Displacement in Y direction for zone III

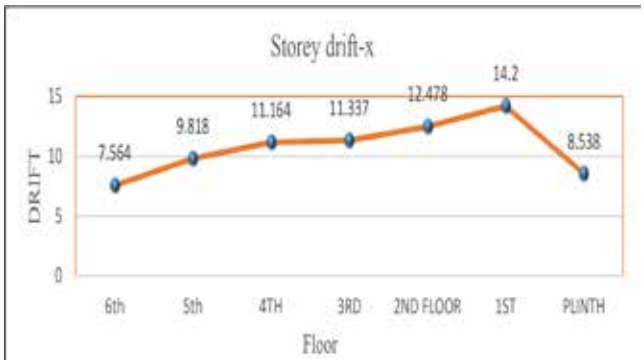

Figure 12: - Story Drift in X direction for zone IV

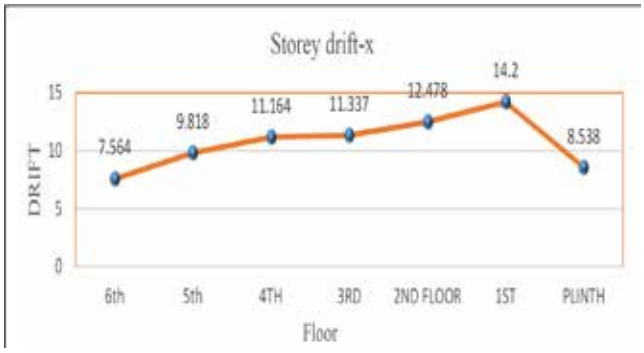

Figure 13: - Story Drift in Y direction for zone IV

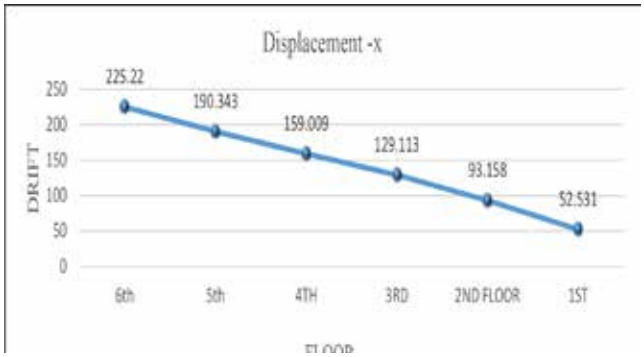

Figure 14: - Displacement in X direction for zone IV

Figure15: - Displacement in Y direction for zone IV

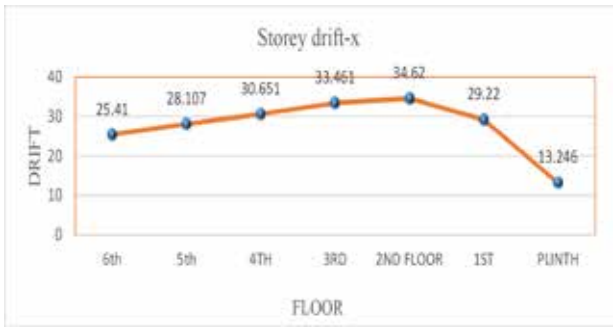

Figure16: - Story Drift in X direction for zone V

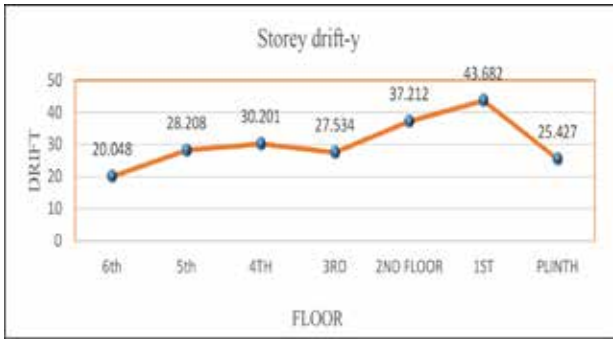

Figure 17: - Story Drift in Y direction for zone V

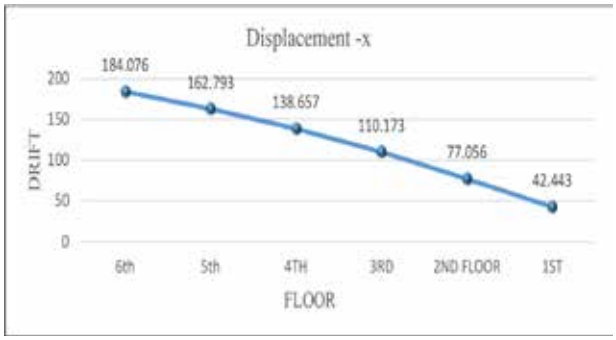

Figure 18: - Displacement in X direction for zone V

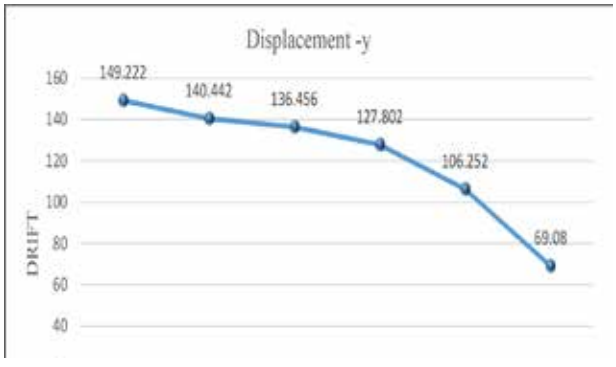

Figure 19: - Displacement in Y direction for zone V

CONCLUSION

Steel structures can be made to meet certain goals by selecting the right-sized members, which results in structures that function as expected and don't deviate from their target positions. The drift achieved by codal steel building under pushover analysis and Time history analysis. The steel building is found to be in IO AND LS in zone III, IV, V in respective ground motion.

According to analytical analyses compared to zones IV and III, the impact of India's seismicity zone V is more valuable and dangerous.

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File Sharing Application using Access Control in Android

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ABSTRACT

The information age has caused the world to become smaller. Nowadays, almost anyone can easily and instantly share files. We almost always learn about data breaches. In addition to the theft of user data, a secure channel is necessary for file sharing in order to be secure. Secure File Access is made up of two parties: administrators and users. With this application, it is possible to upload and manage files in the database. Since the file is AES-encrypted, only someone who has the same key can decrypt it and open it. When a file is uploaded to a server, the administrator has access to it and can decide who can access it. Only the administrator has the ability to permit a user to view.

KEYWORDS: *File sharing, Access control, AES algorithm, Encryption, Decryption*

INTRODUCTION

The sharing of files and information has become crucial to everyday life in the digital age. The demand for secure file sharing apps on the Android platform is rising as mobile devices become more and more common. Strong access control systems and encryption algorithms must be put in place to protect sensitive data from unauthorised access. The Advanced Encryption Standard (AES) algorithm and the Android Keystore system are used to implement Access Control in the File Sharing Application for Android presented in this document. The widely used symmetric encryption algorithm AES is renowned for both its efficiency and security. The secure hardware-backed system Android Keystore, on the other hand, offers a secure location for storing cryptographic keys, shielding them from unauthorised access. This application's main goal is to give users the ability to securely distribute files to particular people or groups while ensuring that only authorised recipients can access and decrypt the files. The file owner can define access permissions and grant access to particular users based on their identities or predefined roles using the access control mechanism. Before files are shared, they are encrypted using the AES algorithm. By converting the plain text data into cypher text, which can only be decrypted with the right encryption key, it offers a high level of security. The Android Keystore system makes sure that the application's encryption keys are safely kept and shielded from various threats like key extraction and tampering The application will make use of user authentication options offered by the Android platform, such as biometric authentication (fingerprint or face recognition) or PIN/password-based authentication, to help with access control. This guarantees that only approved users can access the files and carry out application operations. The File Sharing Application will offer a user-friendly interface for managing shared files, viewing access logs, and revoking access permissions as needed in addition to access control and encryption. To provide a seamless and simple user experience, the application will make use of Android's robust user interface components and design principles. The overall goal of this file-sharing application is to meet the growing demand for safe file-sharing on the Android operating system. The application makes sure that files are encrypted, access is limited to authorised users, and sensitive information is kept secure by integrating access control using the AES algorithm and the Android Keystore system.

AES ALGORITHM

For a variety of applications, AES is considered the standard encryption algorithm. AES operates on fixed-size blocks of data, typically 128 bits in length, and supports three key sizes: 128 bits, 192 bits, and 256 bits. The algorithm consists of several rounds of transformations, including substitution, permutation, and mixing operations. These rounds are applied to the input data using a set of round keys derived from the original encryption key. The security of the system relies on keeping the encryption key secret from unauthorized parties.

Here is a quick explanation of how AES functions:

1. Key Expansion: A set of round keys, one for each encryption round, are created using the original encryption key. These round keys are produced by the key expansion algorithm using bitwise operations and substitution.

2. Initial Round: The input data and the first round key are XORed.

3. Rounds: The number of rounds in AES is fixed and is based on the key size. Four transformations—SubBytes, ShiftRows, MixColumns, and AddRoundKey— are used for each round. By introducing confusion and diffusion, these operations strengthen the encryption technique.

AES S-box, a predefined substitution table, is used to replace each byte of the input with a corresponding byte.

4. Output: The encrypted data is the final state that is obtained.

When using AES for decryption, a similar system is used, but the operations are reversed. The alterations made in each round are their opposites, and the decryption key agenda generates round keys in reverse order.

AES has undergone extensive analysis by cryptographers, and when used correctly with strong key lengths, it is thought to be secure against all known realistic attacks.

It is widely used in many different applications, including those that secure communications, guard data at rest, and guarantee the integrity of digital facts.

ARCHITECTURE

The system Architecture is a conceptual model that describes the structure, behaviour, and more views of the system. It organises the system's components and their relationships in a way that supports reasoning about the system's structure and offers a roadmap for how the system's components will work together to implement the overall system. Android-based smartphones or other devices with Wi-Fi are used in this scenario as hardware that serves as both a sender and a receiver, and the user should have installed any necessary applications on their devices. In essence, there are two transfer modes for files: private and public. Without any security, transmission is carried out by browsing a file or set of data from the source device; no security key is required to send a public file or set of data. Once the relevant file or data is browsed from the source device and the transmission mode is set to public, we must select the IP address from the randomly generated IP address list of the receiving device the recipient device to which the data is to be publicly sent, and then transfer the file. In the case of a private transmission, we must first select the file or data to be sent to the recipient side and then transmission mode as private. Next, the scan-ip process will generate a list of the devices' IP addresses within that Wi-Fi range, from which we must choose the desired IP address of the recipient device. Finally, the secret key, which is an 8-bit secret key generated at random, must be used. When a key is verified, it is displayed and sent to the recipient's phone number if it is valid (i.e., the key should have an 8-bit length). The AES algorithm is used to encrypt and decrypt.

MODULES DEVELOPED

Authenticating users: Create a user authentication module so that users can sign up or log in with their credentials. To ensure secure user authentication, use secure authentication methods like OAuth or JWT.

Access Management: Manage file access and user permissions by implementing access control mechanisms. Create user roles like admin, owner, and viewer to manage different access levels. Make sure

only authorised users can access and modify files and folders by enforcing access control rules.

File encryption: Before storing or sending files over the network, encrypt them using the AES (Advanced Encryption Standard) algorithm. To encrypt files with a secure encryption key, use encryption functions. Make sure the encryption key is managed and stored securely.

Android Keystore: Utilize the Android Keystore system to securely store encryption keys. Generate and manage cryptographic keys within the Android Keystore to ensure they are protected by the underlying hardware security features of the device. Implement key retrieval functions to securely retrieve encryption keys from the Keystore for file encryption and decryption operations.

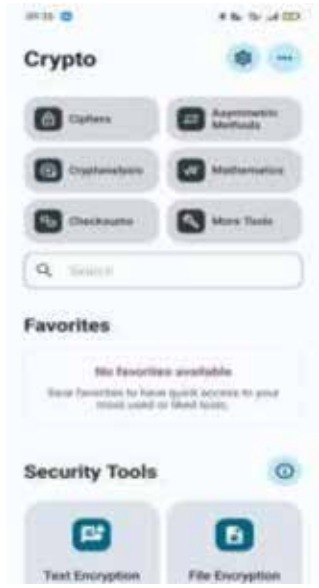
File Sharing and Permissions: Implement file sharing functionality to allow users to share files or folders with other users. Define granular permissions such as read-only, read-write, or no access for shared files. Use access control mechanisms to enforce file access permissions for shared files.

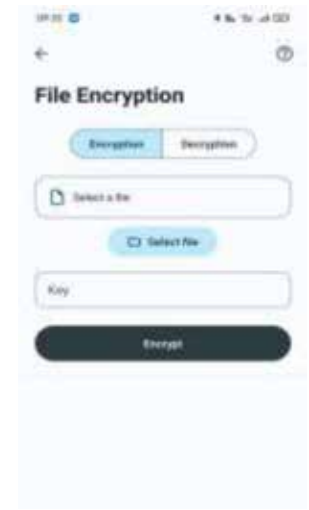
Secure File Transfer: Implement secure file transfer mechanisms to ensure the confidentiality and integrity of files during transmission. Utilize secure protocols such as HTTPS or SFTP for file upload and download operations. Utilise the AES algorithm to encrypt files before transmission and decrypt them after receipt.

Interface for users: Create a user-friendly interface that enables users to access and share files, manage access control settings, and browse through files and folders. Make sure the interface clearly displays the status of file encryption and access permissions.

PROPOSED SYSTEM

We have tried to create a simple system through an Android application where the user can perform the operations on text encryption and file encryption along with the decryption using AES 256-Bit Cypher, where the text and file can be shared using social media platforms by using the concept of explicit intent in Android. We have also tried to implement the Android Keystore. This is the basic prototype to demonstrate the mentioned operation.





IMPLEMENTATION

About Text Encryption (SCT):

Features:

Simple and secure implementation of the AES-256 cipher.

This implementation is to be used as a security add-on on top of messenger or email apps, or we just want to secure sensitive data for whatever purpose.

Implementation:

AES-256, GCM mode, no padding, 12 bytes random IVs. Keys are used as SHA-3 hashes (256 bits).

This AES implementation is considered simple, because we can enter keys of arbitrary length and we don't have to care about options like mode or padding.

About File Encryption (SCT):

Features:

Password-based encryption of files, proceeded files can be stored in the Crypto directory or shared. Decrypted files can also directly be opened.

Implementation:

AES-256, GCM mode, no padding, 12 bytes random IVs. Keys are used as SHA-3 hashes (256 bits).

File size:

The maximum file size is restricted by the Android OS and the memory available, which is obviously depending on your device.

Compatibility:

Compatibility to other file encryption software or services is not guaranteed. A slightly different key treatment or cipher configuration may be reasons for incompatibility.

Opting for AES over DES:

We will strongly have advised to choose the Advanced Encryption Standard (AES) over the Data Encryption Standard (DES) when choosing an Android file sharing app with access control. In comparison to DES, AES is a more reliable and secure encryption algorithm that offers more protection for sensitive data. AES offers a

significantly larger key space with key lengths of 128, 192, or 256 bits, making it very challenging to crack using brute-force attacks. AES has also undergone extensive testing and widespread adoption as a global standard, ensuring compatibility with a variety of platforms and gadgets. It is perfect for file sharing applications on Android due to its effectiveness and speed on modern hardware, offering a solid foundation for protecting sensitive data.

ADVANTAGES

1. Enhanced Security: Access control makes sure that only groups or individuals with permission to access particular files or folders can do so. This assists in safeguarding confidential data and makes it impossible for unauthorized users to access, modify, or share files. Organizations can protect their data and lower the risk of data breaches by implementing access control.
2. Granular Permissions: Administrators can specify and enforce specific permissions for various users or user groups using access control. This makes it possible to have precise control over who can access, modify, delete, or share particular files or folders. Organizations can maintain control over their data and make sure users have the right access levels for their roles by assigning the proper permissions.
3. Collaboration Control: Using access control, file-sharing programs can promote secure departmental or team collaboration. Users can be given access to particular files or folders, facilitating efficient collaboration while preserving the integrity of the data. Access control mechanisms also enable tracking of changes and user activity monitoring, improving accountability and preventing unauthorized changes.
4. Compliance and Auditing: Access control is essential to meet regulatory compliance standards like GDPR, HIPAA, or PCI DSS. Organizations can demonstrate that they have the necessary safeguards to protect sensitive data and follow industry-specific regulations by implementing access controls. In-depth auditing is made possible by access control mechanisms, allowing administrators to monitor file access, modifications, and other actions for forensic and compliance reasons.
5. Greater Productivity: Access control streamlines workflows and eliminates the need for manual file management and permissions handling, which lowers administrative costs. Users don't need to navigate a cumbersome directory structure in order to find and access the files they require.

DISADVANTAGES

1. Complexity: Adding access control features to file-sharing programmes can be challenging. A reliable system that can handle user authentication, authorization, and permissions must be designed and maintained. The cost and time of development may go up due to this complexity.
2. User Experience: The user experience can be harmed by excessively restrictive access control measures. The constant need for users to authenticate themselves or navigate complicated permission settings can impede productivity and cause user annoyance.
3. Administrative overhead: Controlling access in file-sharing programmes frequently necessitates administrative work. Administrators are responsible for handling permissions, defining access levels, and creating and managing user accounts. This overhead can take a lot of time, particularly in bigger organisations with lots of users and files.
4. Potential Security Vulnerabilities: Incorrectly implemented access control mechanisms may result in security flaws. Unauthorised users may access sensitive files if the authentication or authorization procedures are flawed. Additionally, files may be vulnerable to data breaches or leaks due to configuration errors or lax access control measures.
5. Compatibility Problems: File-sharing programmes may need to integrate with other platforms or systems, which can occasionally cause compatibility problems. It's possible that access control mechanisms don't perfectly match the infrastructure already in place, which could

cause interoperability issues and possible data inconsistencies.

CONCLUSION

In conclusion, the creation of a file-sharing programme with access control capabilities is a significant step towards improving data security and user collaboration. The utility makes sure that only authorised individuals can access and manage specific archives or folders by enforcing access control mechanisms like user authentication, authorization levels, and permission settings. There are many advantages to including get entry to control in file-sharing software. First off, it provides protection from unauthorised access, lowering the likelihood of data breaches and data leaks. Users maintain privacy and confidentiality by choosing who has access to view, edit, and delete their files. Second, gaining control encourages collaborative efforts that are friendly to the environment within groups or organisations. The tool encourages teamwork while maintaining control over sensitive information by giving users extraordinary access levels. Users have the option to share files with specific departments or co-workers, ensuring that each person has the necessary rights to carry out their duties. Additionally, gaining access to control makes it easier to comply with rules and regulations relating to the protection of statistics, such as the General Data Protection Regulation (GDPR) or requirements specific to a given sector. The software aids organisations in fulfilling legal obligations and averting potential fines or legal issues related to imprisonment by enforcing granular manipulation over file access. A file-sharing tool that allows access to management tools can also improve productivity and streamline processes. Users can easily find and access the archives they need, saving them time from having to search for them. To find any flaws or weaknesses in the application's access management system, regular audits and risk assessments must be carried out. In conclusion, a file-sharing programme with administrative access is a strong tool for secure and effective data sharing. Groups can protect sensitive information, promote collaboration, and abide by data protection laws by putting in place effective get-entry-to-control mechanisms. To ensure that the software is resilient to new security threats, it is crucial to give ongoing comparison and improvement of getting access to control aspects top priority.

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Enhancing Crop Yield Prediction and Monitoring: Current Developments, Limitations, and Future Directions – A Review

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ABSTRACT

Accurate crop yield forecasting and monitoring are critical for improving agricultural practices and supporting decision-making in the agricultural sector. This paper comprehensively reviews the current developments and identifies critical knowledge gaps in this field. It applies cutting-edge machine learning and deep learning techniques, including CNN, RNN, ELM, and random forest, to accurately estimate agricultural yield. Furthermore, it explores the integration of IoT and cloud computing technologies to develop effective systems for suggesting suitable crops. The study emphasizes the importance of carefully selecting relevant characteristics, optimizing procedures, and leveraging hybrid models to enhance the accuracy of yield predictions. Additionally, it highlights the need to consider factors such as climate change, economic aspects, and soil fertility indices when constructing crop yield prediction models. The study recommends integrating explainable AI techniques and developing decision support systems prioritizing user needs to enhance model interpretability and establish trust. Various limitations in existing research are identified, including the requirement for improved training methods, fine-tuning of model parameters, and accounting for environmental factors. Promising directions for future research include the incorporation of physical system models, the exploration of multi-objective optimization approaches, and the utilization of data mining strategies. Overall, this literature review provides valuable insights into the current state of agricultural yield monitoring and prediction research, emphasizing the potential for advancements to optimize agricultural practices, maximize crop productivity, and enable informed decision-making in the agricultural sector.

KEYWORDS: *Deep learning, Machine learning, Predicting crop yield, Feature selection.*

INTRODUCTION

Crop yield prediction is a crucial agricultural research field that aims to estimate crop harvest potential based on various factors, including crop genotype, environmental conditions, and management practices. Prediction models that are precise and trustworthy provide helpful information to farmers, policymakers, and stakeholders, supporting them in making educated decisions regarding resource allocation, crop management methods, and sustainable farming practices. In recent years, significant progress has been achieved in creating and enhancing agricultural production prediction systems. This progression is affected by incorporating new computing tools, such as machine learning algorithms and data analysis, which allow for more accurate forecasting and a better understanding of intricate interconnections between various components.

One of the most critical factors that significantly affect yield is crop genotype. Genetic traits and traits influence how crops respond to environmental factors and management practices. Including genetic information in forecast models will allow for the adaptation of estimates to specific crop varieties. Researchers can identify genotypes associated with increased yields and resistance to various stresses. Environmental factors strongly influence the growing and development of crops. The dynamic interplay between temperature,

rainfall, sunlight radiation, and soil quality impacts crop production. Incorporating environmental data, including current or historical climatic data, satellite images, and remote sensing data, into forecasts makes it possible to thoroughly understand these factors' impact on crop yields. This connection allows for creating specific management strategies and enables forecasts to be more precise. Management procedures, including farming techniques, irrigation strategies, fertilization plans, and pest control methods, directly impact crop production and resource utilization. The assessment of these practices' individual and collective effects on yields can be done by including them in the prediction models at present. In addition, optimization of management techniques can lead to improved agricultural sustainability, reduced impact on the environment, and resource efficiency as a result of forecast insights.

A comprehensive overview of the most recent advances in crop yield prediction, with a focus on the inclusion of genotypes, climatic conditions, and management practices, is to be presented in this review paper. It reviews the current state of technology in terms of deep learning frameworks, classification techniques, and data analysis, as well as an examination of their application to develop accurate prediction models. In addition, it points out the limitations and problems linked to these approaches and valuable insights on future research directions and potential areas for improvement.

LITERATURE REVIEW WORK

One reviewed study by Saeed Khaki et al. focused on analyzing yield performance data for corn and soybean crops from 1980 to 2018. The study utilized deep learning techniques, specifically Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), in combination with feature selection, to predict crop yields. Through feature selection, the CNN-RNN model achieved an accuracy of 87.82% for corn yield prediction and 87.09% for soybean yield prediction. The model also exhibited a mean squared error (RMSE) of 9%. However, a limitation or research gap identified in the study is the need to address the training problem of the RNN model, which could be mitigated by incorporating LSTM cells. Developing deep learning models can enhance interpretability and provide more transparent insights into crop yield predictions [1]. In a study by M.S. Suchithra et al., the main focus was examining activation functions, soil fertility indices, soil pH, classification, and prediction. The study utilized a dataset of 11 parameters related to soil samples and employed the Extreme Learning Machine (ELM) method. The accuracy scores for predicting various soil parameters were as follows: P with an accuracy rate of over 90%, K at 78%, OC at 80%, B above 85%, and pH classification at 90%. The manuscript identifies a research gap or limitation concerning optimizing ELM parameters for classifying soil nutrients, specifically N2O, P2O5, and K2O. The study suggests exploring advanced neural network (ANN) techniques for tailored fertilizer recommendations specific to different crops [2].

A study by Rishi Gupta et al. focused on extensive data analysis, graphical visualization, k-means clustering, map reduction, and recommendation systems in the context of forecasting crop yields. The study specifically examined two regions in India: Ahmednagar, Maharashtra, and the Andaman and Nicobar Islands. The analysis utilized multi-year (2000-2014) weather and crop yield data. The methodology involved the implementation of the Random Forest algorithm and feature selection techniques like Recursive Feature Elimination (RFE) and Boruta. The results showed that the WB-CPI model achieved a prediction accuracy of 90.22% for Ahmednagar and Maharashtra and 91.55% for the Andaman Nicobar Islands. A limitation or research gap identified in the study relates to including environmental factors such as humidity, wind speed, soil moisture, irrigation, and cloud cover for the recommended crops in different regions and states. Additionally, the study offered recommendations concerning the specific type of fertilizer or nutrients required in the soil to promote optimal growth and yield of the crop to prevent seasonal diseases [3]. In the study conducted by Usman Ahmed et al., the focus was on sensor data and soil nutrients. The researchers collected soil samples from various fields in Pakistan from 2001 to 2009. The methodology employed in the study involved using a Genetic Algorithm (GA), an evolutionary computation approach. A limitation or research gap identified in the research manuscript pertains to optimizing the search strategy and utilizing

individual repair methods. These approaches can be valuable in extracting essential parameters that enhance recommendations for soil fertilization, thereby contributing to the maintenance of crops. The study suggests that considering multi-objective optimization models or artificial intelligence/machine learning (AI/ML) models can help optimize parameters for efficient implementation in the future [4].

In the study by A. Suruliandi et al., the primary focus was cropping prediction. The dataset utilized in the study consisted of 1000 instances and 16 attributes related to crops. The methodology employed in the research involved the utilization of classification algorithms and feature selection algorithms. For classification, the study employed algorithms such as Naive Bayes (NB), Decision Tree (DT), Support Vector Machine (SVM), and Random Forest (RF) bagging. Additionally, feature selection algorithms like Boruta, Forward Sequential Selection (SFFS), and Recursive Feature Elimination (RFE) were utilized. The study's findings revealed that Recursive Feature Elimination (RFE) combined with bagging achieved a crop prediction accuracy of 92% compared to other methods based on soil and environmental characteristics. Scholars' comments on the study's limitations suggest that crop cultivation predictions could be further improved by incorporating additional data mining techniques that have been studied [5].

In the study by Q. Li et al., the main focus was on soil moisture prediction using machine learning techniques. The study acknowledged that having a larger dataset, with a minimum of 52,609 samples, could have improved the training of the predictive model. The researchers developed an Encoder/Decoder Deep Learning Model with Residual Learning based on Short-Term Long Memory (EDT-LSTM) as an alternative tool for data intelligence. The EDT-LSTM model demonstrated superior performance compared to other models in terms of both accuracy and efficiency. It achieved a prediction accuracy of 91.98%. The study also suggests that predicting changes in soil moisture levels during training and testing years could be improved if deep learning models are integrated with physical system models. [6].

The main focus was on using the Internet of Things IoT and cloud computing for crop recommendation in a study by Navd Niranjan Thilakarathne et al. A total of 2200 records were in the dataset used for this study. The approach used various algorithms for crop recommendations, e.g., KNN, DT, RF, XGBoost, and SVM, as well as a range of Machine Learning and Deep Learning algorithms. Random Forest (RF) achieved the highest accuracy among these algorithms, scoring 97.18%. The study aimed to make available valuable information that could help farmers improve the overall effectiveness of their farms and enable them to choose wisely to increase productivity [7]. Data integration, modelling, ensemble models, spatial analyses, and model transparency were the main topics of a study conducted by Sajid et al. The 2018, 2019, and 2020 data have been used for this analysis. This study aimed to predict maize yields throughout the US corn belt, composed of 12 states. The following five machine learning models have been developed, LR, LASSO regression, RFBoost, XG ensemble GBM, and their model has been created. The ensemble model performed better than the individual models for the test years, achieving a relative root mean square errorRRMSE of around 9%. The study analyzed the harvest of maize for 2018 and 2020, with an average yield of 10.77 kg per ha, 10.43 kg per ha in 2019, and 10.23 kg per ha in 2020. The study also suggested using remotely sensed data for better modelling of models at different locations where historical data are scarce. [8]. The primary focus was on the detection of crops in a study conducted by Murali Krishna Senapaty et al. The researchers used sample datasets in CSV format to train and test decision tree machine learning algorithms. Using a Decision Synchronised Machine Learning algorithm to forecast crop yield on soil moisture parameters was the method used in this study. The study's results demonstrated that a machine- learning model achieved an accuracy of 95% with an error rate of 0.5. However, the scholar has pointed to a limitation in the automatic identification of crop yields using soil moisture data and suggests that more improvements could be made to improve plant growth and productivity. [9]. The study's primary objective by Iniyan Shanmugam and colleagues was to predict crop yields. Researchers have used a dataset with approximately 80,000 records collected from 2014 to 2019 at different locations in India to develop this

model. The study investigated two models of deep neural networks (DNN), specifically RNN and LSTM, for predicting field crop yield. The study's findings revealed that the LSTM algorithm outperformed the RNN algorithm in accurately predicting crop yield. The LSTM algorithm achieved an impressive accuracy rate of approximately 93% in forecasting field crop yield. A scholar highlighted a limitation, suggesting that the combination of RNN and LSTM can be utilized to minimize errors when working with datasets of different sizes [10].

Summary of Knowledge Gap:

- Optimization of ELM parameters: The Extreme Learning Machine (ELM) model needs to optimize the parameters to improve the classification of soil nutrients such as N2O, P2O5, and K2O—an advanced neural network.
- (ANN) approaches for fertilizer recommendations tailored to specific crops can be explored.
- Training problem of RNN model: The training problem of the Recurrent Neural Network (RNN) model can be addressed by incorporating Short-Term Long Memory (LSTM) cells. LSTM cells can improve the performance and training efficiency of the RNN model.
- Consideration of environmental factors: To determine suitable crops for different regions within states, it is essential to consider environmental factors such as humidity, wind speed, soil moisture, irrigation, and cloud cover. These factors play a crucial role in crop selection and productivity.
- Multi-objective optimization models: multi-objective optimization models or AL/ML (Artificial Intelligence/Machine Learning) models should be considered to optimize parameters for further implementation efficiently. These models can help improve agricultural efficiency and enable farmers to make informed decisions for maximizing productivity.
- Incorporating remote sensing data: Complications arising from limited historical data in certain regions can be addressed by incorporating data from remote sensing. Remote sensing data, weather forecasts, and soil testing data can enhance the accuracy and comprehensiveness of crop yield predictions.
- Overall, the gaps identified suggest the need for advanced techniques and models to optimize parameters, address training issues, consider environmental factors, and utilize remote sensing data for improved crop yield prediction and agricultural decision-making.

Table 1: shows a summary of the knowledge gap with remarks by a scholar on limitations

Sr No.	Author	Method and algorithm used	Outcome	Remarks By Scholars on Limitations
1.	Saeed Khaki et al.	• (CNN) • (RNN) • (RF) • (DFNN)	• RMSE 9% • Corn and soybean yield of 87.82% and 87.09%.	Deep learning models may be developed to enhance interpretability and provide more transparent prediction insights.
2.	M. S. Suchithra et al.	• (ELM)	• ELM 80%	Optimization of ELM parameters for classifying soil nutrients N2O, P2O5, and K2O may be used.
3.	Rishi Gupta et al.	RF and feature selection techniques, including (RFE) and Boruta,	RF model has accuracy in predicting crop yields, with 83.56%	Environmental factors like humidity, wind speed, soil moisture, irrigation, and cloud cover may be included for the recommended crop of different regions of states.

4.	Usman Ahmed et al.	Genetic Algorithm (GA), an evolutionary computation approach	The GA method yielded 2,035 quantities (kg) for the maize and rice crops, compared to the traditional method's 1,865.47 (kg).	Multi-objective optimization models or AL/ML models are to be considered to optimize the parameter for further implementation efficiently.
5.	A. Suruliandi et al.	• KNN • RF • SFFS RFE	RFE with bagging provided 92% crop prediction accuracy	Data mining strategies may be used and analyzed to predict crop cultivation.
6.	Q. Li et al.	• EDT-LSTM	• EDT-LSTM prediction accuracy is 91.98%.	Deep learning algorithms may be combined with physical system models to forecast soil moisture variance in training and test years.
7.	Navod Niranjan Thilakarathne et al.,	• KNN • DT • RF • XGBoost • SVM	RF performed the best, with a score of 97.18%	To improve and provide valuable insights to farmers. It may need to enhance the overall efficiency of its farms and make informed decisions to maximize productivity.
8	Saiara Samira Sajid et al	• LR, • LASSO, • RF • XGBoos • LightGBM.	Relative root means square error (RRMSE) of approximately 9% for the test years.	For improvement of the performance of different locations with limited historical data by remote sensing data
9	Murali Krishna Senapaty et al	• Decisiontree-supervised machine learning	The machine learning model achieved an error rate of 0.5 and an accuracy of 95%.	The automatic detection of crops based on soil moisture data can be enhanced, leading to better growth and productivity of crops.
10	Iniyan Shanmugam et al	• (DNN), namely, (RNN) (LSTM), are analyzed in	The LSTM algorithm achieved an accuracy of approximately 93%.	The combination of RNN and LSTM can be used to minimize the error of different sizes of datasets.

CONCLUSION

In conclusion, machine learning and deep learning techniques have witnessed significant advancements in crop yield prediction and monitoring. Using CNN, RNN, ELM, and RF models, coupled with IoT and cloud computing, has shown promise in accurately predicting crop yields and developing efficient recommendation systems. Feature selection methods, optimization techniques, and hybrid models have improved prediction accuracy. Furthermore, including climate change factors, economic considerations, and soil fertility indices in crop yield prediction models has proven essential for reliable results. The integration of explainable AI and user-centric decision support systems have addressed the need for interpretability and transparency in agricultural models, building user trust. However, several limitations and research gaps have yet to be identified in the reviewed studies. Future research directions should focus on refining training methods, optimizing model parameters, and incorporating physical system models and data mining strategies. Additionally, advanced techniques such as LSTM cells, multi-objective optimization models, and remote sensing data can enhance crop yield prediction and monitoring accuracy and efficiency. In summary, this literature review highlights the potential of advancements in agricultural practices, maximizing crop productivity, and facilitating informed decision-making in the agricultural sector through improved crop yield prediction and monitoring techniques.

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Salesforce-The Trendy CRM Software

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ABSTRACT

With the emergence of cloud computing, organizations are increasingly considering migrating their Customer Relationship Management (CRM) applications from an on-premise environment (local servers) to an on-demand environment hosted on cloud servers. In the on-premise environment, the organization owns and maintains the infrastructure and software within their own network. In contrast, the on-demand environment involves a third-party provider hosting the infrastructure and software, charging the organization based on a subscription model. Salesforce is the leading on- demand CRM solution in the market.

INTRODUCTION

Salesforce is a cloud-based customer relationship management (CRM) platform that helps businesses manage their sales, marketing, and customer service activities. It provides companies with a comprehensive set of tools and features to streamline their operations, improve customer engagement, and drive sales growth. With Salesforce, businesses can store and manage customer data, track leads and opportunities, automate sales processes, and generate insightful reports and analytics. The platform offers a range of modules and applications to address different aspects of customer relationship management, such as sales management, marketing automation, customer service, and collaboration.

Salesforce's key features include a centralized customer database, customizable dashboards and workflows, lead and opportunity management, email marketing automation, social media integration, customer support ticketing, and mobile access. It also offers a marketplace of third-party applications and integrations to extend its functionality and meet specific business needs. The platform's cloud- based architecture allows businesses to access their data and applications from anywhere, using any device with an internet connection. This flexibility enables sales teams to stay productive on the go, collaborate seamlessly, and respond to customer inquiries in real-time. Salesforce has gained widespread adoption across industries and is particularly popular among sales and marketing teams. Its user-friendly interface, scalability, and extensive ecosystem of partners and developers contribute to its success. The company continues to innovate and release updates to its platform, incorporating emerging technologies like artificial intelligence and machine learning to enhance customer insights and automate repetitive tasks.

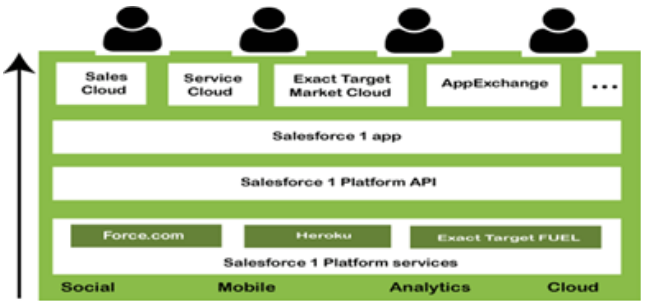

Fig. 1. Salesforce Model

Overall, Salesforce empowers businesses to build stronger customer relationships, drive sales efficiency, and deliver exceptional customer experiences in today's highly competitive marketplace. Salesforce CRM (Customer Relationship Management) is a cloud-based solution provided by Salesforce that allows businesses to manage their customer relationships, sales processes, and marketing activities. The cloud aspect of Salesforce

CRM offers numerous benefits and advantages to organizations:

Accessibility: Salesforce CRM is accessible from anywhere with an internet connection. Users can access their CRM data and applications through web browsers or mobile devices, enabling flexibility and remote access for sales teams on the go.

Scalability: As a cloud-based solution, Salesforce CRM offers scalability to accommodate the needs of growing businesses. It allows organizations to add or remove users, customize features and functionality, and expand storage capacity easily as their requirements evolve.

Data Security and Reliability: Salesforce CRM leverages the security and reliability of cloud infrastructure. Salesforce invests heavily in ensuring data protection, implementing industry-standard security measures, regular backups, disaster recovery, and stringent access controls. This helps safeguard sensitive customer information and ensures business continuity.

Seamless Updates and Maintenance: With Salesforce CRM being a cloud-based solution, updates, bug fixes, and new features are regularly rolled out by Salesforce automatically. This eliminates the need for businesses to handle software installations or perform manual updates, allowing them to focus on their core operations.

Integration and Customization: Salesforce CRM offers a wide range of integration options with other cloud-based applications, allowing businesses to connect their CRM with other tools and systems for enhanced functionality and data synchronization. Additionally, Salesforce provides customization capabilities to tailor the CRM to match specific business needs and workflows.

Collaboration and Mobility: Salesforce CRM fosters collaboration among team members through shared access to customer information, documents, and communication logs. Users can collaborate on deals, tasks, and customer support cases in real-time, enhancing productivity and teamwork. The cloud-based nature of Salesforce CRM also enables mobile access, empowering sales teams to work from anywhere and engage with customers on the move.

Cost-effectiveness: The cloud-based model of Salesforce CRM eliminates the need for businesses to invest in on-premises infrastructure, hardware, or software installations. It follows a subscription- based pricing model, allowing organizations to pay for the services they use, thereby reducing upfront costs and providing predictable ongoing expenses.

ARCHITECTURE OF SALESFORCE CRM

Salesforce CRM follows a multi-layered architecture that enables organizations to manage their customer relationships effectively. The architecture of Salesforce CRM consists of the following components:

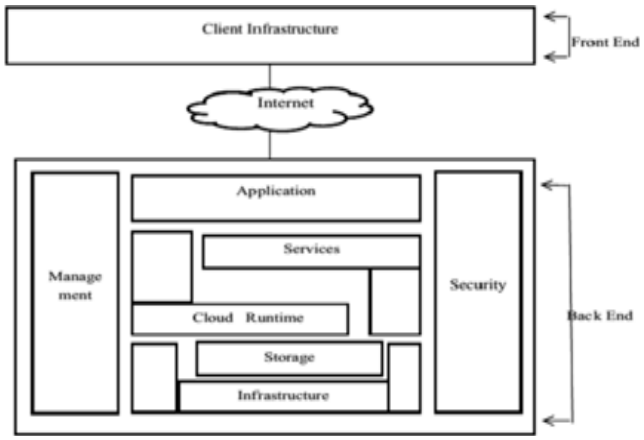

Fig. 2. Architecture of Salesforce CRM

User Interface Layer: The user interface layer is the front-end component of Salesforce CRM that provides the interface for users to interact with the system. It includes web browsers, mobile apps, and other user interfaces that allow users to access and utilize Salesforce CRM's functionalities.

Application Layer: The application layer contains the business logic and processes that drive the various functionalities of Salesforce CRM. It includes a set of pre-built applications and modules that cater to different aspects of customer relationship management, such as sales, marketing, customer service, and analytics. These applications are highly customizable and can be tailored to meet specific business requirements.

Data Layer: The data layer is where all customer data is stored in Salesforce CRM. Salesforce uses a multi-tenant architecture, where data from multiple organizations (tenants) is logically separated and stored

securely in a shared infrastructure. The data layer includes objects, fields, records, and relationships that define the structure and organization of the data within Salesforce CRM.

Integration Layer: The integration layer enables seamless integration of Salesforce CRM with other external systems and applications. It provides various integration mechanisms, such as APIs (Application Programming Interfaces), web services, and connectors, to exchange data and integrate with third-party systems, databases, and other applications. This layer allows organizations to synchronize data, automate processes, and create a unified view of customer information across different systems.

Security Layer: The security layer in Salesforce CRM ensures the protection and confidentiality of customer data. It includes robust security features such as user authentication, access controls, encryption, and data privacy measures. Salesforce implements industry-standard security practices to safeguard data and prevent unauthorized access or breaches.

Metadata Layer: The metadata layer stores the configuration and customization information of Salesforce CRM. It includes metadata components such as objects, fields, workflows, validation rules, layouts, and reports. These components define the behavior, appearance, and functionality of the CRM system and can be customized and extended to meet specific business needs.

Analytics Layer: The analytics layer in Salesforce CRM provides capabilities for data analysis and reporting. It includes features such as dashboards, reports, and data visualization tools that enable users to gain insights from their customer data. The analytics layer allows organizations to monitor key performance metrics, track sales and marketing activities, and make data-driven decisions.

Overall, the architecture of Salesforce CRM is designed to provide a scalable, secure, and customizable platform for managing customer relationships and driving business growth. Its multi- layered structure enables seamless integration, data management, and user interaction, making it a powerful CRM solution for organizations of all sizes and industries.

SALESFORCE CRM OBJECTS

Salesforce CRM includes a wide range of objects that are used to store and manage different types of data within the system. These objects represent various entities and their relationships in the customer relationship management context. Here are some of the key objects commonly used in Salesforce CRM:

Account: The Account object represents a company, organization, or individual with whom the business has a relationship. It stores information such as name, address, industry, and contact details.

Contact: The Contact object represents an individual associated with an account. It stores details such as name, title, email, phone number, and other contact information.

Lead: The Lead object is used to capture and track potential sales opportunities. It stores information about individuals or companies who have expressed interest in the organization's products or services but have not yet become customers.

Opportunity: The Opportunity object represents a potential or ongoing sales opportunity. It stores details such as the potential deal size, stage of the sales process, expected close date, and probability of closing.

Case: The Case object is used for managing customer support and service requests. It stores information about customer inquiries, issues, or complaints and tracks their resolution.

Campaign: The Campaign object is used for managing marketing campaigns. It stores details about marketing initiatives, such as email campaigns, advertising campaigns, events, and their associated responses and leads.

Product: The Product object represents the products or services offered by the organization. It stores information such as name, description, price, and other product-related details.

Opportunity Line Item: The Opportunity Line Item object is used to track individual products or services associated with an opportunity. It stores details such as quantity, price, and total amount for each line item.

Task: The Task object is used for tracking activities

and to-do items related to accounts, contacts, or opportunities. It includes information such as due dates, priorities, and status.

Event: The Event object is used to manage calendar events and meetings. It stores details such as date, time, location, attendees, and related records.

These are just a few examples of the standard objects available in Salesforce CRM. Additionally, organizations can create custom objects to address their specific business requirements and store additional data relevant to their operations. The flexibility and extensibility of Salesforce CRM allow businesses to tailor the object structure to align with their unique processes and workflows.

CHALLENGES TOWARDS SALESFORCE CRM

While Salesforce CRM offers numerous benefits and features, organizations may encounter some challenges when implementing and using the system. Here are a few common challenges faced by businesses in relation to Salesforce CRM:

User Adoption: Getting users to adopt Salesforce CRM can be a challenge. Some employees may be resistant to change or may not fully understand the benefits of using the CRM system. Proper training, communication, and ongoing support are essential to encourage user adoption and maximize the system's effectiveness.

Data Quality and Data Integration: Maintaining accurate and up-to-date data within Salesforce CRM can be challenging, especially when integrating data from multiple sources. Data inconsistencies, duplicates, and incomplete records can impact the system's reliability and hinder decision-making. Establishing data governance practices and implementing data integration strategies are crucial to ensure data quality and integrity.

Customization Complexity: Salesforce CRM offers a high level of customization to meet specific business needs. However, the complexity of customization options can be challenging for administrators and developers without proper expertise. Customization should be carefully planned and executed to avoid creating a system that is difficult to maintain or upgrade in the future.

Scalability and Performance: As organizations grow and their data volume increases, Salesforce CRM's scalability and performance may come into question. Large data sets, complex workflows, and extensive customizations can impact system responsiveness. Proper data architecture design, performance optimization techniques, and regular monitoring are necessary to maintain system performance as usage expands.

Integration with Legacy Systems: Integrating Salesforce CRM with existing legacy systems and applications can pose challenges due to differences in data formats, protocols, or APIs. Ensuring seamless data flow and real-time synchronization between Salesforce and other systems requires careful planning, integration strategies, and potentially the use of middleware or integration platforms.

Cost Considerations: Salesforce CRM is a subscription-based service, and the cost can be a concern for some organizations, especially for smaller businesses or those with limited budgets. Understanding the pricing structure, licensing options, and evaluating the return on investment (ROI) is crucial to determine the affordability and long-term value of Salesforce CRM.

Security and Compliance: While Salesforce provides robust security measures, organizations must still ensure that their data and customer information remain secure and compliant with relevant regulations. Maintaining proper access controls, data encryption, user authentication, and monitoring user activity are essential to protect sensitive data within the CRM system.

It's important to note that while these challenges exist, Salesforce CRM provides extensive resources, support, and a vibrant community to address them. Proper planning, implementation, and ongoing management can help organizations overcome these challenges and leverage the full potential of Salesforce CRM.

SALESFORCE CRM ADVANTAGES

Salesforce CRM offers a range of advantages that can benefit organizations in managing their customer

relationships and driving business growth. Here are some key advantages of Salesforce CRM:

Comprehensive Customer View: Salesforce CRM provides a centralized platform to store and manage customer data, allowing organizations to have a 360-degree view of their customers. It enables businesses to track interactions, preferences, purchase history, and other relevant information, empowering them to deliver personalized and targeted experiences.

Increased Sales Efficiency: Salesforce CRM streamlines the sales process by providing tools for lead management, opportunity tracking, and sales forecasting. Sales teams can effectively manage their pipelines, collaborate on deals, and automate routine tasks, resulting in increased productivity and faster sales cycles.

Marketing Automation: Salesforce CRM offers robust marketing automation capabilities. Organizations can create and execute targeted marketing campaigns, track campaign performance, and analyze results. Integration with email marketing, social media, and other marketing channels allows for seamless coordination and automated workflows, enhancing marketing effectiveness.

Improved Customer Service: Salesforce CRM helps organizations deliver exceptional customer service by providing tools for case management, ticketing, and self-service portals. Customer support teams can efficiently resolve inquiries, track customer issues, and provide timely assistance, resulting in improved customer satisfaction and loyalty.

Collaboration and Communication: Salesforce CRM facilitates collaboration and communication across teams and departments. Features like Chatter, Salesforce's enterprise social network, enable real-time communication, document sharing, and team collaboration. This fosters a culture of knowledge sharing, enhances cross-functional collaboration, and improves internal communication.

Mobility and Accessibility: Salesforce CRM is accessible from anywhere via web browsers and mobile applications. This enables sales and service teams to access customer information, update records, and collaborate on the go, improving productivity and responsiveness.

Scalability and Flexibility: Salesforce CRM is highly scalable, allowing organizations to add users, expand functionality, and accommodate growth seamlessly. The platform can be easily customized and extended through point-and-click configuration or development, enabling businesses to tailor the system to their unique requirements.

Integration Capabilities: Salesforce CRM provides robust integration capabilities, allowing seamless integration with other systems and applications. This facilitates data synchronization, automates workflows, and enables a unified view of customer information across the organization.

Analytics and Insights: Salesforce CRM includes powerful reporting and analytics features, enabling organizations to gain valuable insights into sales performance, customer behaviour and marketing effectiveness. Customizable dashboards and reports provide real-time visibility into key metrics, empowering data-driven decision-making.

Security and Data Protection: Salesforce CRM prioritizes data security and offers robust security features, including data encryption, access controls, and user authentication. The platform complies with industry standards and regulations to ensure the privacy and protection of customer data.

These advantages make Salesforce CRM a popular choice for organizations seeking to enhance customer relationships, streamline sales and marketing processes, and drive business growth.

CONCLUSION

In conclusion, Salesforce CRM offers significant benefits and advantages for organizations in managing customer relationships and driving business growth. With its comprehensive customer view, increased sales efficiency, marketing automation capabilities, and improved customer service features, Salesforce CRM provides a powerful platform for organizations to enhance their customer engagement and deliver personalized experiences. The collaboration and communication tools within Salesforce CRM foster

teamwork and knowledge sharing, while the mobility and accessibility features enable users to access and update information on the go, improving productivity and responsiveness.

The scalability and flexibility of Salesforce CRM allow organizations to adapt and expand as their needs evolve, while the integration capabilities enable seamless connectivity with other systems and applications, ensuring data synchronization and a unified view of customer information. Furthermore, the analytics and reporting features in Salesforce CRM empower organizations to gain valuable insights into sales performance, customer behaviour and marketing effectiveness, enabling data- driven decision-making and continuous improvement.

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Securing the Digital Landscape: Examining Cybersecurity Threats, Confronting Challenges, and Embracing Best Practices

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ABSTRACT

As technology continues to evolve, the threat of cyber attacks becomes more prominent. Cybersecurity has become a top priority for organizations worldwide, and the need for effective cybersecurity measures has become increasingly important. This paper will discuss the various threats faced by organizations, including malware, phishing, and ransomware attacks. The challenges associated with implementing effective cybersecurity measures will also be explored, including budget constraints and lack of expertise.

KEYWORDS: *Cybersecurity, Cyber threat, Security*

INTRODUCTION

Cybersecurity is the practice of securing computer frameworks, systems, and delicate data from unauthorized get to, burglary, or harm. With the growing usage of technology in various industries, the risk of cyber threats has increased significantly, making cybersecurity a top priority for organizations worldwide. This paper aims to provide an overview of the threats, challenges, and best practices in cybersecurity.

TYPES OF CYBER SECURITY

Cyber security can be broadly categorized into several types or domains, based on the nature of the assets being protected or the focus of the security measures [4].A few of the foremost common sorts of cyber security include:

Network security: This focuses on protecting computer networks from unauthorized access, intrusion, and other security threats.

Application security: This is concerned with securing software applications and systems from security vulnerabilities and exploits that can be exploited by attackers.

Information security: This points to secure the privacy, keenness, and accessibility of touchy information and data resources, both in capacity and in travel.

Cloud security: This deals with protecting cloud-based computing services, applications, and data storage from security threats and risks.

Endpoint security: This points to secure person gadgets, such as tablets, desktops, and versatile gadgets, from malware and other cyber dangers.

Identity and access management: This is concerned with managing and securing user identities and access to systems and resources.

Operational security: This focuses on securing the physical and operational aspects of IT systems, such as data centers, networks, and hardware.

Disaster recovery and business continuity: This is concerned with ensuring that systems and data can be quickly restored and recovered in the event of a disaster or other disruptive event.

CYBER THREATS

Malware is one of the most common cybersecurity threats. Malware is malicious software that can infiltrate a computer system and cause damage, steal sensitive information, or gain unauthorized access to the system. Malware can be of many forms such as viruses, worms, Trojan horses, and ransomware. Ransomware is considered as a type of malware, it encrypts an organization's data and demands a ransom payment to restore access of users[6]. According to the 2021 Verizon Data Breach Investigations Report, malware was responsible for 39% of all data breaches.

Phishing is another cybersecurity threat being faced by organizations. Phishing is a social engineering attack that involves tricking people into providing sensitive information such as usernames and passwords. Phishing attacks can happen through e-mail, content messages, or social media, and can be challenging to distinguish.

IMPACT OF CYBER THREATS

The impact of cyber threats can be devastating, both for individuals and organizations. Some of the most significant impacts of cyber threats include:

Financial loss: Cyber threats can cause significant financial losses for an organization. For example, ransomware assaults can result from the misfortune of basic information, which can be costly to recover. Additionally, cyber-attacks can result in lawsuits, regulatory fines, and damage to a company's reputation, all of which can be expensive to address.

Operational disruption: A cyberattack can disrupt an organization's operations, causing downtime, loss of productivity, and delays in the delivery of goods or services. This disruption can be particularly harmful to little and medium-sized businesses which will not have the resources to recover quickly from an attack.

Personal information breach: Cyber threats can lead to burglary of individual data such as social security numbers, credit card numbers and bank points of interest. This data can be utilized for burglary, which can have a long-term effect on individuals.

National Security: Cyber threats can pose a threat to national security. For example, cyberattacks can be utilized to disturb basic frameworks such as control lattices and transportation, causing chaos and devastation.

RECENT SURVEY ISSUES ON CYBER SECURITY TRENDS

Cybersecurity includes awareness of various cyber threats [1] and the use of protective policies (i.e. protection) to ensure the confidentiality, reliability and availability of digital or IT technologies.

Cybersecurity experts consider malware to be the primary weapon of choice for cyberspace cyber defence efforts. Malware is a common attack that is often installed on a device without the owner's knowledge. Like viruses, worms, Trojans, spyware, and robot executables, malware can infect computers in many ways, such as spreading through viruses, tricking users into opening haptic files, or tricking users into visiting malware-infected websites. In the most extreme cases of malware, the malware installs itself on a USB drive attached to the infected computer and then spreads to all connected computers for that computer.

Common Cyber Attacks

Phishing: Phishing attacks include deceiving people into uncovering touchy data such as passwords, credit card numbers, or social security numbers. Typically ordinarily done through misleading emails, messages, or websites that show up authentic but are really false.

Malware: Malware is malicious software, it is designed to corrupt, damage devices/systems, and to gain unauthorized access to systems. Malware includes viruses, worms, Trojans, ransomware, etc. It can infect through links received from email, infected websites, or downloads from untrusted websites.

Denial-of-Service (DoS) / Distributed Denial-of-Service (DDoS) Attack: In a DoS attack, the aggressor overpowers a target framework with a surge of ill-conceived demands or information, causing the framework to end up inert or crash. DDoS assaults include different compromised gadgets (a botnet) planning an assault on a single target.

Man-in-the-Middle Attack: In Man-in-the-Middle Attack or MitM attack, an attacker intercepts and potentially alters communication between two parties without their knowledge. This allows the attacker to

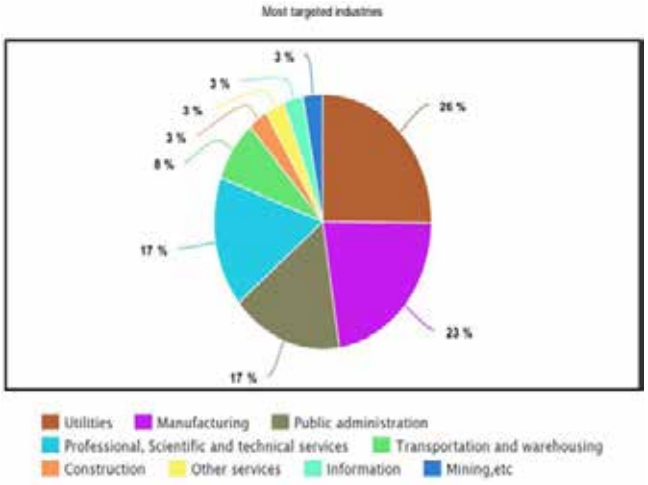
eavesdrop, steal information, or even inject malicious code into the communication flow.

SQL Injection: This type of attack targets web applications that use databases by injecting malicious SQL code into user input fields. By exploiting vulnerabilities, attackers can manipulate the application's database and gain unauthorized access, steal data, or alter data.

Cross-Site Scripting (XSS): XSS assaults happen when aggressors infuse malevolent scripts into websites or web applications that are seen by other clients. These scripts can take touchy information, divert clients to pernicious websites, or control substance on the influenced pages.

Social Engineering: Social engineering involves manipulating individuals to pick up unauthorized get to to frameworks or data. Attackers may utilize different mental procedures to deceive people into revealing confidential data, such as passwords or account details.

Password Attacks: Password attacks aim to gain unauthorized access to user accounts by exploiting weak or stolen passwords. Common techniques include brute force attacks (trying all possible password combinations), dictionary attacks (trying common words or phrases), or using stolen password databases from previous breaches.



GOALS OF CYBER SECURITY

To secure the secrecy, judgment, and accessibility of data and frameworks from unauthorized get to, utilize, divulgence, disturbance, alteration, or devastation. In other words, cyber security aims to prevent malicious actors, such as hackers, cyber criminals, and cyber terrorists, from gaining unauthorized access to sensitive information and systems, or from causing harm to them.

To achieve these goals, cyber security uses a range of technical, organizational, and procedural measures, such as firewalls, encryption, access controls, network segmentation, incident response plans, training and awareness programs, and risk assessments. Cyber security aims to ensure compliance with legal requirements, such as industry standards, privacy laws, data protection laws,etc . Overall, the ultimate goal of cyber security is to create a secure and resilient cyberspace that enables individuals, organizations, and society to benefit from the opportunities offered by the digital age.

CHALLENGES

Implementing effective cybersecurity measures can be challenging for organizations due to several reasons. One of the primary challenges is budget constraints, as implementing cybersecurity measures can be expensive. Numerous organizations battle to apportion satisfactory assets to cybersecurity, driving to vulnerabilities in their systems [2].

Another challenge is the lack of cybersecurity expertise. Many organizations do not have individuals with the necessary skills and knowledge to implement and maintain cybersecurity measures. This lack of expertise can lead to inadequate security measures or misconfigured systems, making them vulnerable to cyber threats.

Furthermore, the lack of standardization in cybersecurity practices can make it challenging for organizations to know which measures to prioritize. Different organizations have diverse security needs, and there is no one-size- fits-all approach to cybersecurity. Therefore, organizations must develop a cybersecurity strategy that meets their specific needs.

Following are few of the challenges that can be faced:

Increasing complexity of systems: As systems become more complex, they become harder to secure, as attackers have more potential attack vectors to exploit.

Insider threats: Malicious or accidental insiders can pose a critical danger to cybersecurity, as they have access to all the sensitive information and systems.

Rapidly evolving threats: Attackers are constantly developing new techniques and tools to bypass cybersecurity measures, making it challenging for defenders to keep up.

Lack of skilled personnel: There is a shortage of skilled cybersecurity personnel, making it difficult for organizations to effectively defend against cyber threats.

Balancing security with usability: Security measures that are too strict can negatively impact usability and productivity, making it a challenge to strike a balance between security and usability.

Resource constraints: Organizations may face budget constraints, making it difficult to implement comprehensive cybersecurity measures.

Third-party risks: Organizations may be vulnerable to cyber-attacks through third-party vendors or suppliers that have access to their networks or data.

Compliance requirements: Compliance requirements such as GDPR or HIPAA can add additional complexity to cybersecurity efforts and require additional resources.

Lack of awareness and training: Lack of awareness and training among employees can leave organizations vulnerable to cyber-attacks.

Emerging technologies: The emergence of new technologies such as AI, IoT, and blockchain present new cybersecurity challenges that need to be addressed.

BEST PRACTICES

Despite the challenges, there are several best practices that organizations can implement to mitigate cybersecurity threats. One of the most critical practices is employee training. Human error is a major factor in many cyber- attacks. Therefore, organizations must provide regular training to employees on cybersecurity best practices, such as how to identify phishing emails and how to create strong passwords.

Another best practice is to ensure that all software is regularly updated. Cybercriminals regularly abuse vulnerabilities in obsolete computer programs to pick up unauthorized get to frameworks [3]. Regular upgrades to programs can fix known vulnerabilities and decrease the hazard of cyber threats.

Implementing strong passwords and multifactor authentication can also significantly improve cybersecurity. Weak passwords can lead to data breaches. Therefore, organizations must require employees to make solid passwords that are troublesome to figure out. MFA or Multi factor authentication adds an extra layer of security as it requires users to provide additional information, such as a fingerprint, a verification code sent to their devices such as mobile/tabs, to access their system.

Other measures that organizations can implement to improve cybersecurity

One important measure is to conduct regular vulnerability assessments and penetration testing. [5] Vulnerability assessments involve identifying potential vulnerabilities in systems and networks, while penetration testing involves attempting to exploit these vulnerabilities to determine whether they can be used to gain unauthorized access[2]. By conducting these assessments and tests, organizations can identify weaknesses in their systems and networks and take steps to address them before cybercriminals can exploit them.

Another important measure is to implement a data backup and recovery plan. Data backups are essential in case of a cyber-attack, as they can help organizations restore lost or corrupted data. Additionally, having a recovery plan in place can help organizations quickly recover from a cyber-attack, reducing the impact of the attack on their operations.

Implementing network segmentation is also a best practice in cybersecurity. Arrange division includes separating an organization into littler fragments, each with its own security controls. This approach can limit the spread of malware or other cyber threats, reducing the potential damage of an attack.

Organizations should consider implementing a security operations center (SOC) or managed security services provider (MSSP). SOC is a team of cybersecurity professionals responsible for monitoring systems and networks for potential threats and responding to

incidents. An MSSP is a third-party provider that offers cybersecurity services to organizations. These providers can offer advanced security solutions and expertise that organizations may not have in-house.

CONCLUSION

Cybersecurity is a critical issue for organizations, and the risks associated with cyber threats are increasing. Organizations must prioritize cybersecurity measures and allocate adequate resources to protect their systems and sensitive information. The threats to cybersecurity are numerous, ranging from malware to phishing attacks, and organizations must develop a cybersecurity strategy that meets their specific needs. Despite the challenges, there are various best practices that organizations can implement to overcome cybersecurity threats, such as training all the employees, updating softwares regularly and the implementation of strong passwords and MFA (multi factor authentication). Staying up to date with the latest threats and best practices is crucial in maintaining an effective cybersecurity strategy.

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Interactive Learning through Game

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ABSTRACT

This paper describes the development of a runner game with interactive learning features aimed at enhancing players' knowledge and skills in programming. The game is designed as a mobile app for Android and iOS platforms and targeted Computer Science students. The development process involves several phases, including game design, content creation, programming, and testing. The game mechanics are based on the endless runner genre, with the addition of interactive learning elements such as quizzes and puzzles that provide players with opportunities to reinforce their knowledge while playing. The game is evaluated through a user study with college students, which demonstrates that the game is engaging and effective in promoting learning outcomes. The results show that players who completed the game exhibited significantly higher knowledge retention [10]. The study also provided insights into the game's soundness and fragility, as well as suggestions for future improvements. Overall, this paper contributes to learning by showcasing an example of how games can be designed to promote interactive learning and engage students in meaningful educational experiences.

KEYWORDS: *Algorunner, Virtual model, Runner game, User interface(ui) component*

INTRODUCTION

According to the principle of based on games learning, students can focus intensely on a subject while playing games, which improves student accomplishment and knowledge retention. This includes gamifying instructional strategies to raise all-around student performance. With digital or non-digital gaming experiences, it is possible to give conventional classroom assignments a little extra spark, boosting student interest and engagement.

Gamification is the art of adding gameplay principles such as badges, scores, leaderboards, and other features to a game to make your journey challenging yet satisfying for each small accomplishment. Students are given clear, satisfying objectives to work towards through game projects and instructions. Using game-based learning is a fascinating topic. While some experts resist that game-based learning enhances test scores compared to conventional teaching methods, others contend that there is little to no difference in test scores. It can take a lot of effort and money to create these games for game-based learning. There is a gap between education experts and game development experts, leading to productivity issues in the area of game-based learning.

Goals or Objectives:

- To Gamify the process of learning.
- To provide a competitive and fun way to learn boring topics.
- To provide an interactive way to learn puzzles asked in placement tests.
- To improve hand eye coordination.
- To provide a beneficial way to pass time.

LITERATURE SURVEY

Game-based learning is an innovative approach to education that involves the use of games to improve

learning outcomes. Research on game-based learning has increased in recent years, with numerous studies examining its effectiveness in improving learning outcomes. Game-based learning is a relatively new area of research that focuses on the use of games as educational tools. The body of research on game-based learning has developed over time, moving from early investigations into the potential educational value of games to more current investigations into the efficiency of certain game-based learning treatments.

Early research into the potential benefits of games for learning: The first game-based learning study explores the potential benefits of games for cognitive development and learning. An influential study was "The Effects of Video Games on Children: What Parents Need to Know", published in 2004 by Cheryl K. Olson and Lawrence A. Kutner. The study, which asked parents about their children's use of video games, found that playing video games can have positive effects on cognitive development, such as improved spatial reasoning and communication skills. problems solving. [5]

The Rise of Serious Games: In the mid-2000s, researchers began investigating the use of games designed specifically for educational purposes, known as serious games. A key article in this area is "Serious Games: Advergaming, Edugaming, Training, and More" by Clark C. Abt in 2006. This article defines the concept of serious games and identifies several categories of serious games, such as adgames (games used for advertising) and edugames (games used for education). [3]

Research on how well game-based learning interventions work. The success rate of educational game interventions has been the subject of greater study in recent years. An example well known is "Learning from Play: A Panel Discussion Using Games for Learning" by Katie Salen,

James Paul Gee and Colleen Macklin, 2009. This article features a panel discussion between game designers and educators, discusses the potential benefits and limitations of game-based learning, and shares examples of successful game-based learning interventions. [6]

Digital instructional games can be useful teaching tools, according to research. When examining the learning process and success, researchers advise concentrating on motivation, game load, and their interactions. When non-native speakers play an English game, gaming knowledge and English skill of the students appear to be additional crucial factors in learning achievement. However, more information is required and has to be clarified concerning the motivational and cognitive effects of games and learner characteristics on learning outcomes. The goal of the current study was to meet this demand. [7]

Shute and Ventura (2013) Measuring and Supporting Learning in Games: The concept of invisible evaluation in game- based educational settings is the main topic of Invisible evaluation. The authors explain how data can be used to measure and assess learners' knowledge, skills, and abilities without interrupting their gaming experience. They describe different types of stealth assessment methods and provide practical guidance for their implementation in game-based learning environments. The book also explores the potential benefits and challenges of using stealth assessment and identifies future research directions for this approach to game assessment. [2]

Mayer (2014) The Cambridge Handbook of Multimedia Learning explores the potential of game-based learning as an effective teaching method. The book discusses the cognitive and motivational mechanisms of game-based learning and provides practical guidelines for designing effective game-based learning environments. It also highlights the benefits and challenges of using games for learning and identifies future directions for research to advance the field of game- based learning. Overall, this book provides valuable information to educators and researchers interested in using games as a tool to improve learning outcomes. [4]

Among the authors Arnab, S., Lim, T., et al. (2015) provided game mechanic mapping for game analysis. This article begins an overview of serious games and their potential as educational tools. The framework is then presented, which consists of four components, including gaming environments, learning objectives,

and game mechanisms. The author provides detailed definitions and examples of each component, emphasizing their interdependence and the need to consider them when analyzing serious games. The authors suggest that the framework could help game designers create more effective serious games by providing a structured approach for understanding the connection between game mechanics and educational results. Additionally, the framework can help researchers and educators evaluate the effectiveness of serious games by providing a common language and set of analytical criteria. Overall, this document provides a comprehensive and practical framework for the analysis of serious games and emphasizes how crucial it is to take the connection between game design and learning objectives into account.[8]

Kiili and Ketamo's (2017) article "Game-Based Digital Learning: A Meta-Analysis" offers a comprehensive literature review on game-based digital learning. The authors conducted 87 empirical studies published between 2006 and 2016 were analysed in a meta-analysis to determine the efficacy of game-based digital learning across a variety of educational contexts and topics. The article begins with an overview of game-based digital learning and its potential benefits, such as increased engagement, motivation, and learning outcomes. The authors then describe their approach to meta-analysis, including systematic review of relevant databases, selection of articles based on inclusion criteria, and extraction and analysis of data from selected studies. The results of the meta-analysis suggest that digital game-based learning is an effective teaching tool across a range of disciplines and educational contexts. The authors found that digital gaming improves learning outcomes such as knowledge acquisition, skill development, and problem solving. Additionally, the authors found that digital game-based learning was particularly effective for low-achieving students and students with learning disabilities. These findings have important implications for educators and policy makers interested in using digital games as educational tools. [9]

The research literature on game-based learning provides insight into the benefits, challenges, and effective design principles of using digital games for educational purposes. Here are some key findings from the research paper:

- Game-based learning can improve motivation and engagement: Games have been shown to be effective in increasing learners' motivation and engagement in the learning process. This is due to immersive nature of game, the presence of clear goals, immediate feedback, and element of challenge and competition.
- Games can improve learning outcomes: Digital games have been shown to be effective in promoting learning outcomes, such as knowledge acquisition, skills development, and problem-solving abilities.
- The secret to good game development is: The usefulness of the game as a teaching tool is greatly influenced by its design. Clear learning objectives, a suitable degree of difficulty, and insightful feedback should all be included in the design of game-based learning. The game should also take the learners' interests and competency levels into consideration.

Overall, the studies on game-based learning offer proof of the potential advantages of adopting computer games as a teaching tool. The findings suggest that game-based learning can improve motivation, engagement, and learning outcomes, and that effective game design is key to its success. However, more study is required to determine the best game-based learning design and execution as well as to solve the difficulties and restrictions related to its application.

PROPOSED WORK

The intent of our project is to gamify the process of learning and provide a competitive and fun way to learn academics topics and interactive way to learn puzzles asked in placement tests. This includes the system's architecture, functional modules, and overall system flow.

System Architecture

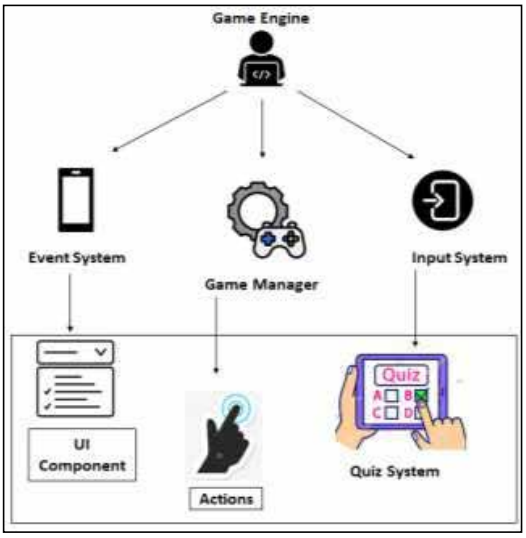

Fig.1: System Architecture for AlgoRunner

Flow of the System

We have shown the flow of our project in Fig.2. The student is the main user which will use the app. The User will start playing, he/she can move left or right according to rescue from obstacle. If user meets with an obstacle he will die and the game will end. If the user does not meet with an obstacle, after some interval of time questions along with three options as an answer will pop up on screen. The user has to choose the correct option, if the selected answer is correct, he can continue to play else he will have to retry the game.

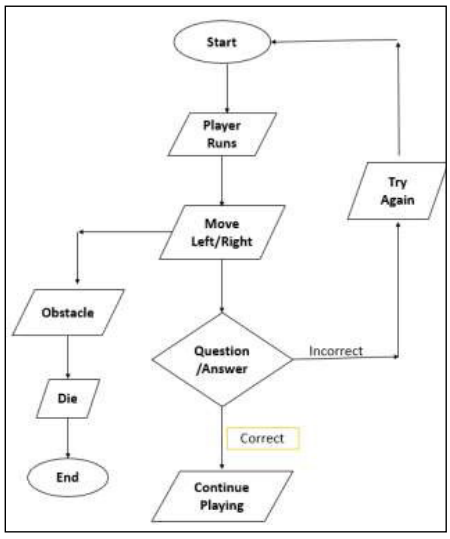

Fig.2: Flowchart for AlgoRunner

Functional Modules

Three modules make up the entire system. Those are UI Component, Actions, Quiz Manager.

UI Component

This will act as a base for the application where the user just has to swipe the character (Runner) and dodge the oncoming obstacles.

Actions

The character can JUMP, SLIDE, MOVE LEFT, MOVE RIGHT to dodge the obstacles. If the runner meets with an obstacle, he will die and the game will end.

Quiz Manager

While the user is playing the game they will receive questions randomly in between they will have to answer the questions correctly within a specified time else they will have to start over. The user has to choose the correct option , if the selected answer is correct, he can continue to play else he will have to retry the game.

Score formula

Score = (int) zaxis_distance * 0.5 + answer_score

RESULT

When the user starts the game, it will look like an endless road and there will be obstacle generation as shown in Fig.3. The user can move left or right to rescue from the obstacle which are getting generated with the endless road generation. It will also display the highest score of the user at the top of the screen which will help to improve the performance of the user.

Fig. 3. Endless Road/Obstacle Generation

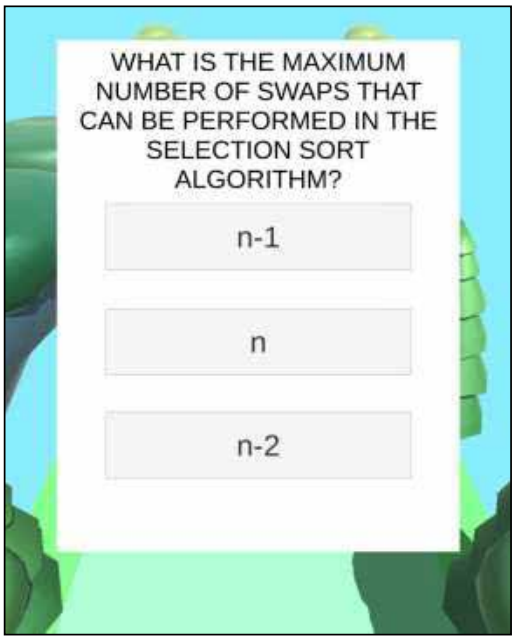

Fig. 4. Quiz Generation

When the question screen as shown in Fig. 4 pops the user has to answer the question correctly to progress further otherwise the game ends and shows "try again" screen. If the user has answered correctly the question screen will pop again after a set amount of time and this process is repeated endlessly until the user either answer incorrectly or collides with an obstacle.

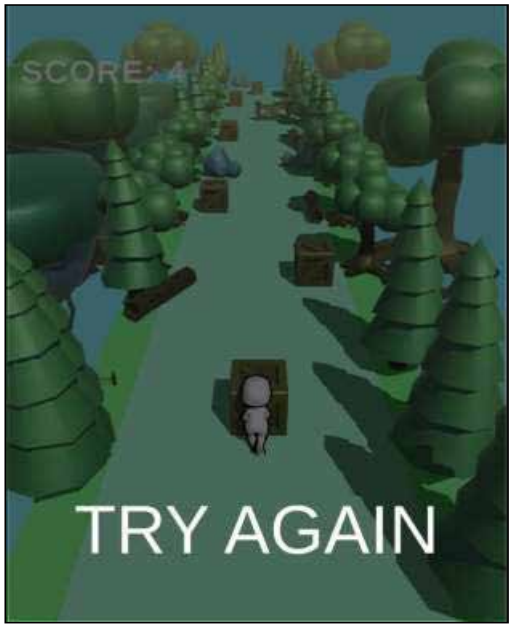

Fig. 5: Fail Screen

If the user gets stuck with the obstacle that are generated along with way, it will end the game and a screen will pop up as try again as shown in Fig.5. Also, if the answer got incorrectly, it will also show the fail screen as shown above and automatically the score board will be calculated.

APPLICATIONS

A. Schools and Universities: The same teaching model has been followed for decades where teachers focus more on curriculum completion resulting in an unproductive learning system. Spark interest in coding in schools where students are new to coding. At a university where students improve their skills and knowledge. Education centers should establish healthy competition among students.

B. Competitive Learning: Competitive learning is a teaching method that lets students try out new research skills without worrying about making mistakes or getting low grades. It can be a fun way to learn and can help students become more engaged in their studies.

CONCLUSION

In this research paper, the developed application addresses the tediousness of learning programming concepts among students. We applied our engineering knowledge to analyze the problem and designed a modern engineering solution in two modules. Through investigating available applications, we identified new solutions and updates. The implementation of the application was done using modern tools such as Visual Studio.

Our study acknowledged the positive influence of game-based learning on motivation, participation, and overall satisfaction with learning. Throughout the project, we applied professional ethics and understood the importance of individual and team work and communication skills while presenting the project in various competitions and conferences for project management.

This research paper presents a proposed solution that can be developed at a generalized level for multiple sectors for life-long learning. It contributes to the advancement of mobile application development for

game-based learning, addressing the educational needs of students in a modern and interactive manner. Future research can further explore the effectiveness and impact of game-based learning applications in different educational settings and contexts.

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Quantum Machine Learning for Disease Diagnosis

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ABSTRACT

Quantum Machine Learning is very promising and an upcoming area that makes use of the principles of Quantum Computing and Machine Learning to process and analyze large data sets more efficiently. QML is supposed to revolutionize many areas, including healthcare, medicine& drug discovery.

Early disease diagnosis is very crucial for effective treatment & improved patient outcomes. Delay in disease diagnosis can have significant negative effects on not only patients but also care givers and the whole healthcare system. Delay in diagnosis causes disease progression, making it more difficult to treat and potentially leading to complications.

In the context of QML, early diagnosis could involve analyzing large datasets of patient information, such as medical records and imaging data, to identify patterns and indicators of disease at an early stage so as to suggest early medication and proper treatment plan. There are many studies being carried out to explore the possible uses of Quantum Machine Learning in healthcare. Here, in this paper we have tried to do the critical analysis of these studies and tried to show their results and the comparison with the traditional machine learning algorithms.

The results obtained by Yogesh Kumar et.al. [28] using the QRFC (Quantum Random Forest Classifier) were: Accuracy was 0.86, F-Score=0.88, Recall=0.91 and Precision was 0.83. Whereas, by using the traditional algorithm (RFC) the values were: Accuracy=0.83, F1-Score=0.85, Recall=0.88 and the Precision was 0.80. Thus in their case, the Quantum version of the algorithm showed better results. There was also a comparison of the execution times of conventional and quantum-enhanced machine learning algorithms, with the quantum random forest having the shortest execution time by 150 ms. Consequently, the work offers a mechanism to quantify the differences between conventional and quantum enhanced ML algorithms in order to choose the best strategy for disease detection.

KEYWORDS: *Quantum machine learning, Disease diagnosis, Machine learning, Quantum Ccmputing, QML.*

INTRODUCTION

Quantum Machine Learning (QML) is a prominent field that makes use of quantum mechanics & machine learning principles to process and analyze large sets of data more efficiently. QML algorithms are supposed to leverage the inherent properties of the quantum systems, viz. Quantum 'Superposition' & 'Entanglement', for performing certain computations faster and more accurately than classical algorithms.

The field of machine learning aims to develop algorithms that learn from the given data & accordingly make decisions / predictions. However, traditional machine learning algorithms often struggle with processing large datasets due to limitations in computational power and memory.

QML seeks to address the aforesaid limitations by exploiting quantum system's unique properties for enhancing the efficiency &accuracy of ML algorithms. The Quantum systems are able to perform certain calculations faster than classical systems by simultaneously considering multiple possibilities through quantum superposition. The Figure 1 shows the overall process of disease diagnosis.

The way we analyze and understand medical data in the context of healthcare has the potential to undergo

a revolutionary change thanks to QML. By using the quantum systems' processing power, QML algorithms could aid in the early detection and diagnosis of diseases, leading to better patient outcomes and more effective treatments. Furthermore, quantum sensors could provide more detailed and precise medical imaging, allowing for more accurate diagnoses and treatments.

Despite its promising potential, QML, at present is in its early development stage. Many of the challenges need to overcome, such as developing algorithms that can work with limited qubits available in current quantum computers, & developing new hardware and software tools to support QML applications. However, as quantum technology continues to advance, QML is likely to have an increasingly significant role in various fields viz. engineering, finance, and healthcare.

Here, we have tried to highlight the fundamental quantum computing application areas & the analysis of its significance in healthcare systems. The processing methods and the applications of Classical ML & the Quantum Machine are visualized in Fig. 2.

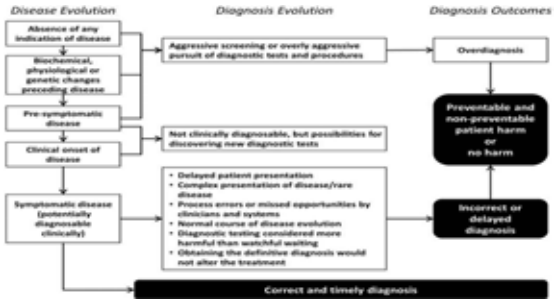


Figure 1: Disease Diagnosis Process
(Image Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4779119/bin/nihms764405f1.jpg)

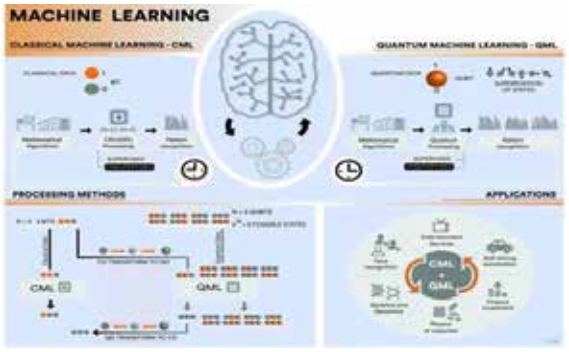


Fig.2: Processing methods and the applications of CML and QML

(Image Source:https://scx1.b-cdn.net/csz/news/800/2017/3-quantummachi.jpg)

It implies that we will have a better of everything from medicines having less side effects to far better diagnostics. In order to exploit quantum computing in healthcare, we are required to develop new 'quantum applications.'

We have tried our best to review literature related to quantum computing & the propensity in design - development of the healthcare - systems that will be considered as next generation. The present work, its causes, effects & future directions in research for a coherent implementation of the quantum computing healthcare related systems has been discussed.

LITERATURE REVIEW

The main goal of ML is to train a computer making use of the algorithms which have already processed data. The tendency of "Quantum Tunneling" encourages the computation of optimization problems quickly [3, 4, 17]. Using the subsets of the 'supervised' & the 'unsupervised' or 'deep' learning, classic methods of machine learning aid in the classification of images, the recognition of patterns and voice, the management of huge data, etc. [5]. New methods for managing, classifying, and organizing the wide variety of available data are now required [6]. Machine learning has been around for a while, and numerous businesses and organizations have invested in it [7].

The organizations where workers are engaged in efficient administration of 'Data Warehouse', able to handle wide variety of data and are particularly interested in learning new methods for carrying this out. A proposed method to get rid of these restrictions is quantum enhanced ML [8]. The susceptibility present in input data that the given approaches may properly treat and handle is one of the concerns to be overcome in quantum enhanced ML [9].

A difficult problem can be solved through adaptive learning, which finds potential behaviors and patterns on its own [10]. Although it has been found that standard machine learning [11] is a process that is adaptable and can successfully map a variety of patterns. However, there are still some difficult problems that can't be solved effectively using the usual ML algorithm approach.

However, the desire to use quantum computers to apply these methods opens the door for quantum- enhanced machine learning [12]. A method called quantum-enhanced machine learning was created to improve on the standard machine learning algorithms. A branch of research on quantum information processing called quantum-enhanced machine learning [1] is concerned with creating machine learning algorithms that can learn from data.

These systems are said to use a set of theories known as quantum algorithms to compute information based on the concepts of quantum theory [12]. Grover search is key component of ML algorithms that are enhanced by accelerate unordered datasets [13].

For the identification of patterns and the extraction of data, numerous machine learning algorithms enhanced by quantum computing have been created [14]. A prospective quantum system is used to conduct machine learning algorithms enhanced by quantum computing, which leverage it's speed to tackle the complicated problems related with the traditional ML methods [15].

With this rate of development, it is evident that these machines will be quickly applied in the future, which will make the analysis process of all data easier. Also, this developing field makes use of powerful ML techniques to further the limits of quantum information theory [16]. M. Niemiec [23] has discussed error-correction in the ANN based 'quantum-cryptography'. In this technologically advanced age, it is common practice to develop streamlined administrative procedures in healthcare facilities in order to map and effectively treat contagious diseases [18].

J. Suo et.al. [24] discussed various quantum algorithms for hard problems. Big Data Analytics in Healthcare is discussed by Y. Kumar et.al. [25]. Waiting time prediction in the radiation oncology is discussed by A. Joseph et.al. [26] by using ML. Data-driven prediction model of Cervical Cancer is given by M. Ijaz et.al. [27].

Hardware advancements made possible by quantum computing and healthcare systems can help the healthcare sector greatly in diagnosing and treating complex medical conditions [19]. The digital world is infused with quantum physics through quantum computing, which enables faster data processing and more complex problem solving [20].

AI and ML are coupled to the traditional computing facilities for the interpretation of CT scans, expedite surgical steps & analyze huge data to construct disease prediction models [21]. Damahe, Lalit B. et.al.[30] discussed the various approaches for the representation, compression & the retrieval of image, Fazil Sheikh et.al. [29] have discussed the status, challenges and possible solutions of QML in healthcare sector.

Quantum computing has no use in medicine without a corresponding increase in the accessibility of medically pertinent data from multiple sources [2]. Beginning in the year 2000, when the 1st 'Quantum Computing' tool went into operation, Parsons18 [22] projected that the applications of quantum computing will have an impact on medical imaging's future.

A comparative study of the traditional ML algorithms and the Quantum Enhanced ML algorithms has been carried out by Yogesh Kumar et. al. [28]. The following Table 1 shows the various evaluation parameters using Min-Max Scalar based on traditional vs. quantum enhanced algorithms for Heart Failure Detection (HFD).

Table 1. HFD using min-max scalar

Sr. No.	Algorithms	Accuracy	F1- Score	Recall	Precision
1.	QRFC	**0.86**	**0.88**	**0.91**	**0.83**
2.	RFC	0.83	0.85	0.88	0.80
3.	QKNN	0.85	0.86	0.87	0.84
4.	KNN	0.82	0.83	0.84	0.81
5.	QDTC	0.75	0.75	0.76	0.73
6.	DTC	0.77	0.79	0.80	0.76
7.	QGNBC	0.81	0.84	0.87	0.80
8.	GNBC	0.81	0.83	0.86	0.79

The following Table 2 shows the various evaluation parameters using Standard Scalar based on traditional vs. quantum enhanced algorithms for Heart Failure Detection (HFD).

Table 2. HFD using standard scalar

Sr. No.	Algorithms	Accuracy	F1- Score	Recall	Precision
1.	QRFC	0.85	0.87	0.90	0.85
2.	RFC	0.83	0.84	0.87	0.81
3.	QKNN	**0.88**	**0.89**	**0.90**	**0.87**
4.	KNN	0.85	0.86	0.87	0.84
5.	QDTC	0.75	0.76	0.76	0.73
6.	DTC	0.77	0.79	0.80	0.76
7.	QGNBC	0.83	0.85	0.88	0.81

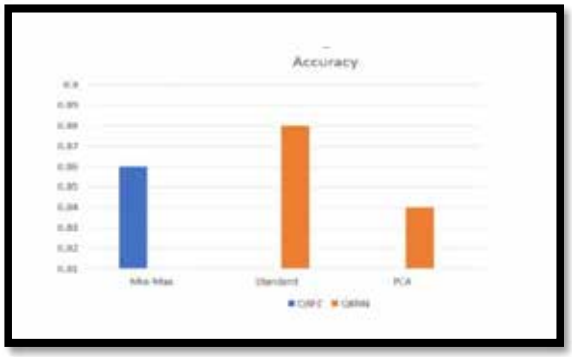
The following Table 3 shows the various evaluation

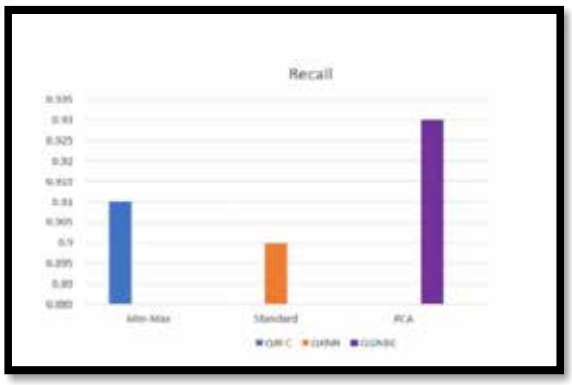
parameters using PCA based on traditional vs. quantum enhanced algorithms for Heart Failure Detection (HFD).

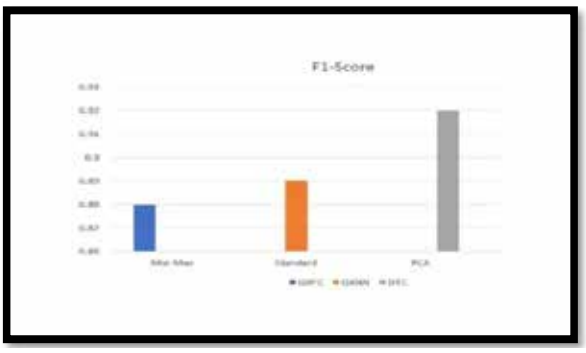
Table 3. HFD using PCA

Sr. No.	Algorithms	Accuracy	F1- Score	Recall	Precision
1.	QRFC	0.82	0.84	0.90	0.79
2.	RFC	0.79	0.81	0.87	0.76
3.	QKNN	**0.84**	0.85	0.88	**0.83**
4.	KNN	0.81	0.82	0.85	0.80
5.	QDTC	0.75	0.90	0.80	0.70
6.	DTC	0.79	**0.92**	0.84	0.73
7.	QGNBC	0.82	0.85	**0.93**	0.80
8.	GNBC	0.80	0.82	0.90	0.76

The graphical summary of the examination of the values shown in the above tables (1, 2, 3,) (Yogesh Kumar et.al.[28]) is in the following Fig. 3.







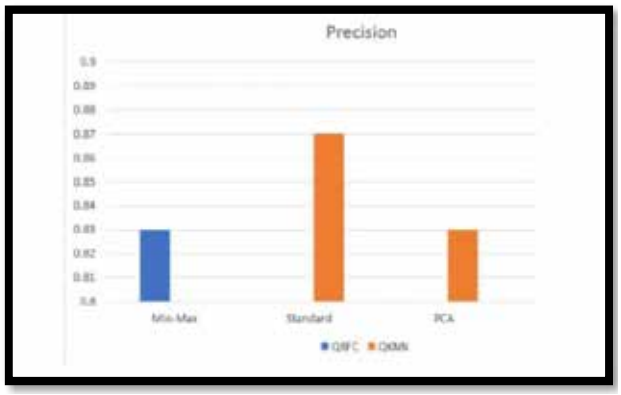


Fig. 3: Evaluation Parameter based Comparison

There are several patents. Some of them are as mentioned below:

1. Researchers at the University of Waterloo have filed a patent related to using QML for cancer diagnosis. The patent, titled "Quantum Machine Learning for Cancer Diagnosis and Treatment", describes a method for using QML to analyze patient data and predict the most effective treatment for individual cancer patients.
2. Microsoft has filed several patents related to the use of QML in healthcare. One of their patents, titled "Quantum machine learning for medical imaging", describes a method for using QML to analyze medical images and detect diseases.
3. IBM has also filed several patents related to the use of QML in healthcare. One of their patents, titled "Machine learning using quantum computation", describes a method for using quantum computation to train the ML models.

CONCLUSION

We have tried to show the advantages, limitations and the kind of work that has been done in the area of Quantum Machine Learning for disease diagnosis. We have also shown the comparison with the classical Machine Learning algorithms. The ongoing advancements in both the fields would influence the future landscape of heart failure detection.

Quantum Computing seems to revolutionize the existing computing systems with very high speed, more efficiency & high reliability. We can exploit these key

aspects of the quantum computing along with machine learning to design &implement healthcare applications that would be computationally efficient. On this front, in this paper, we have tried to provide an all-inclusive study and review of the current literature having focus on leveraging the power of quantum computing to develop solutions in healthcare.

RESULTS AND DISCUSSION

The results of various Classical ML (CML) algorithms & the Quantum ML (QML) algorithms have been shown in tables and graphs. The comparison between CML and QML is also described. Quantum Machine Learning (QML) holds potential for various types of diseases, particularly those that involve complex data patterns and require high-dimensional analysis. Here are some examples of disease areas where QML may be well-suited: Cancer, Neurodegenerative Diseases, Cardiovascular Diseases, Infectious Diseases, Rare Diseases, Precision Medicine and Personalized Treatment, Mental Health Disorders, Respiratory Diseases etc.

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Routing Mechanism with Fuzzy Logic Approach in Wireless Sensor Networks: A Survey

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ABSTRACT

Wireless sensor networks are currently widely employed in a number of applications and scenarios due to their adaptability and capacity to build scalable and reliable wireless networks. A large group of scattered sensor nodes designed for the purpose of acquiring data about the physical environment and transferring it to the base station makes up a wireless sensor network (WSN). These sensors' main function is to collect physical data and turn it into valuable information by combining, analyzing, and disseminating it. WSNs frequently employ non-rechargeable sensor nodes in hazardous locations. As a result, they have power supply restrictions, which creates a variety of difficulties for energy consumption optimization. Improving the way data is transported throughout the network is crucial because the transmission unit uses a significant amount of the sensors' energy. To improve routing protocols used in WSNs becomes prolong interest to extend network life and improve energy saving. This paper illustrates the benefits and drawbacks of a variety of fuzzy logic-based routing systems.

KEYWORDS: *WSN, Fuzzy logic, Routing.*

INTRODUCTION

WSN known Wireless sensor Network is a grouping of autonomous, small, sparsely dispersed objects known as sensors that cooperate to gather data and send it to a base station for later use. For example, a system of geographically dispersed sensors called a wireless sensor network is designed to gather, track, and store physical data before sending it to a hub [1]. Numerous industries, including agriculture, the military, environmental management, industrial use, healthcare, security, and safety, now have new perspectives thanks to sensor technology. WSNs were developed to make sure that a physical event would always be monitored. They must therefore enable efficient and long-lasting connections between the base station and nodes.

Consequently, a number of factors are required when developing a sensor network. to be considered, including node for real-time location and mobility, data collection, deployment, bandwidth(B/W), and the management of traffic. Furthermore, since sensors are typically battery-powered and are not known for being rechargeable, their ability to deliver power is limited. In these high-risk situations, WSNs are typically used despite the fact that significant human intervention is risky. The difficulty of recharging or replacing sensor nodes despite their low cost (change). In order to maximize the networks' longevity, it is imperative to carefully regulate their energy consumption. As smart devices become more prevalent, energy efficiency is now a key component of the Internet of Things architecture [2]. In order to sense, process, send, or receive data, a sensor node needs energy. Nearly half of the total energy is used in this scenario by a sensor node's transmission unit, according to research [3]. Optimizing data transfer between sensors throughout the network becomes essential as a result. It is common knowledge that the "network layer" is where data transmission management happens. The best routing protocol should

be selected by this layer in order to send accurate data with a respectable latency and while taking energy constraints into account. Without a doubt, to achieving high transmission effectiveness one of the major key factors we select appropriate routing protocol. The importance of and need for research into WSN routing strategies is widely held among academics and industry professionals. This paper's main goal is to demonstrate how WSN routing techniques can be improved by using fuzzy logic (FL). The study covers a variety of effective routing techniques. Second, it will outline a variety of research projects that aim to improve routing techniques through the use of intelligent algorithms. Our final topic will focus on the numerous ways that fuzzy logic has been used into LEACH.

FUZZY LOGIC FOR SENSOR NETWORK

A subfield of mathematics known as fuzzy logic was developed to simulate human reasoning [4]. People simulate the decision using fuzzy logic get employed [12]. Fuzzy logic takes into account intermediate belonging values in the range of [0,1], whereas conventional computational systems only take into account the two values 0 for true and 1 for False. Starting with precise variables, the method converts them into linguistic inputs. Fuzzing is the method in question. On the other hand, defuzzification refers to the conversion of a system-generated linguistic variable into a crisp (digital) variable. A fuzzy inference engine is used to divide the output between these two methods while taking into account the membership functions and the fuzzy rules table. For each language input, fuzzy membership functions are used to estimate the membership of the provided values [16]. Membership functions are used to translate a precise (numerical) input into the corresponding linguistic value. Every membership function specifies the values connected to a specific fuzzy metric. For each measure that the fuzzy system takes into account, the inference engine can integrate the inputs and produce outputs that are suitable. The fuzzy rules table always taken a list of if X and Y, X or Y, is taken into account by this engine. As a result, Z. Multiple measures can be combined into a single metric with the help of the fuzzy logic module [17]. Architecture of the basic fuzzy system shown below.

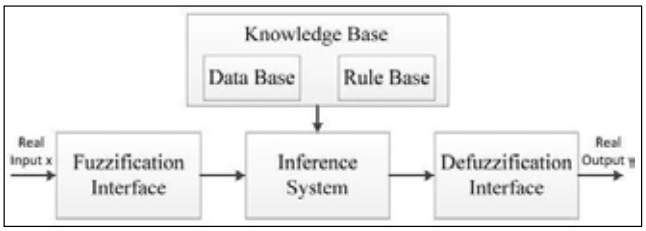

Fig. 2. Architecture of the basic fuzzy system

Bhajantri et al. [2018] look into the failure node patterns in WSNs. The effectiveness of the distributed system identification approach for defect detection is supported by simulation results. Each sensor node periodically sends a beacon message to inform neighbouring nodes of its status. With the sensor node, you can keep an eye on how well your links are working as well as how much energy and bandwidth your neighbours are using. Each node evaluates the observed data while it is being transmitted using fuzzy logic estimate methods to detect faulty sensors.

To create deterministic model for the placement of sensor node that employs a fuzzy approach to identify inactive nodes will discuss by the authors of this paper [2017]. Using the fuzzified approximation, faults of various types can be located both within and between clusters. It assesses the fault rating during each interaction and relays its conclusions to the cluster's central server. Each group's cluster leaders assess the index value against a predetermined limit. A sensor is deemed to be malfunctioning and its status is sent to the node behind it in the network if its cluster value drops below a set threshold.

In their 2017 paper, Sasmita and colleagues discuss a method for fault tolerance based on hazy knowledge. The author uses artificial neural network routing and fuzzy knowledge to implement fault tolerance for WSNs (ANNR). The system uses an Intelligent Sleeping Mechanism (ISM) in addition to an exponent bi-directional memory formation (eBAM) for network decoding and encryption. Several fuzzy heuristics are used to locate the problematic nodes in the network. Data aggregation within the cluster is the responsibility of the Cluster Head (CH). Node Appraisal Technique (NAT), a technique for locating problematic nodes in the network, is based on fuzzy knowledge. The study uses a sleep state method to save energy and a fuzzy

rule to find network problems. Prasenjit et al. (2015) suggested a scalable network failure detection system based on fuzzy rules. Regardless of the nature of their fault, defective nodes are not grouped or under control. To achieve better results in the WSN context, fuzzy logic is used. A non-fuzzy control is developed to obtain the correct sensed values from different types of nodes after nodes are categorized using a set of functions [14]. Raghunath, Thirukumaran, et al. (2019) created instant synchronization using damaged nodes. A fuzzy- based predictor is also used in this strategy to find routing challenges. By avoiding collisions, it reduces gearbox lag times. The fuzzy support method is used to construct the system for speedy installation [15].

Farnaz Pakdel et al. (2016) recommended using fuzzy techniques to spot cluster head issues. If no response is received within a certain amount of time, this method finds a cluster head defect. For selecting a new cluster head replacement, a fuzzy logic system evaluates residual energy and the shortest distance from the damaged sensor node [16]. A heuristic approach grounded in probabilistic theory was proposed by Saeed et al. (2012). When using the variable rating approach, the presented process might only have one issue, namely a different sensing value than what is accepted. The node is obviously flawed if the result significantly differs from the rate variables of surrounding nodes [17]. By Sai Krishna and associates, a fuzzy- based delay-aware routing system has been proposed (2019). The surveyed fuzzy-based clustering protocols comparison shown in below table.

Author	Cluster Size	Fuzzy Based	Multi Hop	Fault Detection
Bhajantri et al. [2018]	Not Fixed	Yes	Yes	Yes
Sasmita et al.[2021]	Not Fixed	Yes	Yes	Yes
Prasenjit et al. (2020)	Not Fixed	Yes	Yes	Yes
Raghunath, Thirukumaran, et al. (2019)	Not Fixed	Yes	Yes	Yes
Farnaz Pakdel et al. (2016)	Not Fixed	Yes	No	Yes
Saeed et al. (2012)	Fixed	Yes	No	Yes
Sai Krishna (2019)	Fixed	Yes	No	Yes

CONCLUSION: OUR PROPOSITION FOR A FUTURE WORK.

It should be suggested that by two fuzzy system integrating concurrently in the same network with the purpose of expand the scope of the previous fuzzy solutions based on the results of this survey: To select first CH value for the fuzzy system with three inputs, such as the energy current CH, the remaining node energy, the distance from the centroid, or the distance to the base station, will be used. The communication between the CHs is the second parameter will use less energy than data transmission from the CH to the BS. With the aim of decide whether should we transmit aggregated data directly to the base station or the nearby CH, choosing second fuzzy system that will only be used by CHs. The distance from the base station, the neighbour's distance with base station, the residual energy, and neighbours' residual energy are examples of fuzzy inputs. Given that fuzzy rules must be updated each time the topology changes, it would be exciting to incorporate additional intelligent algorithms in addition to fuzzy logic, such as neural networks, to automatically optimize the fuzzy rules table. RL is more flexible and adaptable to dynamic networks; By combining its advantages with a fuzzy system to improve the membership functions and the fuzzy rules table.

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Automated Estimation of Leaf Affected Area by Adapting Machine Learning Algorithms

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ABSTRACT

Plant diseases pose a persistent threat to agricultural productivity and global food security. The accurate detection and quantification of disease severity in plant leaves are crucial for implementing timely interventions. The following ground-breaking investigation, we recommend a novel approach to precisely calculate affected area of plant leaves using advanced image processing techniques and machine learning algorithms. Our model not only provides an automated and reliable assessment of disease severity but also empowers farmers with actionable insights to optimize crop management practices. By leveraging this technology, farmers can proactively identify severely affected leaves, implement targeted treatment strategies, and mitigate the economic and environmental impact of plant diseases. Our findings hold significant promise for revolutionizing crop protection practices and fostering sustainable agriculture in the face of mounting challenges posed by plant diseases

KEYWORDS: *Agriculture, Plant diseases, Disease severity, Affected area calculation.*

INTRODUCTION

When assessing the damage brought on by leaf diseases and pests, careful monitoring of the leaf area is a crucial factor. The analysis of plant growth and photosynthesis depends heavily on leaf area. Leaf diseases are the predominant factors that affect the entire plant growth. Hence the need arises to treat these leaf diseases on time; else it causes great loss in production of the yield. Overuse of pesticides to cure plant diseases raises costs, causes environmental degradation, and reduces yields. Hence, their utilization must be minimized. This may be accomplished by applying the right amount and concentration of pesticide to the disease regions and evaluating the disease severity using techniques like image processing. Different destructive and non-destructive techniques are used to estimate leaf area. In destructive techniques, the leaf is first plucked from the plant, and then its area is measured. Non destructive approaches involve measuring a leaf's area without plucking from the plant. Montgomery (1911) was the first to propose that plant leaf area might be determined by calculating the linear measures of leaves using the formula given in equation 1.

$$A = b \times \text{length} \times \text{max width} \quad (1)$$

Where b is a coefficient.

This approach is quicker, simpler, and non-destructive. But the challenge factor is that coefficient b varies between species, the formula is not the same for all plants.

This has motivated us to develop a universal algorithm which calculates the affected area of any leaf. This is obtained by using image segmentation as it plays an important task in segmenting the affected area of leaf. It is discussed briefly in the next section.

METHOD

Here we give details of the method utilized for calculating the affected area of leaf. This is achieved by using K means clustering technique and Lab color. The flowchart for method is shown in Figure 1.

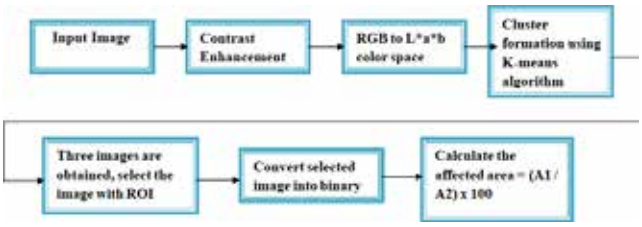

Figure 1: Flowchart for finding the area of affected leaf.

The algorithm for calculating the affected area of the leaf is discussed briefly below. Algorithm for calculation of affected leaf area

Input : Leaf Sample

Output : Affected area in % Step 1. Start

Step 2. Read input image.

Step 3. Enhance the contrast of the image.

Step 4. Convert the RGB image to Lab color space.

Step 5. Employ K means clustering to group the colors in 'ab' space.

The K means algorithm is described briefly as below.

First the number of clusters is decided by using the color space L*a*b. Since the image has three colors form three clusters.

Step 5.1. Set the cluster's centre to zero.

Step 5.2. Put each data point in the cluster that is closest to it.

Step 5.3. Set the average value across all the data points in each cluster as the cluster location.

Step 5.4. Until all points are assigned to the given clusters, repeat 2-3.

Since colour information may be found in the 'a*b*' space, the objects are pixels with 'a*' and 'b*' values. K-means uses the Euclidean distance metric to assign each data point to the cluster.

Step 6. Three segmented images are obtained, among them select the cluster with ROI. Step 7. Selected image is converted to binary image.

Step 8. Calculating Affected Area from the binary image.

By counting the number of pixels in the segmented binary image, this is computed. Diseased region is considered as A1 and Total leaf area is considered as A2. The affected leaf area is calculated by the formula given in equation 2 below.

$$\text{Affected leaf area} = (A1 / A2) \times 100 \quad (2)$$

Step 9. Display the affected area in percentage. Step 10. Stop

RESULTS

The procedures carried out on the diseased leaf are described in this section. The step by step process of the algorithm discussed in the method section is shown with the help of figures. As shown in Figure 2 the input image is read for the operation.

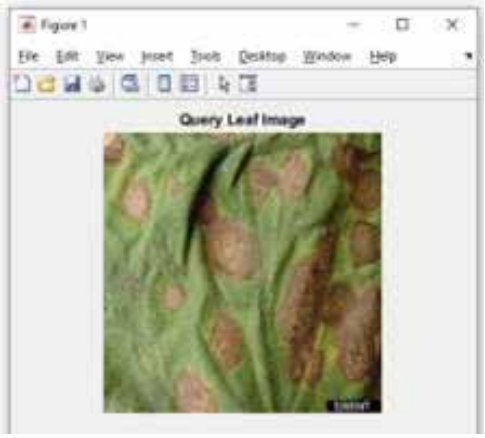

Figure 2: Query Leaf Image

The input image is contrast-enhanced to enhance the diseased features of the input image. This is shown in Figure 3.

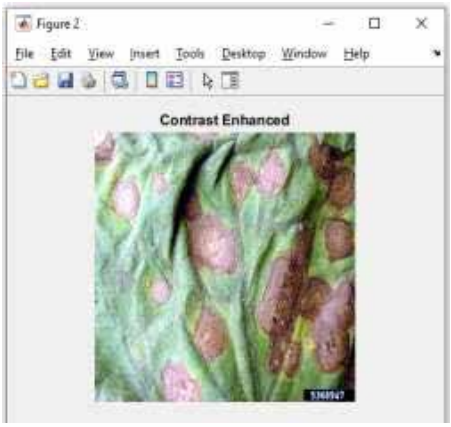

Figure 3: Contrast Enhanced Image

Next it is converted from RGB to L*a*b color space. Using K means clustering algorithm the image is divided into three clusters as shown in Figure 4.

Figure 4: Cluster Formation

From the obtained segmented images, the image with ROI is selected for further operations. This is done using the dialog box shown in Figure 5.

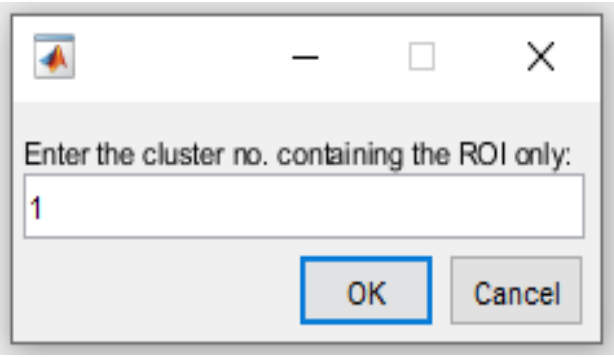

Figure 5: Select an Image with ROI.

The selected segmented image is converted to a binary image, which is shown in Figure 6.

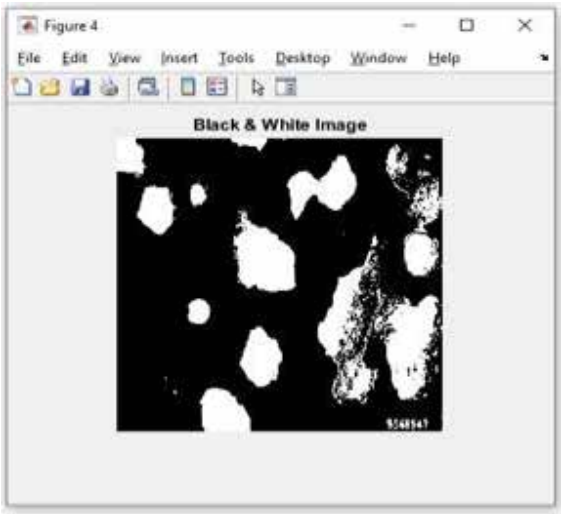

Figure 6: Black & White

And using the formula in equation 1 the disease-affected area is calculated and it is displayed in Figure 7.

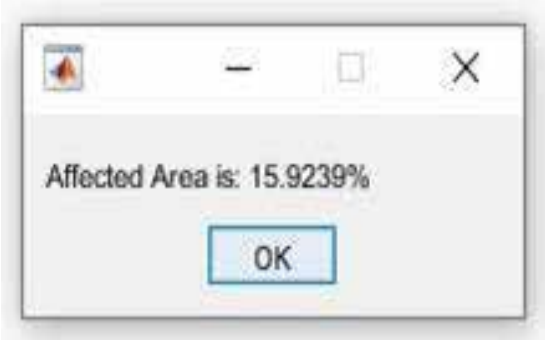

Figure 7: Result.

CONCLUSION

To observe the severity of sickness of leaf diseases, image processing is absolutely necessary. Our research article highlights the significance of automated detection and quantification models for plant diseases, specifically focusing on the calculation of the affected area of plant leaves. As the precision of open-eye observation might be poor and differ from individual to individual. In this article, with the help of K means clustering the affected region is segmented. And the affected area of the leaf is calculated by using equation 2. The severity of the disease is understood by the percentage of the affected area. Based on this, appropriate measures can be taken to minimize the disease. This might be helpful for the farmers to produce better quality and quantity of yield.

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A Review on Scheduling Algorithm for CREW System Management of Railway Operations

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ABSTRACT

Our proposed algorithm aims to more precisely and consistently allocate a driver on a network. This algorithm will be improving operational safety and it is used to automate manual operations. After thorough observation and analysis of several departments on drivers in general and links to those drivers in particular, this algorithm offers safe and consistent schedules for drivers, which reduces the need for manual rescheduling. The digitalized schedule will allow the drivers to locate their leisure days in advance because it can be implemented in web-based applications in future.

KEYWORDS: *Automation, Days, Time, Transportation, Crew scheduling concepts, Scheduling algorithm.*

INTRODUCTION

The issue of driver scheduling affects all modes of transportation, but in this paper, we focused specifically on public transportation, such as trains. Effective time management can have a big financial saving for transportation companies since driver wages make up a significant portion of costs. For instance, about 45% of the total operating expenses are attributable to train driver wages. Terminologies must be introduced in order to make the issue more understandable. A driver schedule is a method that divides up all the necessary driving duties into a set of shifts. The quantity of labor one driver completes in a single day is called a shift. The shifts are just hypothetical because they haven't been assigned to real workers yet. After that, the work is packaged for actual drivers. scheduling theory is concerned with the location of resources to activities over time. The driver typically signs in at a depot to begin a shift. The motorist then performs one or multiple spells separated by breaks. Usually, there is at least one sufficiently long break. in order to eat.

The main objectives and constraints for driver scheduling are as follows:

- Each task is assigned to a shift, which also has to abide by all operational constraints and labour rules.
- There are a limited amount of shifts overall.
- The entire expense is minimal.

LITERATURE REVIEW

Crew planning in railway operations

Various planning levels can be used to categorize train crew choices. This section discusses crew planning actions in relation to operational planning, disruption management, and strategic/tactical planning. For

a comprehensive understanding of the planning procedure, models, and problem-solving methods used in railroad operations, we recommend the following book. We also define the technical words used in crew scheduling and go through the distinct characteristics of the various kinds of railway transit.

Strategic and tactical planning in Crew management

Crew planning considers the availability and long-term capabilities of personnel members with a time horizon longer than a year, as well as the location and capacity of crew depot. Realizing a balanced crew composition in terms of experience and age, as well as making future plans for the requirement for diverse crew types, is crucial for reliable long-term operations. This involves choosing to hire, train, or transfer a crew between depots. Decisions about the locations of the crew depots, including whether to open or close them, are also crucial at this point.

Scheduling of crew in operational planning

Crew planning is the process of creating work plans for crew members in order to adhere to a predetermined schedule. It demonstrates the standard operational planning process for rail transit. The lines, their origin/destination stations, and their pauses at the start of the operation are all determined by the line planning issue. Train types and frequency on each route are set in order to satisfy all travel requirements while optimizing service or reducing operational expenses. Then, for each station and track segment, the arrival and departure timings of each train are computed, taking into consideration all applicable safety constraints. After the timetable for each route is published, trains must be assigned to platforms.

A self-Adapting algorithm for Driver Scheduling

The main advantages of employing metaheuristics are a relatively efficient way to search through extremely large solutions. Regardless of the type of problem being solved, each class of meta-heuristics has a methodical and consistent approach that always returns a solution. Strategic structure GAs, or genetic algorithms, are a significant class of meta-heuristics that have been extensively used in driver scheduling algorithms.

THE S-TRAIN NETWORK

DSB S-tog A/S, a part of the Danish State Railways, serves Greater Copenhagen, the largest train in the Danish firm, on the S-train network. It displays the network of S-trains. There are 85 stations over its 170 kilometres of twin tracks. Every network section is serviced by a minimum of two railway lines that operate three trains per hour, cyclically, in each direction. There are two types of lines: the main line, which runs from around five in the morning until one in the morning the following day, and the supplementary line, which runs all day long. around 6 am to 7 pm. The principal line, such as a line connecting networks, is designated by a colour and a capital letter.

The only two rail routes that do not pass through Copenhagen H are F and F+ (Copenhagen Central Station). The network segment in issue is known as a circular rail segment. The fingers are the last components of the network. The obstacle separating Copenhagen H from Svanemllen station in North Copenhagen is the network. Here is where the network is busiest. Considering each train separately.

A train ride between two terminal stations is referred to as a train task in a timetable. Copenhagen Central Station, KBH, and Farum Station for Lines H and H+ are just a few examples of termini on S-tog train lines. Another train task (w) refers to the responsibility of a train driver that comes after the previous train task.

Relief terminal stations, or locations where a driver can give over control of a train to another driver and take a break or check out, include check-in depots and crew depots. In a non-stop timetable, the conductor designated to operate the first train from a non-relief terminal station likewise conducts the train that arrives at the station. line B.

On a workday, up to 19 drivers may be placed in reserve, while on a weekend day, up to 12 drivers may be placed in reserve. A few reserve drivers are stationed at the Hilliard and Kage check-in depots, but the bulk are in Copenhagen H. The majority of the backup drivers are at work. The majority of reserve drivers work the whole shift, however a small percentage work for a portion of the day before receiving training assignments.

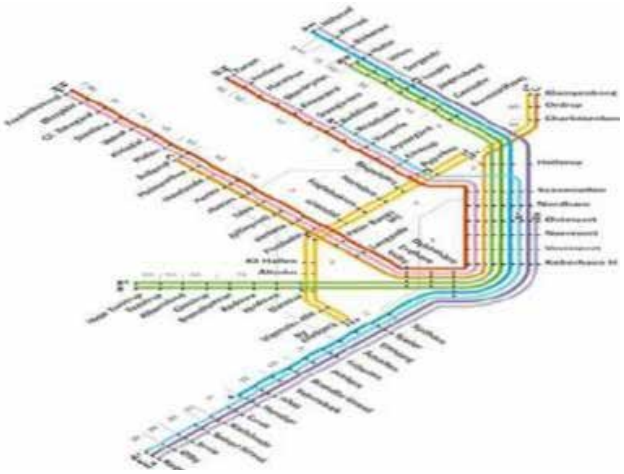

Fig. 1. S-Train Network

DISCUSSION

Link scheduling algorithm:

Every Algorithm is a set of rules, instructions, and conditions to solve a problem in an efficient manner. In this automated driver Link data scheduler, we are designing a link scheduling algorithm to make the process of link scheduling much easier and faster. This link scheduling algorithm can schedule the drivers on their fixed link automatically according to the certain condition, times, and availability of a driver. Right now, the process of scheduling drivers on their allocated link is manual and it is a very hectic process it wastes a lot of time and resources. That is why we are creating an automated driver link scheduling algorithm to make the driver scheduling process much easier.

The algorithm should follow certain conditions.

- Number of Drivers for a particular link

The number of links and their number of drivers is fixed.

- Time

Each link has its own traveling time, so according to that time, the link scheduling algorithm should have to decide the driver's duty and the driver's rest time.

- Rest time

The drivers will get a fixed time duration for rest in a week.

- Rescheduling

The algorithm should reschedule the driver to the link again based on the availability of the driver.

- Problems in the scheduling algorithm

In real life, there could be certain problems arise because of weather conditions, link maintenance issues, loco maintenance issues, driver problems, and other unplanned events. These can create an error or abnormal termination in the working of the algorithm. When such unpredictable errors occur, the algorithm recovery procedure will update the scheduled drivers again according to the availability of drivers of that particular link.

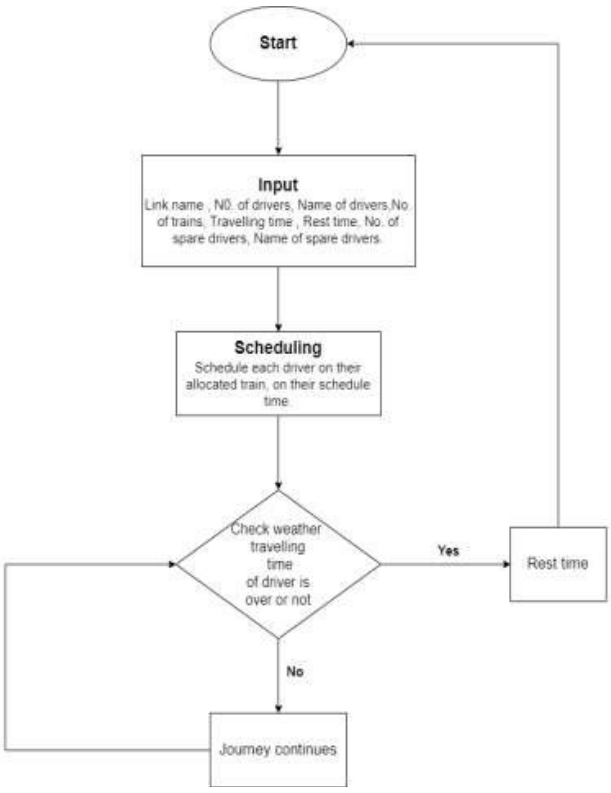

Fig. 2. Flow chart of Link Scheduling

IMPLEMENTATION

The Automated driver data link scheduling algorithm will works in many stages. The working Stages of the system are given below:-

- **Data Input:** The system will be updated with information regarding the driver's availability, working hours, and rest times. Both the drivers

themselves and the transportation company's scheduling system can offer this data.

- **Check for Availability:** The scheduler will initially check to see whether any drivers are available for the next shifts. A list of available drivers will contain the drivers who can perform the shift.
- **Working Hour Check:** The scheduler will next ascertain how many working hours each driver has racked up over the course of the preceding day or week, depending on the policies of the transportation company. If a driver has used up their permitted number of hours, they will be taken out of the pool of available drivers. The scheduler will also take a look at each driver's rest time. The transportation company's rest time policy will determine the minimum length of downtime required before a driver can start a new shift. Unrested drivers won't be included in the pool of available drivers.
- **Shift Allocation:** Based on the pool of drivers that are now available, the scheduler will assign drivers to the upcoming shifts. The allocation will be determined by a number of factors, such as the driver's preferences, seniority, and credentials.
- **Shift Reassignment:** In the event of any unanticipated circumstances, such as a driver reporting sick or an emergency, the scheduler will reassign drivers to the impacted shifts. The shift will be reassigned in accordance with priority and other drivers' availabilities. The system will notify the drivers of their future shifts by email, SMS, or a mobile application after they are assigned to their shifts.
- The system will generate daily, weekly, and monthly data on driver scheduling. The reports will provide details on each driver's shift and hour totals as well as the efficiency of the scheduling system. To improve scheduling efficiency, reduce expenses, and improve driver satisfaction, the scheduler will gradually improve its algorithms.

ADVANTAGES

- The railway department benefits greatly from the Automated Driver Link Data Scheduler technology. The fact that this system replaces the current manual driver scheduling method with an automated digital system is one of its most important features.
- Drivers must be manually scheduled on their assigned link, which takes a lot of time and work. The automated driver scheduling system, however, can do the same duty considerably more quickly and effectively. The railway department may concentrate on other important activities by employing the system to ease the burden of human scheduling.
- The Automated Driver Link Data Scheduler technology also has the benefit of letting drivers see their impending tasks in advance. Drivers will be aware of their upcoming responsibilities as a result, allowing them to plan accordingly. Drivers can better arrange their professional and personal lives if they are aware of their future responsibilities in advance.
- In case of an emergency, the admin can designate a substitute for that driver. This means that the admin may assign another driver to that duty if a driver is unable to complete their tasks due to illness or another circumstance. This guarantees that the train services won't be hampered by a lack of drivers.
- All under-government officials can also utilise this system to keep track of the data for their current and upcoming officials. This indicates that the system may keep and access all data pertaining to the drivers, including their personal data, training records, and employment history. This enables the railway department to monitor all driver information and make sure that they are appropriately educated and equipped to perform their jobs.
- The Automated Driver Link Data Scheduler system benefits the railway department in several ways overall. It eliminates the tedious manual scheduling process for drivers and replaces it with an automated digital system. Additionally, it enables drivers to view their impending tasks in advance, which might assist them in planning their personal and professional lives.
- In the event of an emergency, the admin can designate a replacement driver, preventing a disruption in the train services owing to a lack of

drivers. Finally, all under-government officials can utilize this system to keep track of their past and future officials' information, enabling the railway department to monitor all driver information and make sure that all drivers are suitably educated and certified for their jobs.

FUTURE SCOPE

The automated driver link data scheduler is a software application that is used to schedule the link of train drivers automatically. It uses various algorithms and data analytics to process real-time data and determine the best schedule for train drivers. The system is beneficial for transportation companies as it helps to optimize driver scheduling and reduce costs associated with manual scheduling. As technology evolves, the future scope of the automated driver link data scheduler is promising.

Artificial Intelligence (AI) and Machine Learning (ML) integration: The integration of AI and ML technologies can improve the efficiency of the automated driver link data scheduler. AI can be used to predict potential issues and suggest optimal schedules based on historical data. ML algorithms can analyze real-time data and make adjustments to the schedule as needed. This will improve the accuracy of the scheduler and reduce the need for manual intervention.

Real-time monitoring of driver fatigue: One of the biggest challenges in driver scheduling is driver fatigue. Future versions of the automated driver link data scheduler could integrate real-time monitoring of driver fatigue using sensors and wearables. This data can be used to adjust schedules and ensure that drivers are adequately rested to prevent accidents.

Integration with IoT-enabled devices: IoT-enabled devices such as smart sensors, cameras, and other monitoring devices can be integrated with the automated driver link data scheduler. This will provide more accurate data and enable the system to make real-time adjustments to the schedule based on the data collected.

Predictive maintenance of trains: The automated driver link data scheduler can be used to predict maintenance issues with the trains. This can be done using AI and ML algorithms to analyze data collected from sensors installed on the train. The system can then schedule maintenance activities during periods when the train is not scheduled for use, reducing downtime and minimizing the impact on the transportation network.

Integration with blockchain technology: The automated driver link data scheduler can be integrated with blockchain technology to improve data security and transparency. This will ensure that data is tamper-proof and can be accessed by authorized personnel only. This will improve the overall efficiency of the transportation network and increase trust between stakeholders.

Augmented Reality (AR) and Virtual Reality (VR) integration: The integration of AR and VR technologies can help train drivers to prepare for their scheduled trips. AR can be used to provide drivers with real-time information about the train's location, speed, and other relevant parameters. VR can be used to provide drivers with simulated training scenarios, improving their skills and reducing the risk of accidents.

In conclusion, the future scope of the automated driver link data scheduler is promising. With the integration of advanced technologies such as AI, ML, IoT, blockchain, AR, and VR, the system can be further improved to optimize driver scheduling, reduce costs, and improve the overall efficiency of the transportation network. The system is highly scalable and customizable, making it a valuable asset for any transportation company. As technology continues to evolve, the automated driver link data scheduler will continue to be an essential tool for optimizing driver scheduling in the transportation industry.

CONCLUSIONS

Issue and a plan for using the Branch & Price algorithm to fix it A small number of drivers are used in the construction of the problem, and the recovery period is set at a time that is limited by the drivers' initial commitments. Additional drivers are added to the problem or the recovery period is prolonged if the initial problem size is too large to find a workable recovery solution. Data from the Danish passenger railway operator DSB S-tog A/S is used to test the solution method. In test scenarios, a train line and all tasks connected to it are suspended for the duration of the recovery period. The best integer solutions are found in

5 seconds for test instances with recovery times of 3 to 5 hours.

An algorithm will have clearly specified, explicit phases in its growth. The steps will be detailed enough to make clear what has to be done at each stage, All stages in an algorithm must be feasible (effectively computable), receive a well-defined set of inputs, and provide some sort of result as an output. An algorithm's exact sequence of operations must also be concretely described.

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A Novel Approach for Human Emotion Detection with Speech Recognition using Support Vector Machine in Machine Learning

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ABSTRACT

Speech emotion recognition (SER) is a significant area of research dedicated to identifying and interpreting human emotions based on voice signals. With the rapid advancements in machine learning (ML) techniques, SER has gained substantial attention due to its potential applications in diverse fields such as healthcare, entertainment, and human-computer interaction. This abstract provides a concise overview of research work focused on speech emotion recognition using ML algorithms. The main objective of this study is to create an accurate and efficient system for emotion recognition from speech signals. The proposed approach utilizes a combination of feature extraction techniques and ML models to extract relevant information from the speech data and classify it into distinct emotion categories. The key features extracted from the speech signals include pitch, intensity, Mel-frequency cepstral coefficients (MFCCs), and spectral features. Proposed work worked on accuracy and confusion matrix and overall accuracy achieved by this model is 85.7%, and matric value are in diagonal fashion which indicate good performance for classifier.

KEYWORDS: *Speech emotion recognition (SER), Machine learning (ML), Support vector machines (SVM), Feature extraction.*

INTRODUCTION

Speech emotion recognition (SER) is an expanding field focused on comprehending and interpreting human emotions via voice signals. Emotions play a crucial role in human communication and have a significant impact on various aspects of our lives, including social interactions, mental health, and decision-making processes. Traditional methods of emotion recognition primarily relied on subjective assessments or self-reporting, which are subjective and prone to biases. The emergence of machine learning (ML) techniques has opened up new possibilities for automatic and objective emotion recognition from speech data. ML algorithms can learn patterns and relationships from large amounts of data, enabling the development of robust and accurate emotion recognition systems. This project builds upon the advancements in ML and focuses on developing a system that can effectively recognize and classify emotions from speech signals. The project aims to address several challenges associated with speech emotion recognition. These challenges include feature extraction from speech signals, selection of appropriate ML algorithms, handling of diverse and imbalanced datasets, and achieving high accuracy and efficiency in emotion classification. By addressing these challenges, the project seeks to contribute to the advancement of SER technology and its practical applications in various domains. The project also takes into account the potential real-world applications of speech emotion recognition. Emotion-aware virtual assistants can adapt their responses based on the user's emotional state, providing more personalized and empathetic interactions. Mental health monitoring systems can utilize speech emotion recognition to assess individuals' emotional well-being and provide timely interventions

when necessary. Interactive entertainment platforms can enhance user experience by incorporating emotion recognition to create more immersive and engaging content.

LITERATURE SURVEY

- "Emotion Recognition in Speech Using Neural Networks" by Kim et al. (2013): In this study, the authors investigate the application of deep neural networks, specifically deep belief networks, for speech emotion recognition. They obtained competitive outcomes on standard datasets, emphasizing the effectiveness of deep learning techniques.
- "Speech Emotion Recognition Using Support Vector Machines" by Schuller et al. (2003): In this research, the authors explore the use of support vector machines (SVM) in speech emotion recognition. They evaluate various feature sets, such as prosodic and spectral features, and demonstrate the effectiveness of SVM in classifying emotions.
- "A Survey of Speech Emotion Recognition: Features, Classifiers, and Databases" by El Ayadi et al. (2011): This comprehensive survey provides an overview of feature extraction techniques, classification algorithms, and available emotion databases for speech emotion recognition. It serves as a valuable reference for researchers entering the field.
- "Deep Convolutional Neural Networks for Speech Emotion Recognition" by Satt et al. (2017): In this study, the authors investigate the application of convolutional neural networks (CNN) in speech emotion recognition. They introduce a deep CNN architecture that learns distinctive features directly from spectrograms, resulting in promising outcomes on widely recognized datasets.
- "Speech Emotion Recognition Using Recurrent Neural Networks with Local Attention" by Zadeh et al. (2018): In this research, the authors present a novel approach to speech emotion recognition using a recurrent neural network (RNN) model with a local attention mechanism. They showcase the effectiveness of their proposed method on various emotion recognition tasks and emphasize the significance of attention mechanisms in capturing pertinent information.
- "Speech Emotion Recognition using Transfer Learning from Raw Waveforms" by Eyben et al. (2016): In this research, the authors delve into the implementation of transfer learning techniques in speech emotion recognition. They put forward a transfer learning framework that takes advantage of pre-trained models on extensive audio datasets, effectively adapting them for the purpose of emotion recognition tasks.
- "Speech Emotion Recognition Using Hidden Markov Models" by Deng and Wu (2013): In this study, the authors explore the application of Hidden Markov Models (HMMs) in speech emotion recognition. They present an HMM-based framework that effectively models the temporal dynamics of speech features, leading to competitive results in emotion classification tasks.
- "Joint Speech Emotion and Speaker Recognition Using Deep Neural Networks" by Han et al. (2014): This work addresses the challenge of simultaneous speech emotion and speaker recognition. The authors propose a joint deep neural network (DNN) architecture that learns representations for both tasks and demonstrates improved performance compared to separate models.
- "Adversarial Training for Speech Emotion Recognition" by Xing et al. (2018): This study introduces adversarial training techniques to enhance speech emotion recognition. The authors propose a generative adversarial network (GAN) framework that improves the discriminative capabilities of the emotion recognition model by generating more realistic speech samples.
- "Speech Emotion Recognition using Attention-based Convolutional Recurrent Neural Networks" by Zhang et al. (2019): In this study, the authors aim to harness the benefits of both convolutional neural networks (CNNs) and recurrent neural networks (RNNs) in speech emotion recognition. They introduce an attention-based CNN-RNN model that effectively captures both local and global dependencies present in speech signals. By

doing so, the proposed model achieves state-of-the-art performance on emotion recognition tasks.

- "Efficient Speech Emotion Recognition using Transfer Learning and Autoencoders" by Ramakrishnan et al. (2020): This study explores the use of transfer learning and autoencoders to improve the efficiency of speech emotion recognition systems. The authors propose a framework that leverages pre-trained models and applies autoencoders for feature compression, achieving comparable performance with reduced computational complexity.

These are just a few examples of the proposed works in speech emotion recognition. The field is continuously evolving, with researchers introducing innovative techniques, exploring different algorithms, and leveraging advancements in deep learning and multimodal approaches.

These studies showcase a wide array of approaches and techniques utilized in speech emotion recognition, encompassing traditional models such as HMMs, as well as more advanced deep learning architectures and transfer learning methods. Each of these works contributes to the continuous endeavor to enhance the accuracy, efficiency, and resilience of speech emotion recognition systems.

PURPOSE OF STUDY

This study aims to develop a robust system for speech emotion recognition using machine learning techniques. By addressing the limitations of traditional methods, the study seeks to provide an automated and objective approach to accurately classify emotions from speech signals. The primary objective is to contribute to the advancement of speech emotion recognition technology and its practical applications. The study's overarching goal is to enhance human-computer interaction, enable emotion-aware virtual assistants, support mental health monitoring systems, and improve user experiences in interactive entertainment platforms. The findings of this study can have implications in various fields, including healthcare, entertainment, customer service, and human-computer interaction, where understanding and responding to human emotions are crucial factors. The study aims to contribute to the existing knowledge in the field of speech emotion recognition and provide valuable insights for further research and development in this area. In summary, the purpose of studying speech emotion recognition is to deepen our understanding of human emotions, develop objective and automated emotion recognition systems, advance machine learning techniques, enable personalized technology interactions, and facilitate mental health monitoring and intervention. These purposes collectively contribute to enhancing various aspects of human life, communication, and well-being, Figure 1 describe the same.

Objectives:

- To develop an automated system for accurate speech emotion recognition using machine learning.
- Compare and evaluate different machine learning algorithms for emotion classification.
- Address challenges related to dataset characteristics to enhance the system's robustness.
- Provide insights and recommendations for improving the system's performance and enabling practical applications.

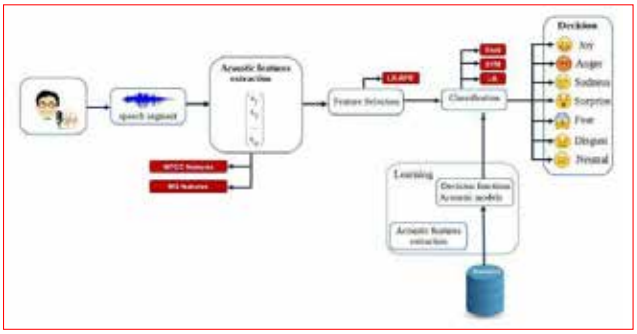

Figure 1: General Block diagram of the proposed system

METHODOLOGY

- Data Collection: Collect the necessary audio datasets for emotion classification, such as RAVDESS, CREMA, TESS, and SAVEE. Ensure that the datasets are properly downloaded and stored in the specified directories.
- Data Preprocessing and Exploration: Import the required libraries, including pandas, numpy, os, librosa, matplotlib, and pydub. Load the audio files from each dataset and extract relevant information

such as file paths, gender, and emotion labels. Combine the data from all datasets into a single dataframe using the concatenation technique. Visualize the distribution of emotions and genders using bar plots to gain insights into the dataset

- Support Vector Machines (SVM): SVM is a widely used algorithm for classification tasks, including SER. It can effectively separate data points in high-dimensional feature spaces and handle non-linear relationships.
- Data Preparation: Filter the dataset to include only female samples as specified in the problem statement. Drop the 'sex' column from the dataframe since it is no longer needed. Preprocess the audio files by applying trimming, padding, and feature extraction techniques (e.g., ZCR, RMS, MFCCs) using librosa and pydub libraries. Encode the emotion labels into numerical values suitable for classification using a predefined emotion dictionary.
- Data Splitting: To divide the preprocessed data into training, validation, and testing sets, the train_test_split function from the sklearn library can be utilized. This function enables the specification of desired proportions for the splits. For example, one can assign 85% of the data to training, 15% to testing, and 30% of the remaining data to validation.
- Model Building: Import the necessary libraries for building the emotion classification model, including keras and sklearn. Define the model architecture using the Sequential API from Keras. Add LSTM layers to the model for sequence modeling and a dense layer with softmax activation for multiclass classification. Compile the model with an appropriate loss function, optimizer, and evaluation metric.
- Model Training and Evaluation: To train the model on the training data, the fit function can be employed, specifying the desired number of epochs and batch size. It is important to monitor the model's training progress by plotting the loss and accuracy curves for both the training and validation sets. This provides insights into how the model is learning over time. Following the training process, it is crucial to evaluate the trained model's performance on the testing set using metrics such as accuracy. This assessment helps gauge how well the model generalizes to unseen data.
- Model Performance Analysis: To analyze the model's predictions compared to the ground truth, a confusion matrix can be generated using the predicted labels from the model and the true labels from the testing set. Visualizing the confusion matrix using a heat-map provides a clear representation of the model's performance.
- Model Improvement and Iteration: Analyze the model's performance and identify areas for improvement based on the evaluation metrics and confusion matrix. Experiment with different hyper parameters, such as learning rate, number of LSTM units, and batch size, to optimize the model's performance. Consider adding additional layers or modifying the model architecture to enhance its capacity to capture emotion-related features.
- Deployment and Application: Save the trained model for future use and deployment in a production environment or application. Integrate the model into an application or system that can perform real-time emotion classification on new audio inputs.

Figure 2a shows the block diagram of proposed system and figure 2b shows the Flow of proposed system.

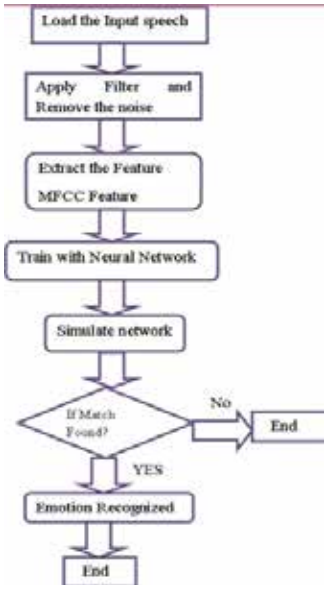

Figure 2a : Block diagram of proposed system

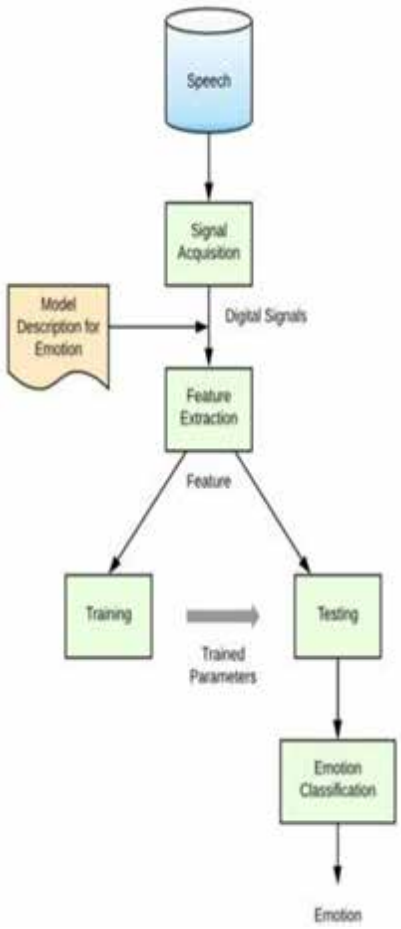

Figure 2b : Flow of proposed system

TESTING,RESULTS & DISCUSSION

Testing

```
from sklearn.model_selection import train_test_split from tensorflow.keras.utils import to_categorical

# Splitting the data into training and testing sets

X_train, X_to_split, y_train, y_to_split = train_test_split(X, y, test_size=0.15, random_state=1) X_val, X_test, y_val, y_test = train_test_split(X_to_split, y_to_split, test_size=0.3, random_state=1)

# Convert class labels to one-hot encoded format num_classes = 6

y_train_class = to_categorical(y_train, num_classes) y_val_class = to_categorical(y_val, num_classes)

# Hyperparameter tuning and optimizer selection

# Experiment with various optimizers for better results

# For simplicity, we'll use RMSProp with default learning rate and decay optimizer = 'RMSProp'

# Training the model for 100 epochs epochs = 100

model.fit(X_train, y_train_class, validation_data=(X_val, y_val_class), epochs=epochs) # Evaluate the model on the test set

loss, categorical_accuracy = model.evaluate(X_test, y_test) print(f"Loss: {loss}, Categorical Accuracy: {categorical_accuracy}")

# Plotting the train and test accuracy for better understanding of the training process plot_accuracy(history)
```

Note: The code assumes that you have defined and compiled the model before training it. Also, the plot_accuracy function is a custom function that you need to define to plot the accuracy, as shown in Figure 3 about the same.

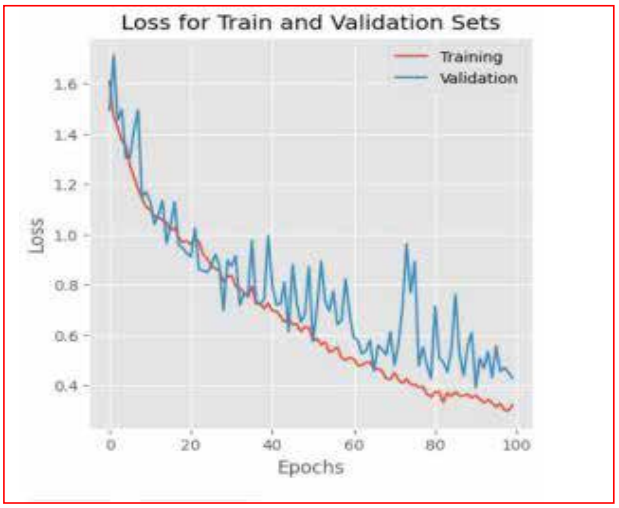

Figure 3: Training and testing

RESULTS AND DISCUSSIONS

This level of accuracy (figure 4) suggests that the model has learned patterns and features in the audio data that are indicative of different emotions. It shows the effectiveness of the chosen approach, including the pre-processing techniques and the LSTM-based model architecture.

However, it's important to consider certain aspects when

interpreting the accuracy. First, the accuracy achieved on the validation set may not necessarily generalize to unseen data, so further evaluation on an independent test set is recommended.

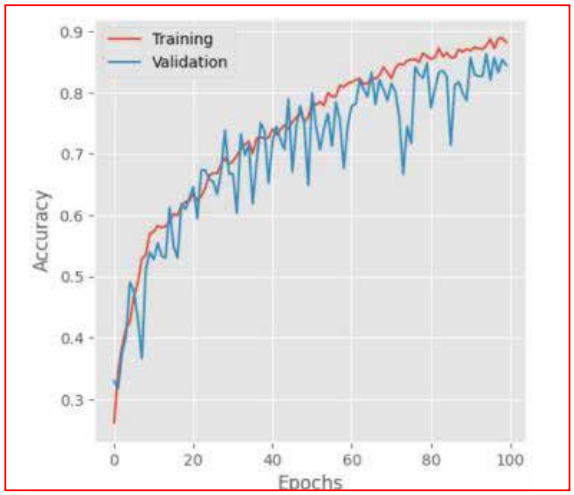

Figure 4: Accuracy

Second, the accuracy might vary depending on the distribution and quality of the dataset, as well as the complexity and variability of the emotions being classified. Overall, achieving 85% accuracy on emotion classification in audio data is a promising result. It suggests that the developed model has the potential to be useful in practical applications such as emotion recognition systems, speech analysis, or human computer interaction. Further refinements and evaluations can be performed to improve the model's performance and robustness.

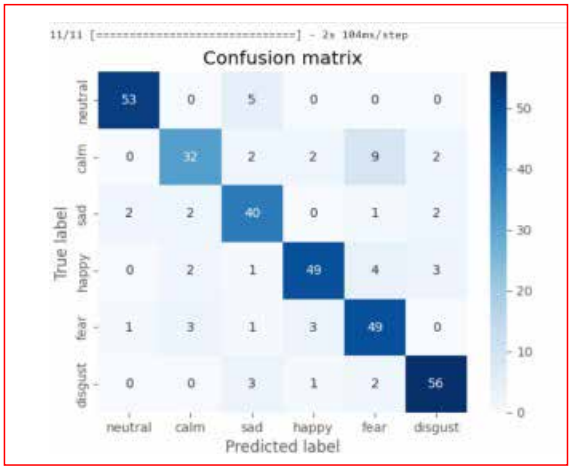

Figure 5: Confusion Matrix

The above confusion (Figure 5) matrix shows the relation between the true label and the predicted label. The colors and numbers show how each label is related to each other.

ADVANTAGES

1. Non-Invasive: Speech emotion recognition is a non-invasive technique that can analyze emotions based on acoustic features of speech signals. It doesn't require any physical contact or invasive methods, making it convenient and comfortable for users.
2. Real-Time Emotion Monitoring: Speech emotion recognition can provide real-time emotion monitoring by analyzing speech signals as they are being spoken. This capability is valuable in applications such as call centers, virtual assistants, or mental health monitoring systems, where immediate emotion detection and response are important.
3. Wide Applicability: Speech emotion recognition can be applied across various domains and industries. It has applications in customer service, human-computer interaction, psychological research, entertainment, voice assistants, and more. It can enhance user experiences, improve communication, and enable personalized interactions.
4. Objective Measurement: Emotions can be subjective and challenging to measure accurately. Speech emotion recognition provides an objective and quantitative measure of emotions by analyzing acoustic features in speech signals. This objective measurement can be valuable in research, clinical settings, or any context where reliable emotion assessment is needed.
5. Automated Processing: With advancements in machine learning and signal processing techniques, speech emotion recognition can be automated and performed at scale. Large volumes of speech data can be processed efficiently, enabling the analysis of emotions in a timely and cost-effective manner.
6. Multi-Modal Integration: Integrating multiple modalities, such as facial expressions, body gestures, or physiological signals, with speech

emotion recognition can significantly enhance emotion recognition accuracy. This multi-modal approach provides a more comprehensive and robust understanding of emotions by leveraging information from different sources.

APPLICATIONS

1. Education and E-Learning: Speech emotion recognition can be used in educational settings and e-learning platforms to assess students' engagement, attention, and emotional states during online courses or virtual classrooms. It can provide feedback to instructors and help personalize the learning experience based on students' emotional responses.
2. Human-Computer Interaction: Speech emotion recognition can enhance human-computer interaction by enabling computers and machines to understand and respond to human emotions. Emotionaware systems can adapt their responses, such as virtual assistants providing empathetic and personalized responses based on the user's emotional state.
3. Call Center Analysis: Speech emotion recognition can be used in call centers to analyze customer-agent interactions. It can automatically detect customer emotions, such as frustration or satisfaction, during phone conversations. This information can help improve customer service, identify training needs, and enhance overall customer experience.
4. Mental Health Monitoring: Speech emotion recognition can be used as a non-invasive tool for monitoring mental health conditions. By analyzing changes in speech patterns and detecting emotional cues, it can assist in diagnosing and monitoring conditions such as depression, anxiety, or bipolar disorder
5. Market Research and Advertising: SER can be employed in market research to analyze consumers' emotional responses to products, services, or advertisements. It helps businesses understand consumer preferences, optimize marketing strategies, and develop emotionally appealing content.
6. Entertainment and Gaming: SER can enhance user experiences in entertainment and gaming industries. It can be utilized to personalize game interactions, adapt game difficulty based on user emotions, and create immersive virtual reality experiences.
7. Psychological Research: SER plays a significant role in psychological research, enabling researchers to study emotional expressions, social interactions, and affective states. It helps in understanding human behavior, emotion dynamics, and psychological disorders.
8. Sentiment Analysis: SER can be integrated with sentiment analysis to analyze social media content, customer reviews, and public opinions. This combination provides a more comprehensive understanding of individuals' emotions and sentiments expressed in textual and audio data.
9. Biometric Security: SER can be utilized as a biometric modality for user authentication and security systems. By analyzing speech patterns and emotional cues, it can help in verifying users' identities and detecting impostors.

CONCLUSION

Our project successfully accomplishes the main objective of utilizing recurrent neural networks with long short-term memory (LSTM) for identifying emotions in individuals. To achieve this, we work with a dataset comprising 1440 files that encompass various emotions such as calm, happy, sad, fear, disgust, surprise, and neutral. The LSTM machine learning model is employed for testing the system. As machine learning models typically operate with numeric inputs, we convert our data into arrays prior to feature extraction. In this model, we utilize Mel-frequency cepstral coefficients (MFCC) as the feature, which is extracted using the librosa package. These extracted values serve as inputs to the developed LSTM model, which utilizes these features to predict the final emotion. The overall accuracy achieved by this model is 85.7%. To further enhance the model's accuracy, we can consider removing random silences from the audio clips and augmenting the data volume by acquiring additional annotated audio clips. These steps have the potential to improve the model's performance.

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Creation of Harvest Productivity Projection Method (HPPM) using Machine Learning Framework through Combating Infection and Generating Knowledge

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ABSTRACT

The identification of crop diseases has become crucial to smart farming methods. Researchers have presented a variety of intrusive and non-intrusive models to carry out this task. Intrusive models are only appropriate for use in therapeutic settings because of their greater deployment costs, increased complexity, and potential for contamination of underlying crops. It is noted that most of these models for non-intrusive approaches perform better on datasets particular to the application and cannot be scaled to bigger datasets. The suggested model uses an adaptive thresholding technique that is initially crop-specific, which helps with effective segmentation for various crop varieties. The chosen feature sets are categorised using an ensemble classification model that integrates classifiers from Nave Bayes (NB), Decision Tree (DT), Linear Regression (LR), Support Vector Machines (SVM), and Multilayer Perceptron (MLP). These classifiers were chosen based on how accurately they performed with various crop varieties. SVM & LR performed better for crops of soy and squash, MLP & LR performed better for crops of potatoes and peppers, while NB performed better for crops of apples and raspberries. The suggested model can achieve an accuracy of 99.5% across several datasets thanks to a combination of these adaptive classifiers, which makes it extremely helpful for a range of classification applications.

KEYWORDS: *Crop productivity projection, Machine learning, Combating infection.*

INTRODUCTION

The multi-domain problem of disease detection using crop imaging includes dataset-based classification and various other procedures. These models must be modified according to their applicability and validated for various datasets. A typical machine learning-based harvest productivity projection model, where various pre-processing, segmentation, feature representation, and classification process can be seen. To improve classification performance, the model first gathers information on productivity.

This discussion led to the conclusion that the majority of these models perform better with correct knowledge and in-depth analysis. In section 4, the proposed model was assessed using various datasets, and its performance was compared to several cutting-edge techniques. Based on this analysis, it was shown that the proposed model performed better than standard models in terms of accuracy, precision, and recall. The paper continues by making a few observations about the suggested model that are relevant to the setting and generating knowledge.

LITERATURE REVIEW

Different models have been put out by researchers to identify the many forms of crop diseases. These models employ cutting-edge categorization methods, which help to enhance accuracy & precision performance for various illness kinds. For instance, research in [5,

6] suggests using the Leaf Wetness Sensor (LWS) and Unified MatrixBased Convolutional Neural Network (UMB CNN) to enhance classification performance for wheat and rice crops. However, because to the high crop specificity of these models, their scalability is constrained. The EfficientNetV2 Model, which exhibits higher accuracy and lower complexity than previous models for various illness kinds, is suggested by work in [7] as a way to enhance this performance. The model employs feature variance maximisation to achieve performance optimisation for various illness kinds. These models detect several feature sets using black box techniques, which helps to enhance the performance of their real-time categorization. However, the size of the training and validation datasets directly affects performance, limiting their potential to scale. These methods divide the input images into segments to make diseased areas more visible before using various classification models to attain higher classification levels. However, the lack of feature selection methods in these models limits their ability to be deployed in real-time.

Researchers have suggested the use of the Genetic Algorithm with Decision Tree (GADT) [14], Graph Theory (GT) [15], the combination of InceptionNet with ResNet V2 [16], and the use of indices like the Normalised Powdery Mildew Index (NPMI), Ratio Powdery Mildew Index (RPMI). These models advocate the use of specialised CNN layers that aid in feature augmentation and improve accuracy, precision, and recall metrics when applied to real-time crop image sets.

The aforementioned models are expanded by the research in [22, 23, 24], which suggests the usage of MobileNet Models based on CNN, Restructured Deep Residual Dense Network (RRDN), and Faster Recurrent CNN (FRCNN), which aid in improving scalability performance under various image sets. With the help of these models, crop images' feature extraction capacities are enhanced. Additionally, window- based classification is applied to these characteristics for more accurate disease identification in various harvest kinds.

Creation of a Harvest Productivity Projection Method Using Machine Learning

The literature review reveals that current models for recognising the presence of illnesses in plants can perform better with specific to the application datasets but are unable to expanded for bigger sets. The classifiers used to categorise identified feature sets include Naive Bayes (NB), Multilayer Perceptron (MLP), Support Vector Machines (SVM), Decision Tree (DT), and Linear Regression (LR), and they are chosen based on how well they perform on various datasets. This flow has been broken up into several smaller modules to streamline the design.

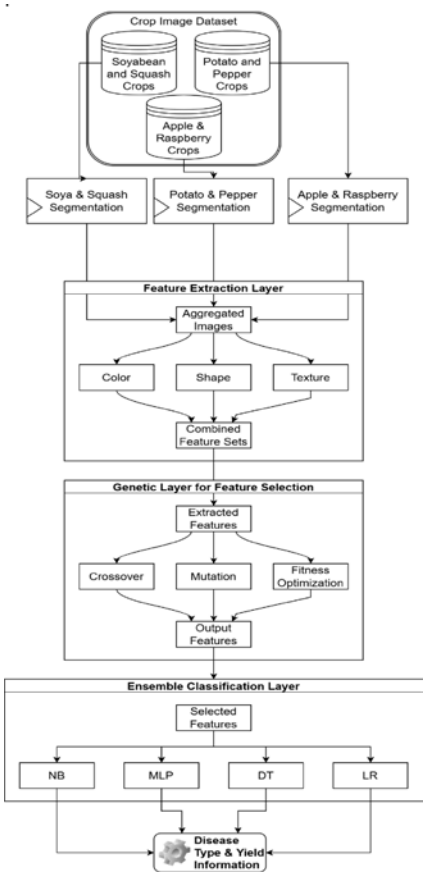

Fig. 1. Flow of HPPM

Crop-specific categorization and extraction of features layer design

o The suggested effort has the ability to categorise diseases in crops like soy, squash, potatoes, peppers, apples, and raspberries. The approach first uses a crop- specific thresholding model to analyse various crops, helping to segment these images. The procedure utilised for soyabean, potato, and squash crops is as follows:

- Take the R, G, and B components out of the photos.
- If, *Img (r, c, G) = 0* then output this pixel
- If, *Img (r, c, R) > Img (r, c, B)* crop these pixels
- Else discard the pixel

Brown-colored elements from the supplied image are retrieved, aiding in the segmentation of the crops soyabean, potato, and squash. We do this pepper:

- Take the R, G, and B constituents out of the photos.
- If *Img (r, c, G) > Img (r, c, R)* and *Img (r, c, G) > Img (r, c, B)*, then output this pixel.
- Else discard the pixel.

This is followed by segmentation for Apple & Raspberry crops, which is done via the following process,

- Extract R, G & B components from the images
- If *Img (r, c, R) > Img (r, c, G)* and *Img (r, c, R) > Img (r, c, B)*, then output this pixel
- Else discard the pixel

Equation 2

$$E_i = P\left\{\bigcup_{j=1}^{R}\bigcup_{l=1}^{C} Canny[|Img(j,l) = 1|]\right\} \quad (2)$$

Where, denotes the edge identification model used to extract image edges, and indicates the edge probability. The final feature vectors are created by combining these features, which are then obtained for each grey level within and. In addition to these features, texture features are also extracted. These features are energy (E), entropy (EN), dissimilarity (D), contrast (Cont.), differential variance (DV), homogeneity (H), and correlation (Corr).

$$E = \sum_{i=1}^{R}\sum_{j=1}^{C} Img(i,j)^2 \quad (3)$$

$$EN = -\sum_{i=1}^{R}\sum_{j=1}^{C} Img(i,j)^1 * \log\big(Img(i,j)\big) \quad (4)$$

$$D = \sum_{i=1}^{R}\sum_{j=1}^{C} Img(i-j)^1 \quad (5)$$

$$Cont = \sum_{i=1}^{R}\sum_{j=1}^{C} Img(i-j)^2 \quad (6)$$

$$DV = \sqrt{\frac{\sum_{i=1}^{R}\left(\sum_{j=1}^{C} Img(i-j) - \frac{\sum_{i=1}^{R}\sum_{j=1}^{C} Img(i-j)}{R*C}\right)^2}{R*C-1}} \quad (7)$$

$$H = \sum_{i=1}^{R}\sum_{j=1}^{C} \frac{Img(i,j)^1}{1+(i-j)} \quad (8)$$

$$Corr = \sum_{i=1}^{R}\sum_{j=1}^{C} Img(i,j)^1 * \left[\frac{(i-DV)*(j-DV)}{DV}\right] \quad (9)$$

Based on these evaluations, different features are extracted for each of the crop types. Thereby improving classification performance. Design of MGA is discussed in the next section of this text.

Design of Genetic Algorithm Model for identification of Variant features

After extraction of features, a Genetic Algorithm Model is deployed which assists in increasing feature variance for efficient classification performance. This is done via the following process,

- Initialize Genetic Algorithm parameters,
  - Number of iterations (N_i)
  - Number of solutions (N_S)
  - Total number of features extracted (N_f)
  - Learning rate of the model (L_r)
- Mark all the solutions as 'to be transformed'
- Perform the following for each iteration in 1 to N_i,
  - Perform the following for each solution in 1 to N_S,
    - Check if the solution is marked as 'not to be transformed', then skip it and go to the next solution sets
    - Else, transform this solution via the following process,
- Identify a stochastic number for feature selection via equation 10,

$$Sel_f = STOCH(L_r * N_f, N_f) \quad (10)$$

Where, Sel_f & $STOCH$, represents selected feature numbers, and a stochastic Markovian process, for generation of sequences between the given ranges.

- Based on the value of Sel_f, identify stochastic but unique features from the set of input features, and evaluate solution fitness via equation 11 as follows,

$$f_i = \sqrt{\sum_{j=1}^{Sel_f} \frac{\left(FV_i - \sum_{l=1}^{Sel_f} \frac{FV_l}{Sel_f}\right)^2}{Sel_f + 1}} \quad (11)$$

- Repeat this process for all solutions, and evaluate an iteration fitness threshold via equation 12 as follows,

$$f_{th} = \frac{1}{N_s} \sum_{i=1}^{N_s} f_i * L_r \quad (12)$$

o At the end of each iteration, mark solutions with $f_i < f_{th}$ 'to be transformed', while mark others as 'not to be transformed'

- Continue this process for all iterations

At the end of the final iteration, identify solution with maximum fitness, and use its features for classification process. These features have higher variance, which improves performance of the ensemble classification process. Design of the ensemble classifier is discussed in the next section of this text.

Design of the Ensemble Classification Model for identification of diseases

These are formulated in T-1:

Classifier	Parameter	Value
NB	Previous likelihood for every category	Equation 11 is used to evaluate the characteristic variability of all the classes
NB	Smoothing Factor	Equation 11 is used to evaluate the characteristic variability of all the classes
SVM	Regularization coefficient	1
SVM	Kernel	Sigmoid
SVM	Gamma	variability of all the classes in inverse
SVM	Shrinking Heuristics	Enabled
SVM	Estimation of probability	Enabled
SVM	Error tolerance	0.01%
SVM	Number of iterations	-1 (No limit)
MLP	Size of hidden layers	3 (Because of 3 different feature sets)
MLP	Activation Function	Leaky Rectilinear Unit (LReLU)
MLP	Solver	Stochastic Gradient Descent
MLP	Learning Rate	L_r
MLP	Iterations	-1 (No limit)
MLP	Error Tolerance	0.01%
MLP	No Change Epochs	N_i
LR	Data Normalization	Enabled
LR	Number of Tasks	$N_S * N_i$
DT	Criterion for convergence	Entropy Maximization
DT	Maximum Depth	$N_S * N_i$
DT	Maximum Features	Sel_f

T-1. Particular parameters

$$C_{out} = NB_{acc} * NB_c + SVC_{acc} * SVC_c + DT_{acc} * DT_c + MLP_{acc} * MLP_c + LR_{acc} * LR_c \quad (13)$$

Where, C_c represents output class for classifier C, while C_{acc} represents test accuracy for the classifier, which is pre-evaluated for the entire image dataset with selected features. Based on this output class, metrics including accuracy, precision, recall, and area under the curve (AUC) were evaluated, and compared with various state-of-the-art models. This evaluation & comparison is discussed in the next section of this text.

RESULTS AND COMPARATIVE ANALYSIS

To categorise agricultural diseases, the suggested CDMBFREC model combines a variety of optimisation approaches. The following sources were used to compile the images for these crops:

A total of 15000 images were collected from these datasets, and these images were segregated into 60:20:20 ratio for training the model, testing the model and validating the model respectively. Equation 14 as follows,

$$A = \frac{N_C}{N_T} * 100$$

Where, N_c represents total number of correctly classified crop images, while N_T represents number of images present in the datasets

NT	A (%) U- C	A (%) SC	A (%) GD	A (%) CB
195	73.89	66.15	84.70	97.31
390	74.21	66.44	85.07	97.63
600	74.39	66.59	85.27	97.83
795	74.52	66.71	85.42	97.96
990	74.58	66.77	85.49	98.02
1200	74.61	66.79	85.52	98.03
1395	74.61	66.79	85.52	98.04
1590	74.61	66.80	85.53	98.05
1800	74.62	66.80	85.54	98.05
1950	74.62	66.80	85.54	98.05
2250	74.62	66.80	85.54	98.06
2400	74.63	66.81	85.55	98.06
2595	74.70	66.88	85.64	98.14
2790	74.80	66.96	85.75	98.24
3000	74.91	67.06	85.87	98.35

T-2. Accuracy of different classification models for detection of crop diseases.

Similar assessments were made for precision (P) efficiency, and the values are shown in Table 3.

NT	P (%) UC	P (%) SC	P (%) GD	P (%) CB
195	85.41	75.43	89.26	90.52
390	85.78	75.76	89.65	90.82
600	85.98	75.94	89.86	91.01
795	86.14	76.08	90.02	91.12
990	86.21	76.14	90.09	91.18
1200	86.23	76.16	90.12	91.20
1395	86.24	76.17	90.12	91.21
1590	86.24	76.17	90.12	91.21
1800	86.24	76.18	90.13	91.21
1950	86.24	76.18	90.13	91.21
2250	86.25	76.19	90.13	91.22
2400	86.25	76.19	90.14	91.27
2595	86.35	76.27	90.23	91.36
2790	86.46	76.37	90.35	91.46
3000	86.58	76.48	90.48	91.58

T-3. Normal accuracy

Similar assessments were made on recall (R) efficiency, and the values are shown in Table 4 below.

NT	R (%) UC	R (%) SC	R (%) GD	R (%) CB
195	84.34	74.50	88.15	96.27
390	84.71	74.82	88.53	96.59
600	84.90	74.99	88.73	96.79
795	85.05	75.13	88.89	96.91
990	85.12	75.19	88.96	96.97
1200	85.15	75.22	88.99	96.99
1395	85.15	75.22	89.00	96.99
1590	85.16	75.23	89.01	97.00
1800	85.16	75.23	89.01	97.00
1950	85.17	75.24	89.01	97.00
2250	85.17	75.24	89.01	97.01
2400	85.18	75.24	89.02	97.06
2595	85.27	75.32	89.11	97.16
2790	85.38	75.42	89.22	97.27
3000	85.50	75.53	89.35	97.39

T-4. Maximum recall of several classification models for agricultural detection of illnesses

According to these findings, the suggested model's crop illness recall efficiency is 8.3% greater than GAN

DATF [18], 19.4% stronger over SPED CCNN [12], and 10.5% stronger than UMB CNN [5]. and the values are shown in table 5 below.

NT	AUC (%) UC	AUC (%) SC	AUC (%) GD	AUC (%) CB
195	75.28	67.39	86.29	96.59
390	75.61	67.69	86.67	96.91
600	75.78	67.84	86.87	97.11
795	75.92	67.97	87.03	97.24
990	75.98	68.02	87.09	97.30
1200	76.00	68.04	87.12	97.32
1395	76.01	68.05	87.13	97.32
1590	76.01	68.05	87.13	97.33
1800	76.02	68.05	87.14	97.33
1950	76.02	68.05	87.14	97.34
2250	76.02	68.06	87.14	97.34
2400	76.03	68.06	87.14	97.52
2595	76.11	68.13	87.23	97.65
2790	76.20	68.22	87.35	97.80
3000	76.32	68.32	87.47	97.97

T-5. Normal AUC

Assessments were made for delay performance, and the values are shown in Table 6 below.

NI	D (ms) UC [5]	D (ms) SC	D (ms) GD [18]	D (ms) CB
195	9.79	11.09	9.37	6.95
390	9.75	11.04	9.33	6.92
600	9.73	11.01	9.31	6.90
795	9.71	10.99	9.29	6.95
990	9.71	10.98	9.29	6.98
1200	9.71	10.98	9.28	7.09
1395	9.71	10.98	9.28	7.20
1590	9.71	10.98	9.28	7.25
1800	9.71	10.98	9.28	7.34
1950	9.71	10.98	9.28	7.38
2250	9.71	10.98	9.28	7.41
2400	9.71	10.98	9.28	7.46
2595	9.70	10.97	9.27	7.49
2790	9.68	10.95	9.26	7.52
3000	9.67	10.94	9.25	7.57

T-6. Average delay (D) of different classification models for detection of crop diseases.

These segmented images are reduced of redundant features using a genetic algorithm model. Based on this assessment, it can be seen that the proposed model, when compared to various state-of-the-art models, has the attributes of offering greater precision, more effectively accuracy, greater recall, and faster performance, making it useful for a wide range of actual time harvest disease identification and application scenarios.

CONCLUSION

In order to enhance the performance of its representation, the proposed model combines a genetic algorithm approach helps to increase the feature variance for various crop varieties. Its classification performance is increased by combining a number of high-efficiency classification models to classify the chosen features. Additionally, it was noted that, for various picture types, the suggested model outperformed UMB CNN [5], SPED CCNN [12], and GAN DATF [18] by 4.9%, 15.5%, and 1.4%, respectively, in terms of precision. Similar improvements were noted for many disease categories. This performance was also assessed by means of recall & fMeasure values. The model incorporates the use of Genetic Algorithms (GA) for choosing features, which enables it to more effectively eliminate redundant characteristics. In future, researchers can extend this model via integration of multiple bioinspired techniques including Particle Swarm Optimization (PSO), Bacterial Foraging Optimization (BFO), etc. Researchers can also integrate deep learning models for improving its accuracy for larger number of disease types. Moreover, the model must be validated for other crop types, and its classification performance must be optimized for yield prediction via integration of different crop specific segmentation, feature extraction & prediction methods.

This will improve its scalability under different crop & disease types.

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AI-Powered Innovations in Agriculture: Transforming Farming Practices and Yield Optimization

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ABSTRACT

Agriculture holds immense importance in India due to its multifaceted impact on the country's economy, food security, rural development, and export potential. With a significant portion of the population engaged in agriculture, it serves as a primary source of livelihood for millions, ensuring food security for the nation's vast population. Artificial intelligence (AI) has the potential to revolutionize agricultural production and enhance efficiency, sustainability, and productivity in several ways. This research paper explores the transformative impact of AI-powered innovations in agriculture, specifically focusing on how artificial intelligence technologies are revolutionizing farming practices and optimizing crop yields. The study investigates the various applications of AI in agriculture, including crop monitoring, pest management, irrigation systems, and predictive analytics. By examining the benefits and challenges associated with AI adoption in the agricultural sector, this research aims to provide insights into the potential of AI-powered solutions to enhance productivity, sustainability, and profitability in farming.

KEYWORDS: *AI-Powered innovations, Agriculture, Farming practices, Yield optimization, Crop monitoring, Pest management, Irrigation systems, Predictive analytics*

INTRODUCTION

Agriculture plays a vital role in feeding the growing global population and ensuring food security. However, the agricultural sector faces numerous challenges, including unpredictable weather patterns, limited resources, labor shortages, and the need for sustainable farming practices. In recent years, the emergence of artificial intelligence (AI) has opened up new possibilities for transforming traditional farming practices and optimizing crop yields [1]. AI technologies, such as machine learning, data analytics, and robotics, offer immense potential to revolutionize the agricultural sector and address these challenges effectively.AI-powered innovations in agriculture, focusing on transforming farming practices and optimizing crop yields, holds significant significance. With the global population steadily increasing, there is a pressing need to enhance agricultural productivity and ensure food security. AI technologies offer immense potential to revolutionize traditional farming methods and address challenges faced by the agricultural sector [10]. By leveraging AI, farmers can achieve enhanced efficiency through precision agriculture, making data-driven decisions on irrigation, fertilization, and pest management. This leads to optimized resource utilization, reduced waste, and improved productivity. Moreover, AI enables the implementation of sustainable farming practices by analyzing data on soil health, weather patterns, and crop performance, which helps in minimizing the use of pesticides, fertilizers, and water. Additionally, AI algorithms can process large volumes of data to predict optimal planting times, disease outbreaks, and yield estimates, enabling farmers to make informed decisions for maximizing crop yields and profitability. By optimizing farming practices and minimizing losses, AI contributes to meeting the increasing global food demand sustainably. Overall, this research has the potential to transform agriculture,

promote sustainability, and ensure food security for the growing population.

Objectives

- To explore the transformative impact of AI in agriculture
- To investigate specific areas where AI is being applied in agriculture
- To assess the benefits and challenges associated with the adoption of AI in the agricultural sector.
- To provide valuable insights for stakeholders in the agricultural industry
- To contribute to the understanding and advancement of AI-powered innovations in agriculture

LITERATURE REVIEW

The literature review highlights the transformative impact of AI-powered innovations in agriculture, showcasing the potential to revolutionize farming practices and optimize crop yields. Precision agriculture, crop monitoring, autonomous equipment, predictive analytics, and yield optimization are key areas where AI is making significant contributions. However, it is essential to address challenges and considerations for successful implementation. Overall, the existing research demonstrates the value of AI in enhancing productivity, sustainability, and profitability in agricultural practices, paving the way for a more efficient and technologically advanced farming industry.

The Role of Technology in Agriculture

Technology plays a vital role in modern agriculture, transforming traditional farming practices into innovative, efficient, and sustainable systems. Advancements in precision agriculture, farm management systems, automation, IoT, data analytics, AI, and biotechnology have revolutionized the way farmers manage their crops and livestock [2]. Precision agriculture techniques enable targeted resource application based on real-time data, optimizing inputs while minimizing waste. Automation and robotics streamline labor-intensive tasks, improving productivity and reducing costs. IoT devices and sensors collect valuable data for informed decision-making, while data analytics and AI enable predictive modeling and optimal farm management strategies. Biotechnology has contributed to the development of genetically modified crops with enhanced traits, improving yields and resilience. Furthermore, digital platforms and mobile applications provide farmers with access to agricultural information, market data, and training resources, empowering them with knowledge and improving their overall productivity [13]. Technology has become an indispensable tool in agriculture, promoting sustainability, resource efficiency, and increased food production to meet the growing global demand.

Overview of Artificial Intelligence in Agriculture

Artificial Intelligence (AI) has emerged as a transformative technology in the field of agriculture, revolutionizing the way farming operations are conducted. AI systems and algorithms analyze vast amounts of data collected from various sources, including sensors, drones, satellites, and farm machinery, to provide valuable insights and support decision-making processes [18]. AI in agriculture encompasses a wide range of applications, such as crop monitoring, disease detection, yield prediction, soil analysis, and autonomous farming. Machine learning algorithms enable the identification of patterns, trends, and anomalies in data, facilitating accurate predictions and optimized resource management. AI-powered technologies also enable the integration of robotics, enabling tasks such as automated harvesting, precision spraying, and weed control. By harnessing the power of AI, farmers can enhance efficiency, reduce resource waste, optimize crop production, and make informed decisions for sustainable and profitable farming practices.[8]

AI Applications in Crop Monitoring and Management

AI applications in crop monitoring and management have transformed traditional agricultural practices by providing accurate and real-time insights into crop health, growth, and yield potential. Here are some key AI applications in crop monitoring and management:

- Disease and Pest Detection: AI algorithms can analyze images captured by drones, satellites, or sensors to detect signs of crop diseases, pests, or

nutrient deficiencies. By identifying early warning signs, farmers can take timely action to mitigate risks and minimize crop losses.

- Yield Prediction: AI models can leverage historical and real-time data, including weather conditions, soil characteristics, and crop growth patterns, to predict crop yields. This information helps farmers optimize their production strategies, plan logistics, and make informed marketing decisions.[5]
- Weed Detection and Management: AI-powered systems can differentiate between crop plants and weeds, enabling targeted weed management. By precisely identifying and targeting weeds, farmers can minimize herbicide use, reduce environmental impact, and optimize resource allocation [8].
- Irrigation Optimization: AI algorithms, coupled with sensor data and weather forecasts, can determine optimal irrigation schedules and water application rates based on crop water requirements. This helps farmers conserve water, minimize water stress on crops, and improve overall water use efficiency.[4]
- Nutrient Management: AI models can analyze soil data, plant characteristics, and historical yield information to optimize nutrient application rates. By tailoring nutrient management strategies to specific crop needs, farmers can maximize yields while minimizing environmental impacts.[6]
- Crop Disease Forecasting: By integrating AI with disease models and weather data, predictive models can forecast the risk of disease outbreaks. This allows farmers to implement preventative measures, adjust management practices, and apply targeted treatments, reducing the spread and impact of diseases.[5]
- Harvesting Optimization: AI-powered technologies can analyze crop maturity indicators, such as color and texture, to optimize harvest timing. This helps ensure optimal crop quality, minimize losses due to over-ripening or under-ripening, and streamline harvesting operations.
- Autonomous Farming: AI-driven robotics and autonomous systems enable tasks such as planting, seeding, and harvesting to be performed with precision and efficiency. These technologies reduce labor requirements, increase operational speed, and improve overall farm productivity [10].

The integration of AI applications in crop monitoring and management empowers farmers with accurate and actionable insights, allowing them to optimize production practices, increase resource efficiency, and enhance overall crop health and productivity.

AI for Pest Detection and Management

AI for pest detection and management has emerged as a powerful tool in agriculture, helping farmers identify, monitor, and control pests more effectively. By leveraging advanced algorithms and machine learning techniques, AI systems can analyze data from various sources to detect pests, predict infestations, and recommend appropriate management strategies. Here are some key aspects of AI for pest detection and management:

- Pest Identification: AI algorithms can analyze images of crops, leaves, or pests captured by cameras, drones, or sensors to identify and classify different pest species accurately. This enables farmers to quickly identify specific pests and implement targeted control measures.[7]
- Early Pest Detection: AI models can continuously monitor crops by analyzing images or sensor data for early signs of pest presence, including visual cues, damage patterns, or behavioral changes. Early detection allows for timely intervention, preventing further spread and minimizing crop damage.
- Disease and Pest Risk Assessment: By integrating pest data with other environmental factors such as weather conditions, crop growth stage, and historical pest occurrences, AI models can assess the risk of pest outbreaks. This information helps farmers proactively implement preventive measures and allocate resources efficiently [9].
- Decision Support Systems: AI-powered decision support systems can provide personalized recommendations for pest management based on specific crop conditions and pest dynamics. These systems consider multiple factors such as

pest life cycles, weather patterns, crop varieties, and pesticide efficacy, assisting farmers in making informed decisions.[8]

- Precision Pest Control: AI systems facilitate precision pest control by enabling targeted application of pesticides or biological control agents. By analyzing pest distribution patterns and utilizing real-time data, AI models can optimize pesticide dosages, minimize chemical usage, and reduce environmental impacts [17].
- Data Integration and Analytics: AI algorithms can integrate and analyze vast amounts of data from multiple sources, including weather data, pest monitoring traps, and historical records. This allows for the identification of correlations, patterns, and trends in pest populations, supporting effective pest management strategies.
- Real-Time Monitoring and Alerts: AI-driven systems can provide real-time monitoring of pest populations, sending alerts to farmers when pest thresholds are exceeded. This timely information enables proactive responses and the implementation of appropriate pest control measures.[9]
- Continuous Learning and Improvement: AI models can continuously learn and adapt based on feedback and new data. By incorporating new information, AI systems can improve pest detection accuracy, refine prediction models, and enhance pest management recommendations over time.

The application of AI for pest detection and management empowers farmers to respond swiftly and effectively to pest challenges [17]. By enabling early detection, precise control measures, and data-driven decision-making, AI technologies contribute to sustainable pest management practices, reducing pesticide usage, minimizing crop losses, and promoting healthier agricultural ecosystems.

AI-Enabled Irrigation Systems

AI-enabled irrigation systems leverage advanced technologies and algorithms to optimize water usage in agriculture. These systems utilize real-time data, including weather conditions, soil moisture levels, crop water requirements, and evapotranspiration rates, to make intelligent irrigation decisions. Here are key aspects of AI-enabled irrigation systems:

- Data Collection and Monitoring: Sensors and IoT devices are deployed to collect data on soil moisture, weather conditions, and plant health. These devices provide continuous monitoring and transmit data to the AI system.[10]
- Data Analysis and Decision-Making: AI algorithms analyze the collected data to determine the optimal irrigation schedule, duration, and volume. These algorithms take into account factors such as crop type, growth stage, soil type, and weather forecasts [13].
- Evapotranspiration Modeling: AI systems incorporate evapotranspiration models to estimate the amount of water lost through plant transpiration and soil evaporation. This helps determine crop water requirements and adjust irrigation accordingly.
- Predictive Analytics: AI-enabled irrigation systems use historical and real-time data to predict future water needs based on crop growth patterns, weather trends, and other relevant factors. These predictions facilitate proactive irrigation management [14].
- Smart Irrigation Control: AI systems control irrigation systems, adjusting water flow and timing based on real-time data and predictive analytics [16]. This enables precise and targeted water application, reducing water wastage and optimizing resource efficiency.
- Automation and Remote Monitoring: AI-enabled irrigation systems can be automated, operating on predetermined schedules or responding to real-time sensor data. Remote monitoring capabilities allow farmers to access and control irrigation systems from anywhere, enhancing convenience and flexibility.[1]
- Water Conservation and Efficiency: By optimizing irrigation based on crop needs and environmental conditions, AI-enabled systems minimize water waste and promote efficient water use. This contributes to water conservation efforts and sustainable farming practices.
- Integration with Other Technologies: AI-

enabled irrigation systems can integrate with other agricultural technologies, such as weather monitoring systems, crop sensors, and farm management platforms. This integration enhances overall farm efficiency and decision-making capabilities [16].

Benefits of AI-enabled irrigation systems include improved crop health, enhanced water resource management, increased yields, reduced energy costs, and minimized environmental impacts. These systems empower farmers to make data-driven irrigation decisions, conserve water, and optimize agricultural practices in a way that promotes both productivity and sustainability.

Predictive Analytics for Yield Optimization

Predictive analytics for yield optimization involves the use of advanced data analysis techniques and models to predict and optimize crop yields [2]. By leveraging historical and real-time data, including weather patterns, soil conditions, crop management practices, and other relevant factors, predictive analytics enables farmers to make informed decisions that maximize crop productivity. Here are key aspects of predictive analytics for yield optimization:

- Data Collection and Integration: Data on various variables influencing crop yield, such as weather data, soil quality, fertilizer usage, pest control measures, and historical yield records, are collected and integrated into a unified dataset.
- Data Cleaning and Preprocessing: The collected data undergoes cleaning and preprocessing to ensure accuracy, consistency, and compatibility for analysis. Outliers, missing values, and inconsistencies are addressed to maintain data quality.
- Feature Selection and Engineering: Relevant features that have a significant impact on crop yield are selected and engineered. This involves identifying the most influential variables and transforming or combining them to create new informative features.
- Model Development: Predictive models, such as machine learning algorithms or statistical regression models, are developed using the cleaned and preprocessed data. These models learn from the historical data to establish relationships between input variables and crop yields.
- Model Training and Validation: The predictive models are trained using a subset of the data and validated to ensure their accuracy and reliability. This validation process helps assess the model's ability to generalize and make accurate predictions on unseen data.[5]
- Yield Prediction: Once the predictive models are trained and validated, they can be applied to new data to predict crop yields. By inputting current or forecasted values of relevant variables, the models generate yield predictions for different crops and growing conditions [15].
- Optimization Strategies: Based on the yield predictions, farmers can implement optimization strategies to maximize crop productivity. This includes adjusting irrigation schedules, fine-tuning fertilizer application rates, optimizing pest control measures, and making informed decisions regarding crop varieties and planting densities.[8]
- Continuous Model Updating: Predictive models can be updated periodically with new data to improve their accuracy and adapt to changing agricultural conditions. This ensures that the models remain relevant and effective in optimizing crop yields over time.

The benefits of predictive analytics for yield optimization include improved resource allocation, enhanced decision-making, reduced risks, increased efficiency, and higher crop yields. By leveraging data-driven insights, farmers can make informed choices regarding crop management practices, leading to optimized yield outcomes and improved overall farm profitability.

Benefits and Challenges of AI Adoption in Agriculture Benefits:

- Increased Efficiency: AI technologies enable automation and optimization of various farming processes, resulting in increased efficiency and reduced labor requirements. Tasks such as crop monitoring, irrigation scheduling, and pest

detection can be performed more accurately and efficiently with the help of AI, leading to improved overall productivity [4].

- Enhanced Decision-Making: AI-powered systems provide farmers with valuable insights and data-driven recommendations for decision-making. By analyzing large volumes of data from multiple sources, AI can help farmers make informed choices regarding crop management, resource allocation, and risk mitigation strategies, leading to better outcomes and improved profitability.[7]
- Yield Optimization: AI algorithms can analyze historical and real-time data to predict crop yields accurately. This information enables farmers to optimize inputs, adjust cultivation practices, and implement strategies for maximum yield potential. By optimizing yield, farmers can achieve higher productivity and maximize profitability.
- Precision Agriculture: AI plays a crucial role in precision agriculture, enabling targeted and precise resource management. By integrating data from sensors, satellites, and drones, AI systems can provide farmers with real-time information about soil moisture levels, crop health, and nutrient requirements. This precision allows farmers to apply inputs such as water, fertilizers, and pesticides in a more targeted and efficient manner, reducing waste and minimizing environmental impacts [15].
- Sustainability: AI adoption in agriculture can contribute to sustainable farming practices. Through improved resource management, including water conservation, reduced chemical usage, and optimized energy consumption, AI technologies promote environmental stewardship. AI can help farmers adopt more sustainable practices, preserve natural resources, and reduce the ecological footprint of agriculture [11] .

Challenges

Cost of Implementation: Adopting AI technologies in agriculture can involve significant upfront costs. Farmers may need to invest in equipment, sensors, software, and training to implement AI systems effectively. The initial financial investment may be a barrier for small-scale farmers or those with limited resources [14] .

- Data Privacy and Security: AI relies on large volumes of data, including sensitive information such as farm management practices and production data. Ensuring data privacy and security is crucial to protect farmers' proprietary information and prevent unauthorized access or data breaches. Implementing robust data protection measures is essential but can pose challenges for some farmers. [9]
- Access to Technology and Infrastructure: Access to AI technology and robust internet connectivity can be limited in rural areas [19]. Lack of infrastructure can hinder the adoption and effective utilization of AI-powered solutions. Efforts are required to address these infrastructural gaps and ensure equal access to AI technologies for farmers in all regions.
- Skill Requirements and Technical Support: The successful adoption and utilization of AI in agriculture require farmers to possess the necessary skills and knowledge to operate and maintain AI systems effectively. Providing training and technical support to farmers to enhance their digital literacy and AI capabilities is crucial to overcome this challenge.
- Ethical and Regulatory Considerations: As AI becomes more prevalent in agriculture, ethical considerations surrounding data ownership, algorithm biases, and responsible use of AI need to be addressed. Developing transparent and accountable frameworks for AI adoption in agriculture is essential to build trust and ensure ethical practices [20].

Overall, while AI adoption in agriculture offers numerous benefits, it also presents challenges that need to be addressed for successful implementation. Overcoming these challenges requires collaboration among farmers, technology providers, policymakers, and researchers to ensure that the benefits of AI in agriculture are realized while mitigating potential risks and promoting equitable access to AI technologies [12]

RESEARCH METHODOLOGY

The research methodology for the study on AI-Powered Innovations in Agriculture: Transforming Farming Practices and Yield Optimization employed a secondary

data research approach. The data collection involved gathering existing data from various secondary sources such as academic journals, research papers, industry reports, government publications, and reputable online databases. The data collection process included conducting a comprehensive literature review using relevant keywords and search terms related to AI applications in agriculture, farming practices, and yield optimization. The selected articles, reports, and publications assessed their relevance to the research topic and the quality and credibility of the sources. The synthesized data is also organized and presented to address the research objectives. By employing a secondary data research methodology [3] , this study aims to contribute to the existing body of knowledge on AI applications in agriculture and provide valuable insights into the transformative potential of AI-powered innovations in improving farming practices and optimizing crop yields.

FINDINGS AND DISCUSSION

The findings of this research shed light on the transformative impact of AI in agriculture. Through the integration of AI technologies, farming practices have witnessed significant advancements, leading to improved efficiency, productivity, and sustainability. AI is being applied in various specific areas within agriculture, including crop monitoring, disease detection, precision farming, autonomous machinery, predictive analytics, smart irrigation, and supply chain management [18]. These applications have demonstrated substantial benefits such as increased crop yields, reduced resource wastage, improved pest management, enhanced decision-making capabilities, and cost savings. However, the adoption of AI in the agricultural sector also presents certain challenges. These include the initial cost of implementation, concerns regarding data privacy and security, limited access to technology in rural areas, and the need for a skilled workforce and technical support. Stakeholders in the agricultural industry can derive valuable insights from this research. Farmers can make informed decisions about adopting AI technologies that align with their specific needs, while agribusinesses can identify opportunities for integrating AI-powered solutions into their value chain [19]. Policymakers can gain a deeper understanding of the benefits and challenges associated with AI adoption, enabling them to formulate supportive policies that encourage innovation and sustainability in agriculture. This research contributes to the understanding and advancement of AI-powered innovations in agriculture by exploring its transformative impact, identifying application areas, assessing benefits and challenges, and providing valuable insights for stakeholders. It serves as a foundation for further research and development efforts aimed at addressing existing challenges and unlocking the full potential of AI in revolutionizing farming practices, optimizing yields, and fostering sustainable agriculture.

Comparison between traditional methods and AI enabled methods in Agriculture for yield optimization

Point of Discussion	Traditional Methods	AI enabled Methods
Crop Monitoring and Management	Field Surveys Visual Crop Inspection Farmer Knowledge and Experience	Disease and Pest Detection Yield Prediction Weed Detection and Management Irrigation Optimization Nutrient Management Crop Disease Forecasting Harvesting Optimization Autonomous Farming
Pest Detection and Management	Pheromone Traps Sticky Traps Mechanical Traps Biological Control Chemical Control Traps and arriers	Pest Identification Disease and Pest Risk Assessment Decision Support Systems Data Integration and Analytics Real-Time Monitoring and Alerts Precision Pest Control

Irrigation Systems	Surface irrigation Sprinkler irrigation Drip irrigation Terracing Traditional wells and canals Paddy field irrigation	Data Collection and Monitoring Data Analysis and Decision-Making Evapotranspiration Modeling Smart Irrigation Control Automation and Remote Monitoring Water Conservation and Efficiency Integration with Other Technologies
Predictive Analytics	Not Available	Data Collection and Integration Data Cleaning and Preprocessing Feature Selection and Engineering Model Development Model Training and Validation Yield Prediction Optimization Strategies Continuous Model Updating

CONCLUSION

In conclusion, this research has successfully explored the transformative impact of AI in agriculture and investigated specific areas where AI is being applied in the agricultural sector. The

findings have revealed that AI technologies have revolutionized farming practices by improving efficiency, productivity, and sustainability [20]. AI is being utilized in various areas such as crop monitoring, disease detection, precision farming, autonomous machinery, predictive analytics, smart irrigation, and supply chain management. These applications have demonstrated significant benefits, including increased crop yields, reduced resource wastage, improved pest management, enhanced decision-making capabilities, and cost savings [12]. Overall, AI holds great promise in transforming the agricultural sector and fostering sustainable and efficient farming practices for the future.

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Active Switched LC based DC-DC Converter for PV System

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ABSTRACT

This research paper proposes a high-step-up DC-DC converter with an active switching LC-network that may be utilised in EV application or as the front-end stage in a photovoltaic (PV) system to create the requisite dc bus voltage. This ASLC converter, which is based on a transformer less DC-DC converter with active switched inductor (ASL) network, adds an active switched capacitor (ASC) network, with just one capacitor and one diode added, while the voltage gain is effectively increased by a compound of ASL and ASC networks. The suggested converter has a basic structure with low voltage strains on the extra diode and capacitor. Furthermore, unlike existing voltage-boosting devices that use switched capacitors, the ASLC converter avoids the capacitor's excessive instantaneous currents. The suggested converter is thoroughly examined, and its performance is compared to that of recently released ASL network-based converters. Finally, the performance of a 100 W, 20/230 V prototype is tested.

KEYWORDS: *ASLC converter, Inverter, Matlab simulation, PV system, EV application.*

INTRODUCTION

Photovoltaic (PV) systems, uninterrupted power supply (UPS) and photo voltaic electrical hybrid vehicles (PHEVs) are just a few of the applications where choppers are used. The output voltage of distributed power supplies is frequently inconsistent and insufficient. Consequently, a significant voltage increase is required to provide the required DC bus voltage. In these systems, choppers are more commonly used. In a conventional boost converter the switch voltage is equal to the output voltage. As a result, high-power-to-weight-ratio switches are necessary. As duty cycle reaches to unity, the static gain of a standard boost converter will be limitless, according to theoretical relationships. Greater duty cycle esteems, then again, bring about a decline in voltage gain and effectiveness, which is generally because of rise in conduction losses. Various high gain boost converters have been presented in various papers to solve the above mentioned problems.

Various approaches and circuits are also shown to boost voltage gain and lower duty cycle values. There are different voltage enhancing techniques such as switched inductor, magnetic coupling, switched capacitor and voltage-lift are some of the voltage-boosting techniques. One of the best approach is presented in this paper by comparing all the possible converter and hence these report is being presented.

In this paper more focus has given to study various present inverter topologies, analyse the converter and importantly design converter for the PV applications with developing close loop software model of converter. The structure of the paper is as follows: Section II discusses the conventional topology operation, Section III presents the proposed ASLC circuit topology with MATLAB Simulations. Implementation of Hardware and analysis of the results are shown in Section IV. Conclusions are drawn in Section V.

CONVENTIONAL TOPOLOGY OPERATION

A chopper circuit is a type of electronic switching device or circuit used in electrical control and signal applications in electronics. In Chopper, there are a number of devices that are used. MOSFET, BJT, IGBT, GTO and other low- power applications Thyristor or SCR for high-power applications a chopper circuit

is straightforwardly changes over a decent DC input voltage to change in DC yield voltage as shown in Fig. 1.

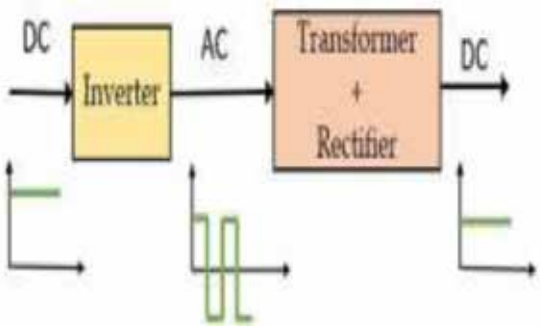

Fig. 1. Chopper operation

It's a habit to rupture. When a signal is in control. Because the switching element is either In power electronics applications, fully on or fully off, It has negligible damage and can deliver well functionality Chopper is nothing but DC to DC converter which are basically classified into 3 types Buck Converter Boost Converter and Buck-boost Converter. Boost Converters are used to enhance the voltage; whose output voltage is greater than the input voltage. In the boost converters, the conversion of dc is done in such a way that the output voltage of the circuit is much higher than that of input voltage. The operation of Boost converter are as In mode 1, for time period , switch is closed. At that time current can flow through inductor and Switch S1 and bigger Energy is stored in an inductor. In mode 2, for time period, switch is open so at that time the previously stored energy in the inductor is freewheeled through diode followed by load. Due to this mode the voltage across load is greater than that of

So the time period is given as. $T = T_{on} + T_{off}$ (1)

The duty cycle is written as: $i_{C1} = C_1 \frac{dv_{c1}}{dt} = -i_{L2}$ (2)

The output voltage across the load will be given by:

$$V_{out} = \frac{Vs}{1-D} \quad (3)$$

The Boost converter is a constant current input source because input current is caused by the inductor linked to the input source. The load out there can be seen as a constant voltage source.

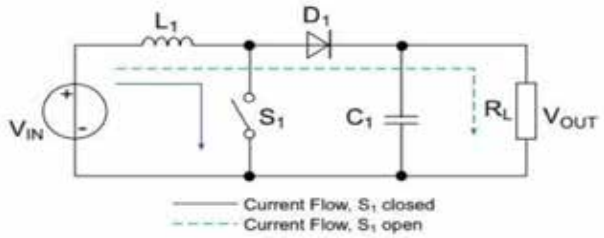

Fig.1.1. a circuit diagram of boost converter

However, since the current supplied to the load is intermittent, smoothing or a higher switching frequency may be necessary to reduce unwanted effects. To design a compatible DC DC converter there is a requirement of High power rated switch required with consequences of high conductive losses and the voltage gain is limited with also large duty cycle [1]. To improve the existing one, improvement has been done in the form of Voltage-lift split- inductor-type boost converters (VL) with the advantage of Simple structure and less voltage stresses by applying VL technique applied to ASL but there is issue with Complex VL cells increase cost and decrease efficiency [2], with an updation in the circuit with switched-capacitor-based active- network converter proposed here which provide high voltage gain without high duty cycle, it suffer from extreme instantaneous capacitor current switch causes losses and causes magnetic noises[3]. Implementation of Active Switched-Inductor and Passive Switched- Capacitor Networks give high voltage gain but circuit became bulky due to calculated inductance [4].With hybrid i.e Active- Passive inductor cell technique is used for improving voltage gain with merit of Voltage stress on the switches are reduced which further deals into increased in cost and size because of more inductors are employed[5].In one of the method active-network converter with coupled inductors technique is used where By adjusting the turn ratio high voltage gain is achieved with relatively small duty cycle But there is drawback of leakage reactance of coupling inductor[6]. To enhance the source side voltage at greater level boost converters are used. That load side voltage is greater than source side voltage. When switch is on, the energy in an inductor is get stored and when switch is off it releases through the load on this principle boost converter works. Because of various reasons like rectifier diodes, power switches and the internal resistance of capacitors

and inductors boost converter fails to provide high gain dc voltage. So to overcome that drawback the new technique called Active Switched Inductor (ASL) is came into the picture. So this technique is mainly used in boost converter to enhance the boosting capacity of the converter. The ASL consists of two inductors which are connected in parallel manner. So this will have used to enhance the voltage gain by switching on both inductors to obtain a high voltage range output from a low voltage DC supply.

ASLC CIRCUIT TOPOLOGY WITH MATLAB SIMULATIONS

ASL technique has some drawbacks such as When voltage lift (VL) technique is used in the ASL based converter, it will enhance the voltage gain properly but voltage lift technique is costly and reduces overall performance of converter and second one when Switched Capacitor (SC) is applied to ASL based converter so voltage gain will be enhanced properly and voltage stress on the switches also be reduced but converter suffers from extra power loss and electromagnetic noises due to instantaneous capacitor currents. So these drawbacks can be overcome by combining ASL and ASC network with additional one diode and capacitor in the converter. To address the aforementioned shortcomings of ASL-based converters, a new technique DC to DC converter with active switch for high gain capacitor and inductor network is presented as shown in Fig. 2.1.

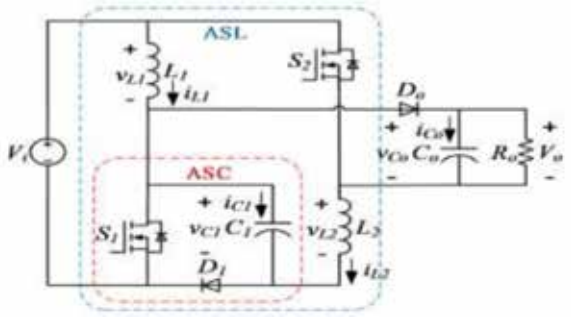

Fig.2.1 circuit diagram of ASLC converter

The suggested converter simply uses one additional capacitor and diode to the typical ASL network, but ASLC network efficiently increases the voltage gain. Furthermore, the extra diode and capacitor are subjected to low voltage strains. Although the ASC network is used, the suggested converter avoids the high-current transients that are a shortcoming of switched capacitor circuits. The given topology is shown in the above diagram. The above converter is achieved by combining the ASL network and ASC network which is called as ASLC network. The ASL network is consist of 2 switches and 2 inductor A S C network is consist of capacitor, diode and switch As a result, just diode and capacitor are needed, and the construction remains simple. Two operating scenarios, encompassing three modes, can be separated based on the currents of capacitor C1, inductor L1, and inductor L2. Table 1 shows the detailed statuses of components various modes. Table 2 depicts the transition between different modes in various scenarios.

Table 1 States of Components in Different Modes

MODE 1	MODE 2	MODE 3
ON	OFF	OFF
OFF	ON	ON
OFF	ON	ON

The above table shows switching of switches of the MOSFET and diode D1 and D2. So in mode 1 both switches are on and diodes are in reverse biased. In mode 2 both switches are closed and diodes are forward biased. And mode 3 is same as mode 2.

Table 2: Transitions Between Modes in Different Cases

CASE	TRANSITION
CASE 1	Mode 1-Mode 2
CASE 2	Mode 1-Mode 2-Mode 3.

Above table shows the different cases and different modes involved in it. Case 1 consist of mode 1 and mode 2. And Case 2 consists of mode 1, mode 2 and mode 3. The detailed operation can be seen by of different mode are as follows:

Case-1 (Mode 1and Mode 2)

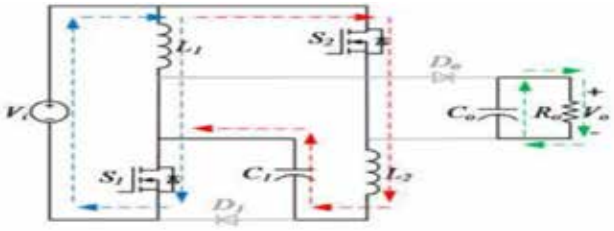

Fig.3.1. a equivalent circuit of mode 1

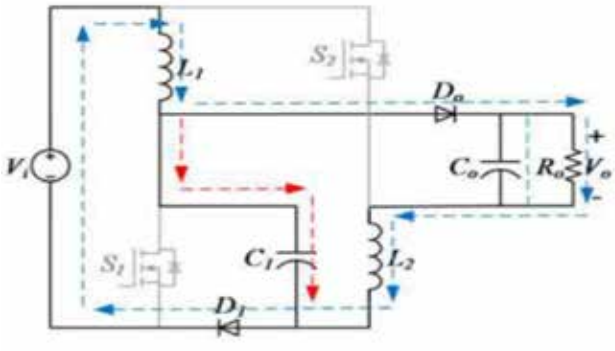

Fig.3.1.b equivalent circuit of mode 2

In mode 1 switch S_1 and S_2 are switched on during this time span, and diodes D_1 and D_0 are in reversed bias. The inductors L_1 and L_2 are parallel charged from the DC source v_i, as shown in Fig. 4.2.a.Initially stored energy in capacitors C_1 and C_0 are released to inductor L_2 and the load, respectively. The two inductor voltages (V_{L1}, V_{L2}) and two capacitor currents (i_{c1}, i_{c0}) in this mode are derived as equation 4 to 7 respectively.

$$V_{L1} = L_1 \frac{di_{L1}}{dt} = V_i \quad (4)$$

$$V_{L2} = L_2 \frac{di_{L2}}{dt} = V_i + v_{C1} \quad (5)$$

$$i_{C1} = C_1 \frac{dv_{c1}}{dt} = -i_{L2} \quad (6)$$

$$i_{C0} = C_0 \frac{dv_{C0}}{dt} = -I_0 \quad (7)$$

In mode 2 both switches s_1 and s_2 are closed at that time frame, and diodes D_1 and D_o are forward biased. Inductors L_1 and L_2 are series coupled with the dc source, as shown in Fig. 4.2.b to transmit energy to the capacitor C_0 and the load R_0. In the meantime, inductor L_1 charges capacitor C_1 from the input source. The voltage and current equations are mention 8 to 11 respectively.

$$V_{L1} = L_1 \frac{di_{L1}}{dt} = V_i - v_{C1} \quad (8)$$

$$V_{L2} = L_2 \frac{di_{L2}}{dt} = v_{C1} - V_0 \quad (9)$$

$$i_{C1} = C_1 \frac{dv_{c1}}{dt} = i_{L1} - i_{L2} \quad (10)$$

$$i_{C1} = C_1 \frac{dv_{c1}}{dt} = i_{L1} - i_{L2} \quad (11)$$

Case-2 (Mode 1, Mode 2and Mode3)

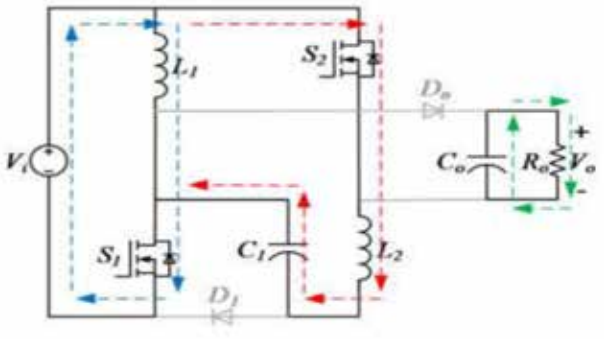

Fig.3.2. a equivalent circuits of mode 1

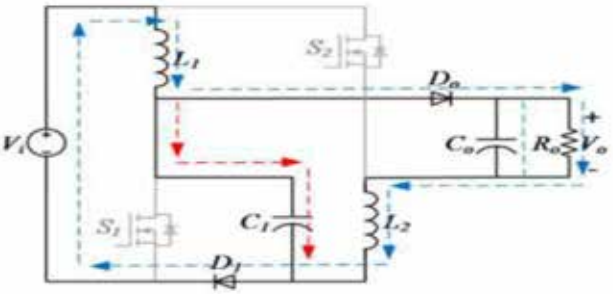

Fig.3.2. b equivalent circuits of mode 2

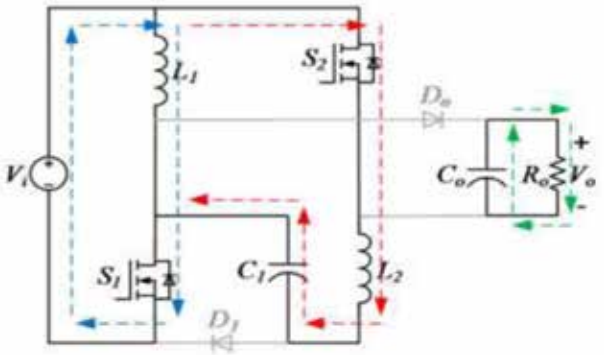

Fig.3.2.c equivalent circuits of mode 3

In Case 2 of mode1 the switches S_1 and S_2 are switched on during this time span, and diodes D_1 and D_1 are in reversed bias. The inductors L_1 and L_1 are parallel charged from the dc source V_i, as shown in Fig. 3.2.a. Initially stored energy in capacitors C_1 and C_1 are discharged cross inductor and the load, respectively. The two inductor voltages (V_{L1}, V_{L2}) and two capacitor currents (i_{C1}, i_{C2}) in this mode are derived in equation 12 to 15 respectively

$$V_{L1} = L_1 \frac{di_{L1}}{dt} = V_i \quad (12)$$

$$V_{L2} = L_2 \frac{di_{L2}}{dt} = V_i + v_{C1} \quad (13)$$

$$i_{C1} = C_1 \frac{dv_{c1}}{dt} = -i_{L2} \quad (14)$$

$$i_{C0} = C_0 \frac{dv_{C0}}{dt} = -I_0 \quad (15)$$

In Case 2 of mode 2 Both switches are switched off at that time frame, and diodes D_1 and D_o are forward biased.

Inductors L_1 and L_2 are series coupled with the dc source, as shown in Fig. 4.2.b to transmit energy to the capacitor C_0 and the load R_0. In the meantime, inductor L_1 charges capacitor C_1 from the input source. The voltage and current equations are mentioned in equations from 16 to 19 respectively.

$$V_{L1} = L_1 \frac{di_{L1}}{dt} = V_i - v_{C1} \quad (16)$$

$$V_{L2} = L_2 \frac{di_{L2}}{dt} = v_{C1} - V_0 \quad (17)$$

$$i_{C1} = C_1 \frac{dv_{c1}}{dt} = i_{L1} - i_{L2} \quad (18)$$

$$i_{C0} = C_0 \frac{dv_{C0}}{dt} = i_{L2} - I_0 \quad (19)$$

In Case 2 of mode 3 Both the capacitor starts to discharge and i_{C0} starts to reduce to zero as inductor are not able to provide required amount of energy. Relations has been built across voltage and current is given below in equations from 20 to 23 respectively.

$$V_{L1} = L_1 \frac{di_{L1}}{dt} = V_i - v_{C1} \quad (20)$$

$$V_{L2} = L_2 \frac{di_{L2}}{dt} = v_{C1} - V_0 \quad (21)$$

$$i_{C1} = C_1 \frac{dv_{c1}}{dt} = i_{L1} - i_{L2} \quad (22)$$

$$i_{C0} = C_0 \frac{dv_{C0}}{dt} = i_{L2} - I_0 \quad (23)$$

Table 3. Parameter Table

Parameters	Values
Input Voltage	20 V
Output Voltage	230 V
Inductor L1 and L2	200uH and 800uH
Capacitor C1 and C0	22uF and 100uF
MOSFET S1 and S2	IRF 540
Input Current	5.3 A
Output Current	0.4343 A
Voltage gain	11.89
Efficiency	88-93%

As per table 3 the parameter is mention above has been put for the desired output.

Matlab Simulation

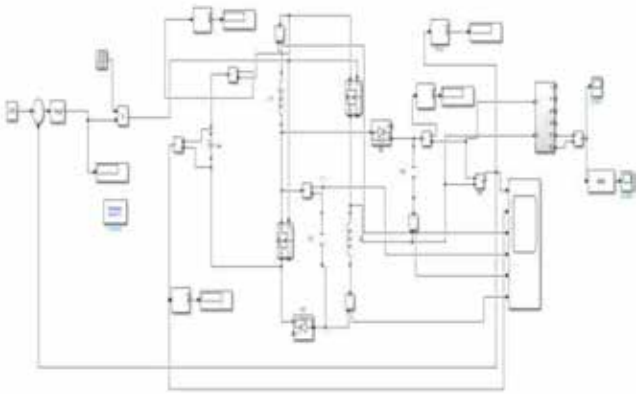

Fig. 4.1a- close loop simulation of the given ASLC converter

Above Fig. 4.1ashows close loop simulation of the given ASLC converter It is required to maintain the voltage level of the system at the desired value even if input given to the converter changes. This system has been verified over MATLAB/Simulink with different input and load condition to check predefined condition.

In close loop one used PI controller to get the desired close loop condition the reference voltage is given as 230 V. The voltage waveform of the converter and the inverter circuit for the close loop is given below

One can tune the PI controller over the MATLAB itself and can use in the actual implementation as MATLAB is one of the advance software to be used. PI controller basically keep the value of output voltage at the reference value.

Fig. below shows the output voltage and current characteristics with respective time and it is very clear that due to close loop simulation the output remains at constant 230 V (229.5 V) which shows that system is

very perfectly adapted to close loop control to make it more advance one can use another control technique but for realization of close loop purpose one have introduced the close loop simulation .The output of close loop and open loop remains same as which indicate that the close loop system is perfectly adapted now if there is load variation in the circuit it does not affect the output voltage ,If one should consider that input is going to change to some value the close loop system adaption will keep the output voltage to the required value in above case it is 230 V.

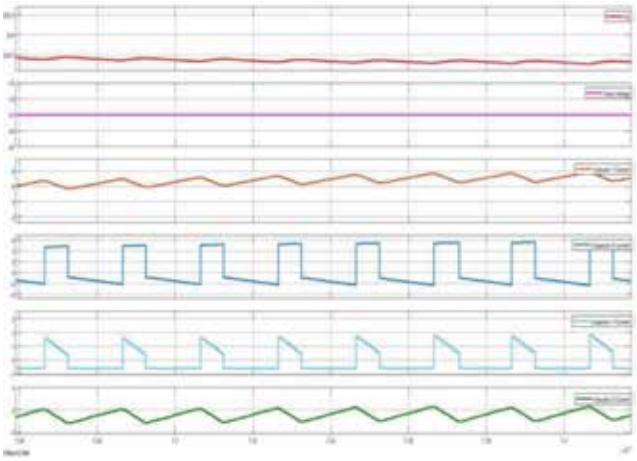

Fig.4.1. b. - close loop output waveform of converter

Inverter side

Output Voltage

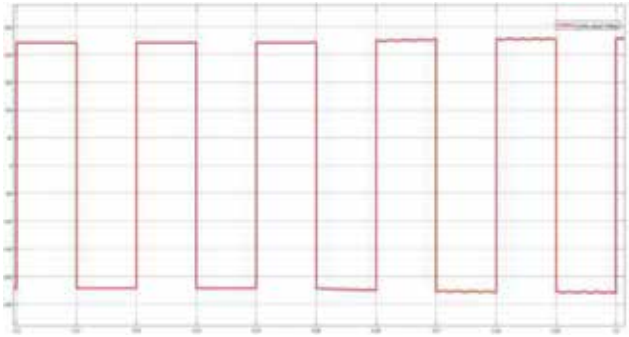

Fig.4.1.c– close loop output voltage waveform of inverter

Fig 4.1.c shows the output voltage that one can get from the MATLAB scope and the output is perfectly 230-volt peak But as one should note that the output seen by load is in RMS form so one should have to find RMS value this feature is provided by the RMS block in MATLAB the output of which is given below.

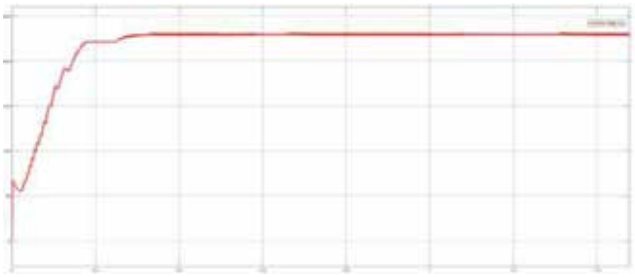

Fig.4.1. d– close loop RMS output voltage waveform

Fig 4.1.d show the RMS value obtained from the scope in this case the output is under damped in attaints the required value after underdamping whereas in in the open loop one should have seen it as over damping it does not cause any much effect at the system is designed to sustain such oscillation.

HARDWARE RESULT

Fig.4.2 b Output of driver circuit

Fig.4.2 a shows the output of the driver circuit with the required gating to the MOSFET,in above cases both the MOSFET have a common pulse to operate the means both have same frequency as 50 KHz, same Ton and Toff timing with.

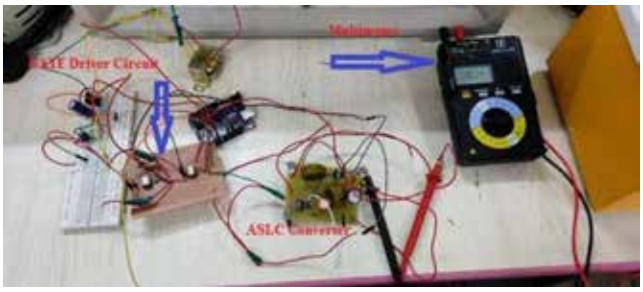

Fig.4.2. b Actual implementation of the circuit

Fig.4.2. b shows the actual implementation of the converter where the output is checked on the multi meter and the output is near about 200V here the desired output is not matched due to uncertainty in the

components and input variation of supply. Once the output of driver circuit is achieved then we have given it to power circuit and load is connected, the output is then verified over multi meter. The main circuit is connected to the multi meter where output is being checked where the gate pulse to the converter is given by output of driver circuit.

To provide the required supply to gate driver assembly a circuit to provide 12V supply is made on the breadboard whereas supply to the main circuit is provided through a DC supply regulator. Arduino is used to generate gate pulses through the programme shown in the driver circuit.

CONCLUSION

As the given converters are the best possible way to change the future of solar energy and have a great control over other parameter with the converter that have designed have efficiency more that 90% and have less voltage stress over the switches. The design is verified over the MATLAB software and checked for the desired output over the given rating Close loop model of given converter is run over MATLAB and output is verified by changing load and changing supply for the same.

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Implementation of Direct Torque Control of Induction Motor with Minimum Voltage Vector Error using Matlab/Simulink

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ABSTRACT

Direct torque control is a way of managing torque and installing a manufacturing machine that uses a vectors. Vector control is fairly strong since DTs that are now manage more than just the active magnitude, it is still difficult and inconsistent. This approach is strongly advised. for managing torque & is more critical to the machinery's power in all industrial processes. As a result, the induction motor's (MT) high torque, climatic fluctuation, and relative temperature are all regulated. The technique established assures a considerable VV measure of performance to restrict the gap between the starting vectors voltages and the last vector voltages contained in those terminals. The set of regulations does not significantly enhance the performance device's perplexity and can be comprehended more accurately with the help of the social service. For 0.55 kW IM degree, pricing can be obtained for a variety of better outputs including a few current DTC modifications. The enhanced DTS method has been tested in order to attain unified worldwide governance in a short period of time and with a rapid reaction. Furthermore, the enhanced approach may identify the frequency of variations due to the increased renewal speed and rate are limited.

KEYWORDS: *Dtc, Minimum voltage vector error, Average-switching- frequency (ASF), Dynamics response and ripple torque.*

INTRODUCTION

The dynamic state update is the basic structure of the vector controller. Under normal functioning and stable conditions, the stator flux and torque, the terminating of the induction's motor may alter significantly. Various induction validity management procedures are available, such as pole exchange, frequency variation, changing the rotor's resistance, altering the stator's voltage, the constant voltages/ frequency, sliding recovery, and more. A revolutionary technique called direct control of torque is applied in conjuction with vector controlling to regulate the both speed as well as pressure of the combustion motor. Since the DT manipulate approach can now manipulate not only magnitudes as well as the currents, voltages, and float states in real time, vector manipulation is preferred to scalar manipulation. Because of the dynamic efficiency of induction motors, this strategy is especially recommended for adjusting torques and tempo. As a result, high excellent torques, stator flux, and MT (induction motor) rated speed is not maintained. The suggested The DT Control approach was developed to offer improved SteadyState performance while maintaining DT Control's quick dynamic reactions. Furthermore, the enhanced technique can resurrect the rate of volatility at all stages in relation to the anticipated cost of reuse.

LITERATURE SURVEY

Fatih Korkmaz et. The purpose of this article is to introduce a new approach for direct torque control using good judgment primarily based space vector modulation on managed use the result to overcome the difficulties of direct torque manipulation. For special operating conditions, Matlab/Simulink protocols for comparing the proposed direct torch control method

with the standard direct torque control strategies were changed. The imitation strategy has shown fantastic gains in terms of bendy torque and speed response compared to traditional direct torque management.

Charles Stephen et.al. 2019, In this more rare and novel amendment rourosed table, the purpose is to lessen modern-day harmonise reliance on - torque-flux based aircraft that could launch any day CAR drives with updated upgrades, using upgraded software and upgraded hardware. They've a study the Simulink version and outgoing car fashions. Overall performance of this system focuses on improved flexibility, faster torque responses, low frequency inverter control, low harmonic losses, and high efficiency. With its above-mentioned capabilities, DTC controllers have the potential to be superb. So the reason here is to explore the superior IM management gadget because of this direct torque is deceptive and study its usual performance traits.

T. Vinay Kumar et. al. 2019, This paper introduces a two-degree changed inverter topology to enhance the overall performance of low-velocity controlled torque (DTC) for 3-section motor input. Based primarily on the role of modern ripples, the proposed technique is given. The rotational law is used to obtain inverter switching states. Low-speed operation of the DTC can be performed with less ripple of flexibility and torque than the usual technique. Predicted sequences of simulations are compared with the DTC method used in usual case study.

Hanbing Dan, et. Al 2021, proposes the DTC innovation, a model presentation control (MPC)-based prompt system converter-acknowledgment motor idea to reduce power gain in driving motors due to the use of common direct power control (DTC). This is paper. Two new test tables are proposed, all of which are evaluated using control of electromagnetic power and stator advances using gate voltage vectors and their individual trade states. Limited Control Set Model Presentation Control (FCS-MPC) is then taken to select the ideal business condition that restricts the consumption function related to electromagnetic power. In conclusion, the exploratory results are shown to investigate the low power extension performance of the proposed MPC-based DTC technique.

SCOPE AND OBJECTIVES

- Analysis and representation of uncontrollable induction machines, with concentration on Simulink mathematical modelling.
- Estimates of torque, flux, and accuracy based on device terminal currents and voltages (voltage versions).
- To put certain torque strategies to the test utilising Modulation of Pulse Width.

IDENTIFICATION PROBLEMS

- Large torques in the back are a problem for industrial motors under direct torque (DT) control, owing to a recent change in the dynamics of automobile fluctuations.
- Meanwhile, various techniques of regulating Dtc control was created to deal with complex problems, however it suffers from an absence of context, also in the death speeches, robustness problems.
- To improve, of DTs control repairing error depending mainly on the lowest voltage-vector defects is introduced the stability of the entire SteadyState mode.
- So Differentiation examines the required Voltage-Vector performance in order to eliminate mistakes between the Voltage-Vector references and the Voltage-Vector is final included in that term.

DIRECTLY TORQUE CONTROLLING

So the selection concept is central to the DT control technique. The DTC method's have a solutions is to choose a vector's voltage is turns the fluxes & creates torques. Controlling an industrial motor via the standard DTC approach entails direct manipulation of the stator flux vector. The contemporary stator must be split among neutral components, includes torque and flux components in DC tools, for this control. This deconstruction technique uses the DTs control method and the Clark transformation methodology. DTC enables extremely low torque response and easy industrial engine management.

DTC provides torque during rotation only by choosing a large output of a voltage vector centred on a flux

vector. By using the hysteresis controller, torque error and flux amplitudes are regulated with in the best-possible bounds. Figure 1 shows an example of spinning determining the inverter switching vectors outcome and the vector of the stator.

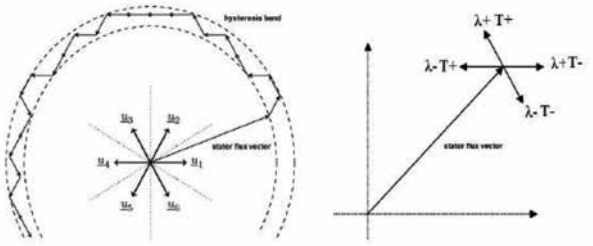

Fig. 1 Rotation of the vector stator-flux, as well as an illustration of the effects of inverting-switching vectors utilised

Eq. (1)-(3) is used to calculate the stator flux linkage vector

$$\lambda_\alpha = \int (V_\alpha - R_s i_\alpha) dt, \quad (1)$$

$$\lambda_\beta = \int (V_\beta - R_s i_\beta) dt, \quad (2)$$

$$\lambda = \sqrt{\lambda_\alpha^2 + \lambda_\beta^2} \quad (3)$$

whereby 'L' indicates a vector of stator flux, huge amounts in two sections from the VA and VB structures, reference lines Ia and Ib, & Rs signifies impact resistance. The manufacturing machine may be described in Equation (4) after lowering the flux in the stator vector and the electro-magnetic torque using the controller

$$T_e = \frac{3}{2} p (\lambda_\alpha i_\beta - \lambda_\beta i_\alpha) \quad (4)$$

Whenever p represents the number of role pairs. Along the DT path, so stator flux rotational method is divided into the six areas, and obtaining correct details regarding the flux of the stator universe has shown to be a swift success. So the state flux suffixes could be analyzed Equation's concept of flux of the stator (5).

$$\theta_\lambda = \tan^{-1} \left(\frac{\lambda_\beta}{\lambda_\alpha} \right) \quad (5)$$

The variable's term and torque values incorporate these measured flexible & torque error value's, as well as the resultant errors are provided as supplies to serve as hysteresis improvers. There, extra hyper parameters in the form of DT are produced by further hysteresis comparison in the forms of fluxes and torque comparisons. Using visible flux removal modifiers, the best generators of electricity are chosen and offered for input and supply the converter in accordance with the hysteresis output.

Modes of IM –

IM The DT platform is typically used to produce IM dynamic statistics as,

$$u_s = R_s i_s + \frac{d\psi_s}{dt} \quad (6)$$

$$O = R_r i_r + \frac{d\psi_r}{dt} - j\omega_r \psi_r \quad (7)$$

$$\psi_s = L_s i_s + L_m i_r \quad (8)$$

$$T_e = \frac{3}{2} p (\psi_s \otimes i_s) \quad (9)$$

$$\psi_r = L_m i_s + L_r i_r \quad (10)$$

⊗ This indicates that the two vectors' cross product, & using i_s and ψ_s is the state parameters,

$$\begin{cases} \dot{x} = A\hat{x} + Bu_s + G\Delta i_s \\ \hat{y} = C\hat{x} \end{cases} \quad (11)$$

where,

$$\hat{x} = [\hat{i}_s, \hat{\psi}_s]^T, \hat{y} = \hat{i}_s, \Delta i_s = i_s - \hat{i}_s, a = -\frac{1}{\sigma}\left(\frac{1}{\tau_s} + \frac{1}{\tau_r}\right) + j\omega_r$$

$$b = \frac{1}{\sigma L_s \tau_r} - j\frac{1}{\sigma L_s}, A = \begin{bmatrix} a & b \\ -R_s & 0 \end{bmatrix}, B = \left[\frac{1}{\sigma L_s}, 1\right]^T, C = [1, 0]$$

$$\sigma = 1 - \frac{L_m^2}{L_s L_r}, \tau_s = \frac{L_r}{R_r}, \tau_r = \frac{L_r}{R_r}, G = [K_1 + jK_2, K_3 + jK_4]^T$$

G is referred to as the description of the matrix. The major goal of estimating ('K1', 'K2', 'K3', & 'K4') are create the necessary FB level (K1) times in order for the automobile to change quicker over its FB counterpart. As a result, K1-K2-K3, & K4 are stated as follows:

$$\begin{cases} K_1 = (k-1)\left(\frac{1}{\sigma\tau_r} + \frac{R_s}{\sigma L_s}\right) \\ K_2 = (1-k)\omega_r \\ K_3 = (k^2 - 1)R_s \\ K_4 = 0 \end{cases} \quad (12)$$

Typically, the value of k is set to 1.2. Other methods of constructing an explanation a matrix, including a step, as to raise the level of intensity of a pointless speeds action exist, but they are frequently complicated.

A circumstance when discretizing (11) approaches can be used to express the current balance,

$$\hat{x}^k = \hat{x}^{k-1} + [A^{k-1}\hat{x}^{k-1} + Bu_s^{k-1} + G^{k-1}\Delta i_s^{k-1}]T_s \quad (13)$$

The current through the stator and flux should be computed using the following formulas for the following samples:

$$\hat{i}_s^{k+1} = i_s^k + \left(a^k i_s^k + b\hat{\psi}_s^k + \frac{u_s^k}{\sigma L_s}\right)T_s \quad (14)$$

$$\hat{\psi}_s^{k+1} = \hat{\psi}_s^k + \left(-R_s i_s^k + u_s^k\right)T_s \quad (15)$$

This makes it possible to forecast torque throughout the subsequent sample as,

$$\hat{T}_e^{k+1} = \frac{3}{2}p\left(\hat{\psi}_s^{k+1} \otimes \hat{\imath}_s^{k+1}\right) \quad (16)$$

METHODOLOGY

- In DTC, the goal is to select a stator power vector directly based on torque and flux errors that vary between torque and stator flux indicators and their estimated values.
- The stator port and rotor port interaction is responsible for the dominant equalization of torque for this system. The torque connection with the stator flux is calculated by a limited number of motor terminals i.e. stator voltages still.
- A high voltage switch vector with six power vectors and two zero voltage vectors is selected for hysteresis control of stator flux and torque.

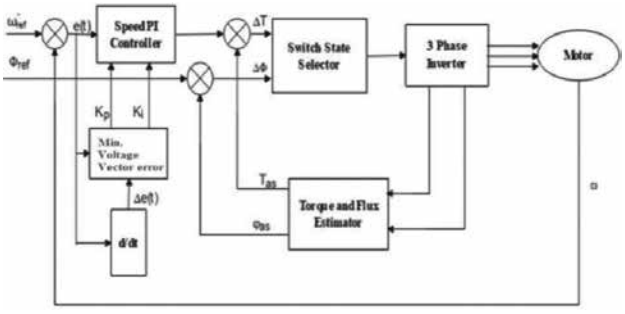

Fig. 2. The block diagram for the DTC of an induction motor

- Direct torque mode controls speed in the desired direction without the use of sensor controls for speed.
- Usually, flux measurement is done based on the voltage combination of the motor components.
- As a result, if the output frequency of the drive output is zero, the engine cannot be controlled. Figure 2 depicts the DT block diagram.
- Induction Motor Drive comes with an inverter power source. The best. The inverter voltage vector may be selected to control the stator fluxconnection and the electric torque directly.

MVE DIRECT CONTROL OF TORQUE SIMULATION

A simulated version involving the MVE of DT Control is provided in Simulink/Matlab. To simulate real-world activities, algorithms for control are written in files and tested every 100µs.

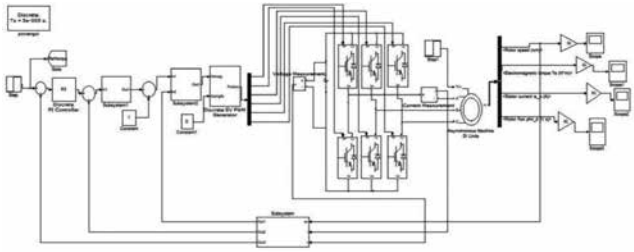

Fig. 3. Simulations of MVE Direct torque control

Table 1: All the Inverter Parameters and Motor

Quantity	Symbol	Value
Rotor Resistance	Rr	5.6 Ω
Stator Resistance	Rs	6.1 Ω
Stator Inductance	Ls	0.573 H
Rotor Inductance	Lr	0.58 H
Mutual Inductance	Lm	0.55 H
Rated Current	IN	2.7 A
Rated Torque	TeN	7.5 Nm
Flux Reference	ψ_s	0.8 Wb
Pole Pairs	p	2
DC Bus Voltage	Udc	300 V
Rated Speed	nN	710 RPM

RESULTS OF MVE DIRECT TORQUE CONTROL

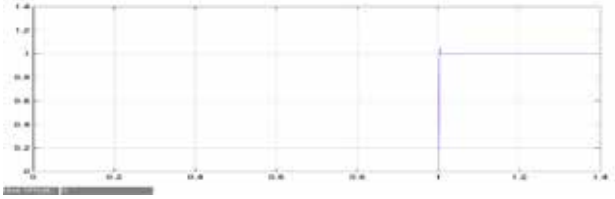

Fig. 4.1. Results of the simulation for torque

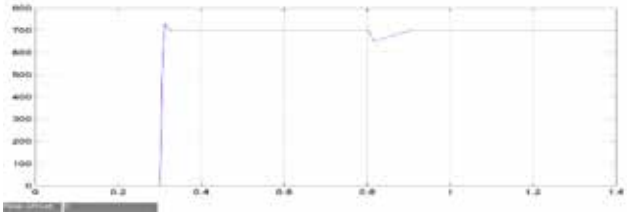

Fig. 4.2. Results of the simulation for speed

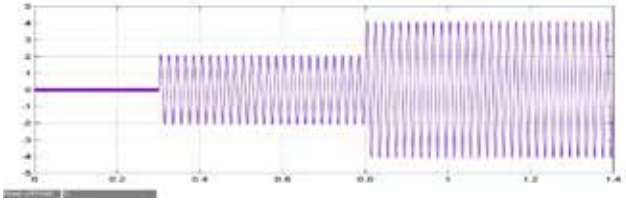

Fig. 4.3. Results of the simulation for stator current

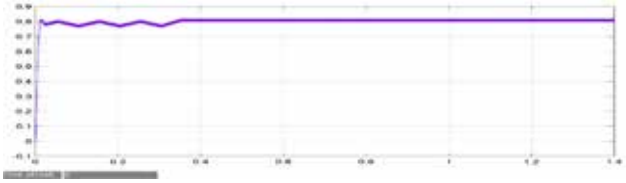

Fig. 4.4. Results of the simulation for rotor flux

So in Fig. 4 depicts the outputs of the Minimum voltage Vector Error simulations. Torque is controlled directly. The motors, whose values are listed below, begin running at the 50 rpm with the no load. So the speed climbed from the 50 rpm to 710 rpm in 0.3second. Next at the 0.8second mark, a typical load of 7.5N is applied. But the machine can be operate continuously in a variety of operating situations, proving the usefulness of the suggested approach at first. Torque control appears at the 0.3 second & stable control at 1 second.

CONCLUSION

This programmed provides a very easy and intuitive sophisticated DT solution for induction motor applications. The torques & flux generated by the induction machines are transformed into the VV control as a consequence of the suggested MVE DT, resulting in a reference VV. The closest to refer to VV may be obtained by optimizing the basic Voltage-Vector charge ratio. Because the suggested technique employs a digital torque regulator, the engine's dynamic reactions are not compromised. Finally, the proposed method achieves mainly consistent switching frequencies, especially when there are big weights.

ACKNOWLEDGEMENT

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Hybrid Renewable Energy Systems and Optimization Techniques: A Review

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ABSTRACT

The climate has an impact on solar and wind energy. Without batteries, storage, or an engine generator, these systems cannot be counted on to function dependably. The existence of two systems and a storage device improves the system's reliability. The battery bank must power the load despite the cloudy skies and the lack of wind. As a result, hybrid power system components need to be the right size. The most recent developments in renewable energy sources will be looked at in this paper. The technical elements of renewable energy systems are also presented. High-renewable energy sources are now used more frequently because of recent environmental and energy crises. This study examines various methods for power systems optimization, addresses world energy scenarios, energy cost and renewable energy system modelling.

KEYWORDS: *Hybrid power systems, Renewable energy sources, Technical simulation, High- renewable energy sources (HRES), Small power systems, Optimization, Artificial Intelligence (AI.*

INTRODUCTION

Natural gas, coal, as well as oil are kind of fossil fuels that are needed to produce electricity. Natural resources were depleted by the use of fossil fuels throughout the 20th century. More than ever, engineers and scientists are working to create and implement environmentally friendly alternatives to traditional energy production techniques. They are aware of the drawbacks of traditional energy sources. The most typical forms of renewable energy come from the sun, wind, and hydroelectricity. The use of wind energy is rising. Performance-wise, wind energy outperforms all other types of renewable energy.

When it comes to isolating and isolating locations that have a low likelihood of connecting to the national grid due to technical and financial constraints, many regions and nations favour isolating and isolating locations with renewable energy systems. The likelihood of connecting inaccessible areas to the national grid is lower. The use of photovoltaic rays, wind, and water can all produce electricity. This system requires a diesel generator and batteries to handle peak demand. The availability of electricity is necessary for both economic growth and individual prosperity. Without compromising dependability or efficiency, a well- designed renewable energy system has the potential to raise quality of life. Although solar irradiance and wind speed are typically complementary, sudden changes can make them unreliable. Bhandari et al. 2,3 installed a brand-new hybrid solar, wind, and hydropower system in a remote Nepalese village.

The functionality as well as the dependability of the system, which heavily depend on each component, can be better understood and improved when each component of HRES is accurately modelled. This paper looks at methods for determining system size and optimization criteria, as well as small power systems powered by photovoltaics (PV), wind, hydro, and hybrid power storage. Examples of mathematical models, graphs, and flowcharts are given whenever appropriate. The paper will also go over the current state

of the world's energy supply and ongoing initiatives to lower energy consumption, with citations where appropriate. renewable energy sources combined. The global capacity for solar and wind energy is shown in Figure 4.

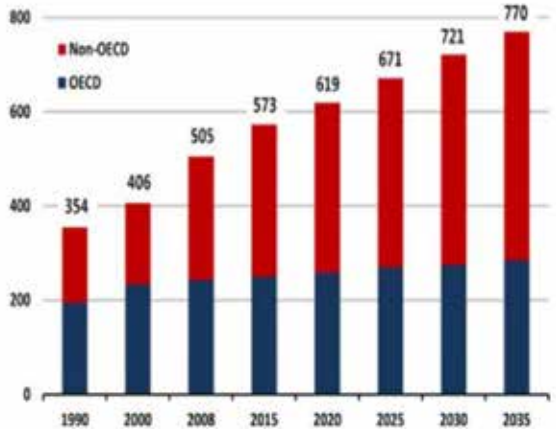

Fig. 1 Consumption of the Energy Globally in Quadrillion BTUs from 1990 to 2035 (source: [1])

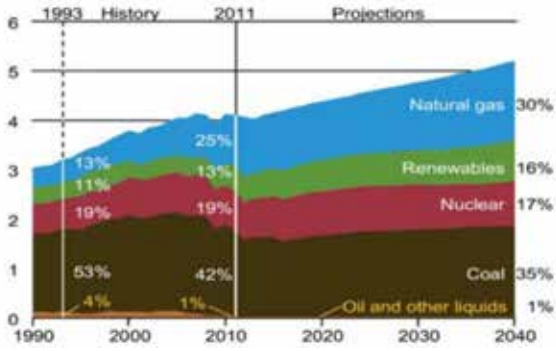

Fig. 2 Amount of Electricity Produced by Burning Fuel 1990-2040

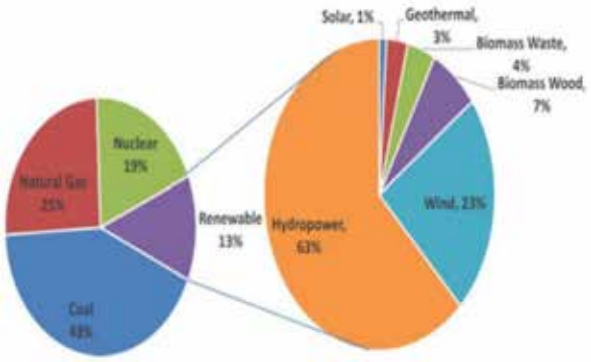

Figure 3 depicts the United States' energy sources (using data from [8]

Figure 5 shows the amount invested in renewable energy from 2004 to 2012 as well as the amount of hydropower produced from 2007 to 2012; in 2013, the amount of hydropower produced made up 3% of the total amount of capacity. Investments in renewable energy sources grew every year until 2012. The cost of PV and wind power equipment has decreased as a result of reduced subsidies for solar and wind energy projects in both Europe and the US. The capacity of hydropower and investments in renewable energy sources are shown in Figure 5.

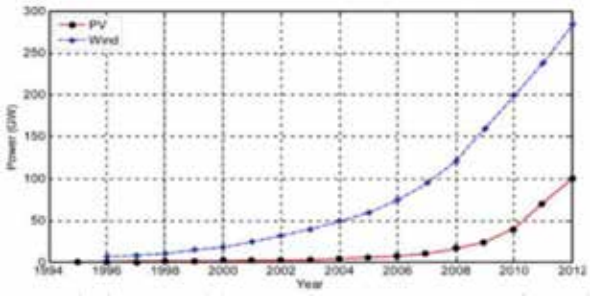

Fig. 4 Existing world capacity (1996-2012) for wind as well as Photovoltaic power, drawn from data in [11]

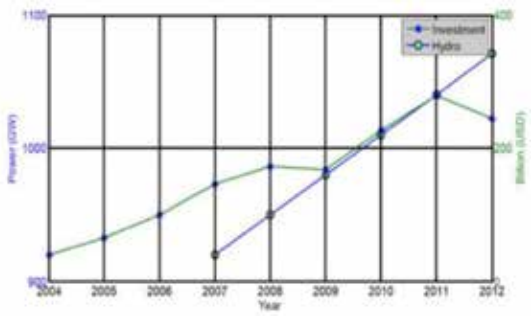

Fig 5. Hydro Power Capacity (2007-2012), Investment in renewable energies (2004-2012)

Off-Grid Systems (Stand-Alone System)

Independent power systems are the majority of remote energy systems. Grid power is not used by off-grid systems. Watches, calculators, remote buildings, even spacecraft, all qualify as independent systems.

Grid Tied Systems

The public electrical grid is the largest independent grid, and is directly linked to the vast majority of transmission networks. A grid-interactive inverter must change DC to AC before it can supply power to the grid.

Hybrid Power Systems

Electricity can be generated by a variety of generators, including those powered by fossil fuels, solar cells, wind turbines, and micro hydropower. These systems are capable of managing not only a single home, but also a town or an island. Many remote areas could benefit from hybrid power systems, particularly in developing countries where connecting to the national grid is costly and dangerous.

Photovoltaic System

Solar photovoltaic ranks third among renewable energy sources in terms of installed capacity, trailing only wind and hydropower.

Solar energy can be collected using photovoltaic panels that have been installed. The California Valley Solar Ranch and the Agua Caliente Solar Project are the two biggest solar power facilities in the world. There are places in the United Stateson this list. Every plant produces more than 250 megawatts [13,14]. Solar panels only generate 1% of the world's electricity because of their high cost.

Battery banks will be needed as long as energy cannot be continuously produced. In 2011, commercial applications above 100 kW had a median reported cost of $4.87/W, while residential and small business applications up to 10 kW had a median reported cost of $6.13/W.

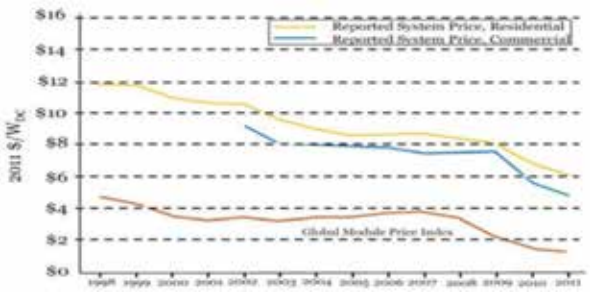

Figure 7 depicts the price of solar power systems in the United States over time [15]

Photovoltaic (PV) solar energy systems are the most cost-effective option for rural communities to satisfy their energy demands. It has been determined whether or not hybrid photovoltaic (PV) power generation systems are commercially viable. These studies showed that the approach works well in settings with fewer than 100 people. [16] Research on the ratio of solar hybrid systems to diesel generator-powered systems was done in 2017 by Muselli et al. The battery's theoretical storage capacity was taken into account during both the backup generator's starting and stopping procedures. El-Hefnawi Shrestha and Goel [19] gave an example of how to determine the ideal battery size and capacity for a specific load. The hybrid PV system's storage needs, including the size of the PV array, were determined using FORTRAN and math in [18]. Statistics were used to quantify the burden and sense of isolation while taking into account the pre-operational stage of the diesel generator.

To calculate the LPSP of a combined solar and battery system, Abouzahr and Ramakumar developed a closed-form method. Iterative improvement allows for the fine- tuning of individual components of a hybrid PV system. [20]. The tilt, azimuth angle, separation from the power line, and cost of electricity all have an impact on this composition. The responsiveness of the power supply to changing load conditions is what determines how effective a hybrid photovoltaic system is. Egido and Lorenzo conducted significant study utilising the load loss probability (LOLP) approach to evaluate the PV array and battery capacity. A grid-connected PV system's battery bank's energy-storage capacity was studied by [22].

Wind System

Wind energy has been used by people since the beginning of time. In the past, grain mills, water pumps, and vessels were all powered by wind energy. Professor James Blyth of Anderson's College in Glasgow constructed the first electric windmill in July 1887. Charles Brush made history when he was the first person in the United States to produce electricity in the dead of winter using a wind-powered device. A hybrid wind energy system needs to have year-round wind energy potential in order to be economically viable. Wind turbines of various shapes, sizes, and arrangements are currently used to capture wind energy. It has the fastest rate of growth of any renewable energy source. Unlike solar energy, it can generate electricity at night and on overcast days. Wind farms produce 35,000 megawatts of electricity in Europe. One of the drawbacks of wind turbines is that they

cannot produce electricity when there is no wind. The addition of additional power sources is necessary due to the demand. Storage devices are required for solar and wind energy because they need to be able to store excess energy for later use. On the other hand, rooftop solar and wind energy systems may continuously generate power. The Rayleigh wind speed distribution was used by Feijoo et al. [24] in their Monte Carlo simulation of the effects of wind farms. Regression analysis and artificial neural network models were combined by [25] to estimate wind turbine power curves. Using long-term wind speed data, Salameh and Safari (1996) examined the capacity factor and windmill parameters. When deciding which wind turbine would be most effective at a given area, the capacity factor must be taken into account. "The capacity factor of hybrid wind energy systems is very important. The wind turbine with the greatest average capacity factor should be used as much as possible. Boccard [27], comparing the capacity factors based on estimates to those based on actual data. In order to optimize an algorithm for the annual wind fraction [28,29] gathered data on the hourly wind speed at five different locations over the course of eight years. The algorithm's precision increased as a result of this. The annual wind percentage was estimated by the algorithm. Inputs include power, the battery, a monthly Weibull wind speed distribution, and model parameters. For the purpose of evaluating LPSPs in self-sufficient wind energy systems with energy storage, Abouzahr and Ramakumar came up with a closed-form solution [30]. A simulation technique was created by Karki and Billinton [31] to determine the ideal proportion of wind energy in an existing power system. To arrive at this conclusion, probability indices were calculated utilizing their method. Dependability and cost effectiveness were taken into account. Monte Carlo simulation was used to develop the method.

Hydro System

The predecessors of turbines, water wheels, have the capacity to transform hydraulic energy into mechanical energy. Then, electrical energy can be created from this mechanical energy. The hydropower turbine was created in the 18th century by Bernard Forest de Bélidor, a French employee of Architecture Hydraulique. The engineer known as Bélidor was Bernard Forest de Bélidor, a specialist in military hydraulics. Brush arc light dynamos that were driven by water turbines lit up Grand Rapids' theatres and stores. A turbine-coupled brush dynamo supplied the first light at Niagara Falls in the year 1881. Direct current was used to power them both. The first 12.5 kW hydroelectric plant in history was built in the Wisconsinn city of Appleton in 1882. Over the past four decades, the amount of electricity produced by hydroelectric sources has increased by 3% every year. 16% of the electricity produced worldwide in 2011 came from the 160 different countries that produced hydroelectricity. Hydropower is the main means by which Venezuela, Bhutan, Ethiopia, Paraguay, Norway, and Paraguay produce electricity [33]. The seasonal cycle of hydropower is slower but more reliable than that of solar and wind power. The water levels in rivers and streams vary a little bit throughout the year as a result of seasonal changes. As a result, energy storage is not necessary. It generated 16% of the world's electricity in 2010, making it the ''most popular'' renewable energy source at the time [34].

Hybrid Renewable Energy System (HRES)

The Papago Indian hamlet in Schuchuli, Arizona, created the first hybrid power system for a hamlet on December 16, 1978, by combining a diesel generator and photovoltaic panels. When the city finally was hooked up to the electric grid in 1983, the residents relied on the system's electricity to run their lights, water pumps, freezers, washing machines, and sewing machines..HRES currently uses a variety of renewable energy sources. To provide electricity to users in remote locations, energy storage devices, micro hydropower (MHP), solar energy, and small wind power sources are frequently used. Alternative energy sources have distinct manufacturing characteristics. Seasonal differences in river flow, the fact that the sun is stronger during the day than at night, and seasonal differences in wind velocity are all examples. As a result, hybrid system configurations frequently use them.

The HRES provides the following benefits

- Depending on the available resources in the area, it might be possible to integrate several renewable energy sources into a single system. Hybrid systems emit no emissions because they use renewable

energy. These systems include, among others, hydropower, solar power, and wind power.

- Modular photovoltaic and wind energy systems are simple to install and do not typically require home design.
- Because the fuel used by HRES energy is unlimited, abundant, and uncontrollable, it cannot be priced. For off-grid applications, the use of more portable hybrid energy systems is ideal.

It is anticipated that commercial wind and photovoltaic energy systems will produce electricity sporadically. Combining photovoltaic and wind energy can lower diesel consumption and boost the battery bank's capacity if a conventional generator is used as a backup. Depending on the available solar and wind resources, a hybrid solar photovoltaic and wind power system may be the most efficient option. A number of factors, including but not limited to environmental conditions, the number of photovoltaic panels, the size of the wind generator, the number of batteries in the storage device, and the distance between the generation site and the power plant, can affect the initial investment, ongoing maintenance, and daily operation of a hybrid system. Another important factor to take into account is the distance between the power plant and the generation site.

Nehrir et al. [36] assessed the performance of a fully autonomous hybrid PV/wind system using MATLAB/ Simulink.

[37] describes how to calculate and integrate the individual unit quantities of hybrid wind, solar, and tidal energy systems. Notton et al. introduced a LOLP-based model for evaluating hybrid PV systems in [38]. Photovoltaic energy, according to the researchers, can provide 75% of the energy required for optimal performance. Wind turbines, solar panels, and diesel generators were the components of a hybrid energy system studied by Elhadidy and Shahid [39]. As the number of wind turbines, PV array size, and HRES battery capacity were varied, the system's performance was evaluated.Chedid et al. employed AHP to quantify hybrid system design characteristics that produced confusion, with the goal of assisting policymakers in figuring out the variables of grid-connected hybrid PV-wind generation systems. As a result, creating hybrid system plans was made easier. They looked into social, technological, political, and economic issues.

Here is the block diagram for the MHP-PV-WG hybrid standalone system.

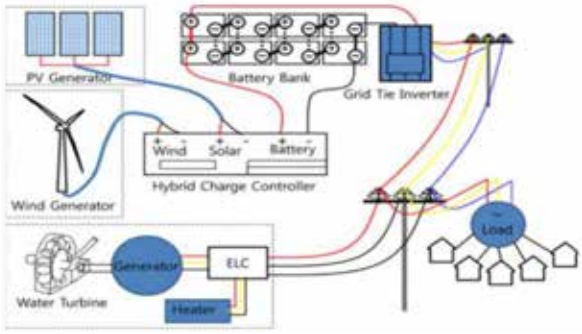

Fig. 8 A typical hybrid micro-hydroelectric, photovoltaic, and wind system is shown

The PV and WG power sources will be connected with the help of a hybrid charge controller. It's possible that the battery bank will need more power to recharge given its current load. Battery power is used to run the load if the power generated by the hybrid system is inadequate. The DC/AC inverter converts direct current to alternating current to satisfy the needs of the consumer load. Parallel connections are required for the battery bank's input terminals, DC/AC converter, and battery chargers. The power structure is evenly distributed. For a hybrid system to reliably deliver energy to customers regardless of environmental conditions, careful planning and development are necessary. Because even slight changes in wind and solar irradiance can affect how much energy is produced. Planning also helps the system save money on costs.

Future of Hybrid Renewable Energy Systems

There are one billion people who lack access to energy. To emphasise the significance of energy concerns for the post-2015 development agenda and the environment, the United Nations General Assembly launched the Decade of Sustainable Energy for All in 2014. This decade runs from 2015 to 2030 [41]. Distributed hybrid systems make use of local energy generation. Distribution systems eliminate the losses involved in the transmission and distribution of energy. To lower electricity costs while maintaining the network's functionality, pinpoint

the location of photovoltaic and wind energy systems as well as their connections to the utility grid. In a number of countries, renewable energy sources provide a considerable amount of the required energy. The cost of developing and manufacturing wind and solar energy technologies has decreased, making them a viable alternative to conventional energy sources. The price of a hybrid system and how dependable its power output is in a variety of environmental circumstances are its two most crucial features. Most authors tried to make these better.

Mathematical Modeling

Hybrid systems are powered by batteries, micro turbines, and diesel generators. Hydro turbines, wind turbines, photovoltaic systems, and fuel cells are the elements that make up hybrid power systems. This element is used in the propulsion systems of hybrid vehicles. In order to acquire accurate readings of the system's components, it is important to simulate the system under different global weather, insolation, and wind speed circumstances. The coordinated efforts of an HRES's constituent parts and subsystems result in its optimization. The kind of load, location, and grid connection must all be considered when designing hybrid systems.The majority of distributed hybrid systems are used to power homes and communal buildings. Examples include lighting, radios, televisions, and various home appliances. Clean, renewable energy is the sole kind of energy HRES utilises. The High Renewable Energy Standard gives preference to using renewable energy while also considering things like cost, reliability, and durability. Modelling a hybrid system's component parts is the first step in enhancing its performance. By combining small hydro-solar and wind power systems with mathematical modelling, Bhandari et al. [42] produced a simulation of HRES. Understanding, problem-solving, and decision-making are all aided by modelling. The complexity of the design has no bearing on how accurately the model predicts performance. The balance between complexity and simplicity should be maintained in reality models. Both deterministic and probabilistic modelling strategies can be used to analyze component performance. Modelling of solar, wind, diesel, and batteries.

PV Array Modeling

The model of a single diode circuit depicted in Figure 10 [44–46] is typically used to calculate the potential energy output of photovoltaic (PV) cells. A PV cell is represented by the ideal single-diode model (ISDM), which consists of a single diode and no shunt resistance.

It is possible to simulate the output current of a single-diode PV cell using Equations 1, 2, and 3. Shunt resistance, represented by the symbol , is necessary for these equations. In the industrial setting, PV cells with two diodes are typically used. In [47], Salam et al. presented a two-diode PV cell model.

$$I = I_{ph} - I_0\left(\exp\left(\frac{V + R_S I}{A}\right) - 1\right) - \frac{V + R_S I}{R_{sh}} \quad (1)$$

$$I = I_{ph} - I_0\left(\exp\left(\frac{qV}{kT}\right) - 1\right) \quad (2)$$

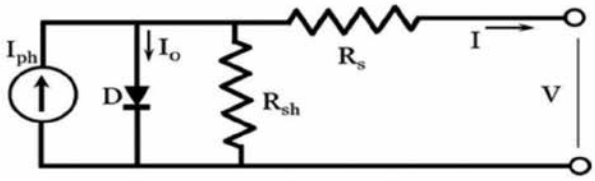

Figure 10 shows a single-diode PV cell model

$$A = \frac{N_S n k T_c}{q} \quad (3)$$

The amount of continuous and diffuse solar energy captured by a photovoltaic system varies depending on the time of year and the sun's angle. Equation 4 is used to determine solar cell radiation.

$$I_T = I_b R_b + I_d R_d + (I_b + I_d) R_r \quad (4)$$

where R_d represents the tilt diffuse factor, R_r represents the tilt factor for reflected solar radiations, I_b represents normal radiations, I_d represents diffuse solar radiation, etc.

The hourly power output of a PV system P_{sj} with a surface area of A_{pv} under conditions where I_{tj} (kW) of total solar radiation is incident on the PV surface on an average day of the month is described by equation 5 [49].

$$P_{sj} = I_{Tj} \eta A_{PV} \quad (5)$$

The system's efficiency η is represented by the number 6[50]

$$\eta = \eta_m \eta_{pc} P_f \quad (6)$$

The efficiency of the module η_m as defined by equation 7 [51].

$$\eta_m = \eta_r [1 - \beta(T_c - T_r)] \quad (7)$$

Module reference efficiency, power conditioning efficiency, array efficiency, reference temperature, monthly average cell temperature, power factor, and array efficiency are all computed in Equation 8.

$$T_c = T_a + \frac{\alpha\tau}{U_L} I_T \quad (8)$$

where,

$$\frac{U_L}{\alpha\tau} = \frac{I_{T,NOCT}}{(NOCT - T_{a,NOCT})}$$

T_a is instantaneous ambient temperature, NOCT is normal operating cell temperature, $I_{T,NOCT} = 800 \mathrm{W/m^2}$ for a wind speed of 1 m/s. Solar insolation and module temperature have a significant effect on PV module performance. A model provided by Zhou [52] in its abridged form is outlined below.

$$v_{oc} = \frac{V_{oc}}{nkT/q} \quad (9)$$

$$P_{max} = \frac{\frac{V_{oc}}{nKT/q} - \ln\left(\frac{V_{oc}}{nKT/q} + 0.72\right)}{1 + \frac{V_{oc}}{nKT/q}} \cdot \left(1 - \frac{R_s}{V_{oc}/I_{sc}}\right) \frac{V_{oco}}{1 + \beta \ln \frac{G_a}{G}} \cdot \left(\frac{T_o}{T}\right)^{\gamma} \cdot I_{sco} \left(\frac{G}{G_o}\right)^{\alpha} \quad (10)$$

where n is the ideality factor (1 < n), T is the temperature of the PV module, and it is this factor that is responsible for all the non-linear effects on which the photocurrent relies. T is a dimensionless coefficient connected to PV module technology, and it is this factor that takes into account all the non-linear temperature voltage effects represents the open-circuit voltage adjusted for temperature.

$$V_t = nkT/q \quad (11)$$

Equation 11 provides an illustration of the power restrictions of PV modules. Photovoltaic modules can produce more voltage and current by being connected in parallel or series. Equation 12 depicts the maximum power output of the photovoltaic array.

$$P_{array} = N_s \times N_p \times P_M \quad (12)$$

where N_s, N_p and P_M stand for the no. of photovoltaic modules that have been connected in series, the no. of photovoltaic modules that have been connected in parallel respectively.

Wind Turbine Modeling

The quantity of power generated by a wind turbine depends on two factors: the wind speed at the hub height of the turbine and the rotational speed of the turbine. Determine the wind velocity at the hub height using the 13th equation of the power law.

$$V_z = V_i \left[\frac{Z}{Z_i}\right]^x \quad (13)$$

V_z An exponent for a power law, denoted by Vz, where Vz is the wind speed at the hub and VZ, Vz is the wind speed at the reference heights Z and Zi, relies on the surface features and atmospheric stability of the layer across which x is valid [54]. The mechanical power of wind turbines may be calculated using Equation 14.

$$P_{\text{mech}} = \frac{1}{2} \rho A C_p V^3 \quad (14)$$

where ρ is the air density $\left(\frac{\text{kg}}{\text{m}^3}\right)$ is the swept area of the rotor blades (m^2) V is the velocity of wind (m/sec) C_p is the power coefficient of the wind turbine.

Betz's coefficient, or the power coefficient C_p, has a maximum theoretical value of 0.593 [55]. Which is often stated as a function of the ratio of the rotor's tip speed to the wind speed (λ), provided by equation 15.

$$\lambda = \frac{\omega R}{V} \quad (15)$$

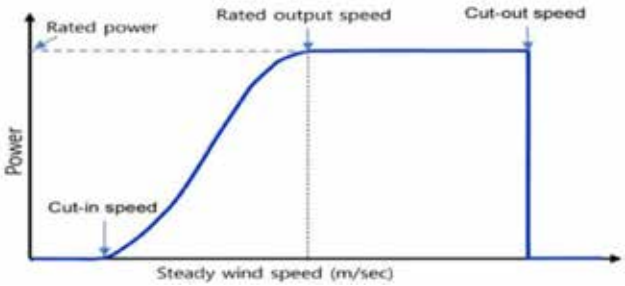

Fig. 11 Wind turbine power characteristics

Figure 11 depicts the electricity generated by wind turbines in steady winds. The ''cut-in speed'' of a wind turbine is the wind velocity at which it begins to spin and produce power. An abrupt braking mechanism stops

the rotor's spin, protecting it from damage. At the wind speed at which the cut- out wind speed is achieved, the rotor will be damaged due to the forces produced by the turbine. This wind is what's causing the issue. The rated output speed is determined by the wind speed at which the greatest power is generated. Between the minimum and maximum speeds is this speed. The wind turbine blades and the electrical generator blades combine to produce electricity from their respective sources of mechanical energy. Equation 16 can be used to calculate $P_{\text{wind}}\ (\text{kW/m}^2)$, the power output of a wind turbine generator.

$$P_{\text{Wind}} = \begin{cases} P_R \cdot \dfrac{v - v_c}{v_R - v_c} & \text{for } (v_c \le v \le v_R) \\ P_R & \text{for } (v_R \le v \le v_F) \\ 0 & \text{for } (v < v_c \text{ or } v > v_F) \end{cases} \quad (16)$$

P_R stands for rated electrical power, while v_C, v_R, and v_F stand for cut-in, rated, and, respectively, cut- off wind speeds. The effectiveness of wind turbines is impacted by their placement height. Use equation 17 to calculate the power generated by a wind farm.

$$P = P_{\text{Wind}}\, A_{\text{Wind}}\, \eta \quad (17)$$

where, A_{wind} is the total area swept by the wind turbine, is the generator and converter efficiency (η) [56].

Engine Generator Modeling

A conventional generator should be used if a renewable energy system that also has a battery bank is unable to meet load demands. A prime mover, synchronous generator, speed-governed engine, and automated voltage regulator make up a generator set [57].

The engine generator's rated capacity must be established prior to installation; please refer to the guidelines below. [38]

1. When the generator is connected directly to the load, the engine's rated capacity must be equal to or higher than the maximum load.
2. The engine generator's current output should not exceed C_{Ah}/5A, when used as a battery charger, where C_{Ah} is the battery's ampere-hour capacity. According to ElHefnawi [18], running a generator at 70-90% of full load saves money.

Modeling of Battery Bank and Its Performance

When autonomy is active, load demand can be satisfied by battery banks even if HRES energy is insufficient or unavailable. The next two days must be used to achieve autonomy. A variety of factors, including the maximum depth of discharge, temperature correction, rated battery capacity, and expected battery life, influence the overall battery size. Consideration should also be given to the battery's capacity and expected lifetime. Equation 18 may be used to determine the ampere-hour capacity of a battery. [58]

$$B_{rc} = \frac{E_c D_s}{DO\, D_{\max}\, \eta_t} \quad (18)$$

where $E_C D_S$ is the amp-hour (Ah) current load, is the temperature correction factor, and DOI is the maximum depth of discharge of the battery (80% for deep cycle batteries). If the total production of HRES is more than the demand, the battery bank is charging; otherwise, it is draining. Calculate the charge of the battery bank at time t using equation 19. [59]

$$E_B(t) = E_B(t-1)(1-\sigma) + \left(\frac{E_{G,A}(t) - E_L(t)}{\eta_{inv}}\right)\eta_{bat} \quad (19)$$

where E and $E_E(t)$ are the quantities of energy being charged into the battery bank at time t, and (t-1) is the total energy generated by renewable energy sources after energy loss in the controller, E is the load demand at time t, and are the inverter and battery bank charge efficiency, and s is the self-discharge rate, which is a function of the accumulated charge and the battery's health. The constraints of Equation 20 limit the amount of battery bank charge that is possible.

$$E_{B_{\min}} \le E_B(t) \le E_{B_{\max}} \quad (20)$$

where $E_{B_{\max}}$ and $E_{B_{\min}}$ are the maximum and minimum charge quantity of battery bank.

For HRES, state of charge (SOC), floating charge voltage, depth of discharge (DOD), maintenance needs, and battery lifespan are the most crucial battery properties. Each of these elements has to be taken into account while optimising the HRES. However, due to the complexity of the matter, the optimisation process in reference [60]took into account SOC and floating charge voltage. Time, current, state-of-charge (SOC) at time (t), and state-of-charge (SOC) at time (t-1) must

all be known in advance for charging and draining the battery.

HRES Optimization Methods

Optimising the size of a battery bank, photovoltaic (PV) array, wind turbine, hydro production capacity, or any other kind of power generation system is achievable using load and loss of power supply probability (LPSP) as the key inputs. When talking about HRES, which can operate either grid-integrated or grid-independently, these factors are of the utmost importance. These aspects will be optimized through HRES.The system must be affordable and capable of producing high output power, LPSP, and LOLP.The hybrid PV/wind energy system was improved using the probabilistic, linear, iterative, artificial intelligence (AI), dynamic, and multi-objective optimization techniques.

Graphical Construction

One approach to the multiple design variable problem is to visualize the ways in which the design variables change. The same graph is used to graphically depict each constraint function. After the contours of the objective function have been drawn, the feasible region can be visually inspected to determine the optimal point on the graph. It is possible to do this by drawing contours. In order to determine the ideal size, Markvart et al. superimposed lengthy time series of climate cycles with low daily solar radiation. They were able to draw their conclusion thanks to this. They came to the conclusion as a result. They came up with the best ratios by using calculations. This determined the ideal size. The first theoretical analyses of a combined solar and wind energy system were provided by Ai and his colleagues in 1959. Keeping the capacity of the wind generator constant, we calculated the hourly performance of a hybrid photovoltaic-wind energy system. By contrasting photovoltaic arrays and battery banks, the annual levelized operating cost of photovoltaic arrays was determined.

Probabilistic Approach

The probability approach, as opposed to giving precise values, acknowledges the randomness of the data and uses a statistical instrument to describe the variable states. Hybrid photovoltaic and wind energy systems may have their power production estimated in a variety of ways, including hourly power, monthly power, the smallest quantity of PV power, and the smallest amount of wind power. The efficiency and low cost of this method make it ideal for gathering load and environmental data.

Hourly Average Generation Capacity Method

Using hourly averages of wind, solar radiation, and electricity demand, this method optimises system size. This estimate is based on the monthly averages of wind and solar energy production over a whole year. The following equations describe the dimensions of the wind and photovoltaic components [63].The objective function that must be minimised is defined in Equation 21.

$$F_c = C_c + C_m \tag{21}$$

where represents the cost of capital investments and represents the annual cost of maintenance. The difference between the power generated and the power demanded should be as small as possible to maintain system balance.

$$\Delta P = P_{gen} - P_{dem} \tag{22}$$

Most Unfavorable Month Method

The approach calculates the optimal size of solar and wind generators based on the wettest month of the year. According to the most current information, there are some months when wind and radiation conditions are less than optimal. [92,93] Equation 23 determines the size for a given PV or wind component.

$$A_i = \max\left(\frac{E_{Load,m}}{E_{i,m}}\right) \tag{23}$$

where m = 1 represents the month of the year, The system's monthly energy output, expressed as a function of land area, is represented by the variables and . The amount of energy that generators (like wind and solar power) supply to the load is represented by equations 24–25.

$$\sum E_i A_i = E_{\text{Load}} \tag{24}$$

$$E_i \times A_i = f_i \times E_{\text{Load}} \tag{25}$$

where f_i is the percentage of load supplied by the generator i.

Deterministic Approach

Deterministic techniques, in contrast to probabilistic ones, always provide a unique solution for a given set of parameters since each set of variable states is produced uniquely by the model's parameters and the previous values of these variables. Bhandari and Stadler determined the cost and size of a PV system for Nepal. [70].

Iterative Approach

An optimisation issue may be solved using an iterative technique by developing a set of ever- improving approximation solutions until a termination criterion is reached. It is usually implemented by a computer. With an increasing number of optimisation variables, the calculation time for this approach climbs exponentially. Using this strategy, Li et al. [74] tuned PV-wind-battery HRES to lower total system costs.

Artificial Intelligence

The analysis and creation of intelligent computer hardware and software is the main focus of AI research and development. Artificial intelligence (AI) was first defined by researchers Russell and Norvig in a 1994 publication as ''the study and design of intelligent agents.'' This indicates that a smart agent is one that actively seeks to achieve its goals. The fields of ANN, FL, GA, and hybrid systems that combine two or more of these all fall under the heading of ''artificial intelligence'' (AI). Both the performance and other aspects of the system are improved by intelligent technologies. Unlike more traditional techniques [95].

Optimization with Genetic Algorithm

Computers can use GA to solve search and optimization issues with accuracy or approximation. In the field, general-purpose search heuristics are referred to as GA. Problem-solving genetic algorithms employ evolutionary biologyideas. Examples include recombination, inheritance, selection, and mutation.

A typical GA must include the following items

a. problem domain genetic model

b. a problem domain evaluation function

Genetic algorithms (GA) may be useful when conventional hill climbing algorithms fail in difficult fitness environments. Figure 12 depicts the process flow for using GA to optimise HRES.Xu et al.[80] utilised a genetic algorithm and an elitist technique to find out how big of a hybrid PV/Wind power plant would be best for a year's worth of consumption (8760 hours). With LPSP being at a premium, saving money was a top priority.

Software based Approach

Hrayshat [91] used HOMER to conduct a techno-economic analysis of the components of a hybrid PV-diesel-battery system for a rural Jordanian home and came up with the system's optimal design. This change was driven by a desire to improve energy efficiency. Information on solar insolation, electricity demand, hybrid generator technical details, costs, caps, and controls is provided to HOMER. It is also possible to learn more about the dispatching plan.

The most efficient hybrid PV-diesel-battery system for a rural Jordanian house was designed by Hrayshat [91], who utilised HOMER to undertake a techno-economic study of the system's components. Maximising energy efficiency was the motivation behind this move..

Optimal Design Criteria for HRES

The goal of the HRES system sizing procedure is to determine the optimal combination of generator sizes (renewable and conventional) and storage capacity for meeting the anticipated demand load with the lowest tolerated degree of security. To create the best HRES, researchers used a variety of economic, reliability, capacity, and other design criteria.

Cost of the Energy

Battery banks are typically replaced every five years, giving a hybrid system an average lifespan of 20 years. Several factors influence energy pricing, including initial and ongoing costs, annual energy production, the likelihood that equipment prices will fall as output increases, and others. Equation 26 depicts a simple relationship for cost estimation.

$$C_E = C_{Cap} \times \frac{R}{E_{Tot}} + C_{O\&M} \quad (26)$$

where E_{Tot} is the total amount of energy produced, $C_{O\&M}$ is the annual cost of operation and maintenance, R is the

annual discount rate for capital costs, and C_E is the cost of energy. C_{Cap} is the investment cost of the HRES generator and storage system. Numerous researchers consider the price of electricity when evaluating the LOLP HRES configuration. The price per kilowatt-hour is an important HRES metric. The price per kilowatt-hour is shown in equation 27.

$$\text{Cost } /kWh(\$) = \frac{C_{\text{Total}}}{E_{\text{Total}}\,(kWh)} \quad (27)$$

where kWh is the used measurement unit and E_{Total} denotes the annual electricity production priced in C_{Total}.

Loss of Power Supply Probability (LPSP)

When deciding on the ideal number of batteries, solar panels, wind turbines, and other renewable generators, this method takes the security of the power supply into account. When the needs of the load aren't satisfied, a hybrid system's reliability is compromised".

LPSPs are used to calculate the normal and long- term power loss of a power system. When the LPSP is equal to one, the load is never dissatisfied, and when it is equal to zero, the load is never satisfied.

The LPSP technique is divided into two steps

a. After the HRES generates more power, the cycle continues until the battery is fully charged, at which time a new SOC is determined. Any excess energy is not consumed once the battery has been fully charged.

b. In the event that the HRES fails to provide enough power, the SOC is recalculated until either the hardware disconnects from the load or the battery bank hits its minimum capacity.

The LPSP can be calculated in terms of battery SOC using equation 28.

$$LPSP = \Pr\left\{E_B(t) \le E_{B_{\min}};\ \text{for } i \le T\right\} \quad (28)$$

i.e., the energy stored in the battery at any given time t is a guarantee that the state of charge at that time is less than or equal to the bare minimum of the provided energy in battery E_{Bmin}.$E_B(t)$.

Loss of Load Probability

LOL refers to the HRES's inability to meet daily peak demand. When the system's demand exceeds its generating capacity, a LOL occurs [98]. Days per year, hours per day, and percentage of time are all ways to measure the frequency and duration of power outages (loss of power, or LOLP). Calabrese was the first to propose the LOLP plan [99].The LOLP is calculated using equations 28 through 29. [17]

$$LOLP = \frac{\sum_{t=1}^{n} \text{hours}\left(I_{\text{supply}} < I_{\text{needed}}(t)\right)}{n} \quad (29)$$

Where,

$$I_{\text{needed}}(t) = \frac{L(t) - P_W(t) - P_{PV}(t)}{V_L}\eta\left(I_{\text{battery}}(t)\right)$$

$$I_{\text{needed}}(t) = \min\left(I_{\max} = \frac{0.2SOC}{\Delta t}, \frac{SOC(t)\sigma - SOC_{\min}}{\Delta t}\right)$$

And I_{needed} (t) is the current required for the load at hour t, I_{supply} (t) is the current supplied by HRES at hour *t, n* is number of samples. V_L is the nominal voltage needed by the system, *L(t)* is the electrical load requirements at hour *t,* $P_w(t)$ is the power generated by the wind turbine at hour *t*, and P_{pv} (t) is the power generated by PV modules at hour When LOLP is low, system costs are high, and vice versa.

CONCLUSIONS

Since hydroelectric renewable energy sources (HRES) are becoming more economically viable, more people are turning to them to provide power to rural regions. The vast majority of the one billion people without access to electricity who live in developing nations should benefit from this initiative. Compared to photovoltaic and wind systems, HRES is able to collect more energy, improving the supply security of these technologies. The structure of the global energy market includes a section that emphasizes renewable energy sources. The experiment proves the accuracy of the battery bank and generator mathematical model. There has been a lot of study devoted to the potential benefits of hybrid power systems that combine renewable energy sources. This article discusses design suggestions as well as the benefits of optimization strategies.

This paper provides a thorough summary and analysis

of years of research on the enhancement of HRES. They could be connected to an existing grid or not. A scope diagram is included in the article to aid readers in understanding the content. The two tables on optimization approaches and HRES optimization based on key criteria will be helpful to academic researchers and members of the research community.

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Development of an IoT based Real-Time Monitoring and Automatic Water Level Control System with Alert Notification through IFTTT

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ABSTRACT

Waste of water monitoring and controlling is an essential service that many utilizes and perform for their industrial and larger commercial applications. The Internet of Things (IoT) could prove to be one of the most important methods for developing more utility, proper system and for making consumptions of water resources more efficient. Liquid monitoring through cloud is effective and it provides an feasible solution for remote monitoring. In this work, the new approach for monitoring and controlling the water level with the help of various cloud service. Wastage of water is very important for the part of focus so, the conservation of water resources is very essential. The water level inside the tank can potentially be determined by this project and the display will show it appropriately. NodeMCU module work on the WI-FI which is use for automatically operation of system. This is close loop control system. IFTTT (If This Then That) web service has been used for sending SMS on mobile.

KEYWORDS: *Water monitoring, Water controlling, NodeMCU module, IFTTT service, Thing speak platform.*

INTRODUCTION

Today, the world is facing the environmental problems and challenges. One of the main issues of the current situation is the lack of drinking water. Clean drinking water and water used for utility purpose is very significant to sustain life and it plays a major role in well-being of human society. In a civilized society, overflowing of water is very concernful matter which leads to precious water wastage and energy losses. This issue can be resolved by just monitoring and controlling the water level with some kind of alertness such as notification on mobile or any android application which can make aware the user about the water level. To overcome the problem of the wastage of water, the monitoring and analysis of roof top tank water level at house hold or any type of buildings with alert notification and demonstrated in the project.

In this project, the aim is to monitor the liquid level using IoT technology specifically by utilizing the NodeMCU and an ultrasonic sensor. The NodeMCU is chosen as it integrates an ESP8266 Wi-Fi module making it cost-effective, compact and efficient. This system utilizes the ThingSpeak platform as a web server which is freely available for use. This platform provides real-time data visualization in the form of a graphical representation and percentage based liquid level on an Android application.

MAIN OBJECTIVES

- To ease the monitoring & controlling the water level through IoT.
- To monitor and control water level at industry and commercial establishments.
- To overcome the problem of low level & overflowing of water occurred during manual observation.
- To enable the human to manage their water level time to time.

The specification of the required components has been given in the Table 1.

Table 1: Used components in the circuit

Sr No	Component	Rating	Pictures	Quantity
1	Node MCU with Wi-Fi module ESP8266	Memory 128 Kb Stroge 4 Mb		01
2	Ultrasonic sensor (HC-SR04) (Simple and water proof)	5V	 	01
3	Connecting wires			As per requirement
4	Water pump	12V		01
5	Plywood			
6	Adapter	5.5V		01

7	OLED Display	5V		01
8	Battery	9V		01

METHODOLOGY OF THE PROPOSED WORK

The internet of things brings up prospects for more direct integration between the physical world and computer-based systems, improving efficiency, accuracy and economic value. This is made possible by the ability to remotely manage objects through existing network infrastructure. The Hardware, NodeMCU, Ultrasonic sensor and relay that make up an IOT-based water level monitoring system are joined by an IOT platform like Things Speak and IFTTT. There is a Wi-Fi module included into NodeMCU that handles wireless connectivity, allowing for quick, secure and precise information sharing. This method for wirelessly monitoring water use in the water tank is based on a hardware and software integrated solution.

WORK FLOW

It's distributed into two phases as follows:

Phase 1: Phase 1 consists of understanding the different hardware components, sensor and microcontroller viz. OLED display, Single channel Relay, Pump, Ultrasonic sensor, NodeMCU and their interconnection.

Phase 2: It consists of understanding and using the Software i.e. Arduino IDE, Things speak, IFTTT and related programming.

System Architecture: This system indicates the architecture of IOT based water level monitoring system with alert notification. The Fig 1 system indicates the architecture of IOT based water level monitoring system with alert notification. The flow of data transfer is from ultrasonic sensor to Node MCU after that with the help of Wi-Fi module the information is given to the web server and then it shows the real time data on the android application and it controls the water level.

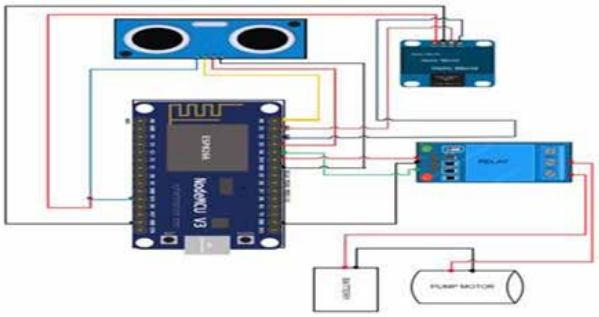


Fig 1: System architecture

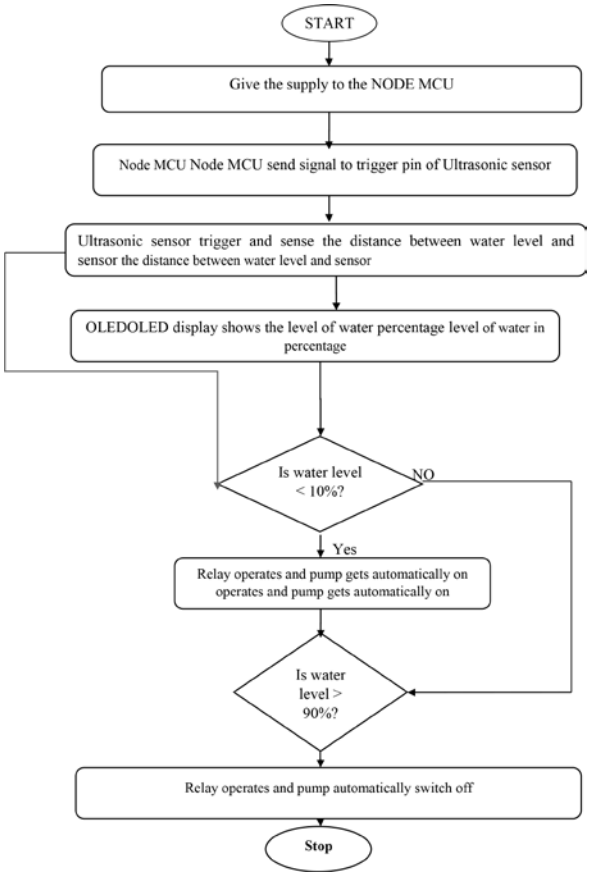


Fig 2: Flowchart of the proposed water monitoring and controlling system

Working of NodeMCU with ultrasonic sensor: The NodeMCU is used with Ultrasonic sensor, ThingSpeak cloud service & Android application (Mobile). The NodeMCU has a 30 pin but out of that, it is used only 10 pins i.e., D0, D21, D2, D3, D4,2(3V3), 3(GND) which is (GPIO16, GPIO5, GPIO4, GPIO0, PIO2) pin, 3V3 pin & GND. O-LED display has 4 pins i.e. Ultrasonic sensor (HC-SR04) which has 4 pin VCC, TRIGGER, ECHO and GND as shown in Fig 3. For notification and displaying the real time water level on cloud, the ultrasonic sensor which calculate the distance and give in the percentage form of present water in the tank. To calculate distance, there is a requirement to dump the program in NodeMCU which contain Wi-Fi module with the help of Arduino software.

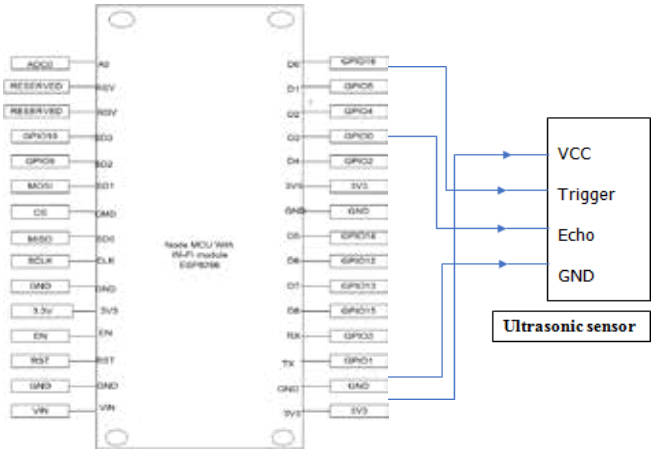


Fig 3: Interfacing of NodeMCU with Ultrasonic sensor

Ultrasonic sensor calculates the distance and that is giving NodeMCU where the EP8266 Wi-Fi is inbuilt and connected to web server which give a real time data of water level and the result can view on the android application and shows the notification. Here firstly, set the overflow level of water tank and the level of water. By considering this, if water is field up to the overflow level then it shows the 100% and also firstly set the upper threshold value i.e., 90% & lower threshold i.e., 10% then it shows notification and give an alert notification regarding the water level and analysis time to time.

Once the echo goes high (5V) and external interrupt get that data then the counter is start in ISR (Interrupt Service Routine) for start and start counter for updated. Update memory of NodeMCU to get the distance continuously.

Calibration for the tank: Distance = $= \frac{D-340\mu S}{2}$

$$\% \text{ Level} = \frac{H-D}{H} \times 100$$

H= Total Height of tank in cm

D= Distance between water level and sensor

Input of relay is connected to the output of NodeMCU and its 3v3 part has been connected to the VCC of relay. GND of relay is connect to GND of NodeMCU. IN pin of relay is connected D4 of node MCU which is shown in Fig 4. Output of relay is connected to the battery positive of battery is connect to the NO of relay and positive of pump is connect to common of relay. Negative of battery and pump is short. Battery gives the supply to the pump. When the water level less than 10% according to calibration motor on automatically and fill the tank above 90%. When water reach above 90% relay sense and motor is off automatically.

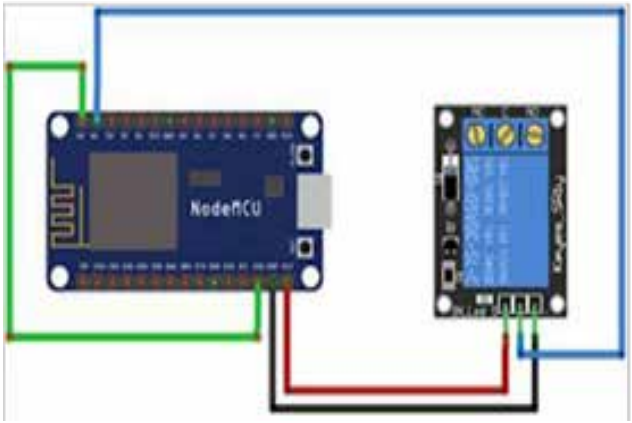


Fig 4: Interfacing of NodeMCU with Relay

Advantages:

- It is low cost with integrated support for Wi-Fi module.
- It is very compact product with very less component, reliable and highly efficient.
- It is the most modern IOT based it technology used for worldwide monitoring and low energy consumption.
- Water leakage detection and reduces the wastage of water.

Applications:

- Liquid level indication and control in industry.
- Oil and Fuel and all types of liquid level monitoring.
- STP (Sewage Treatment Plant) level indication.
- It's used in all types of commercial buildings.
- Offers RTC (Real Time Control) and RTA (Real Time Access).

HARDWARE AND IMPLEMENTATION

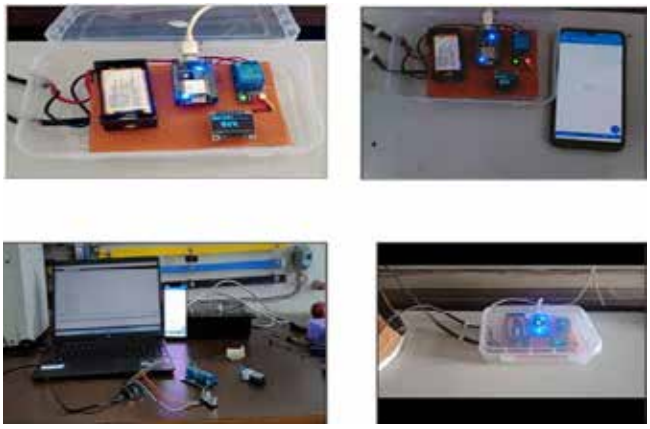


Fig 5: Hardware Implementation of Water Level Monitoring and Controlling System

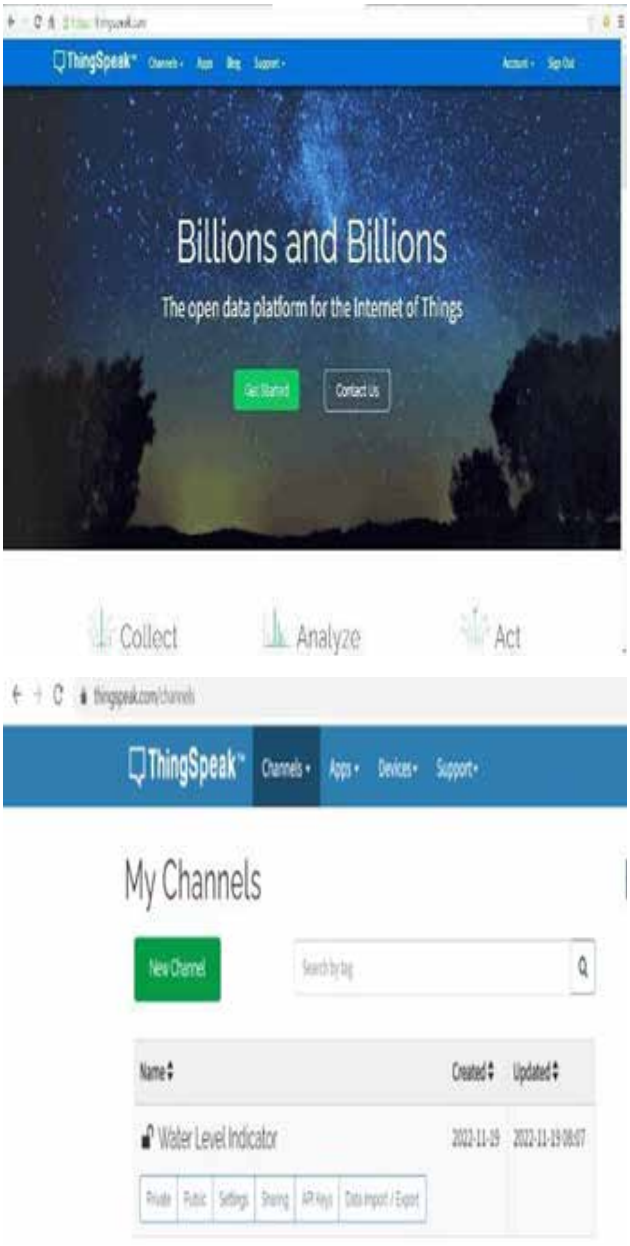
RESULTS AND DISCUSSION

1) Arduino IDE: Arduino IDE (Integrated Development Environment) is an open-source software tool used for writing, compiling and uploading code to Arduino boards.

2) Thinks speak application: Thing Speak is a web-based application and IoT platform that allows users to collect, analyze, and visualize data from connected devices

3) IFTTT: IFTTT (If This Then That) is a popular web-based service that allows users to create automated workflows and connect various internet-enabled devices and services together. It enables users to create applets, which are simple conditional statements that specify an action to be performed when a certain trigger event occurs.

4) Sending data to thing speak: Prior to getting started, one must first register for a ThingSpeak account, sign in and select "Get Started". Go to the "Channels" menu now and on the following page, select "New Channel" to continue. Now, a form for creating the channel is displayed and then completes the "Name and Description fields" as necessary. Next, fill in the label for Field 1 with water and check the boxes next to both Fields. Additionally, check the box next to "Make Public" on the form, then click "Save" as shown in Fig 6. The new channel has now been established.



Now click on "API keys" tab and save the Write and Read API keys, here the use of only using "Write key". Get link as marked in the image which is need to "Copy" the key and link in the program.

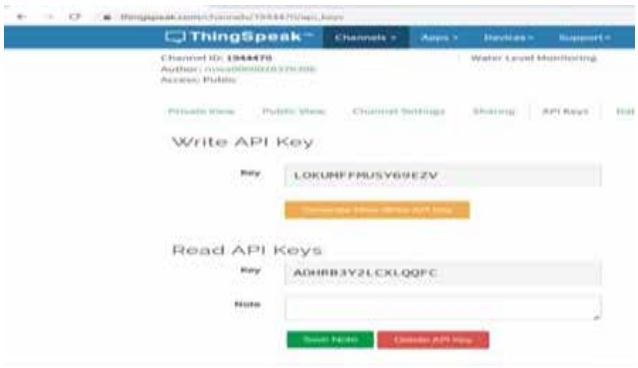


Fig 6: Data is transferred to ThingSpeak IOT based paltform

IFTTT: There are many applications for sending SMS alert, in which mostly GSM module is used. But in this work, there has been a use of IFTTT which is a free web-based service to create chains of simple conditional statement called applets as shown in Fig 9.

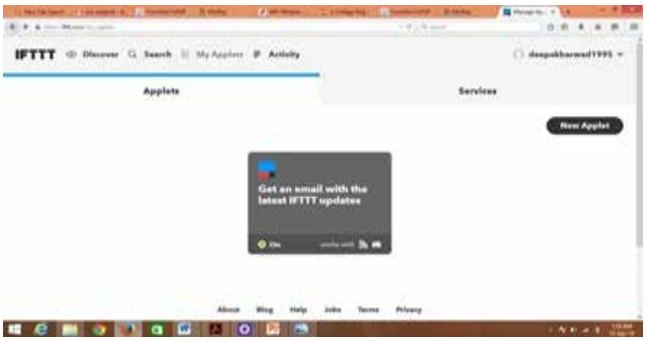


Fig 7: Creating an applet

Steps use for IFTTT: It is necessary to create an IFTTT applet that links to Particle in order to send messages to the phone. Set up the SMS service first. The present connection should function if this has already been configured. Setup the Particle service right away. Create the new applet now, as seen in Fig 10. For the service field (then), select "Particle". Choose "new event published" from the list. The "Event Name Field" can be given any distinctive name, as illustrated in Fig 11. Select SMS in the "that" field as displayed in Fig 12. The message is written as "Water level monitoring" as per the work.

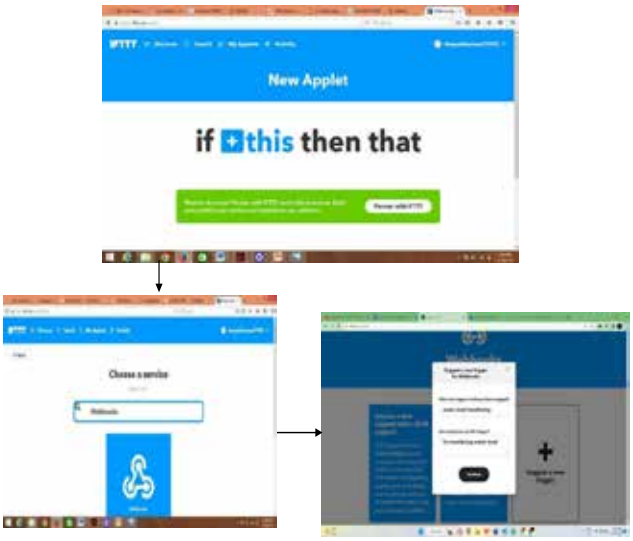


Fig 10: Making a applet with an trigger block for the required service accordingly

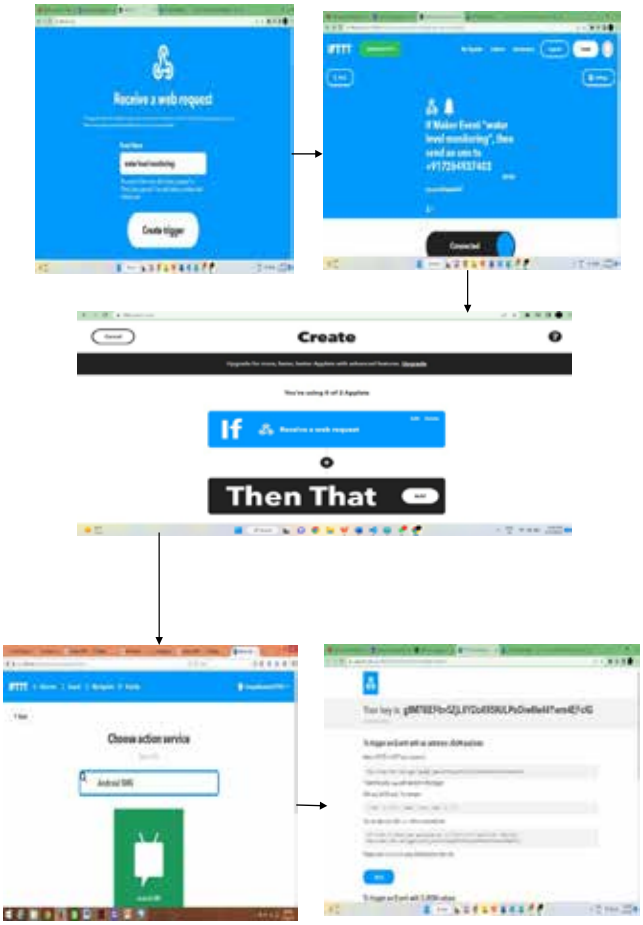


Fig 11: Choosing an Android SMS service with publishing an event name

Fig 12: Receiving an SMS of alert notification as per the applet title

CONCLUSION

The main objective of the proposed system is to implement smart water quality monitoring in a planted tank. Monitoring water quality in real-time is crucial for maintaining the health and safety of aquatic plants and animals. The system described in this paper offers a cost-effective and efficient model for continuous water monitoring. To automate the control of water level, a relay is incorporated into the system. The relay acts as a switch that can turn the water pump or any other water control mechanism on or off. When the water level reaches 90%, the relay is triggered to turn off the water supply, preventing overflow. Conversely, when the water level drops below 10%, the relay is activated to turn on the water supply ensuring that the adequate level is maintained.

Additionally, the Thing Speak mobile application can also be used to monitor the values remotely. To enhance the system's functionality, IFTTT (If This Then That) applets are incorporated. These applets utilize the services offered by Thing Speak such as Thing HTTP and Thing Speak Reacts. By setting up appropriate applets in IFTTT using Things peak's URL, the system can notify the owner when the calculated sensor values exceed a predefined threshold.

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Survey on Wireless Sensor Network Technologies for Dense Forest Monitoring

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ABSTRACT

Wireless Sensor Networks (WSNs) have emerged as a promising technology for dense forest monitoring due to their low- cost, easy deployment, and efficient data collection. This research paper aims to conduct a comprehensive survey of various WSN technologies that can be used for dense forest monitoring. In this study, we compare the performance of various WSN technologies including LPWAN, ZigBee, Wi-Fi, Bluetooth, GPRS, GSM, and RFID for dense forest monitoring based on their range and power consumption. Our results indicate that LPWAN technology provides the longest range and lowest power consumption, making it a suitable option for monitoring dense forests. Wi-Fi and Bluetooth have higher data rates but shorter range and higher power consumption, while GPRS and GSM offer global coverage but with moderate to high power consumption. Although RFID has lower range, it has low power consumption. Our findings suggest that LPWAN is the most suitable WSN technologies for dense forest monitoring due to their low power consumption and moderate to high long range capabilities.

KEYWORDS: *Wireless sensor networks, Dense forest monitoring, ZigBee, Bluetooth low energy, Wi-Fi, LoRaWAN*

INTRODUCTION

Forest is one of the most important ecosystems on earth, providing essential services such as carbon sequestration, oxygen production, and biodiversity conservation. However, forests face various threats such as deforestation, climate change, and forest fires. To protect forests and their inhabitants, it is essential to monitor the forest ecosystem continuously. The dense forest environment makes it difficult to collect data manually. Hence, there is a need for an automated monitoring system that can collect data efficiently and accurately [1]-[5].

Wireless Sensor Networks (WSNs) have arisen as a promising technology for forest monitoring due to their low- cost, easy deployment, and efficient data collection. WSNs consist of a large amount of tiny sensor nodes that can talk with each other wirelessly to collect data from the environment. Each sensor node can measure various environmental parameters such as temperature, humidity, light intensity, air quality and animal tracking. The collected data is sent to the base station for processing and analysis. Nowadays, main wireless standards are in use namely Wi- Fi, Bluetooth, Zig-Bee, RFID, GPRS, GSM, and Low Power Wireless Area Network (LPWAN) [16]-[25]. The evolution of different wireless communication technologies used for node to node communication is depicted in Figure 1.

Wireless sensor network based surveillance systems for remote deployment and control are more cost effective than traditional methods and they are easy to deploy at location of interest. They can even reach areas where satellite signals are not. Additionally, they have a secure mode of data transmission for longer duration. Real time data collected with the help of different

sensors can be transmitted to a remote station through wireless protocols. This will vastly reduce the human requirements and delay of signal transmission in dense forests. Wireless sensor nodes are capable of organizing themselves into a network and communicating with each other by with the help of different routing protocols. When a sensing node detects data, it reports the occurrence of events to the base station or server with wireless communication technology and grid topology [28]-[34].

This research paper aims to conduct a comprehensive survey of various WSN technologies that can be used for dense forest monitoring. The paper is organized as follows. Section 2 provides Literature review of WSN technologies, their applications in dense forest monitoring, different aspects of dense forest monitoring and the requirements of WSN technologies for each aspect. Section 3 presents an analysis of different WSN technologies such as ZigBee, Bluetooth Low Energy, Wi-Fi, and LoRaWAN. In section 4 paper ends with conclusion.

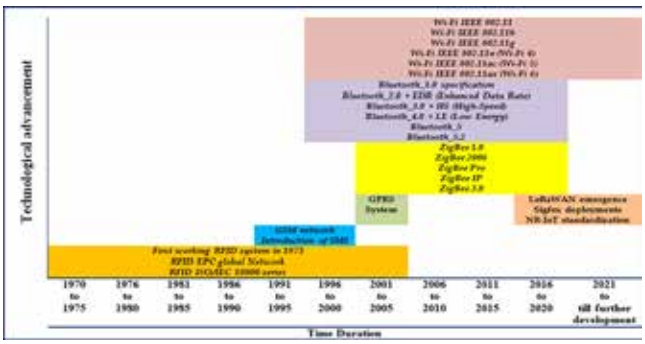

Fig. 1. Evolution of Different Wireless Sensor Network Communication Technologies used in Forest Monitoring

RELATED WORK

Extensive work has been carried out in forest monitoring and reported in terms of hardware and software development relating to sensor node arrangement and deployment. Practical experiments were conducted to understand how data communication is affected by environmental conditions, like forest density, high humidity, and temperature variations. Wireless Sensor Networks (WSNs) have gained significant attention in recent years for environmental monitoring and forest management. Alomari et al. (2017) provided a comprehensive review of recent trends and applications of WSNs in environmental monitoring. Khan and Anjum (2018) highlighted the potential of WSNs in improving forest management. Wang et al. (2019) discussed the application of WSNs for forest monitoring. Li and Luo (2019) reviewed the use of WSNs for forest fire detection. Shi et al. (2020) also reviewed forest fire detection using WSNs. Soares et al. (2020) discussed the use of WSNs in forest management. Zhang et al. (2020) provided a general review of WSNs for environmental monitoring. Sehgal and Kundra (2020) reviewed WSNs for forest monitoring. Zhang and Lin (2020) reviewed WSNs for forest fire detection. Zhang et al. (2021) discussed the use of WSNs for forest ecology monitoring. Guo et al. (2021) reviewed WSNs for forest ecosystem monitoring. Zeng et al. (2021) reviewed WSNs for forest insect pest monitoring. Li et al. (2021) provided a review of WSNs for forest soil monitoring. Al-Fuqaha et al. (2015) present a comprehensive survey of the enabling technologies, protocols, and applications of the Internet of Things (IoT). The authors discuss the various IoT architectures and their components, such as sensors, RFID, and smart objects. They also review the key communication protocols and networking technologies, including Wi-Fi, Bluetooth, and ZigBee, as well as the security and privacy issues related to the IoT. Shrouf et al. (2017) provide a review of the concept of smart factories in Industry 4.0 and discuss the energy management approaches used in such factories. Kanhere and Srivastava (2005) discuss the routing protocols used in wireless sensor networks and their characteristics. Dinh et al. (2013) survey the architecture, applications, and approaches used in mobile cloud computing. Wang and Hasan (2014) present a wireless sensor network-based forest fire detection system. Liu et al. (2010) review the RFID technology and its applications, while Xu et al. (2014) discuss the energy-efficient RFID- based tracking for cold chain management. Balasubramanian et al. (2009) analyze the energy consumption of mobile phones and its implications for network applications. Phuc et al. (2016) analyze the power consumption of GSM, GPRS, and EDGE for machine-to- machine (M2M) applications, while Merlino et al. (2014) investigate the energy consumption of M2M devices in cellular networks. Zheng et al. (2016) provide an overview of the

Low Power Wide Area Network (LPWAN) technology, and Elgala et al. (2011) discuss the potential and state-of-the-art of indoor optical wireless communication. Chen, T., et al. (2016) developed a real- time forest fire monitoring system using a wireless sensor network (WSN) that employs temperature sensors to detect fires. The authors built a communication system based on the ZigBee protocol to enable real-time monitoring and early detection of forest fires. In another study, Kumar, P. & Prasad, R. (2017) conducted a comparative analysis of different WSN technologies for the Internet of Things (IoT), comparing ZigBee, Bluetooth Low Energy, and other technologies. They evaluated the suitability of these technologies for IoT applications based on factors such as energy efficiency, communication range, and other features. Other studies reviewed in this literature review include Gautam, S. & Singh, S. (2017) comparing ZigBee and Bluetooth Low Energy for IoT, Karpuram, G., et al. (2016) developing an RFID-based forest fire monitoring system, Faiyaz, A. & Prasad, R. (2017) reviewing WSNs for forest fire detection and monitoring, Peng, S., et al. (2015) designing a forest environment monitoring system based on GPRS and WSN, and Ha, T., et al. (2018) building a forest fire monitoring system based on LoRaWAN technology.

NEED OF WSN IN FOREST MONITORING

With detail review following assumptions are noted for WSN in forest monitoring related to applications, aspects, requirement and different technologies.

Overview of WSN Applications in Dense Forest Monitoring

The following are the advantages of using WSNs for forest monitoring:

- Low cost: WSNs contain of a huge number of tiny sensor nodes that are low-cost and easy to deploy.
- Easy deployment: WSNs can be deployed quickly without the need for any wiring or infrastructure.
- Efficient data collection: WSNs can collect data from the environment efficiently and accurately.
- Real-time monitoring: WSNs can provide real-time monitoring of the forest ecosystem.
- Remote monitoring: WSNs can be accessed remotely, making it easier to monitor forests in remote areas

Different Aspects of Dense Forest Monitoring and Requirements of WSN Technologies

Dense forest monitoring involves various aspects such as environmental monitoring, fire detection, and animal detection. Each aspect requires different types of sensors and WSN technologies. The following are the requirements of WSN technologies for each aspect:

Environmental Monitoring: Environmental monitoring involves measuring various parameters such as temperature, humidity, light intensity, and air quality. WSN technologies such as ZigBee, Bluetooth Low Energy, and Wi-Fi can be used for environmental monitoring as they provide low power and low-data rate communication, which is suitable for environmental monitoring. The sensor nodes used for environmental monitoring should have a low power consumption and a long battery life to ensure long-term monitoring.

Fire Detection: Forest fires are one of the biggest threats to forests, and early detection is critical to prevent the spread of the fire. WSN technologies such as ZigBee, Bluetooth Low Energy, and LoRaWAN can be used for fire detection. The sensor nodes used for fire detection should be able to detect smoke, heat, and flame and should be able to transmit the data in real-time to the base station.

Animal tracking: Forests are home to a variety of animals, and monitoring their behavior is essential for wildlife conservation. WSN technologies such as ZigBee and Bluetooth Low Energy can be used for animal detection. The sensor nodes used for animal detection should have low power consumption and should be able to detect animal movements and communicate the data to the base station.

WSN TECHNOLOGIES IN DENSE FOREST MONITORING

Zigbee

Zigbee technology has been widely used in forest monitoring due to its low power consumption, low cost, and ability to support large networks. Zigbee is a

wireless communication technology that uses the IEEE 802.15.4 standard for wireless communication, which provides reliable and secure data transmission. Zigbee technology is highly suitable for forest monitoring applications because it can operate at low power levels and can cover long distances, making it ideal for remote forest locations. The Zigbee protocol operates in the 2.4 GHz frequency band and is based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs). The Zigbee protocol is designed to provide low-power, reliable, and secure wireless communication between devices in a network. In a mesh networking architecture, zigbee allows for the creation of large networks with multiple devices. Each device can act as a router, allowing the network to be self-healing and providing redundancy. Even, the Zigbee protocol uses a star network topology, where a central coordinator node controls the network and communicates directly with the other nodes. The other nodes can only communicate with the coordinator node, and they do not communicate with each other directly.

Bluetooth Low Energy (BLE)

Bluetooth technology has also been used in forest monitoring applications due to its low power consumption, high data rate. In forest monitoring applications, Bluetooth technology can be used to collect data from sensors deployed in the forest and transmit it wirelessly to a mobile device or a remote monitoring station. Bluetooth Low Energy (BLE) is a variant of Bluetooth technology that is particularly well-suited for low-power IoT applications. BLE devices can operate on a single coin-cell battery for several months or even years, making them ideal for use in remote locations. But the main drawback of Bluetooth technology is low range, because of which no one can prefer it for development and deployment.

Wireless Fidelity (Wi-Fi)

Wi-Fi technology offers a high-data-rate and widely available option for forest monitoring applications. Its use of Wi-Fi access points makes it possible to collect data from a large number of sensors deployed in the forest, and its compatibility with high-resolution imaging and video data makes it an attractive option for applications such as forest health monitoring. However, its high power consumption and susceptibility to interference may limit its use in certain applications.

Radio Frequency Identification (RFID)

In forest monitoring applications, RFID tags can be attached to trees or other objects of interest, and RFID readers can be used to collect data on the location and condition of these objects. RFID technology has several advantages for forest monitoring applications, including its ability to read tags at a distance, its low cost, and its ability to operate in harsh environmental conditions. However, it also has some limitations, such as its limited data storage capacity and its limited range compared to other wireless communication technologies. Therefore, RFID technology is often used in combination with other wireless communication technologies, such as Zigbee or Bluetooth, to create more robust and versatile forest monitoring systems.

General Packet Radio Service (GPRS)

General Packet Radio Service (GPRS) is a packet-switched wireless data communication service that allows devices to transmit data over a cellular network. GPRS technology can be used in wireless sensor networks (WSN) for forest monitoring applications to transmit data from remote sensors to a central server or monitoring station. In GPRS- based WSNs, the sensors are equipped with GPRS modems that transmit data over a cellular network to a central server. The data can then be processed and analyzed to monitor environmental conditions such as temperature, humidity, and air quality in the forest.

Global System for Mobile Communications(GSM)

Global System for Mobile Communications technology has also been used in Wireless Sensor Networks (WSN) for forest monitoring applications. GSM is a cellular communication technology that operates on licensed frequency bands and provides wide coverage and high data transfer rates. In forest monitoring applications, GSM-based WSN can be used to collect data from sensors deployed in the forest and transmit it wirelessly to a remote monitoring station or a cloud-based server for storage and analysis. GSM-based WSN typically require a GSM modem, which is connected to the sensor nodes and provides wireless communication capabilities.

Low Power Wireless Area Network (LPWAN)

LPWAN (Low-Power Wide Area Network) technologies are emerging as a promising solution for forest monitoring applications due to their ability to provide long-range wireless communication with low-power consumption. LPWAN technologies are designed to provide long-range communication with low data rates and are ideal for IoT and WSN applications that require low-power, long-range connectivity. There are several LPWAN technologies available today, including LoRaWAN, Sigfox, and NB-IoT. These technologies operate in unlicensed or licensed frequency bands and offer long-range connectivity with low-power consumption, making them ideal for use in remote locations where power supply is limited.

REVIEW ANALYSIS

According to the tabular comparison in Table 1, LPWAN technology offers the longest range and lowest power consumption among the listed wireless sensor network technologies for dense forest monitoring. ZigBee also has low power consumption and moderate range, while Wi- Fi and Bluetooth have higher data rates but shorter range and higher power consumption. GPRS and GSM offer global coverage but have moderate to high power consumption. RFID has lower range but low power consumption. Overall, LPWAN and ZigBee appear to be the most suitable WSN technologies for dense forest monitoring due to their low power consumption and moderate to long range capabilities as shown in Fig. 2 and Table 1.

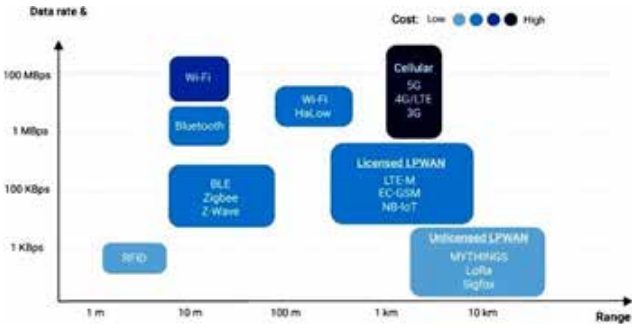

Fig. 2. Comparison of different WSN Technologies in terms of data rate, cost and range

Table 1 providing a comparative analysis of energy consumption of WSN node using Wi-Fi, Bluetooth, ZigBee, RFID, GPRS, GSM, and LPWAN WSN technology in dense forest monitoring. The values are based on research studies as shown in figure. The energy consumption may vary based on several factors, such as the application, network architecture, and environmental conditions. The comparative analysis of energy consumption by each different technology is shown in Table No. 1 and column No. 6.

Table No.: 1 Tabular Data for Different WSN Technologies Used In Forest Monitoring

Sr. No.	Technology	Frequency	Data Rate	Range	Energy Consumption (mJ/bit)	Cost	Suitability for Forest Monitoring	References
1	Wi-Fi	2.4 GHz	Up to 866 Mbps	Up to 100 m	10 - 100	High	Not suitable for remote locations and low-power applications	[16], [17], [28]
2	Bluetooth	2.4 GHz	Up to 3 Mbps	Up to 100 m	0.3 - 0.5	Low	Suitable for short-range and low-power applications, but limited range	[18], [19] [29]
3	ZigBee	2.4 GHz	Up to 250 Kbps	Up to 100 m	0.03 - 0.05	Low to Moderate	Suitable for low-power and low-data rate applications, but limited range	[20], [21], [30]
4	RFID	Various	Up to 640 Kbps	Up to 10 m	10 - 1000	Low to Moderate	Suitable for asset tracking and identification, but limited range and data rate	[8], [22], [31],
5	GPRS	2G/3G	Up to 115 Kbps	Up to 35 km (Line of Sight)	100 - 1000	High	Suitable for long-range and high-data rate applications, but high power consumption	[9], [23], [32]
6	GSM	2G/3G	Up to 384 Kbps	Up to 35 km (Line of Sight)	1000 - 10000	High	Suitable for long-range and high-data rate applications, but high power consumption	[12], [24], [33]
7	LPWAN	Various	Up to 50 Kbps	Up to 10 km (Ur-ban), up to 40 km (Ru-ral)	0.001 - 0.1	Low to Moderate	Suitable for long-range and low-power applications, ideal for remote locations and harsh environments	[13], [27], [34]

CONCLUSION

This research paper highlights the importance of Wireless Sensor Networks (WSNs) in dense forest monitoring and provides a comprehensive survey of various WSN technologies that can be used for this purpose. The comparative analysis of different WSN technologies based on their range and power consumption reveals that LPWAN technology is the most suitable option for monitoring dense forests due to its low power consumption and long range capabilities. This study emphasizes the significance of selecting the appropriate WSN technology based on the specific requirements of the dense forest monitoring application to achieve optimal results. The use of WSNs in dense forest monitoring can enable effective data collection and analysis, leading to improved forest management and conservation.

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Analyzing the Performance of Wireless Sensor Network for 5G Frequency Band

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ABSTRACT

The integration of Wireless Sensor Networks (WSNs) with 5G networks, using Device-to-Device (D2D) communications, enables direct interaction between nearby user equipment (UE) through cellular or ad hoc links. This integration aims to optimize spectrum utilization. The D2D communication architecture is hierarchical, where centralized network software (SDN) communicates with the cloud-based head to minimize the number of long-term requested communication links (LTE) and optimize energy consumption. This paper explores D2D communication in various 5G frequency bands. The concept of a local controller and a centralized architecture ensures operational continuity in cases of infrastructure damage and traffic fluctuations. D2D communication in different frequency bands of 5G is implemented using Matlab, and a comparison analysis is performed.

KEYWORDS: *5G, D2D communications, LTE, WSN*

INTRODUCTION

Wireless Sensor Networks (WSNs) consist of distributed micro-devices equipped with various sensors, enabling the monitoring of environmental parameters and the transmission of information for further analysis by end users. Given the widespread use of WSNs, it is crucial to explore integration techniques with 5G networks. With the growing demand for smart devices and the rapid expansion of internet services, it is projected that mobile data traffic will increase significantly in the coming years. The transition from 4G to 5G is currently being standardized, and both industry and academia are actively working towards a consensus on the key 5G technologies and how to effectively combine them. Several emerging technologies are being developed to enhance data rates and promote environmentally friendly communication. Considering the promise of improved data rates in 5G, it becomes essential to utilize the 5G frequency bands in WSNs to meet the requirements of modern applications.

RELATED WORK

The integration of Wireless Sensor Networks (WSN) with the Internet of Things (IoT) through LTE/5G has proven to be more efficient than previous systems. In order to achieve this, it is important to compare the characteristics of WSN traffic with the regular traffic supported in LTE networks. The integration of WSN and IoT in 5G technology requires the study of new technologies to ensure efficient WSN traffic management [1]. The deployment of 5G technologies offers significant potential in creating an advanced ICT infrastructure for efficient communication in an Internet of Things context. Cognitive radio (CR) technology in 5G can address many of the challenges faced in smart city ecosystems based on ICT [4]. Deploying Wireless Sensor Networks in 5G network environments

presents unique challenges due to low-power sensor nodes operating in diverse environments with limited resources. Energy efficiency and security are major concerns in WSNs [2]. WSN environments can be either static or dynamic, and research has shown that dynamic networks consume less energy compared to static networks [2]. To extend the lifetime of networks, clustering techniques have been introduced to enhance Quality of Service (QoS). Existing work has primarily focused on proposing solutions to extend network lifetime, with limited efforts made in clustering to improve transmission reliability or reduce network latency [3].

5G WSN NETWORKS

A Hierarchical D2D Network

Wireless Sensor Networks (WSNs) can be seamlessly integrated with 5G networks through the utilization of Device-to-Device (D2D) communications, enabling direct interaction among nearby User Equipment (UE) via cellular or ad hoc links. This integration aims to optimize spectrum utilization. A hierarchical D2D communication architecture is illustrated in Figure 1. In this architecture, centralized network software (SDN) facilitates communication with the cloud-based head, reducing the number of long-term requested communication links (LTE) and optimizing energy consumption. The concept of a local controller and a centralized architecture ensures operational continuity in cases of infrastructure damage and fluctuating traffic situations [1].

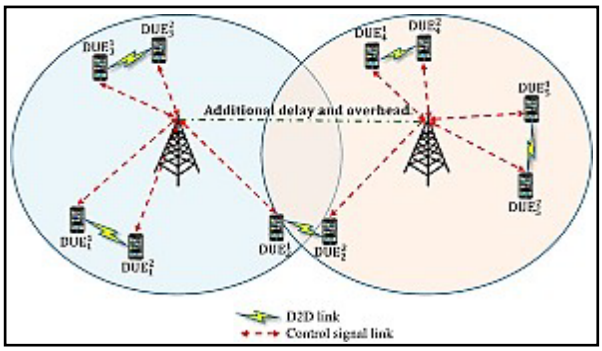


Figure 1: D2D Communication in 5G Networks

Signaling for Cloud Formation

The process of forming clouds involves the initiator broadcasting a request for cloud formation over the Wi-Fi interface. Mobile devices within the area, interested in participating in the service exchange, respond with their resources or services. The SDN application running on each mobile device maintains a database of all the services and resources that a mobile user is willing to share. Upon receiving a cloud formation request from a User Equipment (e.g., smartphone), the SDN initiates the sharing of the complete database with all concerned User Equipment. The SDN's cloud driver records assign an authentication key to the formed cloud. Subsequently, the initiator sends the authentication key individually to each User Equipment. Once the cloud is formed, the devices within it can communicate during their operational duration unless the cloud head sends a termination request.

Frequencies for 5G

In October 2014, the Federal Communications Commission (FCC) of the United States published a Notice of Inquiry (NOI), soliciting comments on various potential frequency bands for 5G. 5G systems are expected to provide enhanced capabilities, and the spectrum allocation for 5G must encompass all the applications envisioned for future networks [1].

Table 1: Band of Frequency for 5G [1]

Frequency Band	Allowed Frequency Range
24 GHz	27.5-28.35 GHz, 29.1-29.25 GHz, y 31-31.3 GHz
39 GHz	38.6-40 GHz
37/42 GHz	37.0-38.6 GHz y 42.0-42.5 GHz
60 GHz	57-64 GHz y 64-71 GHz (extension)
70/80 GHz	71-76 GHz, 81-86 GHz, 92-95GHz

Traffic Model for WSN

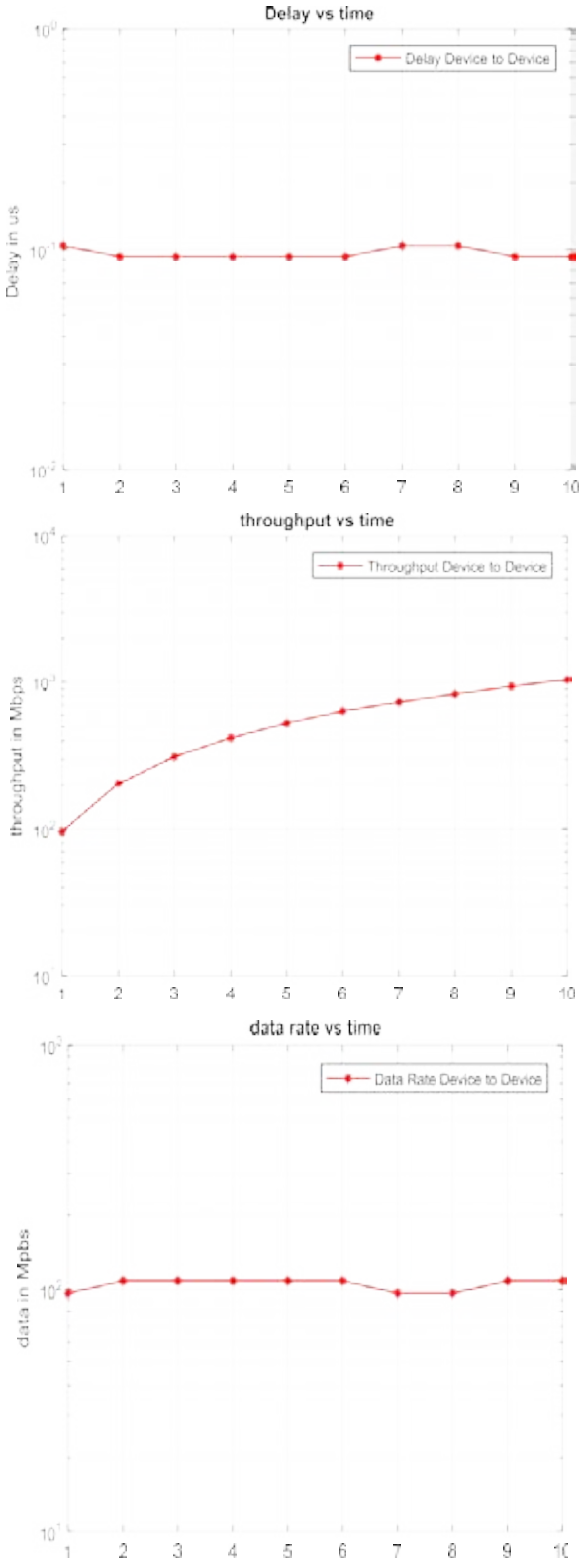
It is important to understand the expected traffic patterns of wireless sensor networks. The traffic characteristics differ according to the applicationn as WSN when interact with the environment in order to detect specific phenomena. The traffic is generated when the phenomenon of interest is detected in event-

based WSNs that are used in different applications and real-time monitoring applications. On analysis of the traffic information like the average load, the bandwidth requirements for different applications, and numerous other details can be found out [1]. Traffic models enables network designers to make assumptions about the networks being designed. The different traffic models each have its own pros and cons.

RESULTS AND DISCUSSION

We evaluate the performance of D2D communication using Matlab 5G Simulation toolbox considering virtual scenario and evaluated the performance parameter such as data rate, delay and throughput for different frequencies as discuss above in table No. 1 and drawn the conclusion as; The experimental results obtained for different frequency bands are as follows. At a frequency of 24 GHz, the system demonstrated a throughput of 104.4 kbps with a delay of 0.096 ms at a sure distance of 5 meters. For undertrained distances of up to 10 km, the system achieved a throughput of 582 kbps with a slightly reduced delay of 0.0937 ms and a data rate of 106.8 bps. Similarly, at a frequency of 39 GHz, the system achieved a throughput of 169.65 kbps with a delay of 0.059 ms at a sure distance of 5 meters, while for undertrained distances of up to 10 km, the throughput remained consistent at 932.1 kbps with a slightly decreased delay of 0.0591 ms. Finally, at a frequency of 60 GHz, the system demonstrated a throughput of 261 kbps with a delay of 0.038 ms at a sure distance of 5 meters. Undertrained distances of up to 10 km exhibited a higher throughput of 1425 kbps with the same delay of 0.0384 ms. These results highlight the varying performance characteristics of the system across different frequency bands and distances, showcasing the potential of higher frequency bands for achieving higher throughputs at shorter distances. It is observed that for all the three performance parameter namely data rate, delay and throughput, the error value approaches to zero. Hence we can conclude that the distance does not affect the performance of D2D communication in 5G infrastructure for WSN.

For Certain Distance = 5Km



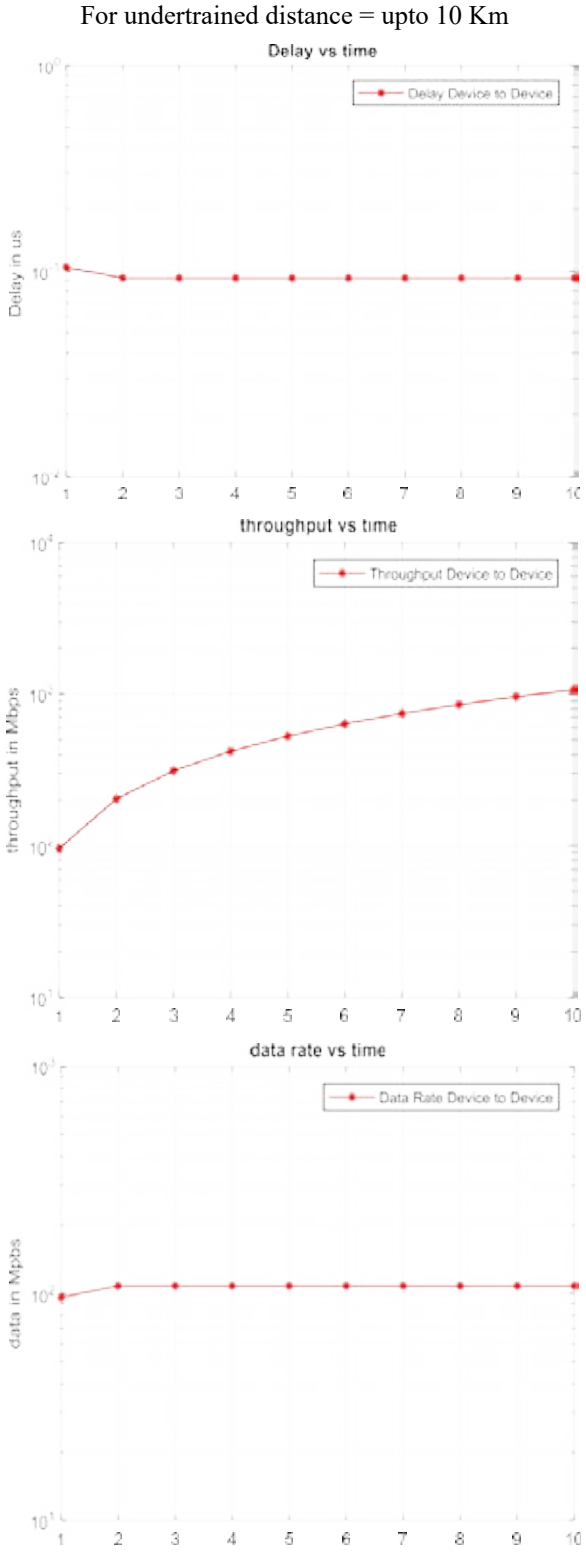


Figure 2: Graph for x Bands of 24 GHz: 24.25-24.45 GHz -25.05-25.25 GHz

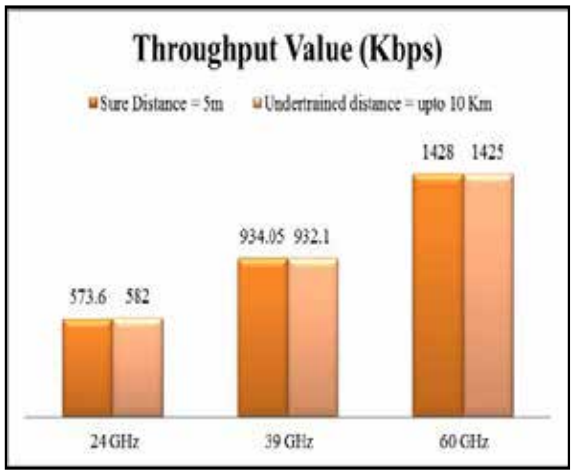


Figure 3(a): Throughput Comparison for sure and uncertain distance

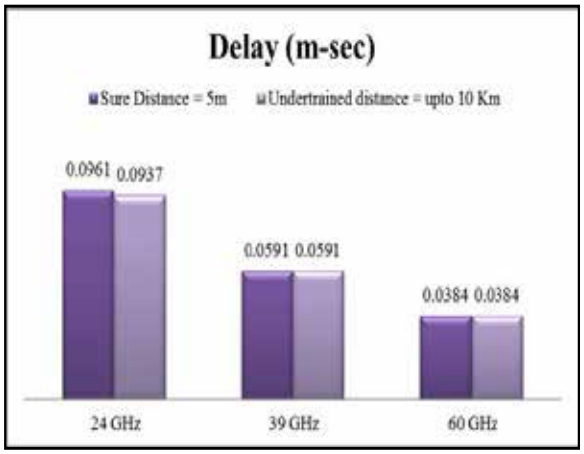


Figure 3(b): Delay Comparison for sure and uncertain distance

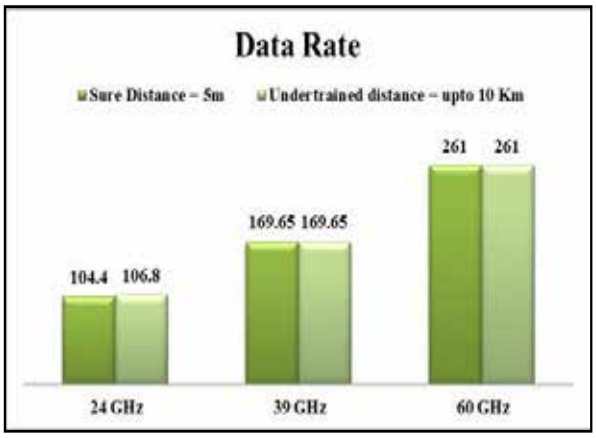


Figure 3(c): Data rate Comparison for sure and uncertain distance

Table 2. Comparative Analysis of parameters (Throughput, Delay and Data Rate) for sure and uncertain distance

Frequency Bands	Sure Distance = 5m			Undertrained distance = upto 10 Km		
	Throughput kbps	Delay m-sec	Data Rate bps	Throughput kbps	Delay m-sec	Data Rate bps
24 GHz	104.4	0.096	104.4	582	0.0937	106.8
39 GHz	169.65	0.059	169.65	932.1	0.0591	169.65
60 GHz	261	0.038	261	1425	0.0384	261

CONCLUSION

In our Wireless Sensor Network (WSN) integrated with a 5G frequency band, several performance metrics exhibit notable trends. As the frequency band increases, the throughput also tends to increase. This indicates that higher frequency bands allow for higher data transfer rates in the network. Similarly, the data rate, which measures the amount of data transmitted per unit of time, also increases with an increase in the frequency band. Another significant observation is that the delay, or the time taken for data packets to travel through the network, decreases as the frequency band increases. This implies that higher frequency bands lead to reduced transmission delays in the WSN.

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Characteristics Mode Analysis of a Circularly Polarized Minkowski Inspired Fractal Antenna for Narrowband Internet of Things Applications

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ABSTRACT

In this work, a circularly polarized narrowband fractal antenna operational at 4.5 GHz for Indian National Satellite (INSAT) Narrowband Internet of Things (NB-IoT) applications have been presented. The overall antenna dimension is 26 mm X 26 mm. The FR-4 substrate with a 4.4 dielectric constant and 1.6 mm height has been selected for the design. Characteristic Mode Analysis (CMA) have been performed in Computer Simulation Technology (CST) software to find the optimal feed location for probe feed in order to achieve the circular polarization. The design is simulated in an Integral Equation Three- Dimensional (IE3D) software. The software results confirm the circular polarization with a Right-Hand Circularly Polarized (RHCP) with gain of 2.5 dBi. The antenna exhibits axial ratio below 2 dB with antenna efficiency of 60%. The antenna is suitable for satellite assisted NB-IoT applications.

KEYWORDS: *NB-IoT, Characteristic mode analysis (CMA), Fractal antenna, Circularly polarized, Satellite communication, Probe feed location.*

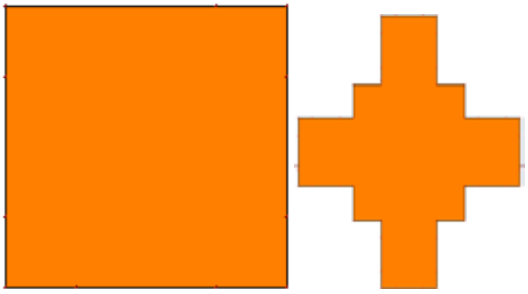
INTRODUCTION

The Internet of Things (IoT) is gaining added importance with increasing wireless devices and the need for connectivity between them. Recently Telecom Regulatory Authority of India (TRAI) came up with a need to connect the remotest areas having deprived wireless connectivity with the help of satellite and IoT [1]. The antenna that is needed to provide satellite to IoT devices connectivity is one of the major challenge. The small size of IoT devices making it even more complicated for an antenna designer to arrive at the desired specification with a compact design. Microstrip antennas being small and low weight antennas with their ease of fabrication and conformability are the suitable candidate for IoT applications [2]. INSAT which operates at 4.5 GHz in the C band [3] is the major transforming technology in Indian satellite communication system mainly focussing on telecommunication, disaster management, news gathering, weather forecasting applications, INSAT can help in connecting the IoT coverage on remotest areas on earth where mobile connectivity is deprived. Direct-To-Satellite IoT, Indirect to satellite IoT and a hybrid approach for providing NB-IoT with the help of satellite is discussed in[1]. The polarization of the antenna is the important aspect, satellite communication for extending IoT connectivity demands circularly polarized antenna at the IoT device end for more reliable operation. Some techniques have been proposed in the earlier literature to obtain circular polarization in microstrip antennas such as truncated corner [4],by exciting orthogonal modes [5], direct to satellite communication system is discussed in [6], elliptical slot (ES) [7], offset feeding network with complimentary ground to improve the polarization [8], Metamaterial structure also helps in attaining circular polarization [9]. As miniaturization is the main objective in IoT antenna design, fractal microstrip antenna becomes an ideal choice [10], [11], [12]. Finding the optimal feed location imposes a special challenge.

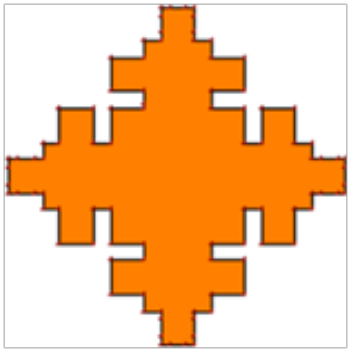
In this paper, a Minkowski Inspired fractal antenna geometry is designed and analyzed up to 3 iterations for NB-IoT applications. The paper is conversed in four sections, section one describes the introduction, section two gives the iterative development of proposed antenna with dimensions. In section three the Characteristic Mode Analysis (CMA) of proposed antenna have been performed to predict the feed point location based on characteristics angle. Section four depicts the simulated results obtained from the IE3D software with feed information derived from section 3. Section five concludes the paper. The designed antenna gives circular polarization at 4.5 GHz (C-Band). The novelty of this work lies in choosing an appropriate feed location for achieving circular polarization at required frequency 4.5 GHz.

ANTENNA GEOMETRY

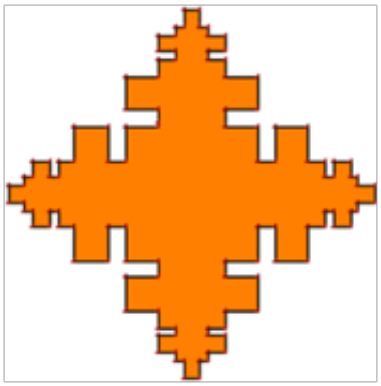
A Minkowski Inspired fractal antenna is designed by considering a square patch as an initiator and subtracting the scaled version of the initiator to its sides in consecutive iterations with the scaling factor of 2, the process of iterative design is shown in figure 1. The detailed dimensions are given in figure 2. the design is completed up to the third iteration.



a. Initiator b. Iteration 1



c. Iteration 2



d. Iteration 3

Fig. 1. Iterative development of Minkowski Inspired fractal antenna

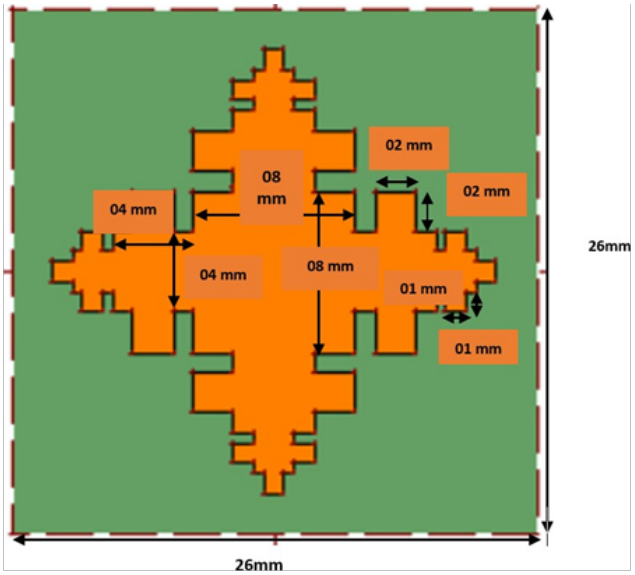


Fig 2. Detailed dimensions of a Minkowski Inspired fractal antenna

Mode Analysis

Characteristics Mode Analysis (CMA) is a valuable tool for predicting natural resonance. According to [13], the impedance measurements derive the mathematical equations governing CMA.,

$$Z = R + jX \quad (1)$$

$$XJ_n = \lambda_n RJ_n \quad (2)$$

R = Z matrix's Hermitian Real component

X = Hermitian Imaginary Z matrix component.

Jn = eigen current

λ_n = eigenvalue

The crucial parameters to pay attention to in the case of CMA are Eigenvalue, Modal significance, and the characteristics angle. Modal significance, which is determined by equation III and has a range of 0 to 1, demonstrates the contribution of a specific mode to the radiation.

$$MS = \left|\frac{1}{1+j\lambda_n}\right| \quad (3)$$

The characteristic angle denotes a mode's resonance frequency. At resonance, $\lambda_n = 0$ and $a_n = 180^o$

$$\alpha_n = 180^o - \tan^{-1}(J_n) \quad (4)$$

When the eigenvalue at resonance is zero, it indicates that the modes are radiating; when it is greater than zero, it indicates that the modes are storing magnetic energy. Therefore, the optimum value for λ_n is zero for the antenna to function as an effective radiator.

The CMA Have been performed in CST Microwave studio. The geometry has been analyzed with CMA and is shown in figure 3(a). Required modifications have been performed in the original geometry for optimal performance based on the information obtained from CMA as shown in figure 3(b).

To observe the natural resonant point and the suitable feed location the current distribution (Figure 4), Far-field and characteristic angles are seen at the first five resonant modes (Figures 5 and 6). The current distribution is more concentrated on edges extending inside the geometry at a frequency of 4.5 GHz, as seen in Figure 4.. From the current distributions the idea of the portions which are responsible for radiation at 4.5 GHz are located and are marked in circles in Figure 4. The Mode 1, Mode 2, and Mode 4, Mode 5 are found to be degenerate modes, giving almost the same response of characteristics angle (figure 6). The characteristic angle is observed to be 90 degrees out of phase between the pair of degenerate modes (Figure 7), making them orthogonal. Exciting the orthogonal modes gives rise to circular polarization which is an essential factor in providing better signal receptivity in satellite-based NB-IoT applications. The geometry have been modified on the basis of current distribution in such a way that, mode 1 and mode 4 are dominant and orthogonal the modified design is shown in figure 3b. The feed point have been placed at the modified locations and the performance of antenna have been observed in Mentor Graphics (IE3D) software simulations. The details of which have been explained in section 4.

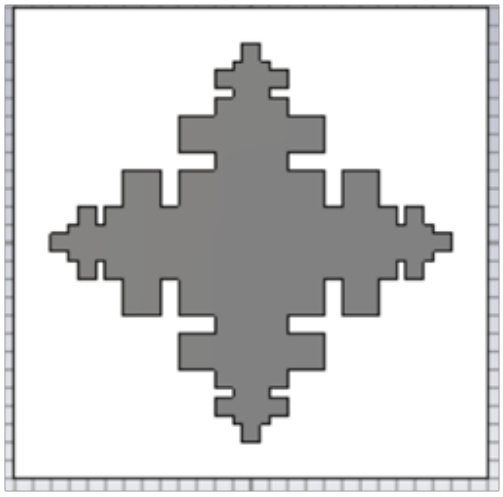


Fig 3. (a) Original design in CST

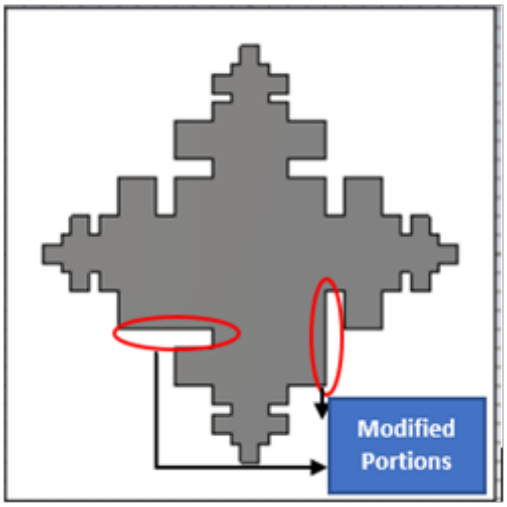
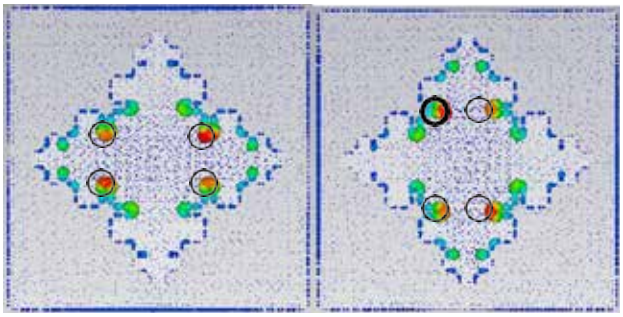
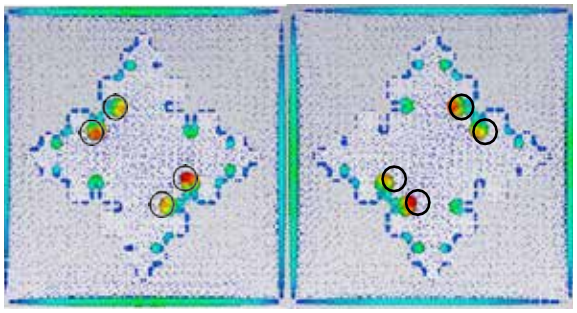


Fig 3. (b) Modified design after CMA Analysis

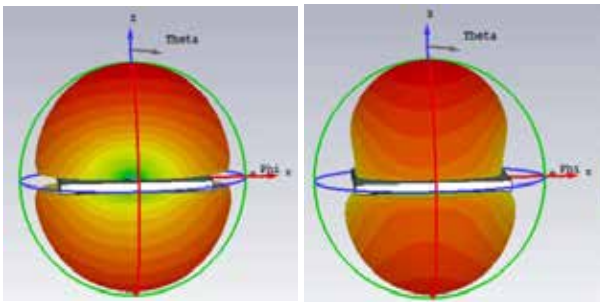


(a) **(b)**

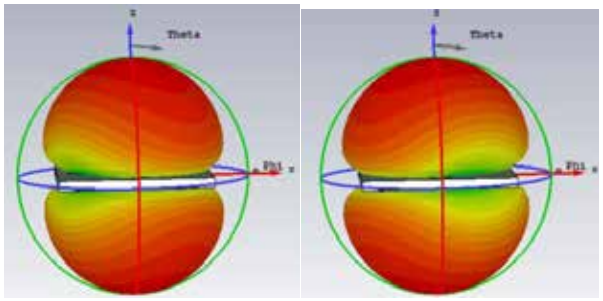


(c) (d)

Fig 4. Surface current, at 4.5GHz (a) Mode 1 (b)Mode 2 (c) Mode4 (d) Mode 5

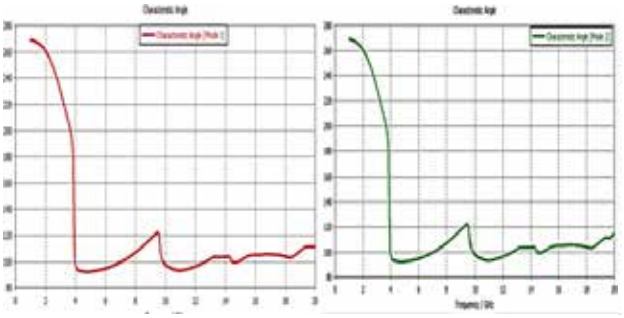


(a) (b)

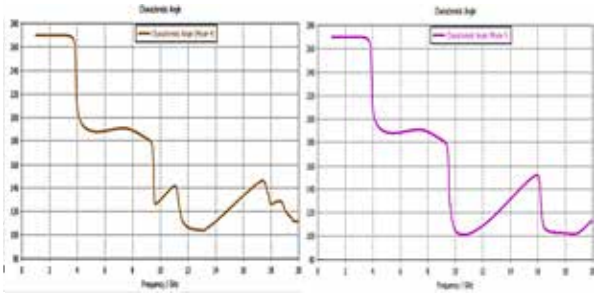


(c) (d)

Fig 5. Farfield, at s=4.5GHz (a) Mode 1 (b)Mode 2 (c) Mode4 (d) Mode 5



(a) (b)



(c) (d)

Fig 6. Characteristics Angle , at s=4.5GHz (a) Mode 1 (b) Mode 2 (c) Mode4 (d) Mode 5

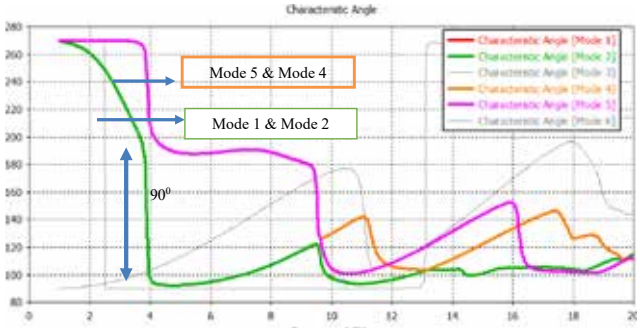


Fig 7. Characteristics Angle showing orthogonal modes

Antenna Simulation

The feed location predicted in CMA has been used to provide a probe feed in mentor graphics simulation (Figure 8) and it is observed that the antenna designed in IE3D resonates exactly at 4.5 GHz (Figure 9) as predicted in characteristics mode analysis (Figure 7) thus confirming the usefulness of characteristics mode analysis in determining the exact feed location in order to excite the antenna with desired polarization and S11 characteristics. Probe feed have been used to power the antenna because it has been proven as a better choice in case of narrowband antennas in the past literatures.

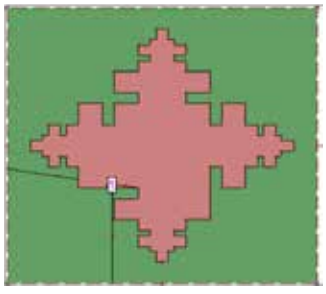


Fig 8. Minkowski Inspired antenna geometry in mentor graphics

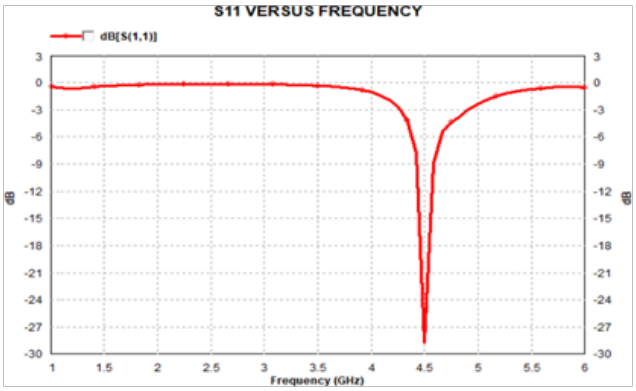


Fig 9. S-Parameters

RESULTS AND DISCUSSION

Probe feed has been incorporated in such a way that Mode 1 is excited and Mode 4 being orthogonal to Mode 1 at 4.5 GHz (Figure 7), the geometry resonates at 4.5 GHz with the S11 of -28 dB with the narrow percentage bandwidth of 3.5% (Figure 9) and VSWR less than 2 (Figure 10) and Z11 of 50 Ohm (Figure 11) at 4.5 GHz showing the perfectly matched port. The radiation pattern shows gain above 2.5dBi. (Figure 12 (a), (b)) shows azimuth and elevation gain display respectively and directivity above 6 dBi. (Figure 12 (c), (b)) shows azimuth and elevation directivity display. With the excitation of orthogonal modes the right hand circular polarization is observed with the RHCP gain of 2.5 dBi as described in Figure 13(b) and RHCP directivity of 5.5 dBi as represented in Figure 13 (d). The total gain is observed to be 2.5 dBi as shown in Figure 13(a)) and total directivity is 6.4 dBi as given in Figure 13 (c). The axial ratio plot in Figure 13 (e) shows that the proposed antenna is circularly polarized. The radiation efficiency of up to 60% is achieved as shown in Figure 13 (f).

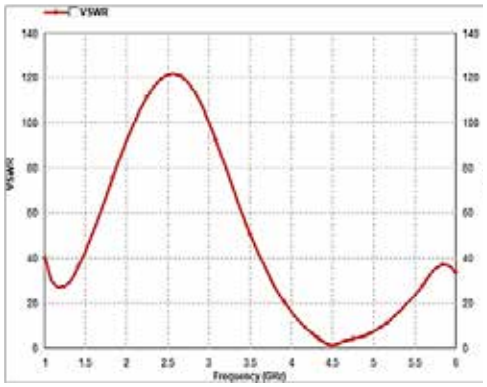


Fig 10. VSWR Plot

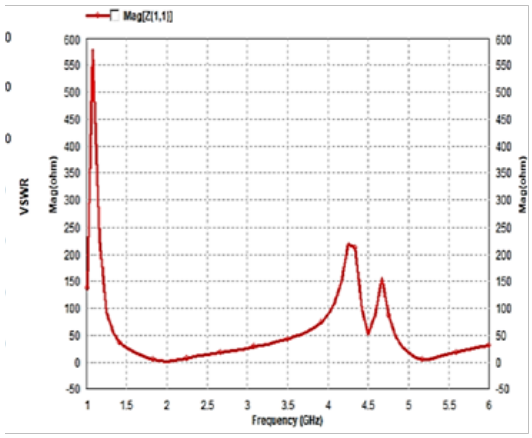
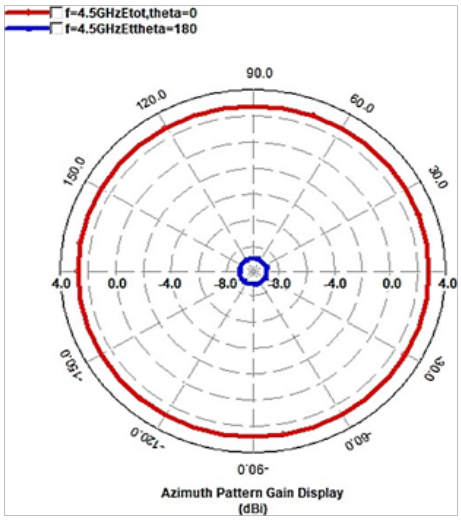
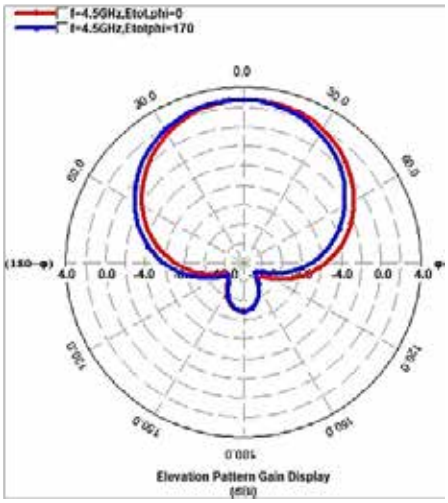


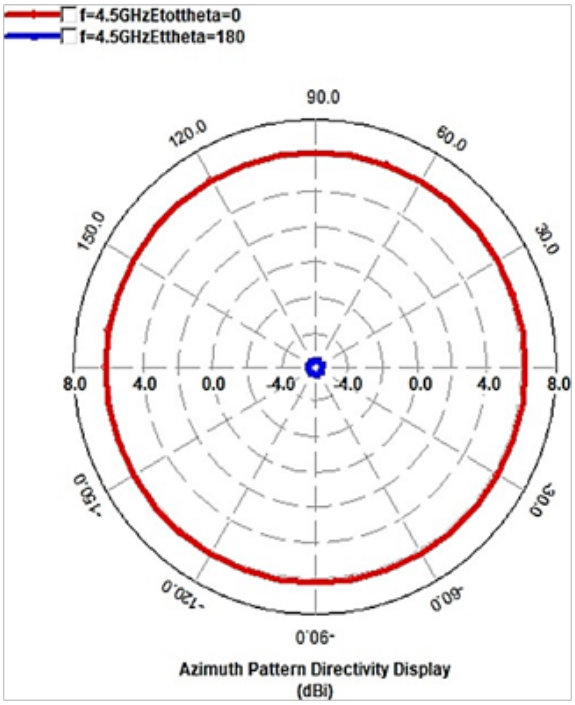
Fig 11. Z11 Plot



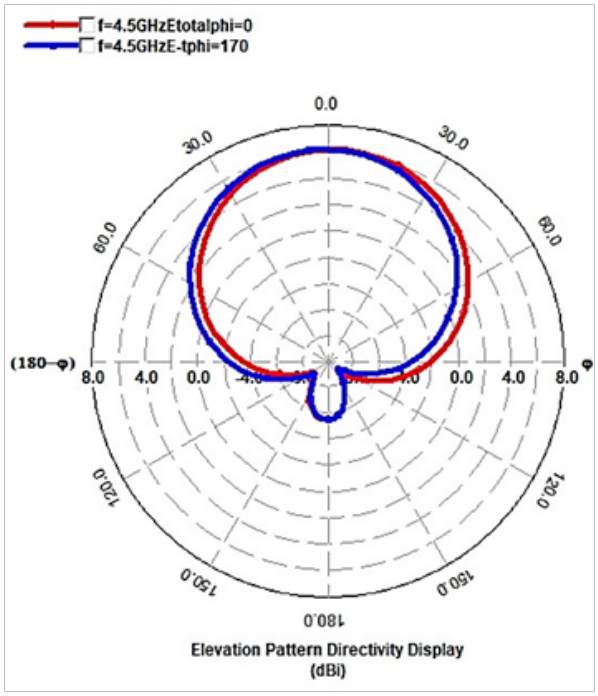
(a)



(b)



(c)



(d)

Fig 12. (a) Azimuth pattern gain display (b)Elevation pattern gain display (c) Azimuth pattern directivity display (d)Elevation pattern directivity display

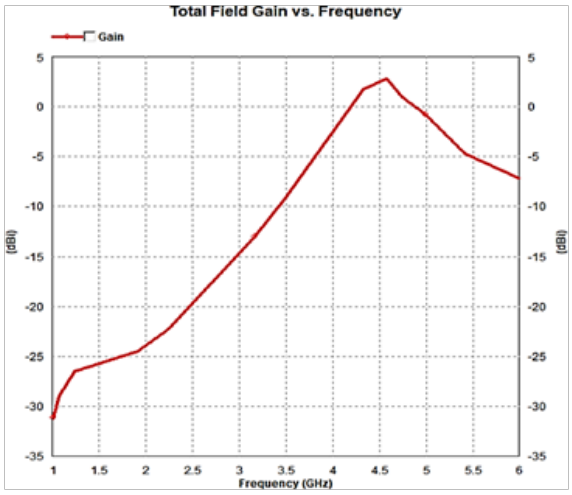


Fig 13. (a) Total Field Gain

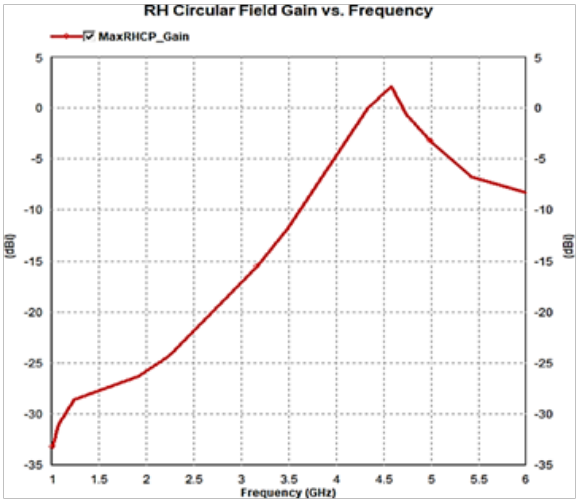


Fig 13. (b) RHCP Gain

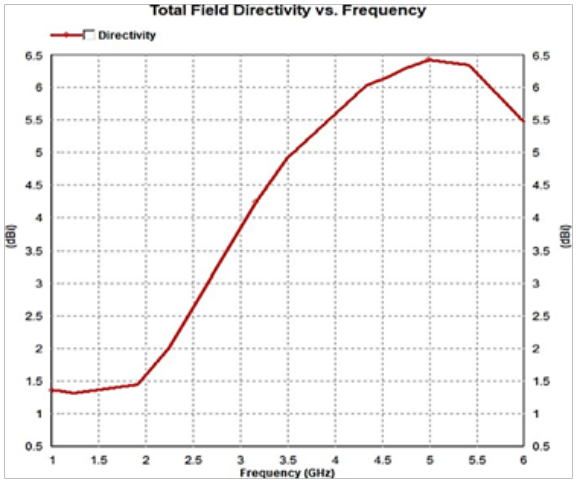


Fig 13. (c)) Total Field Directivity

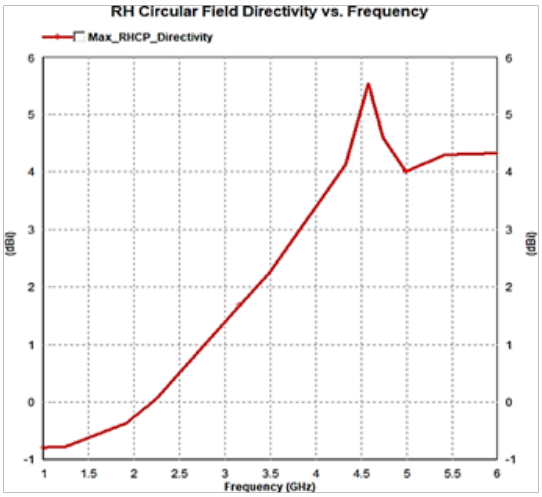


Fig 13. (d)RHCP Directivity

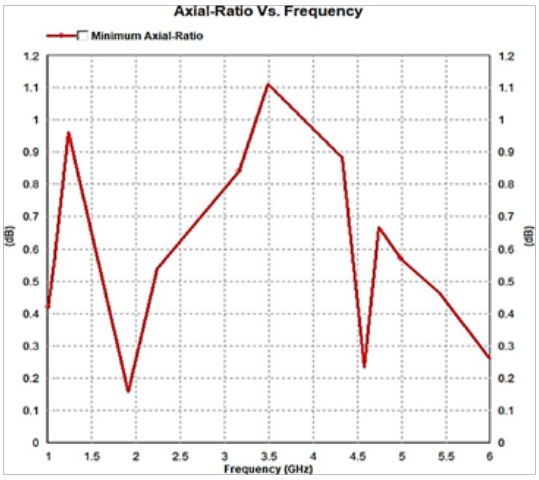


Fig 13. (e) Axial Ratio

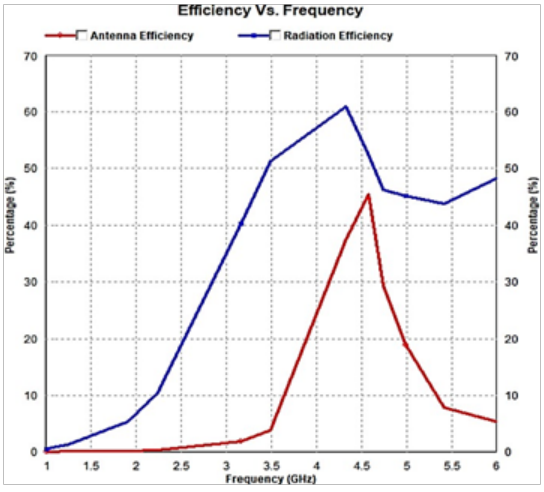


Fig 13. (f) Efficiency

CONCLUSION

The CMA helps in choosing the feed location in an antenna with the choice of desired polarization. The CMA predictions from CST match the Electromagnetic simulations from Mentor Graphics, thus proves that CMA is effective in assisting the antenna designer by providing feed location and nature of polarization at the specific feed point. The proposed Minkowski Inspired fractal antenna with circular polarization and compact in size is suitable for the satellite assisted NB-IoT applications. It helps for connecting the areas having depraved mobile network connectivity with the help of IoT and thus can serve the various applications such as disaster management, supply chain management, asset tracking applications and many more.

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Natural Language Processing based Customer Review Analysis

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ABSTRACT

This research paper explores the use of natural language processing (NLP) techniques for customer review analysis. The effectiveness of feature extraction techniques such as TF-IDF, CountVectorizer, and Word2Vec, followed by model training using Logistic Regression, KNN, SVM, and Random Forest. Different experiments were conduct on two datasets to evaluate the accuracy of the proposed methods. The results show that NLP is an effective method for analyzing customer feedback with accuracies ranging from 80% to 95%. The insights gained from analyzing customer reviews can inform business strategies and improve customer satisfaction. Our research highlights the potential benefits of NLP in customer review analysis and provides a foundation for future research to improve the accuracy of customer feedback analysis.

KEYWORDS: *TF-IDF, Natural language Processing, Word embedding, Word2Vec, Machine learning*

INTRODUCTION

In recent years, e-commerce has seen a significant rise in popularity as consumers increasingly prefer the convenience and accessibility of online shopping. With this growth, customer reviews have become an essential aspect of online shopping, providing valuable feedback to potential customers while influencing their purchase decisions. However, as the volume of reviews continues to increase, it becomes increasingly challenging for businesses to analyze and make sense of this data manually. This is where Natural Language Processing (NLP) and machine learning techniques come in.

NLP is a branch of artificial intelligence (AI) that focuses on how people and machines interact through language. It involves processing and analysing natural language data, such customer reviews, using computer approaches. Businesses may automatically extract insights from customer reviews using NLP and machine learning techniques, such as sentiment analysis, aspect extraction, and topic modelling, to better understand the needs, preferences, and pain points of their target market. The benefits of review analysis using NLP and machine learning techniques are numerous. For one, it enables businesses to identify areas where they are excelling and where they need to improve, providing opportunities for targeted optimization of their products or services. Additionally, analyzing customer reviews can help businesses identify emerging trends, allowing them to be more proactive in their product development and marketing efforts.

In this research paper, we will explore the use of NLP and machine learning techniques in the context of customer review analysis in e-commerce. Specifically, we will investigate how NLP techniques can be used to extract valuable insights from customer reviews, including sentiment analysis, aspect extraction, and topic modeling. We'll also look at how machine learning methods may be used to make these NLP models more accurate and speed up the review

and analysis process. By doing this, we hope to give businesses a thorough grasp of the potential advantages of applying NLP and machine learning approaches for review analysis as well as insights into the difficulties that come with this strategy.

LITERATURE REVIEW

The sentiment analysis of customer suggestion is studied in [1] using the dataset of reviews of women's e-commerce clothing. To address the issue five well-

known machine learning algorithms were used which include XGBoost, Support Vector Machine (SVM), Random Forest, LightGBM and Logistic Regression. This study set out to determine the relationship between product recommendations and reviews. The LightGBM algorithm produced the best results, with an AUC value of 0.96 and 0.98 as the maximum accuracy.

The categorising of opinions is [2]'s fundamental goal. As feature extraction methods, Bag of Words (BOW) and Term Frequency-Inverse Document Frequency (TF-IDF) are used. Customer reviews are believed to be successful in carrying out the task, and voting ensemble classifier has also been employed to evaluate improved performance. It is clear from the outcomes that Unigram makes use of the dataset and enhances performance. A deep learning technique called Deep Convolutional Neural Network, which extracts sentiment from a corpus of text, is introduced in the paper in [3]. The IMDB and Amazon product reviews are used to evaluate the performance of this model. With some minor adjustments to the hyperparameters, such as the filter's size, the number of kernels, and the dropout probability, the trained model can generalise with greater accuracy. The study[4] looks on the extraction and restoration of user experience (UX) data, which supports product design, from customer online reviews. The method for gathering UX knowledge from online customer evaluations is then recommended to support UX-centered design efforts. Users' and designers' reactions to significant features and usage situations are demonstrated in a case study on smart phone evaluations using UX data examples.

[5] presents a methodology for measuring customer happiness in the aviation business.To examine the online consumer reviews, text mining techniques are applied. In order to forecast customer recommendations for airlines, a database of more than 55,000 evaluations is analysed. The Latent Dirichlet Allocation model is used to determine 27 categories of customer happiness, which are each described by 882 adjectives. This resulted in accuracy of 79.95%. To perform feature-focused sentiment analysis, [6]customer reviews from online shopping apps like Amazon are examined. These reviews are related to various mobile devices and manufacturers. Based on the reviews, the suggested models grade mobile phones based on 108 features. The accuracy is low and is upto 52.3% and if the one star integer rating error is tolerated it becomes 93.8%. It is suggested in [7] to use Naive Bayes sentiment analysis on customer reviews of eateries. Data from Tripadvisor restaurant reviews is collected using a web crawling technique, and TextBlob sentiment analysis is performed using the Naive Bayes method. Data is scanned using WebHarvy Tools. Names of restaurants and reviews are among the data gathered. As a consequence of the data collection, 337 data are received, 269 data are utilised for training, and 68 data are used for testing. Additionally, the results demonstrate that, with an accuracy value of 72.06%, the Naive Bayes approach is only slightly (2.94%) better than TextBlob sentiment analysis.

Main objective in [8] is to examine consumer feedback on several restaurants in Karachi. The SWOT'S guide to Karachi's eateries, a very popular Facebook community, is where customer reviews are gathered. Comments on food quality, ambiance, service, and value for money are automatically categorised using text classification techniques.For training and testing, a carefully annotated dataset including about 4000 entries was employed. The random forest method produced the best results, which was 95% accurate. Using sentiment analysis and statistical data analysis, a method for determining relative consumer satisfaction with cosmetics companies was developed in [9]the current study. The top 26 cosmetics brands in the world were used in an empirical case study, and the results included an analysis of relative brand satisfaction and a look at the key factors influencing both positive and negative ratings. NLP was applied to the crawled reviews using the RapidMiner programme. Sentiment scores for the sentences were calculated using the Opinion Lexicon for the Sentiment Dictionary. In [10]Studied deep learning, explainable artificial intelligence, and machine learning techniques. Although DL models in other domains perform well in terms of accuracy, they fall short in terms of explainability, a problem that an implementation of XAI can solve. XAI implementation can enhance DL methods' interpretability, according to the results, which show that they have good accuracy but low interpretability..

The study in [11] investigated the relationships between

underlying factors and customer satisfaction in online ratings from visitors to the Hong Kong Disneyland hotel. Factor analysis, linear regression analysis, and semantic network analysis by Netdraw and SPSS 26.0, respectively, were some of the data analytic techniques used. The highest frequency words in the semantic network were investigated based on their co-occurrence matrix. To discover the hidden relationship between these terms, Freeman's degree and Eigenvector centrality were calculated. In [12] Text analytics was utilised to investigate the relationship between customer experience and associated satisfaction using big data on consumer experiences with front loading washers as reflected by reviews and ratings on the BestBuy website. Utilising linear regression analysis, the quantitative impact of each component was evaluated. By using factor analysis, the original 42 qualities, which were used as keywords in the evaluations, were reduced to 29 traits, which were then broken down into seven components.

METHODOLOGY

The proposed system is implemented using the methodology mentioned in fig 1. Dataset is preprocessed using different preprocessing steps. Then preprocessed data is used to extract features from the text using TF-IDF and word2vec. Extracted feature vectors are then passed to various machine learning algorithms.

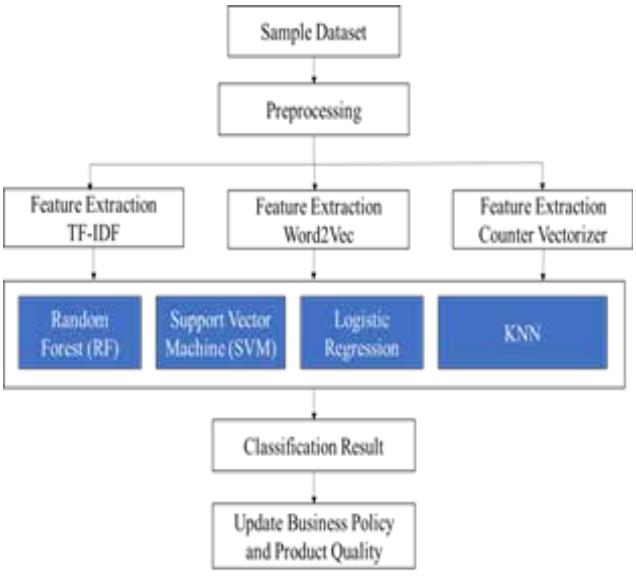

Fig. 1. Block Diagram of proposed Methodology

Dataset

In this study, various datasets have been used to examine model performance. A total of 413841 text-based reviews of mobile phones make up the first dataset. Name of the product, brand name, cost, star rating, and number of reviews. [12] used big data on customer experiences with front-loading washers as evidenced by reviews and ratings on the BestBuy website to study the relationship between user experience and associated satisfaction. The quantitative influence of each component was assessed using linear regression analysis. The 42 original features that were used as assessment keywords were condensed to 29 traits using factor analysis, which were then divided into seven components.

Data Preprocessing

a) Tokenization: The first step in preprocessing text data is to tokenize it, which means breaking the text into individual words or tokens. This can be done using various techniques such as whitespace splitting, regular expression, or using pre-trained models such as spaCy

b) Lowercasing: Convert all the words in the text data to lowercase. This helps in standardizing the text data as it treats words in uppercase and lowercase as the same.

c) Stop words removal: Stop words are common words that do not add much meaning to the text data, such as "the," "and," "a," etc. Remove these stop words from the text data as they can lead to noise and make the analysis less effective.

d) Punctuation removal: Remove any punctuation marks in the text data, such as commas, periods, or question marks. This helps in standardizing the text data and reducing noise.

e) Lemmatization or stemming: Reduce words to their base form using lemmatization or stemming techniques. Lemmatization involves reducing words to their base form based on their part of speech, while stemming involves reducing words to their root form. This helps in standardizing words with different inflections and reduces the dimensionality of the text data.

f) Handling contractions: Expand contractions, such as "don't" to "do not," "it's" to "it is," etc., to ensure consistency in the text data.

g) Handling special characters: Remove any special characters from the text data, such as HTML tags, emojis, etc.

h) Spell checking and correction: Check for misspelled words and correct them to ensure consistency in the text data.

i) Entity recognition: Identify and label named entities such as people, organizations, and locations in the text data. This can be done using pre-trained models such as spaCy or using rule-based methods.

Extract relevant features from the text data, such as n-grams, bag-of-words, or TF-IDF vectors, to represent the text data in a format that can be used for further analysis.

Feature Extraction

In natural language processing, feature extraction is a fundamental process that transforms text data into numerical feature vectors. This allows us to use machine learning algorithms to analyze and make predictions about the text. Three popular techniques for feature extraction are TF-IDF, CountVectorizer, and Word2Vec.

A statistical technique called TF-IDF determines a word's relevance in a document by multiplying its term frequency by its inverse document frequency. This means that terms that are frequently used in a specific document but uncommon throughout the corpus of papers are given more weight. The obtained feature vectors can be applied to tasks like information retrieval and text classification. Each row in the matrix produced by CountVectorizer corresponds to a document, and each column to a word in the corpus. The frequency of each word in the text is represented by the values in the matrix. This method is simple yet effective for text analysis tasks such as sentiment analysis and topic modeling. Word2Vec is a neural network-based approach that generates dense vector representations of words in a high-dimensional space. For tasks like language translation and sentiment analysis, these embeddings are very helpful since they capture the semantic and syntactic links between words. We can produce embeddings for specific words or groups of words by training a Word2Vec model on a sizable corpus of text data. These embeddings can then be used as input features for machine learning models.

Model Training

The choice of feature extraction technique depends on the specific requirements of the project and the nature of the text data being analyzed. It is important to experiment with different methods and compare their performance on the task at hand. By understanding these techniques, researchers can effectively analyze and make predictions about text data using machine learning. After extracting feature vectors from text using techniques such as TF-IDF, CountVectorizer, and Word2Vec, the next step in NLP model training is to pass these vectors to machine learning algorithms for classification or prediction tasks. In order to do this, the data must be split into training and testing sets. The models must then be trained on the training set, and their effectiveness must be assessed on the testing set.

Logistic Regression is a commonly used algorithm for binary classification tasks in NLP. It predicts the probability of a document belonging to a particular class, such as positive or negative sentiment. K-Nearest Neighbors (KNN) is another a text categorization system that is effective, especially when there are several classifications. A well-liked option for NLP jobs, Support Vector Machine (SVM) is a potent algorithm that performs well with high-dimensional data. Random Forest is an ensemble technique that blends various decision trees to increase the model's accuracy.

Following training and evaluation, metrics like accuracy, precision, recall, and F1 score can be used to gauge the models' performance. These measures aid in assessing model performance and contrasting the outcomes of various algorithms. It is significant to remember that the selection of an algorithm and hyperparameters depends on the particular project needs and the type of data being analysed. Overall, it has been found that the training of NLP models is most successful when feature extraction methods like TF-IDF, CountVectorizer, and Word2Vec are combined with machine learning algorithms like Logistic Regression, KNN, SVM, and Random Forest.

RESULTS AND DISCUSSION

Vectors obtained through feature extraction methods were used to train the model. Text data vectors are produced using TF- IDF, CountVectorizer, and Word2Vec. Vectors are then fed into a variety of machine learning training algorithms, including SVM, Logistic Regression, Random Forest, and KNN. Table 1 lists the accuracy for each model on the Phone dataset.

Table 1. Result of Phone review dataset

Feature	Model	Accuracy
TF-IDF	SVM	0.946908
	Logistic Regression	0.931531
	Random Forest	0.925219
	KNN	0.767077
Word2Vec	Random Forest	0.920524
	SVM	0.904014
	Logistic Regression	0.890741
	KNN	0.888152
Count Vectorizer	Logistic Regression	0.933959
	Random Forest	0.923438
	SVM	0.914212
	KNN	0.839430

From results in Table 1, TF-IDF outperforms all other techniques and provide accuracy in the range of 76% to 94%. TF-IDF SVM performs best out of all models and gives accuracy of 94%. KNN gives lowest accuracy in all models.

As we know that TF-IDF vectors are providing highest accuracy therefore used in training of musical instrument review dataset. Logistic Regression performs better than SVM and provide highest accuracy of 88% as mentioned in Table 2.

Table. 2. Result of Musical Instrument review dataset

Feature	Model	Accuracy
TF-IDF	Logistic Regression	0.88090
	SVM	0.87964
	KNN	0. 87164
	Random Forest	0.81785

Below in Fig. 2 confusion matrix is shown

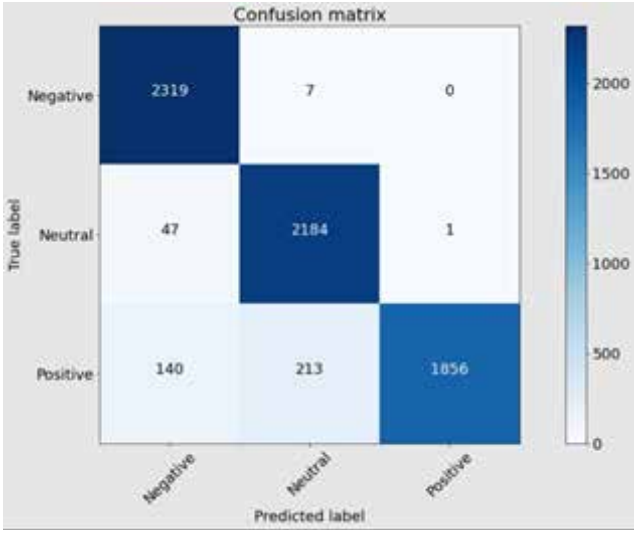

Fig. 2. Confusion Matrix of Music instrument review dataset.

CONCLUSION

In this research paper on customer review analysis using NLP, we explored the effectiveness of feature extraction techniques such as TF-IDF, CountVectorizer, and Word2Vec, followed by model training using algorithms such as Logistic Regression, KNN, SVM, and Random Forest. Our experiments on two datasets resulted in accuracies ranging from 80% to 95%, highlighting the potential benefits of NLP in analyzing customer feedback for businesses. By identifying areas for improvement and gaining insights into customer preferences and opinions, businesses can enhance the customer experience and inform product development and marketing strategies.

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Statistical Analysis of Retinal Image Processing Techniques from an Empirical Perspective

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ABSTRACT

DME is the main reason for loss of vision in diabetics and a major cause of diabetic retinopathy (DR). Excessive flow and deposition of the extracellular fluid inside the macular region are the main reasons for diabetes mellitus. Therefore, it has become a danger to people's health and lives. This article reviews DR, its features, causes, machine learning models, cutting-edge DL models, challenges, benchmarks, and future directions for research. Using fundus images and OCT scans, DME can be diagnosed at any level of DR. An autonomous detection method with computer vision can provide ophthalmologists with a detailed analysis of abnormalities, which is beneficial to them for diagnosis. This is why the introduction of deep learning (DL), the new field of machine learning, With efficient data processing, the DL model can handle small data sets. However, they often include larger datasets for their deep models to improve image extraction and classification performance.

KEYWORDS: *Diabetic retinopathy, Fundus images, OCT images, Deep learning.*

INTRODUCTION

India is going to be the "Diabetes Capital of the World" by counting the number of diabetic patients . According to the IDF, the population of diabetic patients was 53.7 crore in 2021 and is expected to reach 78.3 crore by 2045. The World Health Organization (WHO) revealed in its World Vision Report that more than 220 million people suffer from vision loss or impairment, with half of them being cured by proper treatment. As shown in Fig. 1, 3.9 million of these one billion people had vision-threatening DR. Prolonged diabetes, low blood pressure, and poor glycemic control are strongly connected with DR. Globally, DR, proliferative DR (PDR), and DME affect 6.96%, 6.81%, and 10.2% of the population, respectively. DME, therefore, affects 21 million people globally . The most frequent cause of visual loss in DR-affected individuals may be DME [1].

Common signs and symptoms of DR are blurred vision, hovering and blinking, and vision loss. DR is caused by changes in retinal vascular metabolism caused by irregular blood flow, leakage of blood and blood components through the retina, and thus damage to the macula. This causes the retinal tissue to swell, making vision cloudy or blurry. The disease affects both eyes and if diabetes is prolonged without treatment, DR leads to blindness and eventually diabetic maculopathy. When left untreated and undiagnosed, diabetic retinopathy (DR) progresses to more severe stages, leading to a decline in a person's vision. The disease can exhibit periodic or random progression, resulting in the formation of retinal lesions caused by ruptured retinal blood vessels (RBVs). These lesions include microaneurysms (MAs), haemorrhages (HEs), exudates (EXs), cotton wool spots (CWSs), the foveal avascular zone (FAZ), fibrotic bands, intraretinal microvascular abnormalities (IRMAs), neovascularization on the disc (NVD), neovascularization elsewhere (NVE), tractional bands, and more. These retinal abnormalities manifest in the fundus, which is the rear view of the eye. Timely detection of these retinal lesions and abnormalities is crucial as it aids in identifying the different stages of DR.

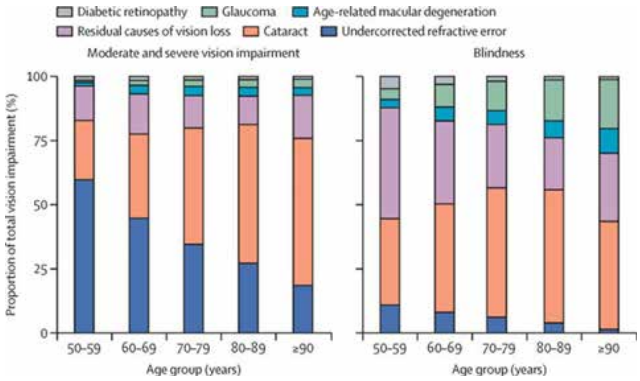

Fig. 1. Comparative analysis of vision impairment versus ocular diseases

To find out the advantages and drawbacks of various DME classification models that have used Deep Learning algorithms that use Color fundus images or OCT images in the diagnosis of DME is the main purpose of this study. It also summarizes the progression of the methods over time and highlights various re-searchable problems which need to be addressed in the context of autonomous DME diagnosis.

Aspects of diabetes mellitus

A chronic medical disorder called diabetes mellitus is brought about by insulin resistance or by altered insulin production in the blood. In people with diabetes, high blood sugar or glucose levels, known as hyperglycemia, can cause long-term difficulties with various body parts like the eye, kidney, neuro system, and cardiovascular diseases [2]. Long-term DME caused diabetic retinopathy and can cause vision loss in people of working age. Microaneurysms (b), haemorrhages (e), hard exudates, soft exudates (c,d,e,f), and neovascularization which are the lesions in the retina that results in blindness are the characteristics of DR which are shown in Fig. 2.

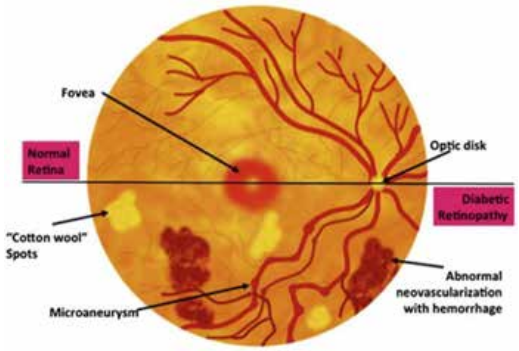

Fig. 2 Characteristics of DR

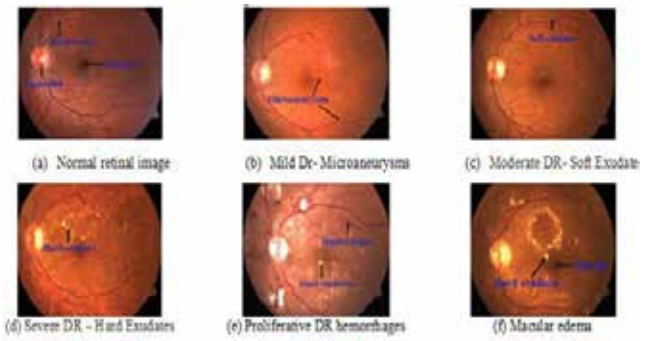

Fig. 3 Retinal Lesions

Various image modalities

Fundus Images

Fundus image has the potential to be a strong tool for the examination of diabetic ocular disorders and determining their progressive stages and how they respond to the treatment in diabetic patients. It is beneficial to evaluate DR because it allows for the visualization of intra-retinal microvascular abnormalities (IRMAs), venous beading, soft and HE lesions, microaneurysms, haemorrhages, and neovascularization [3]. Fig. 3 is obtained using a camera to capture the fundus images, shows DR lesions. The publically available standard data sets are given in the following Table 1.

Table 1: Publically available data sets for fundus images

Data set	Total images	Resolution	Field view of camera (in degree)
EyePACS	88702	NA	--
APTOS	5590	NA	--
MESSIDOR	1200	1440X960 2240X1488 2304X1536	45
MESSIDOR 2	1748	NA	45
IDRiD	516	4288X2848	50
DDR	12522	NA	45
E-Ophtha	463	NA	50
DiaRetDB1	89	1500X1152	50
DRiDB	89	768X584	45
ROC	100	768X576 1058X1061 1389X1383	45

Optical coherence tomography (OCT)

With optical coherence tomography (OCT), eye surgeons can take a cross-sectional view of the retina with the help of light waves in three dimensions. This allows the ophthalmologist to determine the density of various layers of the retina. The publically available standard data sets such as Biomedical Image & Signal Analysis (BIOMISA), Dukes, OPTIMA Cyst segmentation challenge, Noor Eye Hospital (NEH), Mendeley (Ker- many datasets), Dukes2, Retinal OCT Classification Challenge, RETOUCH, OCTID which are used by researchers. Sample OCT scan is as shown in Fig. 4 with marked features.

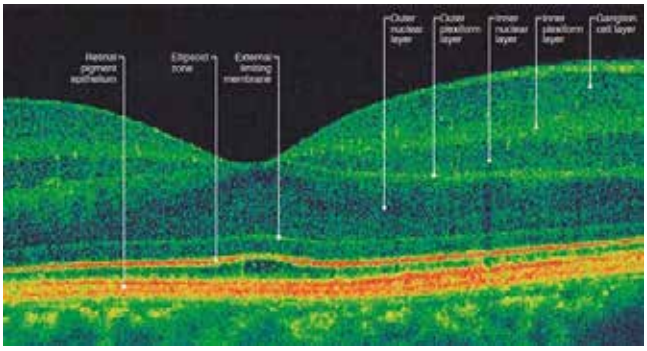

Fig. 4 Sample OCT scan

The research conducted by numerous researchers is discussed in Section 2 of this article. The effectiveness of various algorithms depending on various factors is examined in Section 3. A comparison-based conclusion is drawn in Section 4.

LITERATURE SURVEY

DME detection using fundus images

DME in fundus imaging is defined by the presence of lesions like hard and soft exudates (EX). For quick identification and analysis of the DME, it is essential to consider the location of the macula, fovea, OD, or lesions close to the macula. The many ML-based methods that have been used in these experiments to determine DME from CFP are addressed in this section.

Various Deep learning algorithms are used to detect DR from fundus images. The methods are mainly based on custom convolutional Networks (CNN), Object detection, Ensemble of DL classifiers, Generative adversarial Networks, Transfer-Learning (TL) methods, Auto Encoder (AE), and CNN models with attention Mechanism.

The authors [4] proposed a novel methodology to identify diabetes-based ocular diseases, which consists of DME, DR, and Glaucoma with the application of FRCNN (Fast Region Based Computational Neural Network) with FKM (Fuzzy K-means Clustering) FKM The technique consists of two phases. The first phase consists of the detection of disease and localization phase. The second phase includes the segmentation of the localized regions using FKM clustering. The proposed network can locate the deep features with an absolute representation of ocular diseases and this results in increased efficiency of segmentation in contrast.

The layers for the CNN model consist of Convolution, poll and completely connected layers. The deep architecture of CNN is what gives it its power because it can automatically retrieve distinctive features at many levels of abstraction. The author proposed a novel method with the DME Net 120 algorithm. It pre-processes the fundus image in two stages. The first stage consists of classification between normal and infected images and the next stage classifies the infected image into various stages of DR. It uses the Hierarchical Ensemble of Custom Convolutional network for the classification [5].

S. Wang et al [6] trained an MGAN (Multi-Channel based Generative Adversarial Network) to classify fundus images into various stages of Diabetic retinopathy. This model extracts a series of sub-fundus images which are related to various features of DR. MGAN is capable of identifying the various features of Fundus images without reducing the size of high-resolution images. It gives the advantage of reducing the dependency on labelled data.

Researchers [7] proposed the DR-GAN (DR- Generative Adversarial Network), to process high-resolution images with configurable grading and lesion details. This facilitates the augmentation of data on a larger scale for DR segmentation and grading applications. The retina generator is conditioned through structural and lesion masks and adaptive grading vectors from the latent grading space enabling adjustable severity

for synthesized grades. Moreover, this includes a multi-scale spatial and channel attention module.

As discussed by the work in [8], it is essential to have the capacity to estimate the topology of the vascular networks in complex networks to have a comprehensive grasp of vascular changes and the many diseases that they might cause. To assist in the diagnosis and treatment of eye diseases, the retinal vascular trees are often mechanically dissected into the accompanying arteries and veins. The need to take into consideration projective ambiguity in addition to slight differences in lighting, contrast, and geometry adds to the complexity of the situation. Researchers have developed a novel method that uses the topology of the vascular network to differentiate between arteries and veins in CF images of the retina. This method is based on the fact that veins are more prominent than arteries. Both the estimation of the topology of the retinal blood vessels and the categorization of the A/V are framed as issues of pairwise clustering, and researchers use dominant set clustering to solve both. A graph may be constructed by first finding nodes, then segmenting pictures, and finally making an image. The "weight" of the edge may be determined by dividing the inverse Euclidean distance between its endpoints by the ratio of the edge's intensity, direction, curvature, diameter, and entropy. This then yields the "weight" of the edge. Aortas and veins that have undergone effective healing have a particular morphology and level of intensity.

DME detection using OCT scans

It is feasible that 3D-to-2D image segmentation in OCTA scans may be accomplished by using an innovative end-to-end architecture that is known as an image projection network (IPN). This design was proposed by medical imaging experts [9]. The creation of a projection learning module (PLM) that chooses and eliminates features concurrently via the use of a unidirectional pooling layer is their key contribution. By merging several PLMs, the proposed network can analyse 3D OCTA data and give 2D segmentation outputs, including the segmentation of retinal vascular structures. The measurement of retinal indicators does not need the use of projection maps or segmentation of the retinal layers. The researchers put their network to the test by requesting that it extract retinal vasculature (RVs) and the foveal avascular zone (FAZ) from photographs of the retina. The use of IPN as a 3D-to-2D segmentation network is successful, as shown by experimental data derived from 316 OCTA volumes. IPN is an advancement of state-of-the-art procedures since it integrates data on many modalities as well as volumetric measurements.

According to research that was presented in [10], scans obtained from retinal optical coherence tomography (OCT) might potentially be used to identify visual problems. The underlying factors that contribute to these visual irregularities include shifts in the orientation of the optical coherence tomography (OCT) B- scan and inconsistencies in the layers of the retina. The accuracy of the OCT image analysis will suffer as a result of these alterations. Researchers have developed a pre-processing method that may be used for B-scan alignment as part of this study. The investigators begin by putting forth a TV-UNet model as a means of precisely locating the retinal pigment epithelium (RPE) layer in each B-scan. Researchers determine a baseline and a curvature curve by making use of the RPE layer that has been revealed. To retain the size and form of the sick lesion, a one-of-a-kind alignment strategy that is window-transferring based is required. This strategy must be used to coerce curve points into constructing a straight line. For both training and testing the TV-UNET, the researchers used a wide variety of datasets.

As shown in [11], optical coherence tomography angiography (OCTA) is a non-invasive imaging technology that may be used to examine retinal capillaries. This method offers resolution on the micron scale. Studies that demonstrate a link between micron-scale parameters and the degree of the retinal disease have pro- vided evidence that confirms the diagnostic utility of macular OCTA vascular measures. These metrics have their foundation in the statistical summaries of the retinal layers and regions of interest in 2D and face projection images. OCTA pictures are used by re- searchers to generate a map of retinal vascular density. This is done so that they may investigate the changes in retinal vasculature that occur across different populations and longitudinal scans. Researchers can get a high-quality three-dimensional representation of OCTA-based vessel networks by

using curvelet-based denoising and optimally guided flux (OOF). After that, a three-dimensional map of the density of the blood vessels in the retina should be created. After that, the vessel mask from an OOF-based analysis is diffused throughout the whole of the picture volume to provide a vessel density image (VDI). To conduct inter-patient comparisons of retinal vasculature, non-linear three-dimensional OCT image registration is used. To demonstrate the efficacy of their methodology, the researchers tracked the progression of two diseased patients who had oedema during their studies. Their method is statistically tested by employing simulated capillary dropout data, along with a normal control population that is broken down into two age groups, and patients who have diabetic retinopathy (DR). Even in the presence of oedema, researchers have the potential to see localized vascular abnormalities as a result of simulated capillary loss, natural ageing, and DR illness. These results provide evidence that the framework has the potential to identify microvascular alterations and monitor the progression of retinal diseases.

Experts in the field of retinal image processing [12] believe that medical image registration could be used to evaluate longitudinal and cross-sectional data, objectively track the progression of a disease, and direct a computer-assisted diagnosis and treatment plan. These are just some of the potential applications of this technique. There has not been a lot of research done on de-formable registration for retinal OCT pictures, which is a method that enables more precise and quantitative comparisons. According to the findings of this study, a 3D retinal OCT registration approach known as OCTR expert (OCT RE) should be used. This method is the first attempt to full 3D registration for retinal OCT photographs, and it may be used to analyse longitudinal OCT data for persons who are healthy as well as those who have diseases. To implement this method, initially, an eye motion artefact reduction technique will need to be carried out, and then a design detection deformation registration procedure will need to be performed. During the process of creating a picture, many properties are affixed to each voxel that makes up the image. The process of "detection" involves picking voxels that are "active" and building "point-to-point" correspondences between them. The picture undergoes a hierarchical transformation as a result of the multi-resolution deformation process. The recommended method was put to the test utilizing longitudinal OCT images on a total of twenty healthy participants in addition to four patients who had choroidal neovascularization (CNV).

Researchers [13] have developed a bias-free method of automated segmentation that may be used for optical coherence tomography (OCT) images in this study. The intensity, gradient, and adaptive normalized intensity scores of the segmented scans are taken into consideration by deep neural network regression while attempting to predict the retinal border pixel (ANS). Recasting the problem of segmentation as one of regression removes the need for a large dataset and simplifies the work at hand. On OCT scans with intensity changes, low contrast, speckle noise, and blood vessels, the use of ANS enhances the method's accuracy while also increasing its processing speed. During testing with 114 photos, it took 10.596 seconds for each image to identify eight boundaries, but during training, it took 30 seconds per boundary line. The dice comparison found a similarity index of 0.966 between the two sets, suggesting a good level of precision in the results. Researchers were able to attain an average disparity of 0.612 pixels between human and automatic segmentation by adhering to the strategy that was advised.

According to the findings of the study [14], a modality-specific attention network (MSAN) may be used to classify multi-modal retinal images. This network may use diagnostic pictures of both the fundus and the OCT. MSAN is equipped with two different focus modules: one is for fundus images, and the other is for OCT Scans. Ophthalmologists are required to do a local as well as global analysis of the fundus picture (e.g., from microaneurysms at the micrometre level, optic disc at millimetre level to blood vessels through the whole eye). Therefore, the researchers provide a multi-scale attention module that is specially adapted to fundus visuals. Images obtained with OCT that include substantial background patches cannot be utilized for diagnosis. As a result, it has been recommended that an attention module that is led by regions be used for encoding retinal layer information in OCT images. In the end, researchers develop a retinal image categorization network by fusing modality-

specific characteristics into a multi-modal feature. The model takes into account aspects that are unique to each modality so that it may provide a more precise diagnosis. Their MSAN surpasses previous single-modal and multi-modal retinal image classification systems, as shown by experimental results employing a multi-modal retinal image dataset (fundus and OCT) gathered in a clinical context. Researchers [15] have developed a system that is based on ensemble learning (EL) that can segment retinal boundaries in OCT images in a way that is resistant to defects in the retina. The recommended method's accuracy in segmentation was evaluated using two datasets that were available to the general public. These datasets included photos of severe retinal oedema. The suggested strategy was evaluated alongside two other approaches that are more common. The recommended technique was an improvement over the conventional approaches since it was better at differentiating between normal and pathological retinal boundaries. After conducting an exhaustive reliability examination, it was shown that the manual Measures computed using human annotations and the manual measures produced by applying the suggested technique yielded results that were significantly concordant with one another.

OBSERVATIONS

Based on the review of existing retinal image processing models, it can be observed that bioinspired & deep learning models outperform existing methods in terms of applicability and performance metrics. To further validate this claim, a comparative analysis of these methods is provided in this section, where the reviewed methods are evaluated in terms of accuracy of disease detection (A), precision (P), delay needed to identify diseases (D), computational complexity (CC), and scalability (S) of deployment for different use cases. Accuracy & Precision were directly inferred from the reference documents, but delay, complexity and scalability levels were quantized into ranges of Low (L=1), Medium (M=2), High (H=3), and Very High (VH=4), which will assist readers to compare these techniques on a uniform set of scales. Based on this strategy, the comparison of these models is tabulated in Table 2 and a graphical comparison is given in Fig 5 and Fig 6 respectively.

Based on this evaluation, INSPIRE, PLM , OOF, ANS, MSAN and UNet showed higher accuracy, which is the best method for deep learning for retinal imaging tasks. Therefore, these models should be deployed for very precise use cases. OOF and DRIVE demonstrated higher accuracy using a simplified classification interface. Therefore, these techniques can be used for applications that require high consistency of retinal image processing for various batch operations.

In terms of computational complexity, EL and CAMR are superior to other models and are very useful for low-complexity applications. Therefore, these models should be used for high-performance and low-complexity deployments. It is observed that PLM and ANS are faster, so they can be used in low-latency cases. These models are also useful for large-scale applications that require high throughput with some level of efficiency.

Table 2 Comparison of performance of various algorithms

Model	A	P	CC	D	S
INS PIRE [8]	95.1	91.4	H	VH	H
PLM [9]	97.4	92.7	H	H	H
OOF [11]	97.4	94.1	H	H	H
OCT RE [12]	96.1	90.3	L	VH	H
ANS [13]	96.5	92.1	H	VH	H
MSAN [14]	97.5	93.9	VH	H	H
EL [15]	91.5	90.8	M	H	H
Seg RAVIR [16]	96.5	94.2	H	H	M
CAMR [17]	93.5	93	L	VH	H
UNet [18]	96.5	93.5	VH	H	H
GLUE [19]	97.8	91.2	H	H	H
DRN [20]	90.5	91.6	H	VH	H
RL [21]	94.5	93.8	H	H	M
LR [22]	85.5	91.2	H	H	H
MTLS [23]	85.3	87.3	H	H	H
OCTA Net [24]	90.5	90.5	H	VH	M
FS GAN [25]	94.8	92.4	L	H	H
MGAN [26]	95.3	92.9	H	H	H
Skel Con [27]	96.2	92.3	VH	H	M
CNN [28]	93.4	90.5	H	H	H
DRIVE [29]	90.8	92.8	H	H	M

Fig. 5 Graphical representation of the accuracy of algorithms

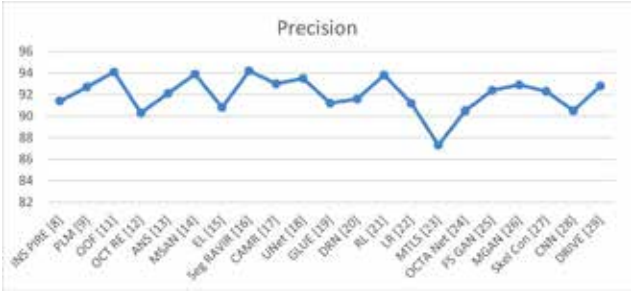

Fig. 6 Graphical representation of precision of algorithms

CONCLUSIONS

In terms of applicability and performance metrics, bioinspired and deep learning models outperform existing methods for retinal image processing based on a review of existing models. Due to the use of deep learning for retinal image processing operations, PLM, OOF, MSAN, RAVIR and GLUE demonstrated greater accuracy based on accuracy evaluations. Therefore, these models must be deployed for use cases requiring high precision. Similarly, OOF, MSAN, Seg RAVIR, CAMR, UNet, and RL exhibited greater precision due to the application of simplified classification interfaces. Thus, these methods can be utilized for applications requiring a high level of consistency in retinal image processing for various deployment operations. AGAN, PSO, and EL outperform other models in terms of computational complexity, making them exceptionally useful for low-complexity applications. Thus, these models must be utilized for deployments with high efficiency and low complexity. It can also be observed that AGAN and RDE have a higher speed and are therefore suitable for use cases with low delay. These models are also useful for large-scale applications that require consistent processing speed at a high level of efficiency for different use cases. In terms of scalability, DNN, AGAN, DDN, and DSC are observed to have superior performance and can be applied to a wider variety of use cases. To further facilitate model selection, a Retinal Rank Metric RRM, which combines these parameters, was estimated. This resulted in the identification that PLM, OOF, MSAN, CAMR, UNet, FS GAN and MGAN exhibit higher accuracy, higher scalability, lower complexity, high speed, and high scalability for different use cases. In terms of real-time evaluation scenarios, it is also possible to observe that Deep Learning Models outperform other models.

FUTURE SCOPE

In the future, the performance of the reviewed models must be evaluated on larger scenarios, and it can be enhanced through the incorporation of low-complexity bio-inspired models such as Particle Swarm Optimization PSO, Grey Wolf Optimization GWO, etc. This performance can also be enhanced through the use of Auto Encoders AEs, Generative Adversarial Networks GANs, and other incremental learning techniques, making these models applicable for real-time clinical use cases.

Conflicts of Interest

The authors declare no conflicts of interest.

Statement of Ethical Approval

For this type of study, statement of human rights is not required.

Statement of informed consent

For this type of study, informed consent is not required.

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A Novel Method for Anemia Detection based on Classification Approach using Artificial Neural Network

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ABSTRACT

Anemia is a result of a deficiency in hemoglobin (Hb), a vital component in human blood. According to the World Health Organization (WHO), Anemia is a serious global health problem that affects a large portion of the population, particularly women and children. Hence, determining the hemoglobin content in blood chemistry is a crucial and basic step in the diagnosis of anemia. The approach for estimating hemoglobin in blood in this study uses artificial neural networks (ANN) and digital image processing approach. The proposed method is based on color parameter measurement. 72 blood samples are used for proposed work. A Back-Propagation Network (BPN) algorithm is implemented on statistical and discrete cosine transform (DCT) features of each image. The algorithmically detected hemoglobin values are verified against standard reference method. Overall 92% accuracy was achieved in the results. This BPN based method on gives a cost-efficient alternative for hemoglobin estimation for anemia diagnosis.

KEYWORDS: *Anemia, Artificial neural network, Back propagation algorithm, Discrete cosine transform, Hemoglobing.*

INTRODUCTION

Anemia has recently become a serious health concern for children and expectant mothers in developing nations like India. World Health Organization (WHO) estimates that 40% of pregnant women and 42% of children under the age of five globally are anemic [1, 2]. Considering this, Anemia arises as a critical concern at community level but still little attention paid towards this issue. The research work proposed in this paper aim to provide a simple and effective method for anemia detection by detecting Hb level in the blood. Red blood cells mostly consist of hemoglobin (Hb). Hb concentration in human blood is a significant factor in determining an individual's physiological state and a crucial factor in a complete blood count. Hemoglobin level in blood is the primary factor impacting the severity of anemic condition in the population because low Hb concentration in the blood is recognized to be anemia in patient. Hemoglobin levels are displayed in the table below to help determine the presence of anemia [3].

Hemoglobin represents the relative amount of the hemoglobin protein within red blood cells compared to the overall blood volume. This measurement holds significant significance in clinical diagnostics and routine blood screening, serving as a crucial indicator for various conditions including chronic hypoxia, polycythemia vera, thalassemia, as well as severe physiological situations like blood loss and dehydration It can offer helpful insights into the circulatory system's vitally crucial roles in oxygen and carbon dioxide transfer, as well as the control of the acid-base balance [11]. A technique and system for detecting the concentration of Hb is therefore desired as help in the diagnosis & monitoring of such conditions.

Other than cyanmethemoglobin or HemoCue procedures, which are recommended by the WHO, various methods are used in the majority of clinics

and diagnostic laboratories. The results acquired using these approaches exhibit substantial difference from readings obtained using standard methods and have given an inaccurate measurement of Hb level in blood, can create a misleading perception of safety, which in turn complicates the interpretation of abnormal health conditions. In addition to this, in developing countries like India, in rural areas with low resource setting does not have basic diagnostics facilities and hence an accurate, straightforward, precise, and feasible method for the determination of blood hemoglobin content is required which should be cost- effective also. A potential development in this area is proposed in this research paper by estimating the hemoglobin in blood using digital image processing techniques and artificial neural network algorithm [14].

The next sections of this article are organized as following: The related works and its shortcoming are described in the section 2, Section 3 discusses the proposed methodology step by step, the method is simulated and experimental results are shown in the section 4, Section 5 expresses the conclusion.

Table 1: Hemoglobin Level for Anemia Diagnosis (in gm/dl)

Population	Non-Anemia	Anemia		
		Mild	*Moderate*	*Severe*
Children 6 - 59 months of age	11.0 or higher	10.0 – 10.9	7.0 - 9.9	lower than 7.0
Children 5 - 11 years of age	11.5 or higher	11.0 – 11.4	8.0 - 10.9	lower than 8.0
Children 12 - 14 years of age	12.0 or higher	11.0 – 11.9	8.0 - 10.9	lower than 8.0
Non-pregnant women (15 years of age & above)	12.0 or higher	11.0 – 11.9	8.0 - 10.9	lower than 8.0
Pregnant women	11.0 or higher	10.0 – 10.9	7.0 - 9.9	lower than 7.0
Men (15 years of age & above)	13.0 or higher	11.0 – 12.9	8.0 - 10.9	lower than 8.0

RELATED WORK

There are two types of anemia detection: invasive and non-invasive. A sophisticated hemoglobin photometer is used in invasive approaches like the HemoCue method to forecast precise outcomes. It is battery-operated, portable, but expensive. The World Health Organization (WHO) color-scale technique is reasonably priced. Using a colour scale, it estimates the hemoglobin amount by putting a drop of blood on small card with six shades. Depending upon the colour match with shade card the Hb content will be estimated. Nevertheless, compared to the HemoCue approach, this method is less accurate [6, 9].

Sahar J. Mohammed et.al. proposed a method for anemia prediction based on rule classification [5]. The dataset collected from 539 patient is used to detect six different types of anemia. The approach utilized by research for anemia detection is based on data mining. The algorithm model such as ZeroR, OneR & PART are implemented for classification purpose. A precise anemia prediction system is designed using these three rule classification methodologies. OneR produced around a 50% increase in accuracy over ZeroR, a simple classifier with the lowest accuracy. In terms of the strategies used, PART offered 85% more accuracy than ZeroR and OneR.

Amir Aslan Aslani et.al. [7] detected the anemic condition in individual by automatic counting red blood cell (RBC) in microscopic images of blood sample. The authors have used circular Hough transform (CHT) and endpoints method to predict the anemic condition based on counting approach. On the input image, two concurrent tasks are carried out. The input image is segmented in the first task using thresholding and erosion on the green channel. The input image in the 2nd part is turned into a grayscale image and edged using the Canny method. In order to remove White Blood Cells (WBCs or leucocytes), the segmented picture is then subtracted from the bordered image. After the margin has been inserted, the image will have estimated RBC continuation added by setting Endpoints. Finally, CHT is applied to the image and it will calculate the number of RBCs. Moreover, new measures for counting error and accuracy have been defined. A fifteen-image sample from the ALL-IDB1 database is employed to evaluate the method.

Digital image processing and support vector machine based approach of RBC morphology counting and grading can also be utilized for iron deficiency detection and thus useful for anemia identification [8]. This approach suggested by R. V. Pellegrino et. al. acquired peripheral blood smear samples and creating a prototype that could analyses them using Raspberry Pi hardware. The system categorized, tallied, rated, and offered suggestions for related diseases for the sample PBS test. The average accuracy of the described system's reading

of the samples of target cells, elliptocytes, and normal red blood cells was 95.77%. against pathology reading.

The approaches discussed for detecting anemia are based on RBC counting, which might lead to ambiguous outcomes. So, considering this, a novel approach based on classification approach is put forward in this research article. It will directly establish a linkage between colour of blood sample and Anemia identification using artificial neural network approach. The proposed methodology returns the result in term of percentage correct classification (PCC) to Hb value of blood sample thus helps to identify the anemic condition in patient [16].

SYSTEM DEVELOPMENT

The proposed methodology describes the system implementation using artificial neural network approach. It also depicts the interrelation of colour of blood sample and Hb value of sample. The detailed process of feature extraction is explained in this segment with the help of block diagram. Finally, the application of backpropagation algorithm is discussed in detail.

Color of Blood Sample and HB Value

Human Blood consists of cellular material, water, amino acids, proteins, cellular wastes etc. red blood cells is major component of cellular material which mainly constitutes 99% of total volume and the remaining is made up of platelets and white blood cells (WBC). Each red blood cell has a volume of around 1/3 Hb. Centrifuging (spinning) is the most used technique for separating blood. Blood that has been centrifuged exhibits three layers which are Plasma, (about 55%), second is the buffy coat made up of platelets, WBC etc., and the third is the heavy bottom part of the segregated mixture or around 45%, is made up of red blood cells [4]. Consequently, it may be concluded that the Hb content of blood can be precisely estimated based on the blood colour. It is common practice to determine the Hb concentration in blood by observing the colour of the blood with direct vision or by utilizing certain chemicals. For colour matching, these techniques rely on human perception. In context of this, estimating Hb may depend on the colour of the blood. Using machine vision, we aim to replace the subjectivity of human colour perception. So, we made the decision to employ a technique to convert each blood sample's colour information into a digital image file. The relationship between the Hb value and the amount of red content in a blood sample image is depicted in the graph below. It can be concluded that as Hb value goes on increasing the red content from RGB plane also goes on increasing.

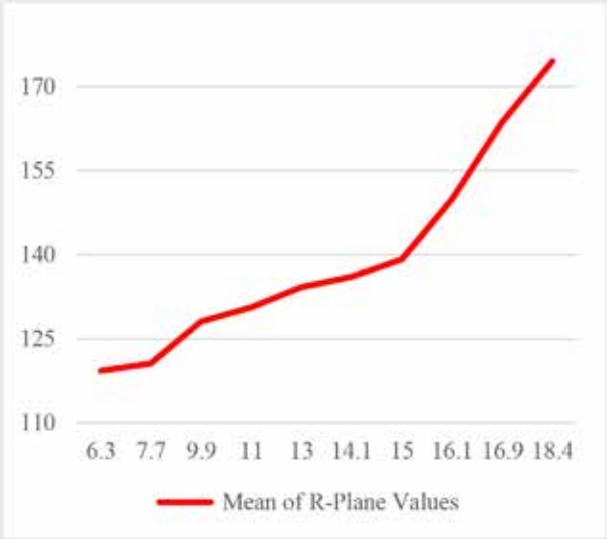

Fig. 1. HB Values Versus Mean of R-Plane Values

Proposed Methodology

The proposed methodology is depicted in the block diagram provided below and explained in detail in this section.

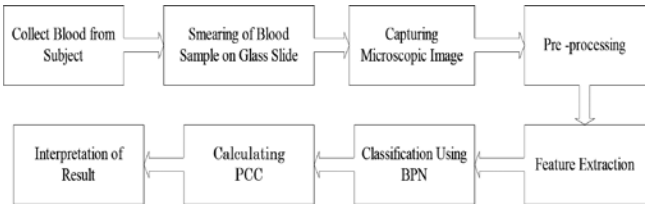

Fig. 2. Block diagram of proposed methodology

The digital images of blood sample are collected from local hospital. The blood samples are collected from different cross section of people of different age group. The color information can be extracted from digital image of blood sample which is used to estimate Hb. The glass slide is prepared by smearing volume of 10 microlitre a blood sample on glass slide and is covered with glass cover slip so that it should be uniformly spreaded. Smeared glass slide of a blood sample is then placed under microscope to capture images of blood

sample. High-resolution images of the blood sample are taken using a camera with superior image quality, which is attached to a microscope magnified by a factor of 10. In this implementation, we are using images having pixel size 1024 x1280 pixel with .BMP format. There are several file formats available for storing digital images that have been acquired. The available image file formats are Bitmap (.BMP), Joint Photographic Expert Group (.JPG), Tag Image File Format (.TIFF) or Portable Network Graphics (.PNG) file format. Out of these, .BMP and .TIFF files have the ability to transmit color information without compromising quality and original features. The other image formats such as .JPG and .PNG files lose some color information, as a result of the original files being compressed for file size reduction. Considering all these factors regarding quality, size, features etc., for the implementation of proposed system, the .BMP image file types have been utilized for system development.

Fig. 3. Microscopic image of blood smear with HB level (HB value is in gm/dl.)

The captured are then pre-processed to extract features of an image for classification. These features mainly include statistical features i.e. mean and standard deviation, statistical feature of discrete cosine transform (DCT) of an image and binary feature of image. Classification of various Hb sample is carried out using back-propagation network which implies supervised learning approach for processing. Finally, the correct percentage of classification i.e. percentage correct classification (PCC) of Hb sample is calculated.

Feature Extraction Methods

Statistical Feature Extraction Methods

The complete process for statistical feature extraction method is explained using block diagram is as shown in Figure 4. Here, we are calculating mean and standard deviation as feature vector for classification using back-propagation algorithm.

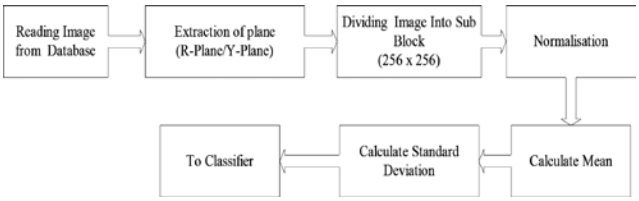

Fig. 4. Flow for Statistical Feature Extraction

The required R-plane from RGB model and Y-plane from YIQ model is extracted for an HB sample microscopic image from the database. Then, the image is divided into sub block of size 256×256 and normalization is carried out on each block to normalize the pixel value in each block. The range of pixel intensity levels is updated due to process of normalization. The normalization will eliminate the redundant data in an image. In this proposed approach, pixel intensity values of each block are normalized over the range 0 to 255. The mean and standard deviation are calculated of these normalized data which are provided as input feature to back propagation algorithm for classification.

DCT Feature Extraction Methods

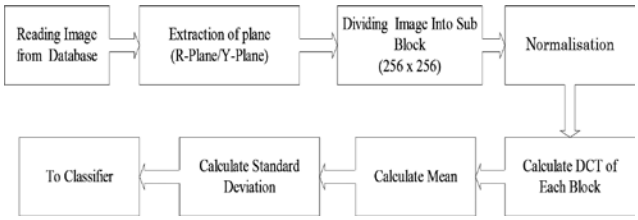

Fig. 5. Flow for DCT Feature Extraction

The detailed flow for feature extraction using Discrete Transform Cosine (DCT) algorithm is described with the help of block diagram in figure 5. The importance of utilizing the discrete cosine transform (DCT) for feature extraction lies in its ability to divide the image into spectral sub-bands of varying significance based on the visual quality of the image. This enables the extraction of more valuable information from the blood sample image. The DCT values of normalized images are calculated which are used to find out feature vector for classification. Mean and standard deviation of DCT values are computed to provide it as a feature vector.

Back Propagation Algorithm

While the back-propagation network (BPN) algorithm technique is a mathematically intricate tool, its

implementation becomes straightforward on a computer due to the iterative nature of the training equations.

A pair of patterns (Xk, Tk) are provided to the network during training, with input pattern is denoted by Xk and target or desired pattern is denoted by Tk. Each layer's trained neurons respond to the Xk pattern's output signals, which results in an output OK at the output layer of neural network. A feedback signal is generated at the output layer as a result of the difference between the actual and desired outputs. The weights of the neurons in each layer's neurons determine the value of this error signal. In the process of minimizing this inaccuracy, new weight values are determined. This depends upon the learning rate factor which maintains the speed and accuracy of the training process [10].

In order to start BPN learning process, we require the following set of input for training purpose:

- The set of training patterns, input and output
- The learning rate value
- Algorithm Termination criterion
- Initial weight and Weight updating Methodology
- The nonlinearity function (usually the sigmoid)

After getting this initial parameter, the backpropagation network algorithm can be implemented for desired system development.

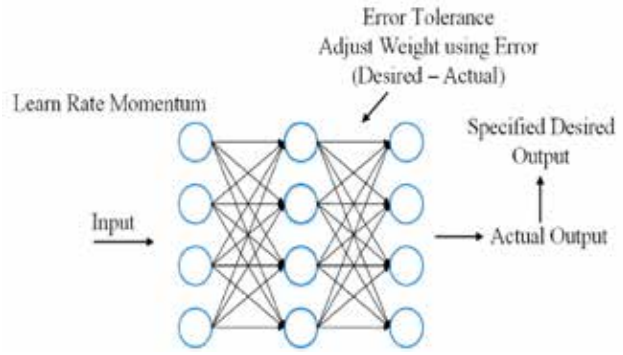

Fig. 6. BPN Learning Process

The initial input sequence(pattern), Xk and related desired outcome, Tk are then applied to begin the procedure. The input causes a response to the neurons of the first layer, which in turn cause a response to the neurons of the next layer, and so on, until a response is obtained at the output layer. The response obtained at output layer is then compared with the target response and the error signal is calculated. The algorithm determines how quickly the error fluctuates as the neuron's activity level varies, compared to the difference in error observed at the output neurons. The computations up to this point were forward-looking (i.e., towards the output layer from the input layer).

To reduce the error in the output, the algorithm takes a step back to the preceding layer and recalculates the weights of the output layer. This will result in modification of the weights of neurons between the last hidden layer and the output layer. The algorithm follows this identical process of calculating the error and determining new weight values, progressing layer by layer in reverse until it reaches the input layer. At this stage, weight updation process stops and then the next pair of input-output sequence is to be chosen by algoriand are processed with identical algorithm steps. Despite the condition that responses are moving forward towards output layer, updated weights are determined by going backward towards input layer [10].

Implementation

ANNs are computational models that can offer feasible solutions to issues when there isn't a known empirical relationship between the problem's input and output parameters. These ANNs must be trained using examples of input-output value pairs. It has been observed that choosing the right input variables will significantly affect how well ANNs work. Back Propagation algorithm from artificial neural network is used in this system implementation since, there is no explicit relation between input and output. Hence, in this system, use of BPN is preferred.

BPN architecture which have been implemented, as illustrated in figure 7 comprised in one input layer, three hidden layers, and one output layer make up five-layer structure. The hidden layer count and the neurons count in each hidden layer varies depending on the level of accuracy and computation time that is acceptable. Three hidden layers with 15 neurons in each layer gives best classification. The MATLAB software with image processing toolbox and statistics and machine learning toolbox is used for implementation of proposed system.

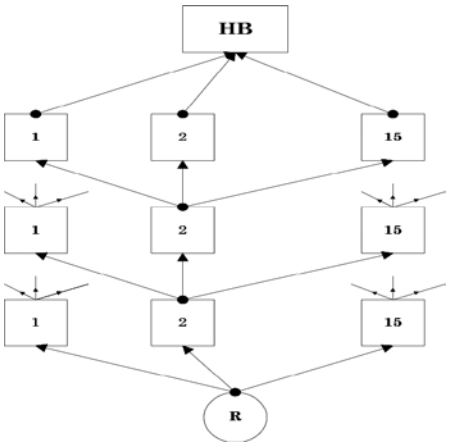

Fig. 7. Implementation Process

RESULTS AND DISCUSSION

For performance evaluation of implemented system, total 72 samples across different age group and gender were collected. The database is categorized into training dataset and testing dataset. Out of total 70 samples used for experimentation, 70% of samples were used for training part and remaining 30% samples were utilized for testing purpose. The accuracy for classification approach is calculated and use as major factor performance analysis purpose. After several iteration, it is determined that the BPN configuration with three hidden layers comprising fifteen neurons each yields the optimum desired results for backpropagation networks. It is verified that BPN architecture with more than three hidden layers and excessive neurons per layer, does not gives optimal accuracies for best results for the implementation.

For analysis purpose, we are extracting mean and standard deviation of R-plane and Y-plane as well as of DCT of R-plane and Y- plane which are used as input feature for classification. The classification is based on HB values. The given Hb sample is to be classified according to its values. The classes will be range of HB values and depending on range, we have the number of classes. The analysis is carried out using two, three and five class classification approach. The accuracy for each is calculated for different set of features as explained earlier. The epoch also plays a important role in deciding the accuracy of classification. The maximum accuracy is obtained for epoch value of 15000. The results are tabulated as below:

Table 2. Accuracy for Classification

Feature	Two-Class	Three-Class	Five-Class
R-Plane	87.75%	87.68%	71.33%
Y-Plane	92.66%	89.72%	75%
R-Plane DCT	86.08%	74.53%	72%
Y-Plane DCT	84.33%	81.29%	69%

The figure below shows graphical representation of tabulated values of accuracy for classification.

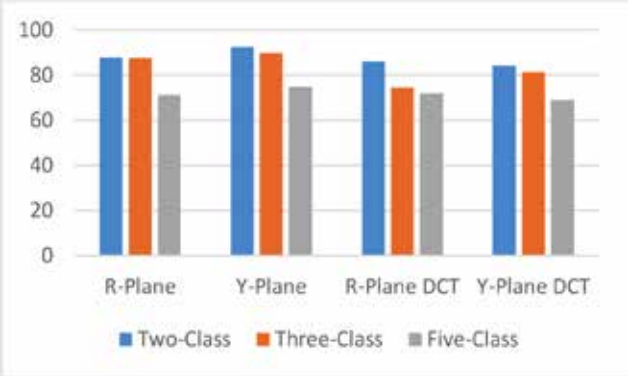

Fig. 8. Accuracy for Classification

Based on classified value, we can decide patient's the anemic condition as per the range mentioned for anemia detection in Table 1 earlier the research paper.

CONCLUSION

The proposed system described in research paper is efficient in classifying the given blood sample according to specified ranges to ensure detection of anemic condition in an individual. To achieve this objective, classification approach based on backpropagation algorithm of artificial neural network is employed which gives accuracy up to 92%. The proposed methodology explains the detailed procedure for database collection which includes emphasis on relation between colour of the blood sample & Hb value and process for capturing the blood sample microscopic images. The feature extraction process involves the system to be analyzed for the different set of features of samples. Thus, ensuring that the results is 0to be obtained for best set of extracted features. Finally, back propagation algorithm is implemented for the classification of input sample among the range of Hb values. This system will help

to determine the anemic condition among individuals living in the rural areas where the basic diagnostic facilities are not easily available. The proposed system in the research paper does not try to replace the existing system rather it will help the physician to predict diagnosis immediately.

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Review of Multiple Input Multiple Output Antennas for Sub-6 GHz 5th Generation Applications

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ABSTRACT

India is aggressively planning for 5G rollout. The government, telecom regulators, and industry players are enabling 5G networks. 5G technology has been tested in several trials and pilots nationwide. 5G technology may deliver faster data rates, reduced latency, and higher network capacity than previous generations of cellular networks. This might enable driverless cars, smart cities, IoT gadgets, and sophisticated healthcare systems. 5G implementation in India has met hurdles. 5G spectrum is a serious issue. Due to cost and availability, the government has delayed 5G spectrum allocation. Telecom companies must invest heavily in 5G infrastructure; thus finances must be considered. 5G infrastructure is another issue. 5G requires dense small cell and fiber optic networks. In highly populated locations, 5G requires extensive fiberization and a strong infrastructural backbone. 5G raises privacy and security issues. 5G networks link many devices and allow data-intensive applications, making user data privacy and security critical. Effectively addressing these challenges requires regulatory frameworks and standards. Despite these limitations, India is optimistic about 5G technology's benefits. The government and industry stakeholders are overcoming challenges and developing a 5G network ecosystem. 5G may improve healthcare, agriculture, education, and entertainment and help India digitize.

Multiple Input Multiple Output (MIMO) antennas are crucial in Sub-6 5G technology, utilizing several antennas mutually at transmitter and receiver ends to enhance communication efficiency. These antennas enable simultaneous transmission and reception of multiple data streams, resulting in increased data throughput, improved spectral efficiency, enhanced coverage and reliability, and beamforming techniques. By utilizing multiple antennas, Sub-6 5G networks can address the growing demands for bandwidth, capacity, and network efficiency in the 5G era. By leveraging MIMO technology, Sub-6 5G networks can deliver higher performance and address the growing demands for bandwidth, capacity, and network efficiency.

KEYWORDS: *5G, Cellular network, IoT, Sub-6, MIMO.*

INTRODUCTION

5G technology is a revolutionary emerging technology that offers high data rates, low latency, and high capacity. It is expected to revolutionize the 2020 generation by enabling societal transformation in educational sector, industrial sector, healthcare sector, and other fields. By balancing latency, cost, and speed, 5G technology will unlock an extensive IoT ecosystem, enabling a trade-off between latency, cost, and speed [1]. When it comes to mobile wireless communication, analog phone conversations have given way to high-quality internet connections that may achieve data transfer speeds of several megabytes per second. Advancements in mobile communication networks and new devices like smartphones and tablets have led to an explosion of mobile applications and exponential network traffic growth [2].

Beam Division Multiple Access (BDMA), an enhanced access technique, will be utilized to enable the transition from 4G to 5G [3] and Non- and quasi-orthogonal or

Filter Bank multi carrier (FBMC) multiple access [3]. BDMA divides an orthogonal beam to mobile stations, increasing system capacity and providing multiple accesses [3]. The existing architecture of wireless cellular networks requires communication to take place at a base station located outside of the coverage area. This results in a significant decrease in spectral, data, and energy efficiency. In order to overcome this difficulty, a novel approach to the design of 5G cellular architecture prioritizes the usage of discrete outside and interior configurations. [4]. It is a big research and technical problem to design high-speed wireless networks with acceptable quality of service and the ability to operate over long distances in non-line-of-sight (NLOS) conditions. The MIMO wireless network technology has the ability to provide wireless networks with a bandwidth of 1 Gb/s; however, there are a number of obstacles, including cost, technological limitations, and legal restrictions, which make it undesirable.

MIMO microstrip patch antennas are a powerful technology that enhances wireless communication systems by increasing data throughput and reliability. These antennas are placed at both transmitter and receiver ends, connected to separate RF channels. They improve signal-to-noise ratio and reduce interference effects. MIMO systems can be designed in various configurations, such as vertically stacked, horizontally stacked, and spatially distributed arrays. They offer increased data throughput, improved reliability, and better coverage, but require more complex hardware and signal processing algorithms than single- antenna systems [5].

MIMO antennas are essential for multi-band operation across a wide bandwidth for various broadband services. Some designs, like gap-coupled feeding structures [6], [7], have a narrow impedance bandwidth. Re-configurable feedings can solve this issue, but diodes and lumped components can decrease performance [8] - [10].

DESIGN OF MIMO ANTENNAS AND ITS PERFORMANCE

Evaluation of important parameters in MIMO antenna systems, including envelop correlation coefficient (ECC), Diversity gain (DG), isolation along with traditional parameters like bandwidth, resonance frequency, radiation patterns, gain, and efficiency, is crucial for fully characterizing multi-antenna devices.

Various techniques so far incorporated to improve performance of MIMO antennas. Researchers use antenna design techniques to improve parameters like bandwidth, gain, efficiency, mutual coupling reduction, and compact size. These may be choice of substrate [11], Multi-element [11], Mutual Coupling Reduction Techniques like Electromagnetic Bandgap Structure (EBG) [12], Dielectric Resonator, Defected ground structure (DGS) [12], Slot Elements, Complementary Split Ring Resonators (CSRR), Neutralization Lines [12].

Choice of substrate

Efficient antenna design depends on the right choice of substrate material, which plays a crucial role in determining overall performance and efficiency. Key characteristics include dielectric constant (ε_r), loss tangent (tan δ), substrate thickness (tan δ), substrate stability (good dimensional stability over temperatures and humidity levels), thermal conductivity (efficient heat dissipation), mechanical strength (stable and durable), cost and availability (cost-effective and readily available), and environmental compatibility (appropriate resistance to moisture, chemicals, UV radiation). By carefully considering these characteristics, antenna designers can select an appropriate substrate material that aligns with their specific requirements, resulting in improved efficiency, performance, and reliability [13].

Multi-Elements

Multi-element antennas significantly improve performance by enhancing various characteristics. These configurations involve arrays or combinations of multiple antenna elements working together, resulting in increased gain, higher directivity, beamforming, polarization diversity, spatial diversity, interference rejection, MIMO capability, and compact and low-profile designs. By combining radiation patterns and signals from multiple elements, multi-element antennas enhance signal reception and transmission, extend the range and coverage area, and reduce interference. They also enable beamforming, polarization diversity, spatial diversity, interference rejection, and support

for advanced technologies like MIMO. Multi-element antennas are ideal for wireless communications, radar systems, satellite communications, and other applications [13].

Mutual Coupling Reduction Techniques

Mutual coupling is the electromagnetic interaction between closely spaced antennas, which significantly impacts antenna performance. To mitigate this effect and improve antenna performance, various techniques are employed. These include increased spacing, orthogonal placement, electromagnetic bandgap structures, electromagnetic shielding, decoupling elements, frequency selective surfaces, active impedance loading, antenna element isolation techniques, diversity techniques, and compact antenna designs. These techniques aim to reduce mutual coupling, improve efficiency, gain, radiation pattern, and isolation between antennas, leading to enhanced system performance in applications like wireless communications, MIMO systems, and phased array antennas [13].

MIMO ANTENNAS WITH DIFFERENT TECHNIQUES

This review article provides an overview of MIMO antennas for Sub- 6 5G wireless communications. It does so by synthesizing the knowledge that has been acquired from earlier research publications that have been written by a variety of authors.

Demos Serghiou [15] designed and presented 64 element folded monopole antenna with 8 ports using FR4 substrate. Antenna works for 3.5 to 4.9 GHz frequency band.

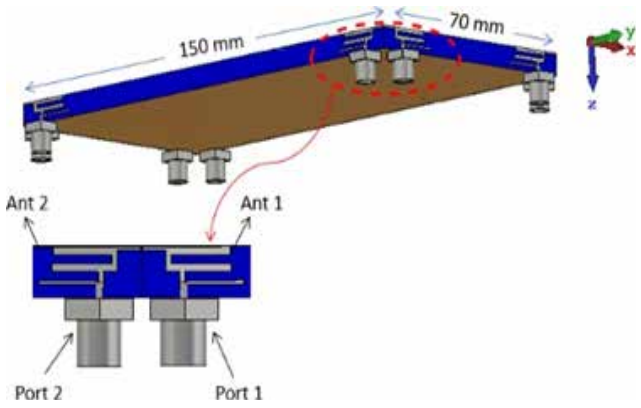

Fig. 1. Design illustartion of 8 x 8 Mimo antenna [15]

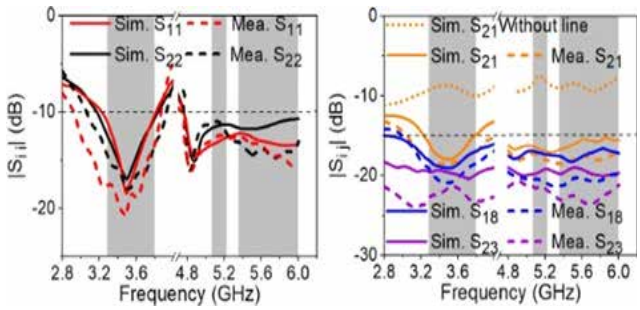

Fig. 2. Results of designed antenna [15]

Gorre Naga Jyothi Sree, et.al. [16], presented very compact design of antenna using fractal MIMO radiator and defected ground structure to improve various parameters like operating bandwidth, diversity gain, ECC, etc. and compared the results with similar antenna systems designed by other researchers.

Fig. 3. Prototype of designed antenna [16]

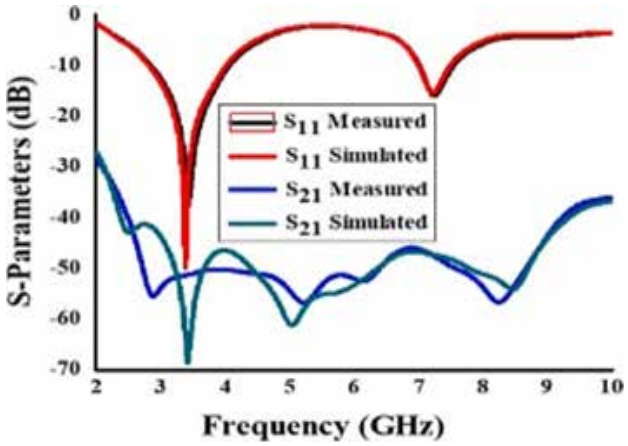

Fig. 4. Results of designed antenna [16]

R. Nagendra, et. al., [17] designed four port MIMO antenna for IoT applications using meander line monopole antenna. Fabricated antenna exhibits good VSWR, Gain and impedance matching. This antenna also operates for multiple bands.

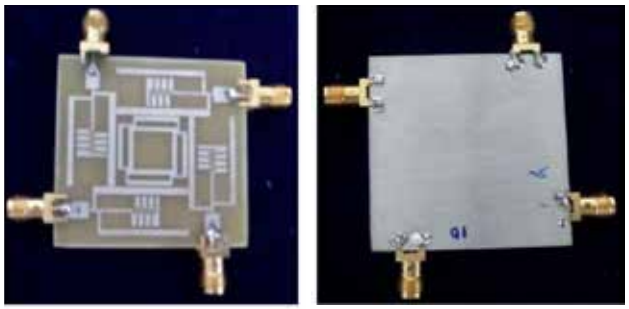

Fig. 5 Front and back profile of designed antenna [17]

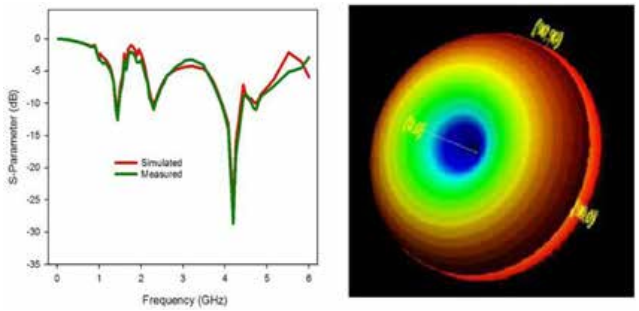

Fig. 6 S11 and 3D radiation pattern of designed antenna [17]

Circularly polarized MIMO antenna is presented by Falih M. Alnahwi, et.al., [18] which is fabricated using FR4 substrate. Unequal pairs of slits are implemented and antenna elements are implemented on corners to achieve desired circular polarization.

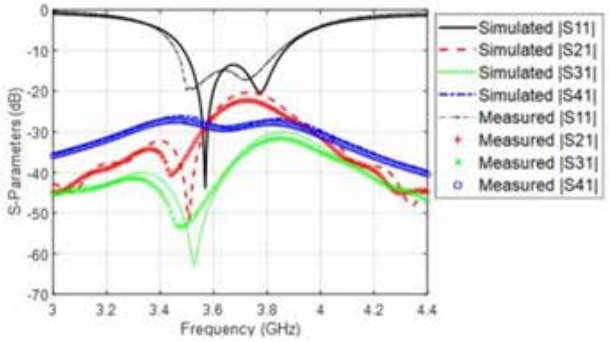

Fig. 7 Fabricated antenna and its results [18]

Malathi Kanagasabai, et.al., [19] designed single element using different types of slots to improve characteristics of the antenna and implemented finalized element in 2 x 1 MIMO antenna. It exhibits improvement in diversity gain, envelope correlation coefficient (ECC), isolation. This antenna design is proposed for vehicular communication.

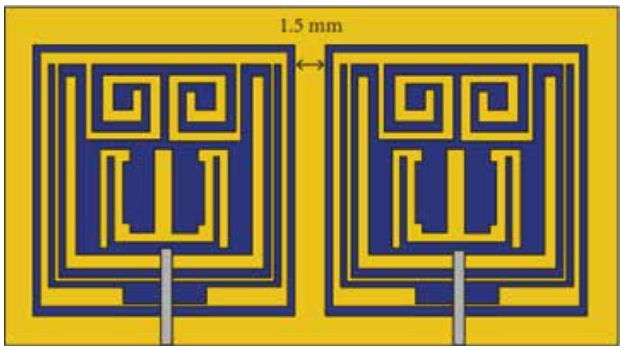

Fig. 8 Configuration of antenna [19]

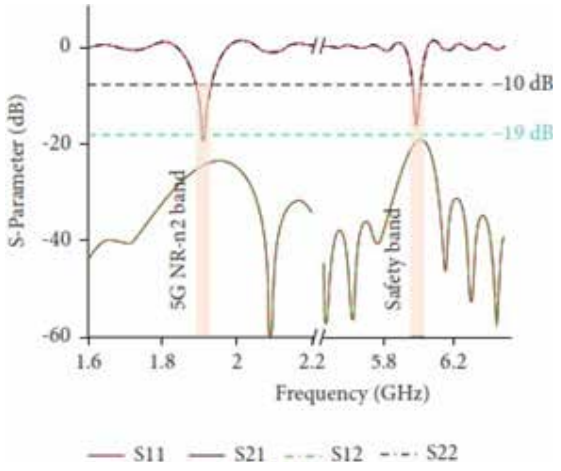

Fig. 9 Simulated results for reflection coefficient and isolation [19]

Suman Sharma, et.al., [20] presented 4 – port MIMO antenna with microstrip patch antenna with a diamond shaped slots and partial ground structure. Gain of antenna is 3.8 dB and 87% of efficiency and ECC less than 0.1. Antenna designed is applicable for smartphone applications.

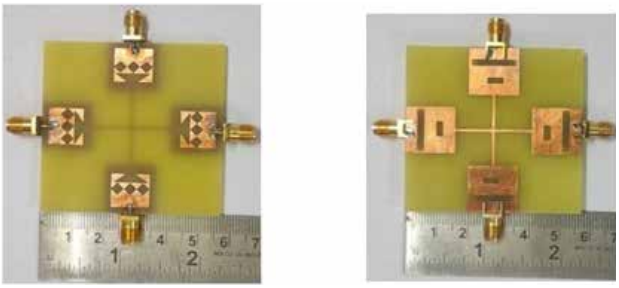

Fig. 10 Prototype of antenna [20]

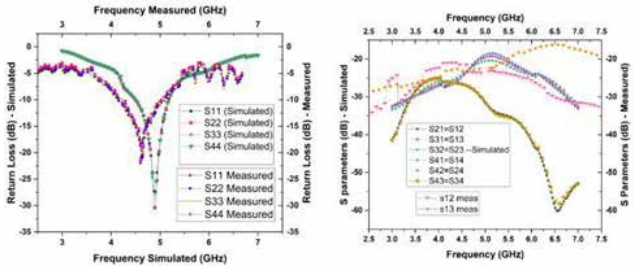

Fig. 11 Simulated and measured results [20]

ANALYSIS OF VARIOUS PARAMETERS

In order to realize the capabilities of 5G communication technology, the MIMO antenna design delivers a high data transfer rate as well as a high capacity. Inter element isolation is another factor that determines how well a MIMO antenna design will work.

Table 1. Comparison of Various Antenna Designs and their Findings

Ref. No.	Technique used	Size of Antenna in mm	Substrate Material	No. of Elements	No. of Ports	Frequency (GHz)	ECC	Isolation (dB)	Bandwidth (GHz)
[15]	folded monopole antennas	70 x 150 x 0.8	FR4	64	8	3.5 – 4.9	< 0.06	<-17	2.8
[16]	DGS	25 X 38 X 1.6	FR4	2	2	3.5	< 0.047	<-72	1.2
[17]	Meander line monopole antenna	44 X 44 X 1.6	FR4	4	4	4.2		<-24.8	Not available
[18]	unequal slits	150 x 75 x 3.2	FR4	4	4	3.48 – 3.87	< 0.02	<-15	10.9%
[19]	ring and loop slots	34.5 x 18 x 0.254	Rogers RT-5870	2	2	1.9 & 5.9	< 0.004	<-18	1.9% 0.64%
[20]	defected ground structure	56 x 56 x 1.6	FR4	4	4	4.9	< 0.01	<-20	800MHz

CONCLUSION

This article presents a summary of recent research in the subject of MIMO antennas for 5G applications, and it does so by way of an overview. Both the antenna's physical structure and the decoupling methods had a role in determining the level of performance achieved by the design of the antenna. The operating frequency of an antenna as well as its range might change depending on the application of the antenna. The practical antenna designs have a large capacity and a strong inter element isolation; additionally, the parameters are tuned in order to achieve the desired outcomes. It has been determined that the most current obstacles that have been posed by 5G communication technology can be overcome with the implementation of MIMO antenna technology.

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Statistical Review of Cache Memory Design Techniques from an Empirical Perspective

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ABSTRACT

Cache memories are high speed Static Random Access Memories (SRAM), and their design is a specialized analytical task that involves design of optimized memory layers, their read & write cycles, and backup circuits. Researchers have designed a wide variety of optimized cache memory designs, and each of them varies in terms of their internal & external operating characteristics. This paper discusses some of the recently proposed cache memory designs in terms of their functional nuances, contextual advantages, deployment-specific limitations, and application-specific future scopes. Based on this discussion readers will be able to identify optimal cache memory design models for their functional use cases. It was observed that Cache Line Size, Cache Associatively, Cache Mapping Function, Cache Replacement Policy, Cache Size, Pre-fetching ,Write Policy, and Hardware-based Cache were the major design characteristics that were used while designing efficient cache types. This text further compares these models in terms of their performance metrics, that include read & write delay, deployment cost, backup efficiency and scalability levels. Based on this discussion readers will be able to identify optimal models for their performance-specific use cases

KEYWORDS: *Cache, Memory, Delay, Read, Write, Cost, Backup, Efficiency, Scalability, Scenarios.*

INTRODUCTION

Cache memory is a small, fast memory unit that temporarily stores data and instructions that the processor is likely to reuse. The design of cache memory is crucial for optimizing processor performance. Here are some key components of cache memory design. The size of cache memory is limited, typically a few MBs, compared to the main memory (RAM). The size of cache is a trade-off between cost and performance, larger cache can store more data but is more expensive. Organization of Cache memory is organized into blocks or lines, each line contains multiple data or instruction items. This allows for efficient data access, as the processor can retrieve an entire cache line with a single memory access. The mapping technique defines how data from main memory is transferred to cache memory. Common mapping techniques are direct mapping, associative mapping, and set-associative mapping. When the cache is full and a new line needs to be loaded, the cache must choose which line to replace or overwrite. The replacement policy determines which line to replace, common policies are FIFO, LRU, and LFU. Cache memory operates in either write-through or write-back mode. In write-through mode, writes to cache are immediately written to main memory, while in write-back mode, writes are temporarily stored in cache and updated in main memory later. When multiple processors share a cache, coherency and consistency must be maintained to ensure that each processor has a consistent view of memory. The cache coherency protocol ensures that all cached copies of a memory location are consistent and up- to-date.

In conclusion, the design of cache memory affects the performance and efficiency of the processor, as it acts as a buffer between the processor and main memory. There are several cache memory design techniques that

can improve its performance. Larger cache line sizes can increase the cache hit rate by reducing the number of cache conflicts. Increasing the associativity of the cache can reduce the number of cache conflicts and increase the cache hit rate. A good mapping function can improve the cache hit rate by ensuring that frequently accessed data is stored in the cache. A good replacement policy can maximize the cache hit rate by replacing less frequently used data with more frequently used data. A larger cache size can increase the cache hit rate, but also increases the cost of the cache. Pre-fetching data into the cache before it is actually requested can reduce the latency of cache misses. A write-through policy updates both the cache and the main memory, while a write-back policy only updates the cache, improving write performance. A hardware-based cache implemented in the CPU can provide faster access to the cache than a software-based cache.

In the next section, such techniques are discussed, along with their internal & external operating characteristics. This is followed by an empirical review of these models in terms of different parameter sets. Finally, this text is concluded with some circuit-specific observations about the discussed techniques, and recommends methods to improve this performance under real-time scenarios.

DIFFERENT MODEL : AN OVERVIEW

A wide variety of cache design models are proposed by researchers, and each of them varies in terms of their internal & external performance characteristics. Extensive analysis and summary Off-chip memory delay and capacity issues are possible in FPGA systems [1]. (HLS). Memory in FPGAs can be either fast on-chip RAM or slower but larger off-chip Memory (block RAMs and registers). It requires a lot of time and effort, but the memory layout can be scratchpad using HLS tools. Memory management in the Xilinx Vitis HLS FPGA is automated by a buffer of C++ source code that the user can modify. To improve performance, port-specific level 1 cache may be incorporated into the private level 2 (L2) caches of a DRAM-mapped array. Separate from the programme that makes use of it, the L2 cache operates as its own dataflow job. By decomposing off-chip memory calls and data storage into dataflow jobs, this method is similar to load, calculate, store but removes human algorithm reworking. According to data collected from FPGA boards, their cache can speed up test runs by a factor of 60, compared to the HLS's out-of-the-box answer. Their caches aren't meant to outperform individually tailored versions in QoR; rather, they're meant to drastically reduce design effort, make the HLS flow more like software, and free the creator to focus on algorithmic enhancements rather than explicit memory management. Caching may be of use only to algorithms with data-dependent or uncertain memory access patterns and satisfactory data proximity.

Memory systems that rely on dynamic random access memory (DRAM) face scaling issues in terms of memory density, energy usage, and expense [2]. Combining dynamic random access memory (DRAM) and non-volatile memory (NVM) in a hybrid design could result in a main memory with high volume and low power consumption (NVM). Cache failure prices vary between DRAM and NVM, which complicates the administration of on-chip cache in mixed memory devices. The mixed memory system's memory entry speed is no longer gauged by the cache hit rate. Currently, there is no way to improve cache hit rates using cache substitution choices. This study looks into the discrepancy between the penalties for cache misses in DRAM and NVM and suggests using the average memory access time (AMAT) to evaluate the efficacy of mixed memories. Least recently used (LRU) cache substitution with a failure cost should be used in hybrid memory systems (MALRU). Knowing where each data block originated, MALRU is able to keep both high-latency NVM blocks and low-latency Memory blocks with remarkable temporal proximity in the last-level cache. Results indicated that compared to LRU and the present mixed memory conscious cache segmentation strategy policy, MALRU may increase system efficiency by 22.8% and 13.1%, respectively.

There is a speed hit and a rise in power usage [3] due to row buffer disputes in DRAM-based memory. Row buffer conflict overheads lengthen activation and precharge times for rows as bitline length and memory capacity grow. The speed effect of row buffer disputes has been studied, and a solution, Row Buffer Cache, has been proposed (RBC). Their RBC architecture prioritises rows with high spatial locality, caching them and protecting them from searches targeting rows without high spatial locality. This RBC layout lessens the

need for row initiation and precharge, which improves the overall efficiency of the system. An evaluation of the RBC architecture versus Benchmark CPU2006 with DDR4 RAM is presented. Using RBC could increase single-core modelling speed by 2.24 percentage points (16.1%) while decreasing memory energy consumption by 68.2 percentage points (23.6%). Multi-core models show that RBC can improve speed by an average of 17% and reduce memory energy consumption by 35.4%.

Based on the findings of [4]'s investigation, cache side-channel exploits pose a serious problem for modern computing infrastructures. By monitoring a target's cache usage, attackers like the Flush+Reload flaw can learn sensitive information about them. To get good speed with memory-intensive apps that can't be kept in the on-chip SRAM, modern computer systems use DRAM cache between the SRAM-based last-level cache and the primary memory DRAM. The result could be great capacity with minimal delay (for example, L3 cache). The purpose of the Memory buffer in this study's ByCA method is security, not speed. Cache entries that are vulnerable to attacks are not stored in the L3 shared cache when using ByCA. ByCA nullifies Flush+Reload attacks by decreasing the interval between cache block accesses. Attackers' intended L4 Memory cache chunks can be tracked with ByCA (based on whether or not they have been flushed by clflush). ByCA repurposes the clflush command to clear out caches higher up the stack while leaving the L4 Memory cache alone (i.e., L1, L2, and L3 caches). When an assailant or victim accesses a target block that has been cleared by clflush, ByCA causes L3 cache to be bypassed so that the perpetrator always gets the block from L4 Memory cache. As the time difference is reduced by ByCA, the attacker's ability to watch cache access becomes useless. In the L4 DRAM cache's Alloy Cache setup, the status of each block is tracked by checking an empty bit in a tag entry. There is only a single bit of expansion required for the private L1 and L2 caches, while tag entries are required for the L4 Memory cache blocks. Through extensive testing, they found that ByCA completely nullified the time fluctuations introduced when an assailant reloaded a target block. While co-running with an assailant who empties and reloads target blocks on occasion, ByCA hides the victim's performance degradation.

LLCs, or last-level caches, minimise the use of costly off- chip storage [5]. That's why LLCs need more space for data storage so they can build apps that rely heavily on data. Abundant stuffing This need is satisfied by non- volatile STT-RAM storage. There is a sizable time and power cost associated with writing to a STT-RAM buffer. Researchers found that large composite LLCs with a combined SRAM-STT-RAM memory were able to manage expensive uploads. As a result of deadlocks, these big LRU-managed LLCs are underutilised (zero-reuse blocks). Scientists prove that LLC errors go down after the deadblock is removed from the equation. In order to determine which deadblock should be removed, the hybrid cache is taken into account. To address this problem, the authors of this study offer Deadblock-based Victim Selection (DVS), a substitution approach with awareness of deadblocks. In as much as 40% of cases, evicting a deadblock from the cache requires moving cache blocks. The Deadblock-based Migration (DM) strategy is proposed by the study community as a means to improve the efficiency of DVS's cache block migration approach. DVS and DM may improve system efficiency by 13 and 52%, respectively, according to a thorough study of the SPEC CPU2006 tasks. The efficiency of large-scale mixed LLCs was found to be enhanced by using deadblock and migration-aware cache substitution.

In today's networks, data leakage is one of the biggest concerns for security [6]. Assuming technology is trustworthy is a prerequisite for most security measures. Hardware is exploited by the Cache-Out family of system exploits due to a Trojan horse in the Microprocessor (CPU). It has been theorised by the study community that the constant barrage of the same data pattern on the same location will eventually set off a memory Malware trigger in the L1 d-cache. Changing addresses after the Malware has been activated will cause read/write errors, memory problems, and data loss. In the peripheral of nanoscale cache memory, cutting-edge circuit features such as wordline underdrive (WLUD) and negative bitline (NBL) for static RAM are used to transport messages (SRAM). Tests suggest that read and write errors can be induced by tampering with the WLUD and NBL. Scientists show the potential drawbacks of using WLUD while writing. Data theft is possible via NBL and column merging. Simulation results for the GEM5 design have been confirmed. Cache- Out. L1

address concealment, read/write authentication, ECC bit scrambling, and reliable ECC are all examples of countermeasures. In conclusion, the steady and dynamic power requirements for 64-bit word size read/write verification using 22-nm technology are 7.56 m^2 and 0.1 W/91.3 W, respectively.

Large L4 last-level caches are now possible thanks to advances in device density, memory technology, and connectivity [7]. (LLCs). LLCs are typically managed by "tagless" archives (e.g., 3-D). The information cache (L3) and the tagless cache are both confused by tagless methods (L4). In order to lessen the intercache substitution tangling costs, many different cache-organization techniques are being investigated by the study community. The geographic and temporal proximity of allocating large blocks of data has been greatly enhanced by the availability of specific tiling forms that fit software access patterns in a number of prominent computing cores. To reduce coupling overheads and disorders, tagless LLCs have energy-efficient alternatives like limited block caching (RBC) and target tag buffer caching (VBC). Methods in linear algebra kernels developed in software are put to the test. The RAM traffic caused by RBC and VBC drops by 83.4% (32 MB L4s) and 67.5% (64 MB L4s), respectively (72.6 MB L4s). When compared to a tagless cache with an LRU strategy in L3, RBC and VBC increase the performance of 8/32/64 MB L4 devices by 16% (0.3%) and 15% (1.8%), respectively. In addition, they show that memory traffic can be decreased by 51% compared to linear superblocks while delay can be improved by 13% compared to the default tagless cache by adapting the hardware allotment for each tagless area superblock to the access sequence of the software tile.

Fig. 1 Level of cache memory

The findings of this study were reported in [8]. Client-server architectures that evolve over time can cause unanticipated bottlenecks in the network. Network buffers save commonly sought information to circumvent this problem. In a standard cache system, each person has their own cache and all caches are retrieved from the same location. Using decentralised cache loading (DCL) is preferable for large networks. The concept of "shared caching," in which a single cache is used by multiple clients, is discussed. Decentralized shared storage is now an issue of the past thanks to a brand new and faultless distribution method. Index coding demonstrates that the distribution strategy is superior to linear models. The proposed workaround is as fast as centralised prefetching.

It has been suggested that the problem of fine-grained 3D layering can be solved by the work presented in [9]. Monolithic three-dimensional integration describes this method of growth. Using M3D integration, it is possible to combine microarchitectural components at the nanoscale scale, including caches, register files, translation lookaside buffers (TLBs), and more. To achieve M3D integration, stacked layers must be operated at low temperatures, which degrades stacked transistor efficiency in comparison to 2D. Due to advances in low-temperature manufacturing techniques, non-volatile memory (NVM) such as magnetic RAM (MRAM) can now be integrated into M3D systems without sacrificing speed. An M3D-based SRAM/MRAM mixed memory design for the L2 TLB-cache is proposed. When compared to both 2D SRAM and 2D SRAM/MRAM hybrid memory, M3D-based SRAM/MRAM hybrid memory uses less electricity without sacrificing speed. Their approach is particularly useful for concurrent tasks with very high L2 cache miss rates because it improves energy economy by adjusting the memory segmentation of the united L2 TLB-cache based on the L2 cache miss rate. Based on the results of the PARSEC benchmarking programmes, the authors conclude that their design reduces the energy consumption of the L2 TLB + L2 cache by as much as 97.7 percent (53.6 percent on average) compared to the standard with 2D SRAM-only memory, with almost no performance penalty. Their method cuts down on the amount of energy needed to reach memory by 32.8%

(10.9% on average) by reducing the number of TLB failures.

Performance of Network Function Virtualization-aware packet processing was studied in [10], which looked at how the speed with which COTS devices accessed memory affected things (NFV). The speed with which data can be accessed from memory is crucial for jobs like table search and others in packet processing. As a result, the on-chip cache memory of many CPUs is crucial for high- performance software routers and switches. The carrier network requires a large buffer memory because many programmes share the same physical system. By combining on-chip last-level-cache (LLC) segments with off-chip interlaced 3D-stacked DRAM components, researchers present a packet processing design that enhances memory access parallelism. Memory queries can be processed in parallel thanks to the off-chip 3D layered DRAM's table entries for bank interleaving and channel parallelism. Cache objects are partitioned into on-chip LLC segments using a hash method based on memory addresses, allowing multiple CPU cores to access them simultaneously. When compared to designs with on-chip shared LLC and without on-chip LLC, the proposed design improves the state of the art by reducing memory access delay by 62%, increasing performance by 108%, and decreasing the likelihood of memory request stalling by 96% for real-time scenarios.

The research in [11] investigates a cache-assisted network with caches of varying sizes. First, use planned positioning methods to take advantage of differences in cache sizes when only one person is linked to each cache. People with short-term or poor memory can benefit from unicast/multicast messages. For three-user systems with variable cache capacities, larger systems, and systems in the tiny total memory era, coded placement (CP) minimises delivery burden. Next, we look at systems with a lot of people and a buffer capacity that's roughly the same. Coding decreases the effectiveness of even the most effective uncoded positioning technique. In the suggested system, encoded subfiles kept in underutilised caches are simpler to decode thanks to unicast/multicast signals sent to the overutilized helper-caches. For devices with two caches, coded location is preferable. In larger systems, it is possible to optimise the settings of the coding positioning technique. When there is more of an imbalance in the connections between users, coded positioning becomes more useful. Using the cache capacities and network design, experts have developed a uniform coded positioning technique for two-cache systems.

To get around the GPU's memory limitation, the authors of [12] propose using a 3D memory structure composed of DRAM and SCM. By using Memory for buffering, the HMS avoids the delay, bandwidth, and energy costs of the SCM. Performance in memory-oversubscription apps may be enhanced by the HMS's ability to absorb a larger portion of available memory than is possible with an HBM alone. A performant DRAM cache architecture is provided by the study team by avoiding the flooding of Memory by100,000 GPU processes. To reduce DRAM cache probe traffic, experts suggest an adaptive L2 cache Tag Cache for storing DRAM cacheline tags (DCLT). To lessen the amount of DRAM cache query traffic brought on by Tag Cache failures, their DRAM cache design gets every DRAM cacheline tag in a sequence with a single column entry. Based on their findings, the HMS could increase efficiency by a factor of 9.8 when memory is saturated (on average, 2.8).

In [13], the authors address the security and private benefits of blockchain technology, as well as the single-bit, six-transistor static random-access memory cell sense amplifier design and IoT-based cache memory. It is common practise for processors and other memory devices to use the protected chunks of data stored in each chip as a distributed ledger system, or blockchain. Static RAM cells with six transistors and MSAs (multiple sensing amplifiers) are all part of the systems (including voltage latch, charge transfer differential, and current differential sense amplifiers). The number of transistors needed, the detecting delay, and the power usage at various resistance levels between 42.3K and 42.3K have all been analysed. Dual slumber, forced stack, sleep transistors, and sleep stack are just a few of the power efficiency techniques available. The power consumption of the device is minimised by power-saving features implemented in the sensing amplifiers and the six-transistor static random- access memory cells. Based on these findings, it can be concluded that a single-bit, six-transistor static random- access memory

cell that employs a voltage latch sense amplifier and a power-saving dual slumber method requires only 33 transistors and 11.65 W, a substantial reduction from the other designs studied.

Studies of a D2D system with tunable cache memory are presented in [14]. File queries can be fulfilled via D2D exchanges when server traffic is low, but only via cache memory when traffic is high. It's possible that the worst- case D2D delivery load can be mitigated through the use of uncoded cache location and linear coded D2D delivery. So, scholars can clearly characterise the minimum D2DDL with uncoded location under a variety of interesting circumstances by using a novel bottom limit on the D2D distribution burden. Once the MD2DDL has been characterised for uniform cache sizes, it can be shown that the network can support individuals with widely varying cache sizes, so long as the smallest cache size is above a certain level. The MD2DDL supports high-cache-size, low-cache-size, and three-user use cases. Analyze the costs of server-based and D2D distribution and compare them. Lastly, a quantitative comparison between cache-assisted D2D and coded distributed computing (CDC) systems is presented.

The capacity of in-package DRAM cache has been shown to be higher than that of conventional memory devices by the research presented in [15]. Increasing throughput and speed could be possible by modifying the memory management settings in each app. It is unfeasible to watch and modify individual cache blocks due to limitations in speed, efficiency, and technology. In this research, we introduce a novel method for keeping tabs on cache blocks by adjusting just two sliders (TTK). Two cost-effective counter-based strategies for Memory block tracking are provided by the study's authors. To further reduce data transfer latency, the experts also provide a state-of-the-art timing system for sending counter data to the Memory layer at optimal times. The proposed methods have been shown to beat the best existing Memory cache setups in models of highly parallel data-intensive apps by 31% and 24%, respectively. Energy costs are reduced by 29% on average with the typical setup.

To fine-tune the memory structure of an estimate computing system, one can alter the degree of cache memory approximation [16]. The OPTIMA protocol allows for the online adjustment of cache settings within a specified tolerance for error. OPTIMA allows for the execution of fault-tolerant programmes on multicore Processors that have both shared and private caches. The OPTIMA system's cache memories use heuristic methods that, in two stages, determine the optimal estimate level for each cache memory in order to optimise power efficiency. Improving energy economy by adjusting estimate levels to keep product quality constant. Next, the output precision is modified so that it reflects the changes in the input pattern. In both the first and second stages, the pace at which the estimate level shifts is different. In order to evaluate OPTIMA's efficiency, experts integrated it into gem5 and ran eight estimate experiments that simulated various multiprocessor systems. The results indicated that the proposed method had the potential to lessen power usage by the memory structure by 44%.

This was researched and written about in [17]. To meet the needs of chips with multiple processors, manufacturers have increased cache layout and storage. A multi-way set- associative structure with strong associativity is used in a common lower-level cache to minimise conflict failures. This layout is quick because all cache set techniques can be called in parallel. This makes heavy use of moving energy. That's why lots of different ideas for saving electricity while using cache memory have been suggested. Unauthorized path access can be prevented through route forecast or incomplete comparison. In this work, we present a robust forecast algorithm for a shared second- level associative memory. The use of real-time tracking of path access supremacy (WADD). Given the first-level cache replacement procedure and mixed-core visits, the suggested method determines the optimal number and location of path options for each incomplete access pattern. This strategy has the potential to foretell travel paths. The energy-delay product is reduced by 13.5% in simulations compared to the standard cache without path forecast, demonstrating that the WADD has the highest energy efficiency. As a result of rapid discovery and reliable forecast, the technique prediction cost is diminished.

The increasing complexity of computer systems necessitates more RAM [18]. Memory design space

study is required to keep these accomplishments. Solutions to the pressing need for more and faster memory have emerged from the study of design areas and their connection to cache memory structure. Arrangements for Space Travel Cache memory design is improved through modelling, analysis, configuration, and development. Depending on the situation, each has advantages and disadvantages. The essay discusses each option and their benefits and drawbacks. The most effective tactic is one that combines elements of different approaches to compensate for their weaknesses.

In [19], a two-stage process is outlined for locating assaults. We gained an understanding of the node, dispersion, cadence, consistency, and distance travelled in the introductory phase. Then, a Deep Convolutional Neural Network is used to identify content poisoning assaults, also called cache contamination attacks (CNN). These assaults can take the form of anything from flooding the network with requests for already-existing data to flooding the network with requests for newly-created data, hijacking inbound interest packets, or labelling data with the incorrect key. Second, a fuzzy decision tree is used to identify a potential inundation assault based on the characteristics (FDT). The focus of this research is on enhancing the assault recognition capabilities of the DCNN and FDT algorithms. In order to better handle the optimization issue, this study improved upon the traditional ROA by introducing a new algorithm called the Decision Oriented Rider Optimisation Algorithm (DO-ROA). The superiority of the aforementioned work in practise is demonstrated by contrasting the proposed DO-ROA algorithm with that of some conventional models on a selection of Type I and Type II performance metrics.

Large working sets in business and research, as reported in [20], favour a shared L2 cache architecture that optimises group cache size and minimises memory off-chip lookups (CMP). An important element that caps directory size is the exponential increase in memory expenses with increasing Processor count. To address this issue, the writers of this article propose a novel lightweight shared storage design. It employs two small fast caches to handle data and index vectors for CMP tiles' most recently stored blocks from L1 caches. The suggested cache technique shortens access times to the on-chip directory memory and facilitates adaptation by removing directory vectors from the L2 cache. The suggested cache technique accelerates up programmes by an average of 6 percent and as much as 16 percent at its finest, with storing expenses as low as 0.18 percent for real-time scenarios.

These cache memory group designs are discussed in [21]. The on-chip cache of a contemporary CPU typically consists of one or two layers, but this is not always the case. Typically, SRAM (static random-access memory) cells are used to construct such memory banks. They consume a lot of memory and processing power. A dearth of authority typically takes precedence over other considerations. This is valid for portable electronics, such as laptops and mobile phones. The number of transistors, detecting latency, and power consumption of various sense amplifiers, such as write driver circuits, current differential sense amplifiers, voltage latch sense amplifiers, and charge transfer differential sense amplifiers, are compared for a variety of resistance values. For a static random-access memory cell with a single bit and six transistors, the voltage differential sense amplifier consumes only 11.34 W of electricity. To put it another way, this design uses as much as 83% less power than the standard latch sense amplifier layout. The current differential sense amplifier is down 77.75%, the charge differential sense amplifier is down 39.62%, and the voltage latch sense amplifier is down 50%. Typically, this is accomplished with the help of power-efficient cache memory designs. Real-time applications benefit more from the low power consumption (8.078 W) of the single-bit, six-transistor static random- access memory cell that uses the forced tack technique and the voltage differential sense amplifier that employs the dual sleep technique.

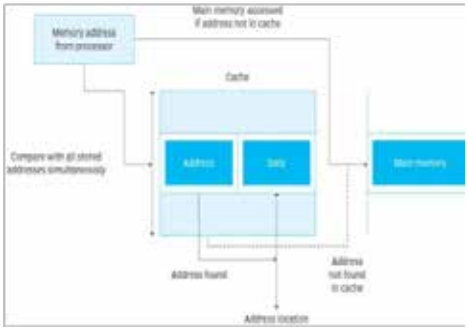

Fig.2 Architecture and data flow of a typical cache memory unit.

The secure and private aspects of blockchain technology, as well as the construction of a sense amplifier for a static random-access memory cell using only six transistors, and the operation of cache memory based on the Internet of Things, are all discussed in [22]. Each chip's storage space is used to keep track of other memory devices that are considered reliable. These designs allow for a write driver circuit, six-transistor static random-access memory cells, and a variety of sense amplifier topologies (voltage latch, charge transfer differential, and current differential). Factors that influence resistance levels (such as R=42.3 and R=42.3K) have also been investigated. The quantity of transistors, the intervals between detections, and the required power are all relevant factors. Power saving techniques include sleeping transistors, sleep stacks, forced stacks, and dual sleep. Several components, including sense amplifiers and static random-access memory cells made up of six transistors, make use of these power-saving methods to lower the overall power consumption of the design. This suggests that a static random-access memory cell with a single bit and six transistors can significantly reduce power consumption. Advantages of Making Up Lost Sleep Over Two Nights The voltage latch sense amplifier only requires 33 transistors and 11.65 W of electricity thanks to its use of the power-saving dual-sleep technique.

Cache memory, also known as "cache," is a type of secondary memory used to temporarily hold data and instructions that are commonly accessed and then executed by a laptop's central processor unit (CPU) at a faster rate, as described in [23]. The cache is an auxiliary memory that supplements the primary memory of the computer. Semiconductor-based, transistor-based random-access memories (RAMs) are used for both short-term memory and long-term storing. A copy of the most frequently accessed information or programme code from main memory is all that is stored in the cache. The shorter the period between when data enters the cache and when it is sent to the CPU, the better. Alterable cache memory is the focus of this research. This project involves using VHDL (Very High Level Hardware Description Language) and an FPGA to plan, create, and construct a configurable cache memory that can be altered in two ways (cache time and associativity) (discipline-Programmable Gate Array). This design's cache memory has a cache size controller unit and a method controller unit built into its layout, respectively, to allow for user and memory capacity customization. As a result, the CPU can get its job done quicker, consume less power, and make full use of the available memory space. The planning stage of modelling can be used to analyse the situation and draw conclusions. Xilinx ISE sketch Studio

14.0 was used to create this design (Xilinx ISim simulator). Verilog is used to create the cache memory's direct mapping and set linked cache. Techniques that operate in two directions, four directions, and eight directions are all available in the set associative memory. The cache memory architecture is built to accommodate a wide variety of mapping techniques, including the deployment of a master node. Power can be saved and the rate at which data enters stored memory increased by turning off unused blocks.

According to the findings in [24], the A64FX Microprocessor is the most advanced Arm-based processor architecture to date. A cache-based multicore CPU that can compete with accelerator technology in terms of memory speed and peak efficiency. To maximise its potential, coders will need a firm grasp on how to exploit its speed capabilities. Here, we provide a design study of the Fujitsu FX1000 supercomputer's A64FX, which can be used to construct Execution-Cache-Memory performance models for steady-state cycles. We pick up on design idiosyncrasies that hint at potential overarching methods to boost efficiency during this time. After verifying the model with elementary streaming loops, we use our findings to improve sparse matrix-vector multiplication (SpMV) and the DW kernel from quantum chromodynamics. We demonstrate that the SpMV's compressed row storage (CRS) matrix storage format is not a viable option, and that the SpMV's SELL-C format can quickly approach bandwidth overload. We present a cache reuse study for the DW kernel and demonstrate that memory-bandwidth overflow is possible provided the appropriate data structure is used for complicated arrays. We compare the A64FX to high-end, state-of-the-art devices like the Intel Cascade Lake AP and the Nvidia V100 to give you an idea of its capabilities. We also explore the potential for power enhancements by modifying the Fugaku system's existing settings

and discover methods to reduce energy consumption by 31% for SpMV parameter sets and 18% for DW parameter sets.

A more rapid rate of Memory updates has been found to occur in cells that are more easily damaged, as reported in [25]. When compared to normal rowers, they lack the endurance and ability to retain their air for longer periods of time. In some cases, Memory cells can function independently. This strategy, dubbed "in-DRAM storage," is relatively recent. DRAM's internal memory storage (buffer) serves many purposes. In this article, we introduce WinDRAM, a memory buffer that includes all accessible regions of DRAM. The most recent items are duplicated in the RAM buffer so that when they are requested again, they will function in addition to the original. The shortened activation interval made possible by this synchronous action reduces the time required to reach memory. Dual- row activation is the term for this method of operation. WinDRAM doesn't routinely reset these frequently-accessed, low-quality cells that make up the memory buffer. There are no potential issue areas in the design of the in-memory data store (cache). WinDRAM proposes a novel approach to in-memory caching by utilising weak rows. Since we don't need to refresh weak rows, we can extend the duration in between resets for the remainder of the rows. There's a chance that this will reduce the frequency of changes by 80-90%. It's 15%–25% quicker than standard Memory, and it's 12.7% quicker than what was seen in previous experiments. Overall energy consumption drops by 10% to 15% in practical settings.

Using Named Data Networks' flexible data layer, the researchers in [26] investigated the best ways to rapidly deploy local network storage. Content that the cache policy has determined needs to be preserved will be delivered to the cache unit via the cache interface that has been designated as an output on the configurable data layer. Various parts of a request were categorised independently based on their Quality-of-Service requirements. In addition, we used the content's popularity and the inter- cache cooperation to determine the cache likelihood of the categorised content. The cache criterion was based on the proportion of free cache capacity, and the cache likelihood was used to determine if the data should be retained. Increasing the number of caches finds and decreasing the average transfer delay, the experimental findings demonstrate that the suggested cache placement strategy is superior to the normal cache placement strategies.

The Register Renaming Unit (RRU) is responsible for maintaining a mapping between an instruction's mental registers and its corresponding physical registers. To accomplish this, it makes extensive use of a RAM-based Alias Table. (s). This research makes use of an 8T-Cell SRAM gadget to demonstrate the construction of an alias table in memory. For a full two-way, three-operand cycle, it features multiport operations for writing, receiving, and content addressing. A type 21T-Cell SRAM-based CAM cell, with 32 rows and 6 bits, is used to create the Alias Table memory. There are four data inputs, two data outputs, and two data inputs. After the content-address has quickly checked each item in the memory alias table against the under-test register, it will release the corresponding match index address. According to the findings, while both write ports are active during one half- cycle, all four read ports are active simultaneously during the other half-cycle. Each half-cycle of the read step is dedicated to processing one of the two content-address paths. That's right; all three occur simultaneously, within the same time frame. The Memory Alias Chart displays the three activities that can be completed in a 1 GHz cycle with an average power consumption of 0.13 mW based on HSPICE models performed with 90 nm/1 V CMOS technology.

The writers of reference [28] detail the fabrication of stacked CMOS cache memories with support for four-way set associativity. The cache's construction, administration, and configuration have all been topics of discussion. We also discuss level 1 and level 2 cache memory layout and development. Layout of cache RAM is the most crucial design decision. Because it employs a collection of many direct-mapped caches, set associative mapping is the most effective method for structuring CMOS cache memory. This four-way set associative cache memory can be used in silicon-based computing and cellular transmission devices& their configurations. A comparative survey of these models is discussed in the next section of this text.

PERFORMANCE EVALUATION & COMPARISON

After conducting such in-depth tests, it became abundantly evident that the functionality of the different cache models that were being investigated exhibited significant differences in performance. The parameters of read and write delay (D), deployment cost (DC), backup efficiency (BE), and scalability levels were used in this analysis, and these outcomes were rated accordingly (S). The performance of these measurements may be evaluated more objectively on a scale when their values are first fuzzy-sorted into the categories of Low (L = 2), Medium (M = 3), High (H = 4), and Very High (VH = 5). In order to make this assessment process easier, the models and the performance measures that correlate to them are outlined in Table 1. On the basis of this tabulation, higher-performing models might potentially be chosen for a variety of deployments.

Table 1. Performance evaluation of different models

Method	D	DC	BE	S
QoR [1]	M	VH	H	H
MAL RU [2]	H	H	H	H
RBC [3]	L	H	H	M
ByCA [4]	L	M	L	H
LLC [5]	M	H	H	H
WLUD [6]	L	H	H	M
VBC [7]	M	H	H	H
DCL [8]	M	VH	H	M
M3D [9]	**L**	**H**	**M**	**H**
NFV [10]	**M**	**L**	**M**	**M**
CP [11]	**L**	**M**	**H**	**H**
DCLT [12]	**L**	**H**	**H**	**H**
MSA [13]	**M**	**H**	**H**	**M**
MD2 DDL [14]	**M**	**L**	**H**	**H**
TTK [15]	**H**	**M**	**VH**	**H**
OPT IMA [16]	**H**	**M**	**VH**	**M**
WADD [17]	**H**	**H**	**VH**	**H**

As per this evaluation& figure 1, it can be observed that RBC [3], ByCA [4], WLUD [6], M3D [9], CP [11], and DCLT [12] have lower read and write delays. While, NFV [10], and MD2 DDL [14] can be used for lowering deployment costs. It was also observed that OPT IMA [16], TTK [15], and WADD [17] showcase higher backup efficiency, while, QoR [1], MAL RU [2], ByCA [4], LLC [5], VBC [7], M3D [9], CP [11], DCLT [12], MD2 DDL [14], TTK [15], and WADD [17] showcase higher scalability, thus can be used for large-scale memory design use cases.

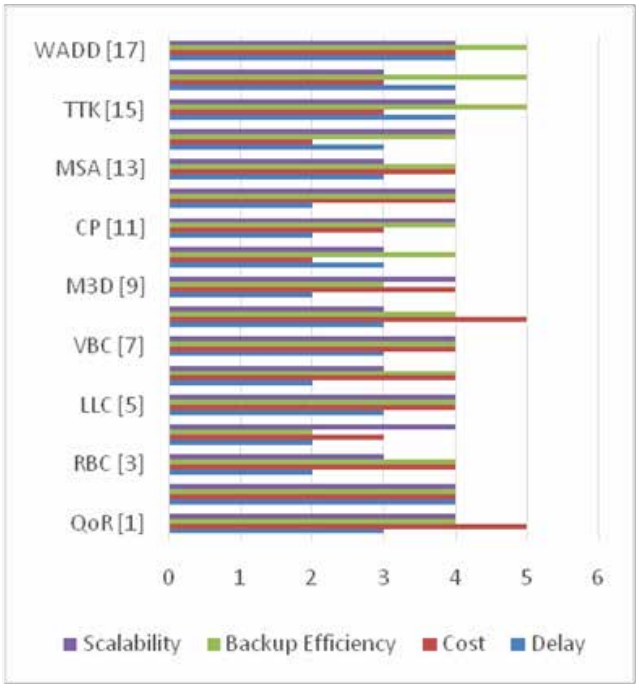

Figure 1. Comparison of different models

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Using Talent Management Strategies to Retain Talented Employees in the Pharmaceutical Industry

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ABSTRACT

The organizations success depends on human resource of that organization but the pharmaceutical Industries of India are facing the problem of retaining talented employee. The challenge for managers today is to maintain employee engagement and ensure that they retain in the organization for longer period of time which would be beneficial for both the employee and the employer. The manager of the pharmaceutical organization must be aware of the current recruitment & selection procedure and retention strategies of their organizations. The primary goal of this study paper is to determine whether talent management practises have any impact on keeping talented personnel in the pharmaceutical business. In this research paper the author done the descriptive study of five different pharmaceutical industries. Target population consisted of medical representative and executive. A structured questionnaire was distributed and primary data was collected by using simple random sampling method, analysis was done using the SPSS version 21.0 package. Different qualitative factors and quantitative factors were in use into concern to influence in retaining the talented employee through descriptive statistics. The data was analyzed and compiled in frequency tables to determine for each determination, the number of replies to each variable. In the study adopted correlation and regression analysis at the 5% significance level to determine the strength and relationship of different variables.

From the total analysis it was clear that talent acquisition had a positive and maximum influence (Pearson's correlation coefficient = 0.877) on retaining the talented employee and talent management, compensation strategies and succession planning are positively correlated with retaining the talented employee (.588, .705, .0424, respectively). From the findings of the study it is clear that HR management in pharmaceutical industries have very less concern on carrier panning and succession planning strategy adopted and most of the organization the employees are not willingness to stay with the company for a longer amount of time. The study also recommends the pharmaceutical companies to conduct induction programs nicely and provide best knowledge to the newly appointed employee which helps in retaining the talented employee.

KEYWORDS: *Talent management strategies, Talent acquisition, Talent compensation, Retaining talented employee, Pharmaceutical company.*

OBJECTIVE

To analyze the impact of talent management strategies and determine how talented employees can be retained in the pharmaceutical industry.

MAJOR OBJECTIVE

- Analyze the impact of tactics for acquiring and retaining talented personnel in the pharmaceutical company.
- Analyze the impact of talent development strategies on retaining talented employees in the pharmaceutical company.
- Examine the influence of compensation strategies adopted to retain talented employees in the pharmaceutical company.
- To study the impact of succession plan strategies to sustain the talented employees in pharmaceutical company.

The reason of this research is to find answers to these questions and gain new knowledge about the subject of study. As research is the major technique used in practically all fields of organizational research to widen and narrowly arrive at precise findings and recommendations, it aids in expanding the frontiers of knowledge.

To perform the study successfully, we used a systematic approach in which we determined the target population, research design, instruments for data collecting, and data analysis methodologies.

DESIGN OF RESEARCH

The design of the research is the plan of the total analysis, which shows how data is to be collected and the analysis has been done to determine the idea of the total research. The research design which was used is a descriptive research different tool was used to analyze the data which was collected from primary reserch.

Population

In this study, the researcher targeted five pharmaceutical companies: Aristo Pharmaceuticals, Ajanta Pharmaceuticals, Palsons Drugs and Chemical Industries, Torrent Pharmaceuticals, and USV Pharmaceuticals. The targeted population consisted of managers and medical representatives, with a sample size of 200.

Sampling Frame

The sampling process used in this research was a stratified sampling method and employees of the five pharmaceutical firms were divided into five strata.

Research Instruments used in this research

The questionnaire was the main tool for the study and a survey was done to collect data from 200 sales force five pharmaceutical companies. A stratified random sampling process was used in the total process employees were divided into ten strata. The stratum was developed and based on the company's sales force and management teams, who might be managers or medical representatives.

ANALYSIS OF DATA

The information gathered was analyzed and made it comprehensive, then summarized, coded, and tabulated.

Demography of Respondents:- Gender

The data of the study shows that the majorities (89.7%) were male and only (10.3%) of the respondents were female.

Respondents Age

In this research, the researcher find that the maximum 44.7 are in age between 35-40 years, 20.0% are age in between 30-34 years, 14.4% are age in between 40-41 years, 8.8% are aged in between 24-29 years, 6.5% are more than 45 years and only little ie. 5.6% of respondents were below 24 years. Therefore, the analysis of the research indicated that data were collected from all age ranges.

Educational background

The study shows that the educational background of the respondents, the majority (39.6%) were graduates, (34.0%) have professional degrees ie MBA, (20.3%) were Postgraduates in science and only 6.1 had some other degree. It is obvious from this survey that the respondents are well qualified, and thus they grasp the purpose of the study and the information they supply for excellent research.

Employee working duration in years:-

According to the findings of this study, the bulk of respondents (48.2%) had worked for 0-5 years, 19.7% for 5-10 years, 16.5% for 10-15 years, and only a handful (3.6%) had worked for more than 20 years. The data shows that the respondents can understand the working and strategies organization therefore they can provide a good view of the research purpose.

Talent Acquisition

From the study, the author finds many talent acquisition strategies that are effective in retaining talented employees in the pharmaceutical industry.

1. Talent acquisition strategy has an impact on employee retention strategy
2. Talent acquisition strategy has no impact on employee strategy

Talent Acquisition on Employee Retention

According to the statistics, 68.0% of respondents feel that diverse talent acquisition techniques influence employee retention in the pharmaceutical sector, whereas 32.0% believe that talent acquisition strategies have no influence on employee retention in the pharmaceutical industry.

Strategies for Talent Attraction in Organization

The data of the study revealed that the majorities (34.7%) were attracted by various incentives and compensation plans, (32.3%) were drawn by well-developed and published training programmes, (19.4%) by well-developed career routes, while a few (5.6%) were attracted by flexible working hours, and 8% are unable to say. From the analysis, it is clear that the majority of respondents say that various inventive and compensation plans are necessary to attract new talent. This reveals the implication that various incentives and compensation plans make the employees experience the organization is concerned with, and the pharmaceutical organization can use this strategy to retain their talented employees.

Talent Development

This study shows that many pharmaceutical organizations have adopted talent development strategies to retain talent and manage talented employees. To retain talented employees, many companies have adopted talent development programs as talent retention strategies.

The study reveals that the majority of pharmaceutical organizations organize quarterly meetings, in which they organize many workshops and management development programs to support and retain talented employees. The company also organizes new leader workshops to assist the sales force in making them well equipped to take on new responsibilities.

The majority of employees believe that the organization has started guidance and leadership development programs that can develop talent management and help retain talented employees, showing that pharmaceutical companies must implement leadership. This demonstrates that the majority of pharmaceutical companies have established leadership programmes to boost talent management and retain talented employees.

Talent Compensation Strategies From the data it can be concluded that the pharmaceutical organization has adopted compensation strategies to improve talent management that can retain talented employees in a pharmaceutical company.

STRATEGIS FOR EMPLOYEE RETENTION & TALENT MANAGEMENT

From the data findings, the researcher's findings revealed that most of the respondents think that pay should be according to performance and budget compensation. The Pharmaceutical organization should make a benchmark according to competitors and make a suitable pay range, in this The survey results suggested that 89.2% of respondents agreed that the organisation benchmark parallel to the rivals so that the organization can come up with adequate remuneration, while 10.8% disagreed. According to the results of this survey, 12.0% of respondents disagree that the awards provided by this organisation are proportionate with their level of effort, while 5.0% are undecided. According to 60.0% of respondents, the benefits offered by this organization are comparable with the effort put in, while 20.0% strongly agreed.

Succession Planning

The study attempted to assess whether succession planning practices had an influence on keeping talented

employees in the pharmaceutical business. Using succession planning strategies to retain employees, the employee believes that succession planning is adopted in most pharmaceutical companies. The employee in the organization always tries their level best for their performance and does better according to their capacity, capabilities, and their ideas. The employees always try their level best for performance which is beneficial to them only.

Employee Retention

The study reveals that every pharmaceutical company organize induction/training program for their new employee so that they can understand their duties and responsibilities and how they can perform better in the organization, the manager also assist the newly appointed employee when they are on the field

Analysis of Regression on Talent Management Strategies

The researcher used a multiple regression analysis in this study to determine the impact of talent management techniques on retaining talented employees in chosen pharmaceutical organizations. The data was analyzed and the result was computed using multiple regression analysis using the Statistical Package for Social Sciences (SPSS).

Table 1 Model Summary on retaining the talented employee

Model	R	R square	Adj. R Square	Standard error of estimation
1	0.898	0.807	0.234	0.277

The coefficients of the determinants explain how changes in the independent variable can make changes in the independent variable. In this study, the dependent variables are retaining the talented employee and the independent variables are talent acquisition, talent development, compensation, and succession planning, so the value of R square is 80.7 percent, so the required factors for retaining talent were considered as a result of R square and approximately 19.3% other factors are to be found in further research.

Table 2 : ANOVA on Retaining the talented employee

Models	Sum of squares	df	Mean square	F	Sig
Regression analysis	1.34	10	0.25	53.11	0.00
Residual	99.90	57	1.26		
Total	101.24	67			

ANOVA

Talent acquisition, talent development, remuneration strategies, and succession planning are the predictors (constants). Employee retention is one of several variables. The model is statistically significant because the significance value is smaller than 0.05. The crucial F at the 5% level of significance was 7.9. As a result of the estimated value of F above the critical value of F (value = 53.1233), we can conclude that the model is noteworthy in its entirety. The model is statistically significant because.0000 is less than 0.05. As a result, at a 5% significance level, F is greater than the critical value of F (value = 53.1233).

CONCLUSION

The study concluded that most of the pharmaceutical organizations are providing financial benefits as a talent attraction strategy; the plan can be implied that would or has a constructive output and bring more talented employees in the organization. From this study, we also can conclude that the pharmaceutical business enterprise must guarantee that their employees are ready in all components to satisfy the top management and who can perform better in the field. The survey also indicated that pharmaceutical organisations use Talent Management and Workforce Planning as skills improvement approaches to improve talent management and retain talented personnel, which means that the organization ensures that talent is used effectively to the best use, and workforce planning should be such that it guarantees all of the respective skills for their advantaged use. Every worker receives deals based on their capabilities. The examiner concluded that the business enterprise has well-evolved on boarding programs for brand-new personnel, which means that each new worker may be comfortable considering the onboard program.

Recommendation of the Study

Pharmaceutical companies must build a good on boarding procedure for new workers in order to onboard competent staff during the transition. Organizations should improve their employee's learning needs. Salaries are competitive and compensation is based on business success, so you need to establish a structure to ensure that employees are aware of their competitiveness and reward them appropriately. Organizations need to be able to provide benefits in a variety of ways, as they can provide benefits to their employees for motivation and cover and protect them in specific aspects.

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How Corporate Governance Practices are Followed in Information Technology Sector Listed in the "Bombay Stock Exchange Sensex"

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ABSTRACT

The information Technology sector is one of the prominent sectors of India that has contributed a lot towards the economic development of our country. It has made efficient and responsive governance services at ease. The IT sector is the main reason behind the country's digital transformation, thereby making its global presence. Effective implementation of sound Corporate Governance (CG) is gaining importance due to the increasing number of corporate failures, frauds, scams, unethical business practices, corrupt practices, and insufficient disclosure. It is now widely held belief that good governance is very essential to prevent financial crises and bankruptcies and to encourage investment in the domestic market and foreign markets. Therefore, good governance in this sector is important. The study aims to identify the applicable sections in "The Company Act 2013" and regulations of "Security Exchange Board of India Listing Obligations Disclosures & Regulations,2015" relating to Corporate Governance (CG). To explore the CG practices based on parameters that are followed in IT companies namely Tata Consultancy Services, Infosys, HCL Technologies, and Tech Mahindra listed in BSE Sensex. For the study, the researcher gathered secondary data from their annual reports for 2020-21.

KEYWORDS: *CG, Information Technology Sector, BSE Sensex, "The Companies Act 2013", "SEBI LODR 2015", JEL Classification Code: G34*

INTRODUCTION

CG is about rules, procedures, and systems for better and sound governance. It mainly focuses to direct the directors and their obligations towards duties, and responsibilities to act for the interest of the company wherein they work. CG ensures transparency and accountability. CG safeguards the interest of the shareholders. Effective CG framework in an organization leads toward corporate excellence. This framework creates long-term trust between investors and the organization. "It is a way that an organization is managed, directed, and controlled" (Cadbury, 1992) CG maintains the relationship and allocates responsibilities between managers, shareholders, and board members to become competitive. (Anon., 1998 and 2004). With the increasing number of scams, fraud, and illegal business practices it has become important for the organization to have transparency and accountability in business transactions which can be fulfilled by implementing CG practices. CG practices are developed in statutory legal provisions.

Role of Information Technology in the Indian Economy

Indian economy in the 21st century is vastly technology driven. The government depends on IT services provided by the IT industry. The IT industry in India is considered the hub of technology and knowledge. As per an article in the Times of India, the IT sector contributed 10% of the GDP in 2019 (TOI, 2021). The growth rate of the IT sector in 2019- 20 is 10% approx. Top-five IT companies in India are "TCS, Infosys, HCL Technologies, Wipro, and Tech Mahindra". As per BSE SENSEX, TCS, Infosys, HCL Technologies, and Tech Mahindra were present.

Review of Literature

Author	Title of the paper	Findings
(Kiranmai & Mishra, 2019)	"CG Practices in State-owned Listed Companies"	CG variables has no effect on the firm performance of the sampled companies.
		24 sampled SOEs get an excellent grade on the basis of guidelines given by the Department of Public Enterprise
(Maheshwari, 2018)	"CG Practices in Indian Corporate IT Sector included in BSE SENSEX: A Comparative Study"	The degree of compliance in all the sampled companies is the same.
		Infosys secures the highest position in terms of the CG Disclosure Index with 95 points.
(Bajpai & Mehta, 2014)	"Empirical Study of Board and CG Practices in Indian Corporate Sector: Analysis of CG Practices of ITC and ONGC"	Chairman and CEO should be different. In ONGC, the CEO position is vacant. While in ITC, the position of chairman and CEO is held by the same person.
		None of the companies have a lead independent director.
		From the study, it can be found that the ONGC compliance level is high than ITC.
(Bhardwaj & Rao, 2014)	"CG Practices in India: A Case Study"	The majority of sampled companies are following mandatory compliances of Clause 49.
		Bajaj Auto, Infosys, and Dr. Reddy are following voluntary disclosures beyond Clause 49.
		Infosys company is rated as a best-governed company by ICRA and CRISIL.
(Dwivedi & Jain, 2005)	"CG and Performance of Indian Firms: The Effect of Board Size and Ownership"	There is no linkage between CG and firm performance.
		There is an association between foreign shareholding and the increasing market value of the company.
(Brennan, 1997)	"CG practices in Irish companies"	Need improvement in CG disclosure
		As per the research conducted, Irish companies are not complying with CG practices.
		Presence of Woman directors is less in the board of directors.

Source: Author's adaptation

Parameter for the Study

1. "Company Philosophy on CG": Every company must develop its philosophy on CG and the code of conduct of business. It has to be included in the CG Section of the annual report.
2. "Board of Directors expertise (BOD)": They are the key persons who are responsible for making effective decision-making and thereby leading to the proper functioning of the organization. Thus, it is important to include their area of expertise in the annual report.
3. "Presence of Independent Director (ID)": Applicable sections and regulation has mandated the presence of 1/3rd of ID on BOD. ID in a board committee takes better decisions and thus protects the interest of stakeholders.
4. "Presence of woman director": Section 149(1)(b) of "The Company Act 2013"2013 includes that every company must include at least 1 woman director on its board.
5. "Tenure of Independent Director": Every company must specifically mention the te e of independent directors in its annual report. As per "Sec 149(2)" and "Sec 149(3)", e company must have independent directors for up to 5 consecutive years.
6. "Directorship Held": "Sec 165 sub-sec (1)" of "The Company Act" and "Reg 17A" of "SEBI LODR 2015", the maximum no. of directorship holding

of the directors of the company in other companies such as listed private/public companies should not be in 10 companies.

7. "Board Meeting Held": The meeting should be frequent. It should be in between 120 days.
8. "Independent Director Meeting held": Independent director's role in decision-making is important. Every company must hold a separate independent director meeting.
9. "Director's Remuneration": Disclosures of remuneration paid as a sitting fee for each director is a must in the annual report.
10. "Compliance Certificate": There must be a compliance certificate given by auditors and company secretaries enclosed in the annexure of the annual report.

RESEARCH OBJECTIVES

a) To identify all the applicable sections in "The Company Act 2013" and regulations of the "Security Exchange Board of India Listing Obligations Disclosures & Regulations" relating to CG.

b) To explore the CG Practices followed in IT Companies Listed in BSE Sensex mandated by "The Companies Act 2013" and "SEBI Listing Obligation Disclosures Regulation 2015".

METHODOLOGY

Research Design: Descriptive and exploratory in nature.

Sample Size: For the study, four companies from the IT sector listed in BSE Sensex are selected which are TCS, Infosys, HCL Technologies, and Tech Mahindra Source of Data Collection: Secondary data gathered from Annual reports of 2020-21, available at the company's websites.

Data Analysis: Based on data gathered from the annual report. For the presence of each parameter in the company, the assigned score is "1" and the absence of the parameter assigned score is "0". The final score of all four companies is determined.

Applicable Sections of "The Companies Act 2013" and applicable "Regulations" of "SEBI Listing Obligations and Disclosures Regulations 2015

Sl No.	Particular	Applicable Sections of The Companies Act 2013	Applicable Regulations of SEBI LODR 2015
1	Board Composition	Section 149: "Companies should have a minimum of 2 directors in private sector".	Regulation 17: "Requirement pertaining to board of directors"
		Section 149(6): "Companies to have independent directors in the board"	
2	Directorship held	Section 165(1): "Directorship held should not be more than 10 in case of	Regulation 17A: "Maximum no. of directorship held"
3	Board Meetings	Section 173: "Companies shall hold board meetings within a gap of 120 days".	-
4	Independent Director meetings	Schedule IV of The Companies Act 2013	-
5	Composition of Committees	Section 177: "Composition of Audit Committee"	Regulation 18: "Requirements pertaining to the Audit Committee
		Section 177(9): "Vigilance Mechanism"	"
		Section 178(1): "Composition of Nomination and Remuneration Committee"	Regulation 19: "Requirements pertaining to Nomination and Remuneration Committee"
		Section 178(8): "Composition of Stakeholder Relationship Committee"	Regulation 20: "Requirements pertaining to Stakeholders Relationship Committee"
			Regulation 21: Requirements pertaining to "Risk Management Committee"
			Regulation 22: "Requirements pertaining to Vigil Mechanism"

Source: Author's adaptation

DATA ANALYSIS

For attaining the objective, the researcher has taken into consideration the relatable sections and regulations of CG. This study is Descriptive in nature

Company 1: Tata Consultancy Services

a. Board Independence: It comprises 9 board of directors.

b. Board Diversity: In TCS, two non-executive women directors comprise the board of directors.

c. Directorship held: In TCS, during Annual Year 2020-21, No director held any directorship in more than 10 listed companies or in 10 publicly listed companies. Thereby, it is in compliance with "Sec 165 sub-sec (1)" of "The Companies Act 2013" and "Reg 17A of "SEBI LODR 2015".

d. Frequency of Board Meetings: During AY 2020-21, TCS held seven board meetings.

e. Composition of Committees: TCS has constituted mandatory committees which composed of a Chairman and Independent directors. It has committees such as the "Audit Committee", "Nomination and Remuneration Committee", "Stakeholder and Relationship Committee", and "Risk management committee". It also incorporated a vigilance mechanism.

Company 2: Infosys

a. Board Independence: It comprises 9 board of directors

b. Board Diversity: 2 are women directors constitute the board of directors.

c. Directorship held: In Infosys, during Annual Year 2020-21, No director held directorship in more than 10 listed companies or in 10 publicly listed companies. Thereby, it is in compliance with applicable Section and Regulation.

d. Frequency of Board Meeting: During Annual Year 2020-21, seven meetings were held within 120 days. Thereby, "Sec 173" is followed.

e. Composition of Committees: In Infosys, various committees have been constituted which are the "Audit Committee", "Nomination and Remuneration Committee", "Stakeholder Relationship Committee", "Corporate social responsibility committee", and "Risk management committee".

Company 3: HCL Technologies

a. Board Independence: It comprises 12 boards of directors

b. Board Diversity: 2 are women directors constituted the board of directors.

c. Directorship held: In HCL Technology, No director held any directorship in more than 10 listed companies or in 10 publicly listed companies in AY 2020-21. Thereby, it is in compliance with "Section 165(1)" and "Regulation 17A".

f. Frequency of Board Meeting: During Annual Year 2020-21, fourteen meetings were held within 120 days. Thereby, "Section 173 of The Companies Act 2013" is followed.

g. Composition of Committees: In HCL Technologies, various committees have been constituted which are the "Audit Committee", "Nomination and Remuneration Committee", "Stakeholder Relationship Committee", "Corporate social responsibility committee", and "Risk management committee".

HCL Technologies has also constituted a few voluntary committees namely the "Share Transfer" and "Other Matters Committee", "Committee on Frauds", "Customer service committee", and "Management Committee".

Company 4: Tech Mahindra

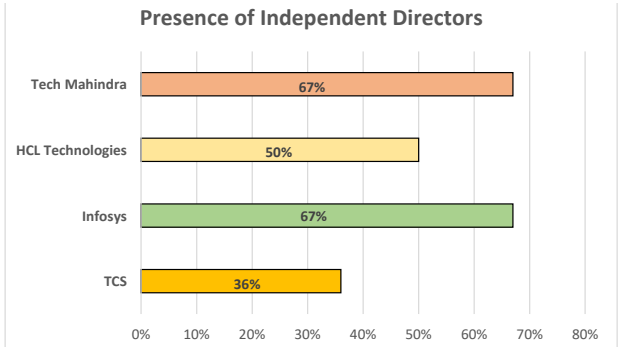
a. Board Independence: Board consists of nine directors

b. Board Diversity: 3 are women directors constituted on the board of directors.

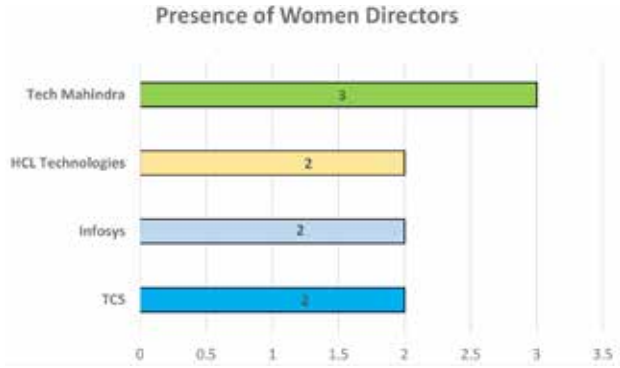
h. Directorship held: In Tech Mahindra, no director held any directorship in more than 10 listed companies or in 10 publicly listed companies. Frequency of Board Meeting: Seven meetings were held within 120 days. Thereby, "Sec173" is followed.

i. Composition of Committees: In Tech Mahindra, various committees have been constituted which are the "Audit Committee", "Nomination and Remuneration Committee", "Stakeholder Relationship Committee", "Corporate social responsibility committee", and "Risk management committee".

A few voluntary committees have been constituted namely "Investment Committee", and "The Securities Allotment Committee".



Source: Author's adaptation



Source: Author's adaptation

Parameter of Corporate Governance

Sl. no	Parameter	TCS	Infosys	HCL Technology	Tech Mahindra
1	Corporate Governance Philosophy in Company's Corporate Governance Section of Annual Report	1	1	1	1
2	Board of Directors expertise	0	1	1	1
3	Presence of Independent director	1	1	1	1
4	Presence of woman director	1	1	1	1
5	Tenure of Independent director	1	1	0	1
6	Directorship Held	1	1	1	1
7					
8	Board Meeting Held	1	1	1	1
9					
10	Independent Director Meeting held	0	1	1	0
11	Director's Remuneration	1	1	1	1
12	Compliance Certificate from Auditors/ Company Secretary	1	1	1	1
13					
	Total Score	8	10	9	9

Source: Annual Report 2020-21

FINDINGS

Compliance Level at TCS

TCS meets specified requirements as outlined in "The Company Act 2013" and "SEBI LODR 2015", and has established a BOD comprising an ED, a NED, and an ID. The structuring of governing members demonstrates compliance with the minimum criteria set forth by these regulations. Remarkably, TCS exceeds the minimum requirement by having more than 67% of the ID on its board, surpassing the threshold of 33.3%.

Furthermore, TCS has prioritized diversity within its board, consisting of two women directors and five male directors,

ensuring a balanced representation. Additionally, all the directors hold directorships in less than 10 listed companies, adhering to the guidelines that promote effective governance.

To foster effective decision-making and governance practices, TCS conducted a total of seven board meetings during the annual year 2020-21. This regular meeting schedule enables the board to deliberate on strategic matters, review performance, and provide guidance to the organization.

TCS has also fulfilled the mandatory requirement of forming various committees as prescribed by "Sec 177", "Sec 178(1)", "Sec 178(8)" of "the Companies Act 2013" and "Reg 18", "Reg 19", "Reg 20", "Reg 21" of "SEBI LODR 2015". All committees ensures effective oversight and governance in key areas such as audit, remuneration, and stakeholder relationships.

Demonstrating a commitment to integrity and accountability, TCS has established a policy to address the vigilance mechanism of directors. This policy helps safeguard against any potential conflicts of interest or misconduct and ensures that the directors operate with the highest level of ethics and professionalism.

Compliance level at Infosys

Infosys has formed its BOD comprising ED, a NED, and an ID. The governing members meet the minimum requirements established by these regulations. Notably, the board boasts a strong presence of independent directors, accounting for 67%, exceeding the mandated threshold of 33%.

Emphasizing gender diversity, the board at Infosys consists of two women directors and four male directors, ensuring a balanced representation and promoting inclusivity within the organization.

To maintain effective governance practices, all directors on the board of Infosys hold directorships in less than 10 listed companies. This adherence to the limit reinforces focused engagement and dedicated commitment to the responsibilities associated with their director roles.

During the annual year, Infosys conducted a total of seven board meetings, providing ample opportunities for deliberation, decision-making, and strategic guidance. These meetings serve as crucial platforms to review performance, address key issues, and ensure the effective functioning of the organization.

Infosys has also fulfilled the mandatory requirements by establishing all the prescribed committees. These committees, covering areas such as audit, remuneration, and stakeholder relationships, play an essential role in enhancing governance practices and fostering transparent decision-making.

Infosys further demonstrates its commitment to ethical practices by adhering to a robust vigilance mechanism policy. This policy ensures that the directors uphold the highest standards of integrity, preventing conflicts of interest and misconduct, and promoting ethical behavior throughout the organization.

Compliance level at HCL Technologies

HCL Technologies places great importance on upholding governance standards, and to that end, it has established a BOD comprising a diverse mix of "executives, non-executives, and independent directors". The board not only adheres to regulatory requirements but goes beyond by ensuring that independent directors make up 50% of the board, surpassing the minimum threshold of 33%.

Recognizing the significance of gender diversity, HCL Technologies has achieved commendable representation with 40% women directors and 60% male directors on its board. This commitment to inclusivity fosters a culture of equality and brings a balanced perspective to the organization.

In adherence to CG practices, HCL Technologies limits the number of directorships held by its directors to dedicate sufficient time and attention to their roles within HCL Technologies, ensuring focussed leadership.

Throughout the year 2023, HCL Technologies conducted a total of fourteen board meetings, underscoring the company's commitment to regular engagement and thoughtful deliberation on strategic matters. These meetings provide a vital platform for reviewing performance, making crucial decisions, and offering guidance to steer the company's growth trajectory.

HCL Technologies has formed mandatory committees that play a pivotal role in effective governance. These committees, as prescribed by regulations, address important aspects such as audit, remuneration, and stakeholder relationships, bolstering transparency and accountability across the organization.

Moreover, HCL Technologies places a significant emphasis on vigilance and ethics, exemplified by the formulation of robust policies that safeguard the integrity and professionalism of its directors. These policies promote ethical conduct, prevent conflicts of interest, and uphold the highest standards of CG throughout the organization.

Compliance Level at Tech Mahindra

At Tech Mahindra, the composition of the BOD reflects a balanced mixture of ED, NED and ID. Out of nine members, 11% are executive directors, 22% are "non-executive directors", and the majority of independent directors account

for 67%. These exceed the minimum requirement of 33% independent directors specified by regulations.

Furthermore. Tech Mahindra complies with the provision that no director holds a directorship in more than 10 listed companies, ensuring their focus and commitment to their roles within the organization.

During the period, Tech Mahindra conducted seven board meetings, fulfilling the requirements of regular engagement and decision-making. These meetings provide a platform for strategic discussions, performance reviews, and guidance to drive the company's growth and success.

Tech Mahindra has constituted all mandatory committees as required by The Companies Act 2013. These committees, covering areas such as audit remuneration, and stakeholder relationships, contribute to effective governance and oversight.

Based on the annual report of 2020-21. Tech Mahindra, along with HCL Technologies secures 9 points out of 10 in terms of CG parameters, reflecting their strong commitment to sound governance practices. TCS follows closely with 8 points, while Infosys leads with a perfect score of 10 points.

However, it is worth noting that in HCL Technologies' annual report, the specific tenure of independent directors was not explicitly mentioned. In Tech Mahindra, an independent directors meeting was not held during the AY 2020-21. In the case of TCS, the annual report lacks information on board member expertise, and no independent director meeting was conducted.

It is essential for companies to address these gaps and provide comprehensive disclosure and adherence to CG principles to ensure transparency, accountability, and effective decision-making.

CONCLUSION

CG is all about rules, processes, and principles incorporated by the organization that inbuilt investor confidence in that organization, and by implementing sound CG practices, the chances of fraud and scams are less. The principles of CG are transparency of businesses and accountability of businesses. The performance of an organization depends on the board of directors' decision-making. "Sec 149" and "Sec 149(ii)" of "The Companies Act 2013" and "Reg 17" of "SEBI LODR 2015" are about "board composition" and the "presence of ID". All sections and regulations relating to CG practices like the composition of committees such as "audit committee", "stakeholder relationship committee", "nomination and remuneration committee", and "risk management committee". By conducting exploratory research, all the relatable statutory provisions on CG are identified. The findings of the study concluded that TCS, Infosys Ltd, HCL Technologies, and Tech Mahindra have complied with all the relatable Sections, and regulations. From the study, it is found that Infosys Ltd has included all the parameters of CG in its annual report for 2020-21. Whereas, it can be seen that in HCL Technologies the tenure of ID is not specifically laid down and in Tech Mahindra no independent director meeting was held in AY 2021. Therefore, from the study conducted out of all four IT companies, Infosys Limited stands first considering all the important parameters of CG.

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Uncertainty Management Approach for MSMEs

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ABSTRACT

Uncertainty inherent in every business. In the current unprecedented environment amid lockdown and corona crisis, where everything had almost come to a standstill and future has become uncertain, business sustainability has become a challenge. The grappling struggle is also reflected in the MSMEs, which is the engine of economic growth and considered as the backbone of Indian economy. The paper aims to strengthen the MSMEs approach in managing the uncertainties, by synthesizing the impacts and approaches in a conceptual model. Initially the paper elaborates the understanding of uncertainty, which is mostly overlapped with risk. Through systematic review from the rich available literature the dimensions of uncertainty are explored and further an approach to channelize the impact is proposed. Based on the critical analysis, the paper synthesis three impacts of uncertain situations, analyse and frames strategies. The proposed conceptual model is referred as Strategizing Uncertainty Model, is an effort to contribute to structuring and defining the uncertainty management. The optimization term relates to building a positive and opportunistic perspective towards uncertainty. Uncertainty management is an important phenomenon in managing the current uncertain situations and further in the ever-growing complex and competitive business environment, where noting is constant, it is required to be considered and practiced in enterprises and managerial processes. The paper concludes with the suggestions and elaborates the need and potentiality of incorporating uncertainty management perspective not only in MSMEs, but in a global business scenario.

KEYWORDS: *Uncertainty, Managing uncertainty, MSME, Strategic management, Uncertainty management*

INTRODUCTION

Uncertainty is inevitable in situations which have not been seen in a century [1]. So, MSMEs need to build a competitive edge and competency towards uncertainty to sustain in the ever-changing and increasingly complex business environment through modern and new approaches [2].

Worldwide, Micro, Small & Medium Enterprises (MSMEs) are termed as the engine of economic growth and also considered as the backbone of Indian economy. According to the recent Annual report 2018-19 of Government of India‟s Ministry of Micro, Small & Medium Enterprises (MSMEs) stated that the share of MSME in the GDP was 28.90 percent for the year 2016-17 [3]. MSMEs are producing diverse range of products and services which not only satisfy the domestic needs of the country but also meet the standards of global markets.

Under the Atmanirbhar Bharat Abhiyann program, MSMEs are redefined on 1st June 2020. The new definition has elevated the parameters for enterprises to get categorised in MSMEs. According to the

new definition [4], the enterprises engaged in the manufacture or production of goods or the enterprises engaged in providing or rendering of services is

i. a micro enterprise, where the investment in plant and machinery or equipment and annual turnover does not exceed one crore and five crores respectively

ii. a small enterprise, where the investment in plant and machinery or equipment and annual turnover does not exceed ten crores and fifty crores respectively

iii. a medium enterprise, where the investment in plant and machinery or equipment and annual turnover does not exceed fifty crores and two hundred fifty crores respectively

From 6.33 crore MSMEs in India, almost 99.4 percent enterprises fall under the micro enterprise and 0.52 and 0.007 per cent is comprised by small and medium enterprises in respectively [5].

Even though Micro enterprises hold 99.4 percent of enterprises in the MSMEs. In normal times MSMEs have difficult time to sustain in the global scenario, with constant changes in the market dynamics due to regulatory upheavals, technological changes, abrupt changes in consumer behaviour and globalization. Especially Micro and Small industries are the most vulnerable because of their capacity, scale of operations, scarce resources, limited managerial process and less margin for managing sudden slumps. But with the unexpected situations like Corona Pandemic, National Lockdown, Demonetisation, GST implementation and bank crisis; the survival becomes an intensified challenge.

This research is significant as the MSME sector is truly a strategic asset for the economy of the country. The contributions and benefits of the MSMEs have immensely widened in the other sectors. Among all the sectors, micro, small and medium enterprises (MSMEs) was the largest job creator in the last four years – with growth of 13.9 per cent – and will continue to be so in the next three years, according to a survey by the Confederation of Indian Industry (CII) [6]. It is also promoting and expanding inclusive growth in the entrepreneurial activities and business innovations. Presently, the MSME sector is associated, in public perception, with low quality standards. The MSME sector is anticipated to be upgraded through modern and new approaches to achieve global quality standards. [7]

REVIEW OF LITERATURE

Uncertainty

Lack of knowledge about probabilities of future events in Uncertainty [8]. Uncertainty is mostly mis-conceptualised with the risk [9]. Commonly Risk and Uncertainty are considered to be synonyms[10] as the definition of risk in PMBok [11] is as an uncertain event that can impact any event. In many literatures work the risk and uncertainty concepts overlap and properly distinguished is not available [12]. Uncertainty is when, there is not a single, nor complete understanding of the event to be managed [13]. In risk situation the decision maker is able to draw out a distribution of the outcomes of the events where as in uncertain situation, it‟s impossible to draw any probable outcomes and prediction of the event [8]. While practicing uncertainty, more focus is drawn to threats and less to opportunities, although it is subjected to opportunities equally as threats. Risk is related to the negative impact of having threats, but uncertainty is related to both positive and negative impact, as it can have threats or opportunities [14]. At different phases of projects, the practice of uncertainty should vary [15]. Due to lack of proper distinction in dimensions of uncertainty, which leads to risky and unjustified decision [16]. A need of better research about uncertainty and its understanding can structure the management of uncertainty for any enterprise.

Dimensions of Uncertainty

Unlike risk, uncertainty is difficult to measure as it is subjective, multi-dimensional and varies in degree of experience and source [17]. A study defined uncertainty in terms of ambiguity and complexity and further elaborated the four strategies to manage uncertainty. Many phenomena of an organisation can be broadly understood, when internal and external sources of uncertainty are explicitly considered [18]. But the paper aims to focus only on the external unprecedented and unforeseen situations for an effective and in-depth analysis. The four strategies mentioned in the study are: Ignore, Knowledge generation, Interaction and Coping Strategies [19]. Studies have built an opportunistic perspective towards uncertainty and linked it with

strategic management and entrepreneurship [9]. Uncertainty dimensions vary with the level of impact on any enterprise and thus the need to set the elements of impact need to be defined which can further elaborate its strategies and effect.

Managing Uncertainty

Managing uncertainty involves either reducing risk or cope with the strategies [20]. Further, a study elaborates three dimensions to reducing risk: Information gathering, proactive collaboration, networking and five dimensions to coping with strategies: flexibility, imitation, reactive collaboration, control and avoidance [21]. The misconception of uncertainty as risk leads to implementation of risk management strategies to extreme uncertain situations and causes failure in the management level [22]. Unforeseeable uncertainty requires advance level of strategy management [22]. The strategy thus cannot be same in every level of the uncertainty as the impact of uncertainty can have a direct or am indirect impact on the enterprise. For building a competitive edge for any organisation dexterity, continuous improvement, customer orientation, constant innovation and quest towards globalisation is involved [23]. Although uncertainty cannot be completely eliminated but believed to be minimised implicitly by reflective learning and knowledge exchange [23].

UNCERTAINTY MANAGEMENT APPROACHES

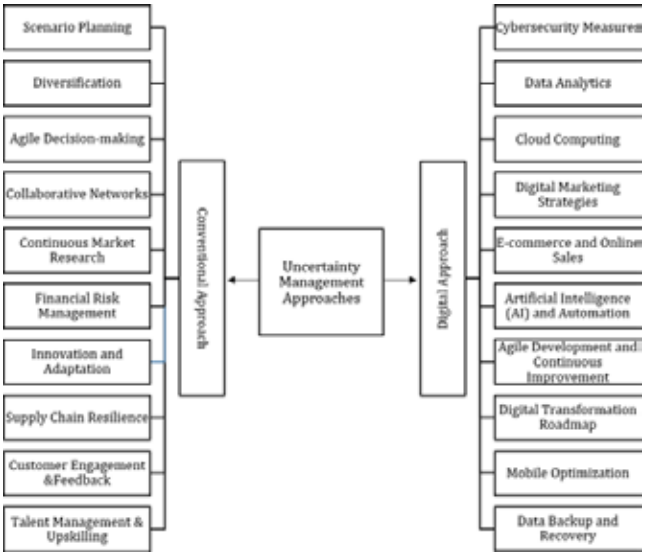
From the above literature study, the following conceptual model in synthesised for an external unforeseen situation. The model primarily distinguishes the impact type in Direct, Indirect or No Impact. Direct and Indirect Impact are generally associated with the uncertainty, as no impact can barely be a possibility in external unforeseen situation. The decision making in assessing the impact depends on the managerial perspective, experience and analytics. Any effect of the uncertainty impact can further be positive or negative, where positive is closely determined to be an opportunity and negative to a threat. The model does not include any risk factor to eliminate the overlapping of any risk management term and hence the threat level is incorporated. The level of threat or opportunity can be gauged by an enterprise by assessing the impact of the uncertainty at different spheres of business. The strategy at every level need to be different depending on the uncertainty experienced [22] thus a constructive strategy is framed at every level. The strategy definitely can be further improvised and more defined, according to the sector of enterprise, product and goals of the enterprise. The model further has a scope and potential to be elaborated into more structured form. More the defined and structed the model develops; the aim of the paper will be enriched in uncertainty management. Thus, the model can be recognised as a „Strategizing Uncertainty Model", as it aims to convert the uncertain situations towards the benefit of the organisation. The model holds a positive perspective by considering any uncertainty or uncertain situation to be an opportunity of growth. To develop and implement this uncertainty management practice in any enterprise, there is definitely the need of uncertainty management tools that need to be practiced at every spere and level of managerial process.

Table 1 : Proposed Conceptual Model : Strategizing Uncertainty Model

Impact of Uncertainty	Effect	Threat Level	Opportunity Level	Strategy
Direct Impact	Positive	Very Low	Very High	Optimise the situation and
	Negative	High	Very Low	Gather Information and Mitigate the Losses
Indirect Impact	Positive	Moderate	High	Flexibility and Innovative Approaches
	Negative	Moderate	Moderate	Analyse and Adopt Change or Alternatives
No Impact	No effect	No	Highest	Explore & tap new potential from the available resources

MSMEs mostly comprising of micro enterprises hold a high vulnerability level even in the slightest uncertain situation. For sustaining the high level of the uncertainty, mostly risk management tools are implemented [22] which does not efficiently address the uncertainty impact in MSMEs. For uncertainty to be addressed following tools are synthesised from the above literature study. Kaizen, Value stream mapping, Quality tools and Total productivity tools are considered to the practices for Lean Approach [24]. Also, lean thinking along with resourcefulness can develop a perspective of always optimising the situations and resources in a positive way. Strong Communication Technology, Flexibility, Innovative approaches and strive for attaining internationalisation, dexterity and customer

oriented are the approaches to build competitive edge [22] in uncertainty. The customer- oriented enterprise will always have a practice of upgrading and improving the product or service according to the changing customer requirement. Along with that Knowledge and transparency of information with the various levels of the organisation [21] will keep a clarity while assessing of the level of impact of the uncertainty. Further the enterprises with a practice of analysing the situation at every regular interval can definitely have a clue of predicable uncertainty. The practice of these tool in the enterprise can elevate the level of clarity in decision making and gauging the impact of any uncertain situation if faced. Although, the paper is confined to support and strengthen the MSMEs in addressing the uncertain situations, the tools mentioned can be adopted at other sectors.



Conventional Approaches

1. Scenario Planning: MSMEs can enhance their preparedness by developing multiple scenarios based on different potential outcomes and uncertainties. By considering various scenarios, businesses can better understand the range of possibilities and devise appropriate strategies for each situation. This proactive approach allows MSMEs to assess risks, identify potential opportunities, and establish contingency plans accordingly. By anticipating and planning for different scenarios, businesses can be better equipped to navigate uncertainties, make informed decisions, and adapt their strategies as needed. This flexibility and preparedness are key to maintaining resilience and successfully managing unexpected events..
2. Diversification: MSMEs can effectively reduce uncertainty by diversifying their product or service offerings, target markets, and revenue streams. By expanding their range of offerings, businesses can mitigate risks associated with relying solely on a single product or service. Similarly, targeting diverse markets allows MSMEs to tap into new customer segments and reduce dependence on a specific market's conditions. Furthermore, diversifying revenue streams by exploring different sources of income can provide stability and resilience in the face of changing economic landscapes. By embracing diversification, MSMEs can minimize the impact of uncertainties and create a more robust and adaptable business model.
3. Agile Decision-making: MSMEs can benefit from adopting agile decision-making processes that prioritize flexibility and quick adjustments in response to changing circumstances. This approach allows businesses to adapt swiftly and make informed decisions based on real-time information. By embracing agile decision- making, MSMEs can effectively respond to market shifts, customer feedback, and emerging trends. It involves gathering and analyzing data, engaging stakeholders, and utilizing iterative feedback loops to make timely and informed decisions. This agile mindset enables businesses to stay proactive, seize opportunities, and navigate uncertainties with greater agility and resilience.[25]
4. Collaborative Networks: MSMEs can greatly benefit from forming partnerships and collaborative networks with other businesses, suppliers, and industry associations. Through these alliances, they can share resources, knowledge, and expertise, collectively managing uncertainties and creating new opportunities. Collaborative networks enable MSMEs to tap into a wider pool of resources, access specialized skills, and leverage shared experiences to navigate uncertainties more effectively. By fostering partnerships, businesses can also expand

their reach, gain market insights, and develop innovative solutions through collaboration. This collaborative approach helps MSMEs mitigate risks and fosters growth, resilience, and a competitive advantage in the marketplace.

5. Continuous Market Research: MSMEs should allocate resources to ongoing market research in order to stay updated on industry trends, customer preferences, and emerging technologies. By conducting thorough market research, businesses can gain valuable insights that help them anticipate changes and adjust their strategies accordingly. Understanding customer needs and staying ahead of industry developments enables MSMEs to proactively adapt their products, services, and marketing approaches. By investing in continuous market research, MSMEs can maintain a competitive edge, identify new opportunities, and make informed decisions that align with the evolving market landscape.

6. Financial Risk Management: MSMEs should prioritize the implementation of effective financial risk management practices to ensure their financial stability in uncertain situations. This includes developing contingency plans, maintaining adequate reserves, and actively managing cash flow. By having contingency plans in place, businesses can anticipate potential risks and establish strategies to mitigate their impact. Maintaining sufficient reserves provides a buffer to withstand unforeseen financial challenges. Additionally, managing cash flow ensures a healthy and sustainable financial position. By proactively managing financial risks, MSMEs can enhance their resilience, maintain stability during uncertain times, and position themselves for long-term success.

7. Innovation and Adaptation: MSMEs should actively cultivate a culture of innovation and encourage employees to think creatively. Businesses can effectively transform uncertainties into opportunities by embracing change and proactively adapting to new market conditions. Encouraging employees to explore innovative solutions, experiment with new ideas, and think outside the box fosters a dynamic and agile work environment. This mindset allows MSMEs to identify emerging trends, respond to customer needs, and stay ahead of the competition. By embracing innovation, MSMEs can leverage uncertainties as a catalyst for growth, differentiation, and long-term success.[26] [27]

8. Supply Chain Resilience: MSMEs should prioritize assessing and strengthening their supply chain resilience by implementing various strategies. This includes diversifying suppliers, enhancing transparency, and developing contingency plans. By diversifying suppliers, businesses can reduce reliance on a single source and mitigate the impact of disruptions. Enhancing transparency throughout the supply chain allows for better visibility and risk management. Additionally, developing contingency plans enables MSMEs to effectively respond to unforeseen events and minimize disruptions. By proactively addressing uncertainties in the supply chain, MSMEs can ensure continuity of operations, maintain customer satisfaction, and sustain their business growth.

9. Customer Engagement and Feedback: Maintaining strong customer relationships and actively seeking feedback is essential for MSMEs. By understanding customer needs and preferences, businesses can adapt their offerings and strategies to better meet market demands. Regularly engaging with customers allows MSMEs to gather valuable insights, identify improvement areas, and promptly address any concerns. By fostering a customer-centric approach, MSMEs can build loyalty, enhance customer satisfaction, and stay competitive in the ever-evolving market. Actively seeking feedback demonstrates a commitment to continuous improvement and helps MSMEs establish long-lasting relationships with their customers.

10. Talent Management and Upskilling: MSMEs should prioritize talent management, which includes both attracting and retaining skilled employees. By investing in attracting top talent and creating a conducive work environment, businesses can build a strong team capable of handling uncertainties effectively. Furthermore, providing opportunities

for upskilling and professional development equips the workforce with the necessary skills and knowledge to adapt to changing circumstances. By nurturing talent within the organization, MSMEs can foster employee loyalty, increase productivity, and enhance their ability to navigate uncertainties and drive business growth.

Digital Approaches

1. Cybersecurity Measures: MSMEs should prioritize cybersecurity to secure their digital assets and consumer data. By putting in place strong security protocols, conducting regular audits, and training employees, MSMEs may reduce the risks associated with cyber threats and data breaches.[28]
2. Data Analytics: By harnessing the power of data analytics, MSMEs can leverage valuable insights into customer behavior, market trends, and operational performance. Through the analysis of data, these businesses can make well-informed decisions and uncover potential opportunities, thereby minimizing uncertainty in the decision-making process.[26]
3. Cloud Computing: The adoption of cloud computing solutions can significantly improve agility and scalability for MSMEs. By utilizing cloud-based infrastructure and software, businesses can efficiently adjust their resources, gain access to real-time data, and reduce dependence on physical infrastructure. This enables MSMEs to adapt quickly to changing needs, streamline operations, and optimize resource allocation.[26][27]
4. Digital Marketing Strategies: Developing and implementing effective digital marketing strategies play a crucial role in enabling MSMEs to expand their online presence, effectively reach their target audiences, and enhance customer engagement. By taking a proactive approach to marketing, these businesses can reduce uncertainty in attracting and retaining customers, thereby increasing their chances of success in the digital landscape.
5. E-commerce and Online Sales: MSMEs have the opportunity to embrace e-commerce platforms and online sales channels, which can help diversify their revenue streams and decrease reliance on physical stores. This adaptation enables them to respond to evolving consumer preferences and market dynamics, ensuring greater flexibility and resilience in their business operations. By leveraging the potential of online sales, MSMEs can expand their reach and capture new market opportunities..
6. Artificial Intelligence (AI) and Automation: The integration of AI technologies and automation into business processes can have a transformative impact on MSMEs. These businesses can streamline operations, enhance efficiency, and minimize human error by leveraging AI-driven tools for customer service, inventory management, and predictive analytics tasks. This adoption allows MSMEs to optimize resource allocation, make data-driven decisions, and allocate their workforce to more strategic and value- added activities. Integrating AI technologies and automation ultimately empowers MSMEs to operate more efficiently and effectively in a rapidly evolving business landscape.[26][27]
7. Agile Development and Continuous Improvement: MSMEs are encouraged to adopt agile methodologies for software development and digital projects. This iterative approach empowers them to swiftly adapt to market changes, incorporate customer feedback, and embrace emerging technologies. By following agile principles, MSMEs can enhance their project management, foster collaboration among team members, and ensure continuous improvement throughout the development process. This flexibility and responsiveness enable MSMEs to deliver high-quality software and digital solutions that meet evolving customer needs and stay competitive in the dynamic market landscape.[25]
8. Digital Transformation Roadmap: The development of a well-defined digital transformation roadmap is crucial for MSMEs to effectively navigate uncertainties related to technological advancements. Businesses can systematically implement digital initiatives by creating a clear plan that outlines goals, timelines, and resource allocation. This roadmap provides a strategic framework for adopting new technologies, optimizing processes, and integrating digital solutions into their operations. With a

well-structured approach, MSMEs can effectively manage the challenges associated with digital transformation and maximize the benefits it offers in terms of growth, efficiency, and competitiveness.

9. Mobile Optimization: Given the growing prevalence of smartphones, it is essential for MSMEs to prioritize mobile optimization for their websites and digital platforms. By ensuring a seamless user experience across mobile devices, businesses can minimize uncertainties associated with user engagement and conversions. Mobile optimization includes responsive design, fast loading times, intuitive navigation, and mobile- friendly content. By prioritizing mobile optimization, MSMEs can effectively engage and retain mobile users, capitalize on the mobile-driven market, and enhance their chances of converting visitors into customers.

10. Data Backup and Recovery: The implementation of robust data backup and recovery systems is vital for safeguarding against potential data loss or system failures. By regularly backing up critical data and testing recovery procedures, businesses can mitigate uncertainties caused by unforeseen incidents. This proactive approach ensures that MSMEs can quickly restore their systems and minimize downtime in the event of a data breach, hardware failure, or natural disaster. By prioritizing data backup and recovery, businesses can maintain business continuity, protect sensitive information, and instill confidence in their customers and stakeholders.

DISCUSSION

Uncertainty term is a rapidly developing term in the business enterprises. The concept of uncertainty and its management discussed in this paper is to distinguish the risk from the uncertainty. Where risk is a quantifiable term and uncertainty to be a completely unmeasurable and unpredictable term related to any event. Thus, implementing risk management strategies during the uncertain situation is not an effective measure. The potentiality of the uncertainty management to develop into a managerial process is explored.

MSMEs, the engine of economy are worst hit to uncertainty and a need to address their uncertain situations is elaborated. Uncertainty management holds a crucial importance in the MSME. The uncertainty management approach can be developed in the MSMEs by use of the uncertainty management tools. The proposed Strategizing Uncertainty Model is an effort to develop a structured and defined approach to alleviate and optimise any unforeseen or unprecedented external situation. Overall, the paper also seeks to offer a comprehensive and conceptual overview of existing knowledge on Uncertainty and contribute further to develop and frame the uncertainty management with the Strategizing Uncertainty Model.

CONCLUSION

The paper implies the potentiality and importance of Uncertainty Management in all the enterprise and in the field of Management for overcoming the ever-changing complex business environments. The work contributes insights into efficiently managing external unforeseen and unprecedented situations associated with the MSMEs and how to cope up with rapidly changing business dynamics with the Uncertainty Management approach. perspective. The practical implication is the synthesised and proposed Strategizing Uncertainty Model, which can be used as a structure to better plan the strategies to uncertainties. The proposed conceptual model is view with the MSMEs dimension, and can be partially applicable to the other sectors. This leads to a scope of further structing and frame working of the uncertainty management for a common model. To enhance the model, and the topic further literature regarding project management, strategic management must be explored.

MSMEs should assess their digital readiness, prioritize areas of improvement, and carefully implement these approaches based on their specific needs and resources.

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Sustainable Determinants in the Development of Micro and Small Enterprises of Eastern Maharashtra

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ABSTRACT

The study examined the determinants in the development of Micro and small enterprises of Eastern Maharashtra. A descriptive survey design was adopted. All the registered micro and small businesses in Eastern Maharashtra is routine in this study. A structured questionnaire is customised for data collection. The collected data is analysed using SPSS to perform simple linear regression for testing the research hypotheses. The 0.05 level of significance is used for the hypothesis testing. According to the study's findings, the statistically significant degree of firm growth is most likely influenced by the owner's age, contact to capital, family-owned business history, and the interest rate. Contrarily, entrepreneurship training, the owner's expertise, the rate of inflation, and competition are less likely to have an impact on the expansion of businesses at a statistically significance level. The lasting variables, including the owners' gender, educational background, age of the business, type of business, location of the business, social responsibility, tax rate, and attitude towards society, did not statistically significantly affect the growth of MSEs.

KEYWORDS: *MSE, Sustainable, Determinants, Eastern maharashtra, Performance measurement, Capital structure.*

INTRODUCTION

In the last fifty years, the MSE sector of the Indian economy has grown to be one of the most lively and dynamic. MSEs not only play a significant role in generating a large number of employment opportunities at a capital cost that is significantly smaller than that of large-scale industries, but it has also aid in industrialising rural and under-developed regions, thereby dropping regional differences and warranting a more unbiassed dispersal of revenue and wealth transversely the country. MSEs are auxiliary businesses that support large industries, and this sector has a significant positive impact on the socioeconomic progress of the nation.

Maharashtra is the leading state in terms of industrial output in India. However, only a small number of people have entered the medium and big sectors. The industrial structure has temporarily become unbalanced as a result of this. Small business owners have dominated the industrial sector in recent decades. For the growth of other regions, the patterns and traits of entrepreneurship in Maharashtra are instructive. Therefore, it is interesting to look at Maharashtra's entrepreneurial activities and the variables that have led to their success. The development and operation of entrepreneurship are often influenced by a wide range of circumstances. These include past employment, family history, caste, origin, education, technical expertise, financial situation, backing from the government, personality, the entrepreneur's character attributes, etc. These elements not only determine successful or unsuccessful entrepreneurs, but also have an impact on industrial growth and the production process. Therefore, it is essential to develop the elements or provide the conditions that foster entrepreneurship and afterwards industrialization in order to promote industrialization.

The creation of jobs, the provision of goods and services, and other activities that create value are all contributions made by the micro and small enterprise sector to the "nations' economy". The industrial sector is expected to develop more quickly and sustainably,

and the Five-Year Plan for Growth and Transformation envisions permitting the sector to progressively show a vital role in the economy. To do this, boosting micro and small businesses and aiding the growth of medium and big industries are given particular attention. Small businesses in India, especially in the eastern area, are increasingly up against competition from not only their peers but also from huge businesses functioning in specialist industries that were once understood to be limited to the small enterprises (Ntakobajira, 2013).

The misconception about MSEs, according to Amyx (2005), is one of the main obstacles. Prospective customers believe that small firms are unable to deliver high-quality services and can only handle one major project at a time. Small business failure is attributed in large part to inadequate planning, bad funding, and subpar management (Longenecker, 2006). A number of variables, such as the degree of economic growth, the growth of real per capita income, population expansion, and technological advancement, are typically linked to the development of small to medium size businesses, the evolution of their share of employment and production over time, their market orientation, and their location.

LITERATURE REVIEW

A company's strength is its human capital because it can solve its difficulties thanks to people's knowledge and talents. The results of Anwar's (2019) study show that human capital is significant because it is based on the idea that women are not only in charge of family reproduction but also produce raw materials, process food, and are thought to be responsible for half of all production. The most significant input into the production process is human capital (Ahmed et al., 2020a, 2020b). According to Bobba et al. (2020), human capital accounts for more than half of the overall value of production.

Due to MSMEs' failure to expand their resources and capabilities, businesses fail and don't flourish (Surin et al., 2017). In addition to the issue of human capital, MSMEs also face the issue of declining business turnover, which prevents money from being accessible for production turnover. For a company or enterprise, capital is crucial. A firm cannot function as it should without finance. To operate, businesses of all sizes require finance (Sudaryono, 2017).

Highlighting the challenges faced by Dalit business owners. According to Sharma, P. (2013), she focuses on encouraging female entrepreneurship. She also underlines the fact that men and women are partners on an equal footing in all spheres of life, particularly in terms of economic growth. According to D. Venkatramaraju (2011), small-scale industry includes a variety of pursuits, including manufacturing, services, retail, financing for building, infrastructure, etc. SSI contributes significantly to economic growth. According to Kumar, S. (2013), MSMEs are the driving force behind an inclusive and balanced economy through generating demand for goods and services in addition to rapid economic growth. The multinationals of tomorrow may be today's MSMEs.

In his research, Lokhande M.A. (2015) concluded that entrepreneurs have a great desire to advance, be ahead of others, be independent, and forge their own identities, along with the creation of public wealth through their companies. In rural and semi-rural areas, there are numerous new growth centres where young people from various socioeconomic backgrounds are involved in entrepreneurial activity. According to Kalam, P.G. (2012), there are numerous swings in the total number of units on paper as a result of closings and illnesses, but given the expansion of SSI entrepreneurship, SSI plays a very important role. In order for the SME division to reach its full probable, it is important that business owners take the necessary steps with the assistance of the government.

Porter, Competitive Strategy: Free Press, (1992) illustrates how the risk of additional products and the negotiating power of customers and suppliers are probable aspects in attaining a modest edge.

According to M. Porter, Competitive Strategy. New York: Free Press, (1988)., a company has a durable advantage when the advantages of its unique assets outweigh the tactics of its rivals. As a result, a company's modest benefit necessity be needed to withstand attempts at replication by other businesses. A company can gain a competitive advantage if it is successful in developing and putting into action a strategy that takes advantage of new technical developments and capabilities that can result in the creation of a new company structure.

It's difficult to manage a company's finances since poor financial management can have an effect on a

company's long-term financial health. Additionally, both the individual and the business will be affected by sound financial decisions. Financial literacy is a comprehensive understanding of financial principles, individual/corporate financial planning, and both personal and business financial management, C. T. Widiastuti (2017).

Hypothesis

- H01: There is no significant mean difference between the nativities of respondents and their capital structure to start the business
- HO2: There is no significant mean difference between the nativities of respondents and their Performance Measurement of Functional Areas
- HO3: There is no significant mean difference among the district wise enterprises of respondents and Performance Measurement of Functional Areas
- HO4: There is no significant indirect effect between pre stat up activities, valuation, monitoring and their sustainability of the business

RESEARCH METHODOLOGY

A descriptive survey was the methodology used for this investigation. The design is focused on how variables relate to one another, testing hypotheses, creating generalisations, and utilising theories with broad applicability (Adamu & Sani, 2016). The author underlined that when it comes to gathering a group of people's opinions, attitudes, qualities, and beliefs using a questionnaire, descriptive survey research is the most suitable design. According to the previous, the strategy was deemed suitable because the study will use questionnaires to gather respondents' perspectives.

134 senior managers from 187 small businesses in Eastern Maharashtra, made up the study's population. The owners and managers of the small enterprises in the study region are the executives. Because of the manageable size of the population, the study included all 134 employees. This choice was made in accordance with Creswell's (2011) recommendation that the researcher use the complete population for the study if the population is small.

A questionnaire served as the data collection tool. The decision to employ a questionnaire was made in accordance with Gall and Borg's (1996) recommendation that questionnaires be used when gathering information regarding capital structure to start the business, Performance Measurement of Functional Areas, pre stat up activities, valuation, monitoring and their sustainability of the business. They continued by saying that questionnaires also have the benefit of being less expensive and time-consuming.

In pilot research involving 40 managers of legally registered small enterprises in the Kirfi, the tool was validated by three experts. As recommended by Madiha and Walid (2016), who claimed that Cronbach's Alpha is the best instrument to examine a questionnaire's internal consistency, the programme was used to conduct the Cronbach Alpha reliability test. Reliability coefficient for the instrument is 0.78. The instrument met Madiha and Walid's (2016) recommendation, according to which a survey study should be regarded reliable if its reliability coefficient is less than 0.7. Consequently, the tool was employed for the study.

To gather information from the respondents, the researchers employed three surveys. The method for gathering data was direct. This method was deemed appropriate since it allowed the researchers or research assistants to fully explain to the respondents the significance of all information and the confidentiality of it (Adamu & Kabir, 2019). The direct technique, the authors continued, offers the benefit of collecting a higher percentage of completed questionnaire copies. The survey should be finished in 4 weeks. The SPSS, received the collected data. To produce descriptive statistics on means and standard deviations in order to respond to the study objectives, this programme was utilised. The basic linear regression inferential statistical approach with 0.05 significance level was used.

ANALYSIS & OUTCOME

H01: There is no significant mean difference amongst the nativities of respondents and their capital structure to start the business

The std. coefficient for the regression analysis used to test the first null hypothesis in Table 1 was 0.230, which is consistent with the R value. The t value is 2.6335 and the R2 is 0.053. The dependent variable is affected by the independent variable by 5.3%, according to the R-squared value. The fact that the p-value was smaller

than alpha (0.000 < 0.05) shows that there is a significant mean difference amongst the nativities of respondents and their capital structure to start the business. The theory was not verified.

Table 1.

Std. Co- efficient	T	R	R^2	Adj. R^2	P value
0.230	2.6335	0.230	0.053	0.045	0.010

HO2: There is no significant mean difference between the nativities of respondents and their Performance Measurement of Functional Areas

The regression analysis used to produced an R-value of 0.351 and a std. coefficient beta of.351 with t = 4.179. According to the calculated R^2 of 0.123, Prince has a 12.3% impact on the sustainability. The p=0.000 value was less than the 0.05 threshold for significance. The p- value found shows that the significant mean difference amongst the nativities of respondents and their Performance Measurement of Functional Areas. The contrary conclusion was not supported.

Table 2.

Std. Co- efficient	T	R	R^2	Adj. R^2	P value
0.351	4.179	0.351	0.123	0.116	0.00

HO3: There is no significant mean difference among the district wise enterprises of respondents and Performance Measurement of Functional Areas

The result of the third hypothesis in Table 3 shows the std. coefficient beta of 0.200 with a corresponding. The R^2 of 0.040. The value of 0.0400 obtained indicates that promotion has an impact of 4% on the sustainability. The p-value was smaller than the significance level (0.025

< 0.05), it indicates the significant mean difference between the district wise enterprises of the respondents and Performance Measurement of Functional Areas. The null hypothesis was therefore not retained.

Table 3.

Std. Co- efficient	T	R	R^2	Adj. R^2	P value
0.200	2.265	0.200	0.040	0.032	0.025

HO4: There is no significant indirect effect between pre stat up activities, valuation, monitoring and their sustainability of the business According to Table 4's regression analysis, the std. coefficient beta value was found to be 0.370,. The location has a 13.7% impact on SSB sustainability in Eastern Maharashtra, according to the R^2 value of.137. The p-value was under the.05. significance threshold. The outcome demonstrates that indirect effect between pre stat up activities, valuation, monitoring and their sustainability of the business. Therefore, the hypothesis was not kept.

Table 4.

Std. Co- efficient	T	R	R^2	Adj. R^2	P value
0.370	4.430	0.370	0.137	0.130	0.00

FINDINGS

According to the study-based results of the first hypothesis, the nativities of the respondent and their capital structure affects the viability of small companies in the Eastern Maharashtra. The findings are in accordance with those of Ferri, Mohd, Radiah, and Hamidreza (2012), who found a dearth of research on the effects of supply channel innovation on company demonstration, mainly in transport-focused agricultural businesses (SMEs). Believed that the product has a favourable link with the buying choice, which results in the sustainability of the small business, also agreed with the conclusion.

According to the findings of the second hypothesis, small enterprises in the Eastern Maharashtra are impacted by the Performance Measurement of Functional Areas. The findings support claims made in the literature, such as those in research by Imoleayo (2010), that prices have a big impact on the nativity of the businesses in the Eastern Maharashtra. The research by Ade, revealed that products description has a beneficial effect in the marketing practises of small enterprises in India, also supports the conclusion. Obonyo (2013) reached similar conclusions as well. Despite a long history of research, the relationship between marketing techniques and the financial presentation of SME is still unclear.

The third null hypothesis result showed that district wise enterprises favorably affect the Performance Measurement of Functional Areas in the Eastern

Maharashtra. The outcome is consistent with Mustahpha's (2017) study, which demonstrates the value of growth of micro and small enterprises for all sizes of businesses. Gumel (2019), who emphasizes the need of creating and implementing effective determinants for the development of businesses, supports the conclusion as well.

According to the findings of the fourth research hypothesis, pre stat up activities, valuation, monitoring and their sustainability of the business favorably affects the viability of small businesses. The outcome is consistent with the findings of past research like Kartikasari, Irham, and Mulyo's (2018) earlier study.

CONCLUSION

The study discovered that the sustainability of micro and small enterprises in Eastern Maharashtra is positively impacted by the capital structure of the businesses, with the measurement of the performance criteria for the various functional areas in the businesses. This implies that any small firm will gain from success and sustainability over its rivals if it makes steps for pre start up activities, valuation, monitoring to incorporate the sustainability in the business. As a result, this will aid in hastening the increase of the firm' profitability. Therefore, it follows that small business owners' failure to incorporate the sustainable determinants for their expansion and development.

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Enrollment Excellence: Leveraging Hybrid Marketing Approaches to Achieve Full Admissions in Indian Graduation Colleges

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ABSTRACT

The competition among Indian graduation colleges for attracting and enrolling students has intensified in recent years. To achieve full admissions, colleges need to adopt effective marketing strategies that leverage both traditional and digital channels. This research article explores the concept of hybrid marketing approaches and their application in the context of Indian graduation colleges. By examining various strategies, including online platforms, social media, search engine optimization (SEO), content marketing, and offline promotional activities, this study aims to provide insights into how colleges can optimize their marketing efforts to achieve maximum enrollment. The findings highlight the significance of integrating traditional and digital marketing methods to effectively reach and engage prospective students.

INTRODUCTION

Competition among Indian graduation colleges to attract students is fierce, necessitating effective marketing strategies for full admissions. Hybrid marketing, combining traditional and digital approaches, offers potential solutions. This research explores hybrid marketing in Indian graduation colleges, analyzing online platforms, social media, SEO, content marketing, and offline promotions. The study aims to provide insights on optimizing marketing efforts for maximum enrollment.

Background

Indian graduation colleges face challenges differentiating themselves in a crowded market. Traditional marketing approaches have been relied upon, but digital advancements require hybrid marketing adoption.

Problem Statement

Indian graduation colleges lack comprehensive and effective marketing strategies for full admissions. Overemphasis on traditional channels limits reach, engagement, and conversion rates, hindering enrollment targets and competitiveness.

Objectives:

1. Explore hybrid marketing in Indian graduation colleges.
2. Examine digital marketing strategies for enhanced enrollment.
3. Investigate benefits and challenges of hybrid marketing.
4. Provide recommendations and best practices for optimal marketing and full admissions.

Significance of the Study

The study is vital for Indian graduation colleges, offering insights on utilizing hybrid marketing for full admissions. Integration of traditional and digital strategies can expand reach, enhance brand visibility, engage prospective students, and increase conversion rates. The findings contribute to higher education marketing knowledge, specifically in the Indian context, and provide practical guidance.

Scope and Limitations

The research focuses on marketing practices of Indian graduation colleges, exploring hybrid marketing for full admissions. It investigates traditional and digital strategies, considering factors like target audience, location, and budget constraints. Generalizability may be limited to Indian graduation colleges' specific context. Nonetheless, the study provides valuable insights and adaptable recommendations for colleges to suit their circumstances and goals.

LITERATURE REVIEW

Marketing Strategies in Higher Education: Effective marketing strategies are crucial for achieving full admissions in higher education. The shift from traditional to digital approaches has been driven by technology and changing student behavior.

Traditional Marketing Approaches: Graduation colleges have traditionally used print media, direct mail, education fairs, billboards, radio, and TV ads. However, their impact has diminished as prospective students turn to digital platforms.

Digital Marketing Approaches: Digital marketing enables targeted messaging, personalized experiences, and campaign tracking. Strategies include website optimization, SEO, social media, email and content marketing, and online advertising.

Hybrid Marketing Approaches: Hybrid marketing combines traditional and digital strategies for cohesive campaigns. It maximizes reach and engagement by utilizing both online and offline channels.

Theoretical Framework: The Diffusion of Innovation theory explains the adoption of digital marketing in higher education. The Integrated Marketing Communication model ensures consistency across channels. Customer Journey Mapping optimizes enrollment by identifying touch points for hybrid marketing.

METHODOLOGY

Research Design: To achieve the objectives of this study and gain insights into the utilization of hybrid marketing approaches for achieving full admissions in Indian graduation colleges, a qualitative research design will be employed. This design allows for the collection and analysis of qualitative data, providing in-depth understanding of the topic.

The research design will consist of qualitative data collection through interviews and focus groups with key stakeholders, such as college administrators, marketing professionals, and prospective students. These qualitative methods will help capture in-depth perspectives, experiences, and insights related to the implementation of hybrid marketing approaches in the context of Indian graduation colleges.

Data Collection: For the qualitative phase, semi-structured interviews and focus groups will be conducted. Key stakeholders from a diverse range of Indian graduation colleges will be selected using purposive sampling to ensure representation from different regions, sizes of institutions, and program offerings. The interviews and focus groups will be audio-recorded and transcribed for analysis. The data collected will focus on understanding the current marketing strategies employed, the integration of traditional and digital approaches, the challenges faced, the perceived benefits of hybrid marketing, and any best practices or success stories.

Data Analysis: The qualitative data collected from interviews and focus groups will be analyzed using thematic analysis. The transcripts will be coded, and emerging themes and patterns will be identified. The analysis will involve categorizing and grouping the data to identify common trends, challenges, and success factors related to the implementation of hybrid marketing approaches. The qualitative findings will provide rich insights and real-life examples to support the recommendations and best practices.

RESULTS AND DISCUSSION

Overview of Indian Graduation Colleges: Indian graduation colleges encompass a variety of institutions offering undergraduate programs across disciplines. Understanding their characteristics and dynamics sets the stage for exploring marketing strategies employed to achieve full admissions.

Traditional Marketing Strategies

Print Media Advertising: Indian graduation colleges use print media advertising, such as newspapers

and magazines, to target specific geographic areas. However, its effectiveness has declined with the rise of digital platforms.

Direct Mail Campaigns: Direct mail campaigns involve sending promotional materials to prospective students. While they create a tangible connection, their response rate has decreased with the prevalence of digital communication channels.

Education Fairs and Events: Education fairs and events provide opportunities for colleges to showcase programs and engage with prospective students. Their effectiveness may vary based on location, timing, and competition.

DIGITAL MARKETING STRATEGIES

Website Development and Optimization: Well-designed and user-friendly websites are crucial for Indian graduation colleges. Optimizing websites for search engines and mobile responsiveness enhances visibility and accessibility.

Search Engine Optimization (SEO): SEO techniques help colleges improve online visibility and search engine rankings. Optimizing website content, keywords, and meta tags increases the chances of being discovered by prospective students.

Social Media Marketing: Indian graduation colleges leverage social media platforms to engage with prospective students and share valuable content. Platforms like Facebook, Instagram, LinkedIn, and YouTube facilitate targeted advertising and interactive communication.

Content Marketing: Colleges utilize content marketing to provide informative blog articles, videos, webinars, and podcasts. By establishing themselves as authoritative sources, colleges build trust and credibility among prospective students.

Hybrid Marketing Approaches

Integrated Marketing Campaigns: Integrated campaigns combine traditional and digital channels to create a cohesive brand message. Aligning print media advertisements, direct mail campaigns, and digital marketing efforts ensures consistency and enhances effectiveness.

Personalized Communication: Personalized communication, through email marketing and CRM systems, helps colleges establish deeper connections with students and address their individual needs and concerns.

Data Analytics and Targeting: Leveraging data analytics tools, colleges track and analyze marketing campaigns, website traffic, social media engagement, and conversion rates. This data- driven approach informs decision-making and enhances targeting efforts.

Challenges and Opportunities: Challenges in implementing hybrid marketing approaches include budget constraints, limited expertise, resistance to change, and measuring impact. However, opportunities arise in reaching wider audiences, real-time engagement, performance tracking, and cost-effective marketing.

Best Practices and Case Studies: Successful implementation of hybrid marketing approaches involves developing comprehensive strategies, utilizing targeted social media advertising, creating informative website content, nurturing leads through personalized communication, and monitoring performance. Case studies highlight successful examples that inspire other colleges seeking enrollment excellence.

RECOMMENDATIONS

Integrated Marketing Strategy Framework: Indian graduation colleges should develop an integrated marketing strategy framework that integrates traditional and digital marketing channels. This framework should include a comprehensive plan, target audience identification, key objectives, effective resource allocation, and performance indicators.

Key Considerations for Hybrid Marketing

When implementing hybrid marketing approaches, colleges should consider understanding the target audience, customizing communication, ensuring a seamless user experience, maintaining consistent branding, and making data-driven decisions.

Developing a Digital Marketing Team

Building a dedicated digital marketing team or partnering with experienced agencies can enhance the effectiveness of hybrid marketing approaches. The team

should consist of professionals with expertise in various digital marketing channels.

Continuous Monitoring and Evaluation

Regular monitoring and evaluation of key performance indicators are crucial for optimizing hybrid marketing strategies. Colleges should establish a system for ongoing evaluation of enrollment outcomes, website analytics, social media engagement, lead generation, and conversion rates.

CONCLUSION

Summary of Findings: This study examined the utilization of hybrid marketing approaches in Indian graduation colleges. Traditional marketing strategies have been effective but face limitations in the digital age. Digital marketing strategies offer new avenues for engagement. Hybrid marketing approaches, integrating traditional and digital channels, enable colleges to reach a wider audience, personalize communication, track performance, and make data-driven decisions.

Implications for Practice: Colleges should adopt an integrated marketing strategy framework, prioritize personalized communication, invest in digital marketing expertise, and continuously monitor and evaluate campaigns. Collaboration among colleges can drive enrollment excellence.

Future Research: Further research can explore the long-term impact of hybrid marketing approaches, compare effectiveness across different college types and regions, investigate emerging digital marketing trends, and consider cultural and regional factors for localized strategies.

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Impact of Foreign Direct Investment (FDI) on Indian Economy

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ABSTRACT

This study examines the effects of foreign direct investment on the Indian economy, recognizing the crucial function of FDI as a major engine of economic growth. In the current global milieu, FDI has emerged as a momentous arena in burgeoning markets. The study primarily concentrates on scrutinizing the patterns of FDI influx into India from 2000-01 to 2019-2020. The main objectives include determining the impact of FDI on the Indian economy, evaluating the approvals of FDI inflows to India by country, and examining FDI inflows across various industries throughout the given timeframe. For this study, secondary information has been culled from a variety of sources, including the Reserve Bank of India Bulletin reports and the yearly reports issued by the Department of Industrial Policy and Promotion (DIPP) of the Government of India. The article concludes by offering suggestions to increase FDI inflows into India.

KEYWORDS: *Foreign direct investment, Sector-specific FDI inflows, FDI inflows by Country, RBI*

INTRODUCTION

The term of foreign direct investment (FDI) means the transfer of money from one country to another country through the purchase of stock in foreign corporations or the investment in real estate. FDI is typically used by businesses to increase their presence on foreign markets. Developing countries, in particular, actively seek FDI to spur economic growth and increase national income or GDP. FDI entails investing in domestic companies, organizations, and equipment, rather than participating in the stock market. It offers various advantages, including enhanced supply chain management (SCM), job creation, improved logistics and infrastructure, among others.

As a source of non-debt capital for India's economic growth, FDI has been crucial. India has had notable FDI development despite the COVID-19 pandemic, the global economic slump, and other obstacles. In order to encourage FDI, the Indian government has taken a number of actions, including easing FDI restrictions in industries like oil refineries, telecommunications, power exchanges, stock exchanges, and defence.

Millions of people in India have been pulled out of poverty as a result of the country's exceptional GDP development over the previous two decades, making it a desirable destination for FDI. Significant FDI inflows have been observed in important industries like manufacturing, services, telecommunications, construction, computer software and hardware, and autos. India has received major FDI from countries like Mauritius, Singapore, the Netherlands, Japan, the United States, and the United Kingdom.

REVIEW OF LITERATURE

Bhattacharyya Jita and Bhattacharyya Mousumi (2012), in their empirical study titled "The Influence of Overseas

Direct Investment and Trade in Goods and Services on Economic Advancement in India," examined the complex relationships between FDI, goods trade, service trade, and economic growth in the Indian setting. Their research aimed to identify the long-term relationships between these variables. The findings showed a one-way link in which FDI positively impacted economic growth and favorably impacted merchandise trade. The study also found that there were two-way relationships, demonstrating the interdependence between service trade and economic growth in India as well as trade in goods.

Shalini Singh and Manish Singh (2011) In "Exploring the Path of Overseas Capital in India," a thorough investigation was made to delve into the dynamic world of foreign direct investment (FDI) in the Indian context. This study carefully examined the inflow of FDI into India, spanning a remarkable period from 1970 to 2007, by harnessing the power of secondary sources and using painstaking time series analysis. Primarily driven by the pursuit of unravelling the intricate relationship between FDI inflows and India's economic growth, the overarching objective was to unravel the nuanced patterns of fluctuation in FDI inflows while unravelling their profound impacts. Employing a discerning lens, this research sought to unveil the underlying factors behind these ebbs and flows, ultimately painting a comprehensive portrait of the prevailing trends within the realm of FDI.

Gaurav Agarwal and Mohd. Amir Khan (2011) in a comparative study titled "Impact of FDI on GDP: China vs. India," the researchers analyzed FDI's influence on the Gross Domestic Product (GDP) of both countries from 1993 to 2009. They made use of a growth model that included factors like GDP, human capital, labor force, FDI, and gross capital formation into account. According to the results, a 1% increase in FDI led to a 0.07 percent boost in China's GDP and a 0.02 percent increase in India's GDP. Notably, China showed a greater link between FDI and economic development than India, indicating more effective FDI utilization.

Jatinder Singh (2010) in the study titled "Economic Reforms and FDI in India: Policy, Trends, and Patterns," researchers analyzed the FDI inflows into India considering government policies since 1980. The analysis revealed a rising trend in post-reform FDI inflows. A comparison with other developing economies showcased significant growth in FDI inflows to India, indicating a positive response to liberalization measures introduced in the early 1990s.

Gajendran Lenin Kumar and S. Karthika (2010) the "Sectoral Performance through Inflows of Foreign Direct Investment (FDI)" study investigated the impact of FDI on various Indian industries and the country's economic growth. It highlighted FDI's facilitation of technology transfer, increased domestic capital, raised production levels, and created employment opportunities. The study analyzed FDI inflows into India and the economic growth driven by the top 10 investing countries.

Joyshri Acharyya (2009) carried out a study titled "FDI, Growth, and the Environment: Evidence from India on CO2 Emission during the Last Two Decades." This study looked at how FDI inflows affected environmental deterioration and India's GDP development. The study analyzed the FDI inflows and their effects on India's GDP growth over a two-decade period from 1980 to 2003. The study also highlighted the significant long-term economic impact of FDI inflows on carbon dioxide (CO2) emissions, emphasizing the environmental consequences resulting from economic activities. Keshava, Dr. S.R. Rathnamma (2008) conducted a comparative analysis titled "The Effect of FDI on the Indian and Chinese Economies." This study analyzed the economies of India and China using comparative analysis. It highlighted that these two countries, with a combined population of 37% of the world, experienced significant GDP growth rates exceeding 9% (according to the Asian Development Outlook 2005 and World Development Report 2006). The study also provided statistics on FDI flows and stocks in India and China, indicating their respective contributions to the economies.

R. Banga (2006) in a thorough study titled "Unleashing Export Diversity: Assessing the Influence of Japanese and US Foreign Direct Investment on the Indian Manufacturing Sector," the effect of FDI on export diversification in a developing country was carefully examined, with special attention paid to India. Intriguing revelations emerged from the investigation, emphasizing the distinctive impacts of FDI inflows from the US and Japan. Notably, the findings showcased that FDI from the US had a favorable and positive influence on India's export intensity during the post- liberalization era. However, in contrast, Japanese FDI did not yield a significant impact on India's overall exports. These

observations shed light on the nuanced role played by different countries' FDI in shaping export diversity within the Indian manufacturing sector.

Pradhan, Prakash J., Abraham, Vinoj, and Sahoo, Kumar M. (2004) in the paper "Foreign Direct Investment and Labor Dynamics: Unveiling the Indian Manufacturing Scenario," researchers looked at the effects of FDI on employment and wages in the Indian manufacturing sector. Comparing international companies to their domestic equivalents, the data showed that neither had a significant impact on manufacturing employment. However, an interesting pattern emerged as foreign firms demonstrated a tendency to offer comparatively higher wages to their workforce. This suggests that labor also reaped benefits from foreign investment in India.

OBJECTIVES OF THE STUDY

1) To examine the FDI trends in India during last two decades.
2) To assess the inflow of FDI in India from different countries.
3) To evaluate the distribution of FDI inflows across various sectors in India.

RESEARCH METHODOLOGY

Data Collection

This study only uses secondary data sources. The information was acquired from a number of trustworthy sources, including RBI Bulletin Reports and Annual Reports issued by the Department of Industrial Policy and Promotion (DIPP) of the Government of India, articles from newspapers and journals, textbooks, reliable internet sources, websites, and UNCTAD. The data collected covers a time span of twenty years, from 2000 to 2020, and is analyzed using graphs and tables.

Statistical Tools

For this research paper, the following statistical tools and methods have been employed; the percentage method and graph analysis conducted using Microsoft Excel software.

LIMITATIONS OF STUDY

- This study is solely concerned with how FDI affects the Indian economy.
- Only the chosen time period is considered in the analysis of FDI Inflows on the Indian Economy.
- Only information from 2000 to 2020 was collected.
- Only secondary data were used to examine how FDI affected the Indian economy.
- There were no continuous-time series data in the RBI Bulletin reports.
- Inadequate time was allotted for data collecting.

DATA ANALYSIS & INTERPRETATION:

Table 1. FDI Inflows by Financial Year from 2000 to 2020:
(Amount USD Million)

YEAR	FDI INFLOWS	FDI GROWTH RATE (In %)
2000-2001	4029	-
2001-2002	6130	(+) 52%
2002-2003	5035	(-) 18%
2003-2004	4322	(-) 14%
2004-2005	6051	(+) 40%
2005-2006	8961	(+) 48%
2006-2007	22826	(+) 155%
2007-2008	34843	(+) 53%
2008-2009	41873	(+) 20%
2009-2010	37745	(-) 10%
2010-2011	34847	(-) 08%
2011-2012	46556	(+) 34%
2012-2013	34298	(-) 26%
2013-2014	36046	(+) 05%
2014-2015	45148	(+) 25%
2015-2016	55559	(+) 23%
2016-2017	60220	(+) 08%
2017-2018	60974	(+) 01%
2018-2019	62001	(+) 02%
2019-2020	74390	(+) 20%
Grand Total	**681854**	

Source : Department of Industrial Policy and Promotion.

The table presented above illustrates the Foreign Direct Investment (FDI) inflows into the country in absolute terms, showcasing a significant growth from USD 4,029 million in the year 2000-2001 to USD 74,390 million in the year 2019-2020, reflecting a remarkable

increase of 19 times. This data highlights the FDI trends over the past two decades in India. Notably, there was a substantial increase of 52% in FDI inflows during the financial year 2001-2002, reaching USD 6,130 million compared to the preceding year. Despite minor fluctuations in the subsequent years from 2002- 2003 to 2005-2006, there was a substantial surge in FDI inflows during the financial year 2006- 2007, amounting to USD 22,826 million, representing a growth rate of 155% compared to the previous decade. Another significant increase occurred in the financial year 2007-2008, with FDI inflows amounting to USD 34,843 million, showing a growth rate of 53% compared to the previous year. In the year 2008-2009, there was considerable investment of USD 41,873 million in Foreign Direct Investment (FDI) and so forth. Following this, there were some fluctuations in FDI inflows between 2009 and 2014, with a subsequent increase in the financial year 2015-2016, where FDI inflows reached USD 55,559 million. Subsequently, FDI inflows continued to rise in the financial years between 2016 and 2019. Consequently, the year 2019-2020 recorded the highest FDI inflow figure of USD 74,390 million over the past 20 years.

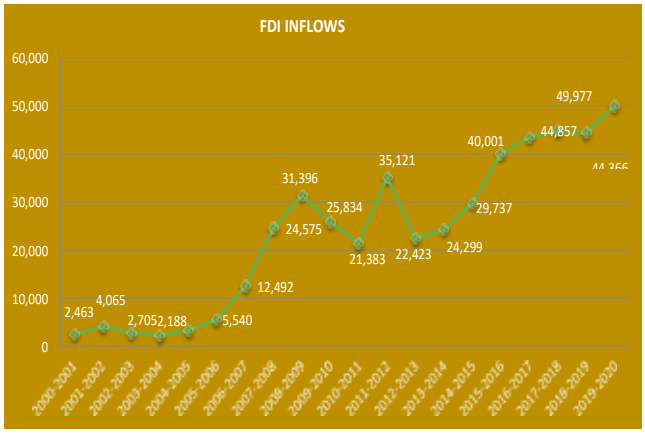
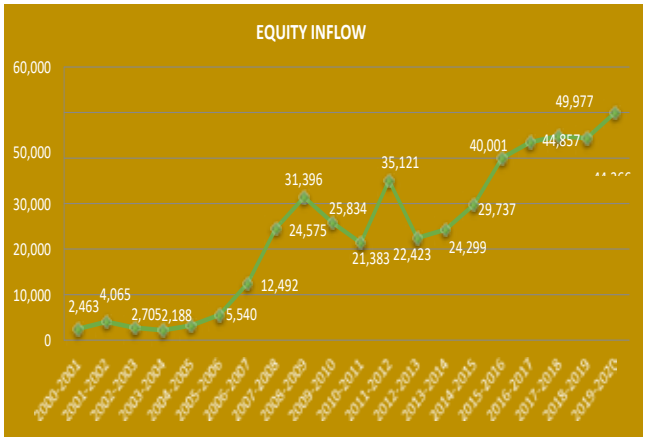


Table No. 2: FDI Equity Inflows by Financial Year (Amount USD Million)

Financial Year	Amt. of FDI Inflows		Percentage Growth over previous year
	In Rs Crores	In USD Million	
2000-01	10,733	2,463	-
2001-02	18,654	4,065	(+) 65 %
2002-03	12,871	2,705	(-) 33 %
2003-04	10,064	2,188	(-) 19 %
2004-05	14,653	3,219	(+) 47 %
2005-06	24,584	5,540	(+) 72 %
2006-07	56,390	12,492	(+) 125 %
2007-08	98,642	24,575	(+) 97 %
2008-09	142,829	31,396	(+) 28 %
2009-10	123,120	25,834	(-) 18 %
2010-11	97,320	21,383	(-) 17 %
2011-12	165,146	35,121	(+) 64 %
2012-13	121,907	22,423	(-) 36 %
2013-14	147,518	24,299	(+) 8%
2014-15	181,682	29,737	(+) 22%
2015-16	262,322	40,001	(+) 35%
2016-17	291,696	43,478	(+) 9%
2017-18	288,889	44,857	(+) 3%
2018-19	309,867	44,366	(-) 1%
2019–20	353,558	49,977	(+) 13%
Grand Total	**2,732,444**	**470,119**	

Source: Department of Industrial Policy and Promotion (As per DPIIT's FDI database)



The Foreign Direct Investment (FDI) Equity inflow into India has witnessed a substantial increase from Rs. 10,733 crores in the financial year 2000-2001 to Rs. 3,53,558 crores in the financial year 2019-2020, marking an impressive growth of 33 times. This information, as shown in the table and graph, gives a thorough picture of all FDI equity inflows into India from 2000 to 2020, a period of 20 years. Notably, FDI Equity Inflows in India saw a positive effect with a considerable

growth to Rs. 18,654 crores in the fiscal year 2001-2002. Furthermore, in the year 2008-2009, there was a significant investment of Rs. 1,42,829 crores in FDI Equity Inflows, highlighting a substantial growth in foreign investments. However, there were fluctuations in the inflow of FDI Equity Inflows between 2010 and 2014. Nonetheless, there was a considerable surge in FDI Equity Inflows in the financial year 2015-2016, reaching Rs. 2,62,322 crores. Subsequently, FDI Equity Inflows continued to rise in the financial years between 2016 and 2019, culminating in the highest figure of Rs. 3,53,558 crores in the year 2019-2020.

Table no. 3: Top Twenty Country-Wise FDI Inflow

(Amount USD Million)

Sr. No.	Country	Amt. of FDI Inflows		Percentage with Inflows
		(In Rs . crores)	(In USD Million)	
1	Mauritius	795,941.1	142,710.4	30.36
2	Singapore	609,561.5	97,669.6	20.78
3	Netherland	208,321.9	33,852.0	7.2
4	Japan	196,105.1	33,499.2	7.13
5	U.S.A	176,222.2	29,779.4	6.34
6	United Kingdom	150,411.1	28,210.9	6
7	Germany	68,944.3	12,196.0	2.59
8	Cyprus	57,993.5	10,748.4	2.29
9	France	50,511.0	8,539.3	1.82
10	Cayman Islands	49,847.8	7,535.9	1.6
11	UAE	41,702.7	6,990.6	1.49
12	Switzerland	27,240.9	4,842.4	1.03
13	South Korea	27,824.1	4,478.1	0.95
14	Hong Kong	27,220.7	4,408.0	0.94
15	Luxembourg	19,256.7	3,082.7	0.66
16	Spain	16,822.6	2,991.2	0.64
17	Italy	16,781.0	2,927.8	0.62
18	China	15,112.1	2,378.7	0.51
19	Belgium	12,153.2	1,977.6	0.42
20	Canada	11,971.9	1,937.1	0.41

Sources: Department of Industrial Policy and Promotion (As per DPIIT's FDI database)

Upon analyzing the table, it becomes evident that Mauritius has emerged as the leading investor in Foreign Direct Investment (FDI) Equity Inflows in India, contributing a substantial amount of 142,710.44 million USD. This investment from Mauritius constitutes 30.36 percent of the total equity investments made by the top 20 investing countries in India from the years 2000-2001 to 2019-2020. Singapore holds the second position, with an equity inflow of 97,669.64 million USD, accounting for 20.78 percent of the total equity investments made by the top 20 countries. Notably, Singapore's investment in India has positioned it as a significant contributor to the equity capital inflow. The Netherlands and Japan have also made notable equity capital investments, amounting to 33,852.04 million USD and 33,499.21 million USD, respectively. These investments represent

7.20 percent and 7.13 percent of the total equity investments made by the top 20 countries. Moreover, considerable the United States of America and the United Kingdom, respectively, have made equity capital investments of 29,779.40 million USD and 28,210.85 million USD. An intriguing aspect is that the combined equity investment inflows from Mauritius and Singapore, totalling 240,380.08 million USD, are nearly equivalent to the investments made by the remaining 18 top-level equity investing countries in India, which amount to 200,375.27 million USD. The difference between the investments from Mauritius, Singapore, and the other 18 countries is merely 40,004.81 million USD. Therefore, it is clear that Singapore and Mauritius are important players in the FDI equity landscape of India.

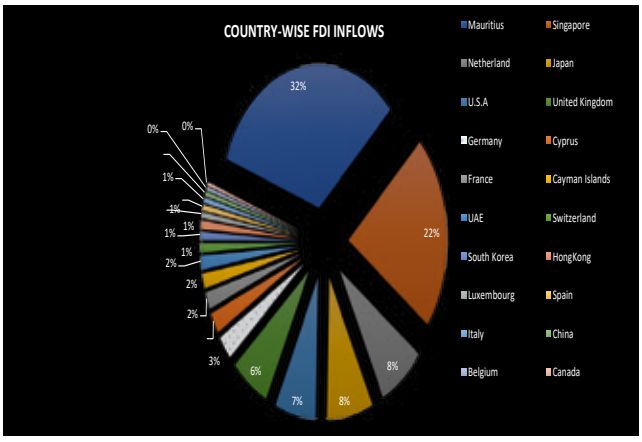
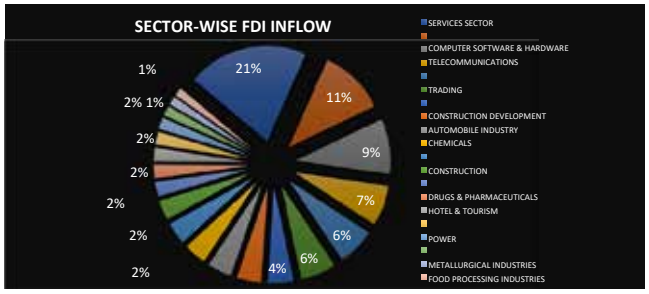


Table No. 4: Top 20 FDI Equity Inflows by Sector from 2000–2001 to 2019–2020

(Amount USD Million)

Sr. No.	Sectors	Amt. of FDI Inflows		% of Total Inflows
		(In crores)	(In USD Million)	
1	Finance, banking, insurance, non-financial business, outsourcing, research and development, courier, and technical testing and analysis.	471,730.1	82,003.0	17.45
2	Computer Software & Hardware	276,006.4	44,911.2	9.56
3	Telecommunications	219,188.6	37,271.0	7.93
4	Trading	176,004.7	27,595.0	5.87
5	Townships, Housing, Built-Up Infrastructure	123,964.0	25,662.3	5.46
6	Automobile Industry	143,741.7	24,210.7	5.15
7	Chemicals (Other Than Fertilizers)	98,554.4	17,639.5	3.75
8	Construction (Infrastructure) Activities	108,382.5	16,846.9	3.58
9	Drugs & Pharmaceuticals	87,814.3	16,500.6	3.51
10	Hotel & Tourism	91,778.5	15,289.0	3.25
11	Power	82,650.6	14,987.9	3.19
12	Metallurgical Industries	74,595.4	13,401.8	2.85
13	Food Processing Industries	61,811.5	9,980.8	2.12
14	Non-Conventional Energy	57,144.3	9,225.5	1.96
15	Information & Broadcasting	55,361.3	9,208.1	1.96
16	Electrical Equipments	50,720.0	8,604.0	1.83
17	Petroleum & Natural Gas	40,915.5	7,824.2	1.66
18	Hospital & Diagnostic Centers	41,154.7	6,726.9	1.43
19	Consultancy Services	34,701.9	5,834.8	1.24
20	Industrial Machinery	32,588.6	5,619.5	1.2

Source: Department of Industrial Policy and Promotion (As per DPIIT's FDI database)



The table highlights that the services sector, including finance and banking, received the highest equity investment of USD 82,002.96 million, representing 17.45 percent of the top twenty sectors attracting FDI equity inflow into India from 2000-2001 to 2019-2020. Conversely, the industrial machinery sector witnessed the lowest equity investment of USD 5,619.50 million, accounting for

1.20 percent of the top twenty sectors attracting FDI equity investment. A noteworthy investment was made in the computer software and hardware sector, totalling USD 44,911.95 million, or 9.56 percent of the top twenty industries. Similarly, the telecommunications services sector attracted equity investment of USD 37,270.95 million, covering 7.93 percent of the top twenty sectors. The trading sector received an investment of USD 27,594.95 million, constituting 5.87 percent of the top

twenty sectors' FDI equity investment. Investments in other sectors include USD 25,662.33 million in construction development, USD 24,210.68 million in the automobile industry, USD 17,639.48 million in the chemicals sector (excluding fertilizers), USD 16,846.88 million in construction infrastructure activities, USD 16,500.62 million in the drugs and pharmaceuticals sector, and USD 15,288.97 million in the hotel and tourism sector. Additionally, USD 14,987.93 million was invested in the power sector, USD 13,401.78 million in metallurgical industries, and USD 9,980.75 million in food processing industries.

FINDINGS OF THE STUDY

- The FDI inflows into the Indian economy showed a constant rising trend from 2000–2001 to 2019–2020, showing significant expansion.
- In 2019-2020 alone, India received FDI inflows amounting to USD 74,390 Million. The cumulative FDI inflow for the period between 2000-2001 and 2019-2020 reached USD 681,954 Million.
- The data reveals that in the last financial year (2019-2020), FDI equity inflows into India amounted to USD 49,977 Million. The cumulative FDI equity flow from 2000-2001 to 2019- 2020 totalled USD 470,119 Million.
- Analyzing the data, it becomes apparent that Mauritius and Singapore accounted for the highest FDI equity inflows, investing USD 142,710.44 Million and USD 97,669.64 Million, respectively, from 2000-2001 to 2019-2020. Mauritius and Singapore collectively contributed to 51% of the total FDI equity inflows, while other countries accounted for the remaining 49% during the same period.
- From 2000 to 2020, the services sector saw the biggest FDI equity inflows, totaling USD 82,002.96 million and accounting for 18% of all sectors. Notably, the computer software & hardware sector (10%), telecommunications sector (08%), trading sector (6%), and construction development sector (6%) were among the sectors that received significant FDI equity inflows.

CONCLUSION

The enormous contribution made by foreign direct investment (FDI) to India's economic growth is reiterated by this study. FDI is not only crucial for achieving sustainable economic development but also demonstrates a positive and accelerating trend within the country. The findings clearly indicate that India presents a highly promising investment destination for both developed and developing nations. To leverage this opportunity, it is essential to liberalize the rules and regulations surrounding FDI in India.

It is advised that the Department of Industrial Policy & Promotion take action to create new and update existing FDI policies with an emphasis on promoting, approving, and facilitating investments in light of the study completed. Additionally, efforts should be made to enhance ease of doing business indicators in various sectors, including streamlining processes related to starting a business, obtaining construction permits, accessing electricity, and labor market regulations. Such measures will create favourable conditions for foreign investors to explore opportunities in India.

In conclusion, Foreign Direct Investment not only contributes to employment generation in India but also provides support to medium and small-scale industries, such as MSMEs. Additionally, FDI is crucial to the nation's posture on the world stage as a result of the liberalization and globalization processes.

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A Study on the Effects of Personnel Relation with Respect to Conflict Management in an Organization

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ABSTRACT

This study examines the effect of personnel relation in solving conflict in working terms with respected varible "Personnel Relations" in the Nagpur region. This research deals with various techniques to be implemented to solve and resolve conflicts among personnel. The study also shows that how we can control the conflict in an organization to maintain the healthy human relations in working environment. The study also shows role of personnel relation in an organization and the impacts of conflict on the organization. A quantitative approach has been used in this study. The study is descriptive and analytical in Nature. The gathered data obtain using online questionnaire with rating scale and secondary data is also used in the study. For the purpose of data analysis, Percentage analysis model has been adopted and different type of statistical tools used in the study to complete the study and for the effective results. The study found that personnel relation plays vital role in organization for solving the conflict of the organization. The result shows the importance of impact of personnel relation in solving conflict in an Organization.

KEYWORDS: *Human relations, Conflict, Organization, Management, Nagpur.*

INTRODUCTION

In order to achieve or meet the corporate goals and objectives, it is crucial for the human resources department to plan, control, and discharge duties and powers to different personnel in an effective manner. Conflict management is term that deals with identifying and resolving problems in an result oriented manner. The main objective of the study is to highlight the resons of conflicts and various solutions on it that will affect and resolve conflicts and maintain organistion dignity.

Personnel Relations in an organization

A personnel relation is a connection between an organization's people resources. It includes relationships between management and employees as well as between employees. Relationships between personnel and outsiders are also included (such as clients, suppliers).

Personnel is an important asset for an organisation. Positive interpersonal interactions hence increase productivity and efficiency. It is necessary for the growth and success of the company.

In addressing the psychological components of organisational performance, the human relations approach seeks to increase the effectiveness of organisations. Relationships between people and inside organisations are combining.

According to Mac Farland, human relations is the study and practise of exploiting human resources via knowledge and understanding of people's behaviours, attitudes, feelings, and relationships at work.

Organizational Conflict

The condition of disagreement or miscommunication caused by actual or imagined differences in needs, views, resources, and interpersonal relationships among the organization's members is known as organisational

conflict, also known as workplace conflict. No matter what task or decision they are discussing, conflict always emerges when two or more people are involved.

Simply described, organisational conflict is the result of human encounters that start when one organisation member realises that his or her aims, views, or attitude are incompatible with those of other organisation members. Viewpoint incompatibility can arise within an individual, between two individuals, or between organisational groups.

Conflict Management:

Conflict management is the process of handling disagreements. Any given day, you might have to deal with a conflict with a family member, a coworker, or another person.

Conflict management is the art of identifying issues and resolving them in a fair, reasonable, and efficient manner. The process of managing conflicts deals with (perceived) conflicts or incompatibilities caused by, for example, conflicting opinions, objectives, and desires.

It's essential to have someone on hand who is educated about disagreements and how to resolve them because conflicts frequently develop at work. This is more important than ever in the marketplace of today. Everyone wants to demonstrate their value to the company they work for, which occasionally can result in disagreements.

NEED TO STUDY

Aim of the Study

The aim of the research of is to determine the various conflict resolution techniques and use them in different organization to reduce organizational conflict. In the Nagpur region.

Objectives of the study

1. To find out what are the effect of personnel relation and solving conflict in an organization.
2. To find out what are the provisions related to conflict management.
3. To explore the conflict management styles.
4. To find out how we can control the conflict in an organization to maintain the healthy human relations in an organization.
5. To find out what are the impacts of conflicts.

LITERATURE REVIEW

The study deals with in establishing connections that live among conflict operation, communication and connections at work. Conflicts in organisations takes place when employe didnt get proper working environment or they are not appriciated related to their work. Conflicts should be properly managed and solved , because conflict leads to bad image of organisation and may affect it reputation.

A desire to recreate people's management of peace in the university system using the analysis of the human relations theory of management. The research approach for the study was literature and observations, and theoretical analysis was used to interpret and make meaning of HRTM. A formal or informal social group inside a workplace, the creation of affinity in the workplace, motivation, and communication, among other assumptions of the theory, are further argued and supported by me as the road map for managing people. In a similar vein, it becomes a useful tool for managing students' unrest in Universities. The relevant of the theory to crisis management was equally exemplified, coupled with the development of a theoretical model to better simplify the nexus between HRTM and crisis management.

Conflicts in organizations occur when interests and activities of individuals or groups within an organization confront each other and prevent attainment of one party"s objectives. When conflicts are not well managed, employees become aggrieved and tend to behave in a way that does not promote good relationships among employees for the attainment of organizational goals. By means of providing empirical justification for these assertions, the study sought to establish the relationships that exist among conflict management, communication and relationships at work.

This study focuses on the origins, consequences, and

solutions of organisational conflict. What factors cause conflicts in organisations. Other terms that are highlighted in the report include conflict, which causes a lot of ambivalence and leaves many academics and administrators unsure of its significance and best ways to handle it. Conflicts will always exist in human life. In organisations or even across nations, it is unavoidable. Conflict is an inevitable part of life for both individuals and organisations.

The study also found that rivalry for dominance, leadership style, a lack of common resources, etc. all contribute to disputes in organisations. Ineffective conflict management might result in poor productivity or service performance. Effective conflict resolution management generates good results. Thus, not all conflict situations are bad. Efforts should always be made to ensure that the causes of conflicts are addressed as soon as they are noticed.

Literature Gap

As per the study existing study there are various conflict resolutions theories and techniques are available but they lag in implementation.

Hypothesis

H0-The number of employees who are aware about organizational conflict and conflict resolution techniques.

H1- The number of employees who are not aware about organizational conflict and conflict resolution techniques.

RESEARCH DESIGN AND METHODOLOGY

The study is descriptive in nature, as it will explain the effects of employee relation in solving conflict in an organization.

Sample Design

The sample was developed to help with thorough planning of the strategies and methods to be utilized for obtaining important data. The study employed both primary and secondary data sources.

The sample is built on the foundation of simple random sampling. The respondents make up the sample for the planned research, which is a form of probability sampling.

Data Collection

A survey questionnaire with multiple choice, dichotomous, and Likert's five-point grading items was the research tool utilized to gather the primary data for this study. Around 168 questionnaires distributed among respondents and out of 100 responses filled together.

The secondary data is collected from a number of internet sources, as well as several regional, national, and worldwide journals.

Questionnaire Design

The questionnaire has been incorporated 14 questions in all which has been divided into 4 sections.

1. Personal Information.
2. Multiple choice questions. 3.Dichotomous questions.
4. Likert's five-point grading scale.

Table 1: Questionnaire Design

Section	Variable has been considered	Questions included in each section	Measurement
Personal Information	Gender only	Q.1	Nominal
Multiple choice questions	1. Effects of human relations in solving conflict. 2. Effects of conflict in the organization. 3.Conflict management styles. 4. Pair of best conflict management style. 5. Maintain the healthy human relations	Q.3 Q.4 Q.6 Q.9 Q.11	Nominal

Dichotomous questions	1. Awareness about conflict in organization. 2. Conflict management style are helpful. 3. Conflict management play important role. 4. Conflict is a problem in organization.	Q.2 Q.7 Q.10 Q.14	Nominal
Likert's five- point grading scale	1. Human relation can help to solve conflict. 2. Conflict management style shows impact. 3. Control conflict by maintaining healthy human relations. 4. Bad impact of conflict.	Q.5 Q.8 Q.12 Q.13	Nominal

Source-Primary Data

DATA ANALYSIS

Descriptive Analysis of Primary Data by (Percentage analysis method).

As per the survey, the male respondents are more as compare to female respondents The percentage of male respondents is 59% and 41% of female respondents.

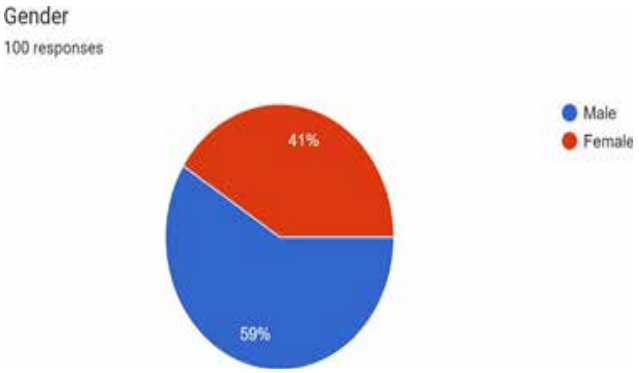

Figure 1. Gender

Male	59%
Female	41%

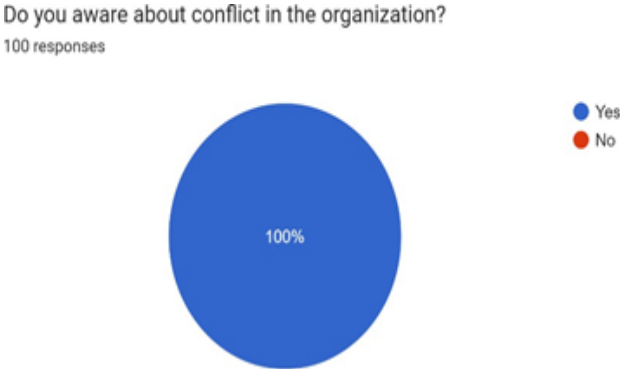

Figure 2. Awareness about conflict in organization.

Yes	100%
No	-

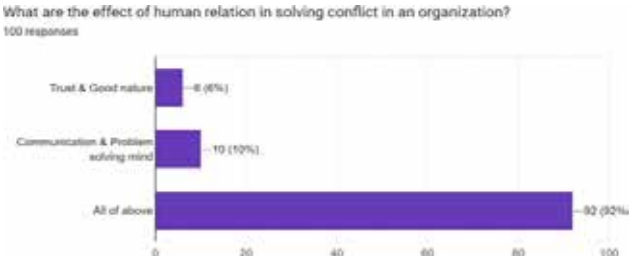

Figure 3. Effects of personnel relations in solving conflict.

Trust & Good Nature	6%
Communication & Problem-solving mind	10%
All of the above	92%

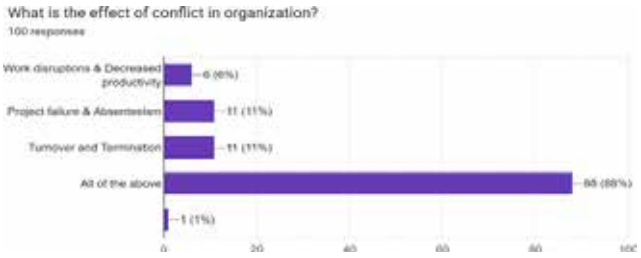

Figure 4. Effects of conflict in the organization.

Work disruptions & Decrease productivity	6%
Project failure & Absenteeism	11%
Turnover & Termination	11%
All of the above	88%

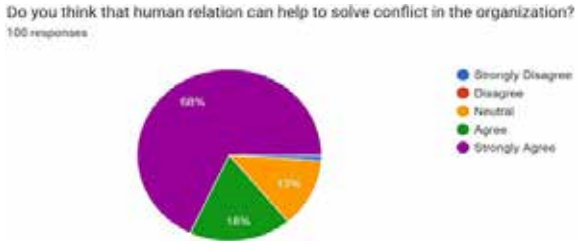

Figure 5. Human Relations can help to solve conflict.

Strongly Disagree	1%
Disagree	-
Neutral	13%
Agree	18%
Strongly Agree	68%

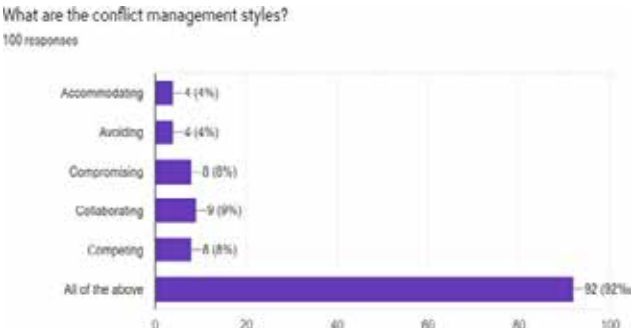

Figure 6. Conflict management styles.

Accommodating	4%
Avoiding	4%
Compromising	8%
Collaborating	9%
Competing	8%
All of the above	92%

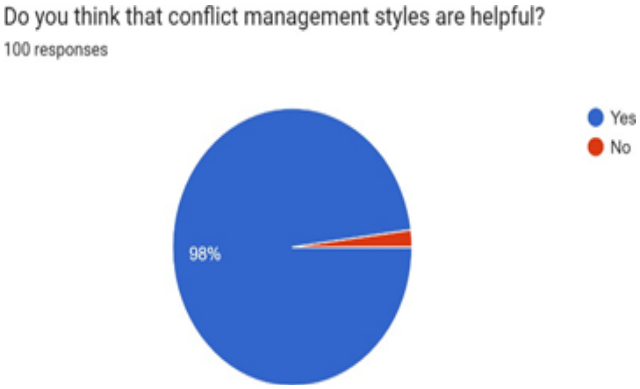

Figure 7. Conflict management styles are helpful.

Yes	98%
No	2%

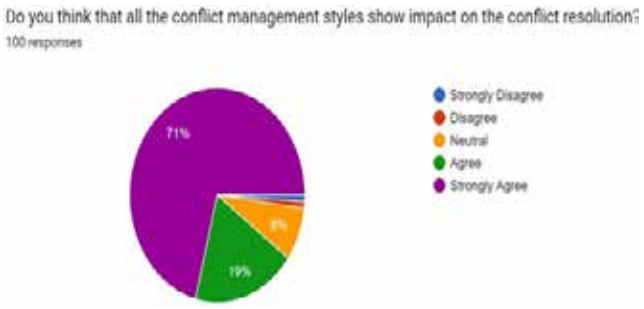

Figure 8. Conflict management styles shows impact.

Strongly Disagree	1%
Disagree	1%
Neutral	8%
Agree	19%
Strongly Agree	71%

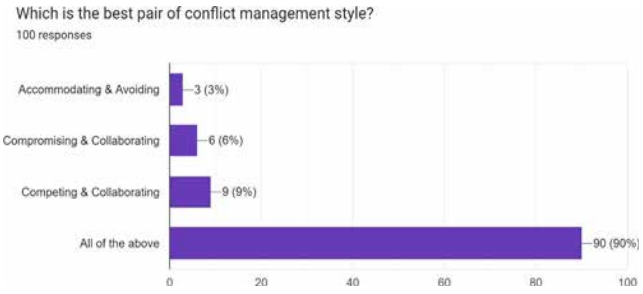

Figure 9. Pair of best conflict management style.

Accommodating & Avoiding	3%
Compromising & Collaborating	6%
Competing & Collaborating	9%
All of the above	**90%**

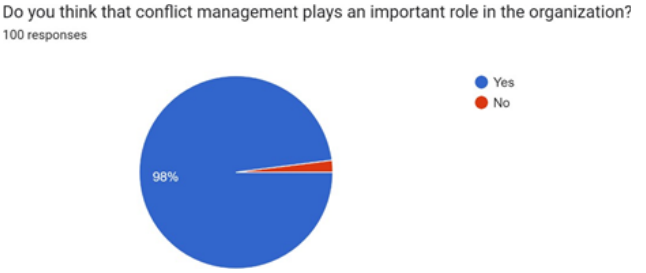

Figure 10. Conflict management plays important role.

Yes	98%
No	2%

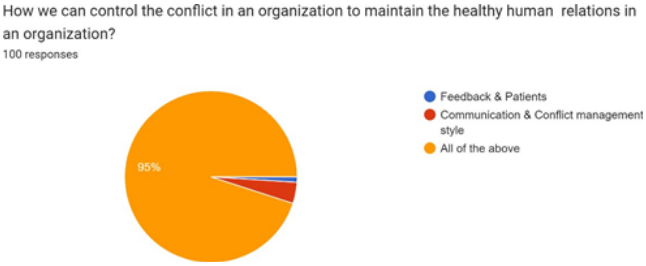

Figure 11. Maintain the healthy human relation.

Feedback & Patients	1%
Communication & Conflict management	4%
All of the above	95%

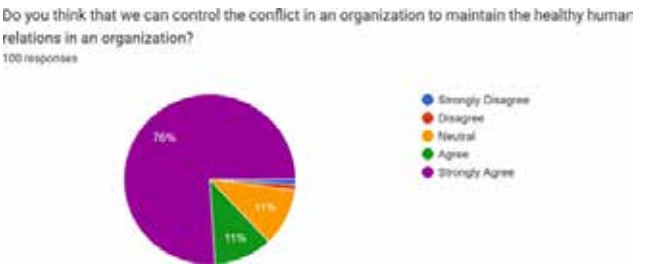

Figure 12. Control conflict by maintaining healthy human relation.

Strongly Disagree	1%
Disagree	1%
Neutral	11%
Agree	11%
Strongly Agree	76%

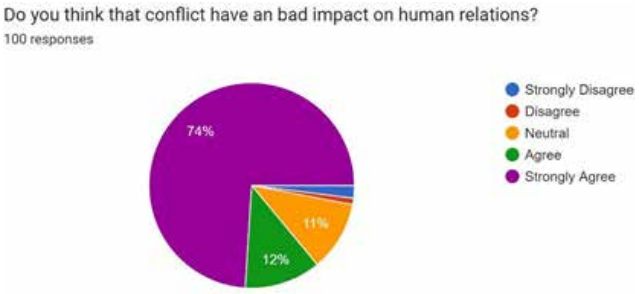

Figure 13. Bad impact of conflict.

Strongly Disagree	2%
Disagree	1%
Neutral	11%
Agree	12%
Strongly Agree	74%

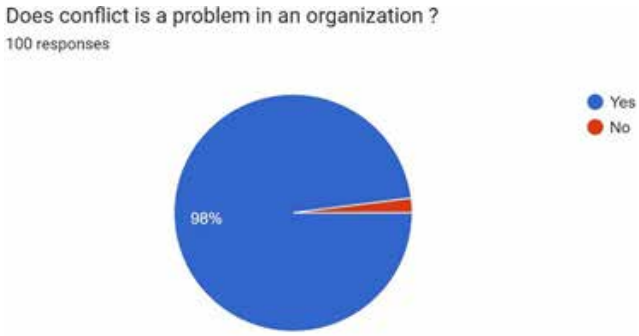

Figure 14. Conflict is a problem in the organization.

Yes	98%
No	2%

DISCUSSION

Findings

As per the figure 1, the male respondents are more as compare to female respondents. The percentage of male respondents is 59% and 41% of female respondents.

As per the figure 2, 100% of the respondents are aware about the conflict in the organization.

As per figure 3, 92% of respondents said that Trust & Good Nature also Communication & Problem-solving mind these are effects of human relations in solving conflict in the organization.

As per figure 4, 88% of respondents said that work disruptions & decrease productivity, project failure & absenteeism and Turnover & Termination these all are the effects of conflict in the organization.

As per figure 5, 68% of respondents are strongly agreed with the statement that human relations can help to solve conflict in the organization.

As per figure 6, 92% respondents said that Accommodating, Avoiding, Compromising, Collaborating and Competing these all are the conflict management style.

As per figure 7, 98% respondents said that conflict management styles are helpful.

As per figure 8, 71% respondents are strongly agreed with the statement that conflict management styled shows impact on the conflict resolution.

As per figure 9, 90% respondents said that all are the best pair of conflict management style.

As per figure 10, 98% respondents said that conflict management plays an important role in an organization.

As per figure 11, 95% respondents said that Feedback & Patients also Communication & Conflict management these are the factors that helps to maintain the healthy human relations.

As per figure 12, 76% respondents are strongly agreed on the statement that control conflict by maintaining healthy human relations in the organization.

As per figure 13, 74% respondents are strongly agreed on the statement that conflict has bad impact on the organization.

As per figure 14, 98% respondents said that conflict is a problem in the organization.

CONCLUSION

This study examines the effect of personnel relation in solving conflict in an organization with respected varible “personnel relations”. In the Nagpur region. The study found that personnel relations plays an important role in organization for solving the conflict of the organization. The result shows the importance of effect of personnel relation in solving conflict in the organization. Also there are different conflict management styles are given in the

study that Accommodating, Avoiding, Compromising, Collaborating and Competing they are very helpful for each and every organization when there is a situation of conflict. They show the positive results. The study also found that feedback & patients also communication & conflict management these are the factors that helps to maintain the healthy human relations.

LIMITATIONS

1. The Human Resource Management sector forms the study's perimeter.
2. The study is bounded with the effect of conflict on human relations in an organization.
3. The study is bounded with the conflict management.
4. The study is for Nagpur region only.

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Impact of Artificial Intelligence on Indian Retail Industry: Awareness and Experience of Consumers Regarding AI-based Retail

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ABSTRACT

AI being used in different spheres of people's lives like healthcare and finance. But today, it also has a significant role in the retail industry. The AI used in online retail is more personalized than offline retail because it has its long journey to be personalized for consumers in India for now. AI helps retail to be personalized, automated, Demand Forecasting and much more. Personalization plays an important role in online retail. For example, it can personalize website interface, recommend products and services and make shopping more convenient for consumers. Automation is a key element in offline retail. Majority of consumers are unaware about the uses of AI in their everyday lives, especially when it comes to retail. Many people think AI is only used in scientific terms, or that it's something only robotics engineers use. However, this is not true. AI is used in many aspects of daily life and will soon be used as a part of all industries. Consumers are unaware about the fact that they already experienced such a services in retail sector online and there is a huge scope for offline retailers to become completely AI enabled.

KEYWORDS: *Artificial intelligence, Personalization, Automation, Consumer experience, Consumers awareness, Retail*

INTRODUCTION

Everything is possible with AI today. Retail Industry is fastest growing industry and by using AI it became more simple and human friendly. But what exactly AI in Retail Industry? Artificial Intelligence is any system that uses software, data, or model to automate tasks that normally require human intelligence.

This digital world has already introduced consumers to online retail format and they are already experienced the personalized and automated retail services, to understand their experience about use of AI technology in retail will be compared to their awareness about offline use of AI in retail. Online retail stores like Amazon.in, Flipkart, and Myntra are the best example. Some of the offline projects are Amazon Go (US), Bingo Box (China), Watasale (India). Because use of AI in offline retail is new for the consumers there is only one or two stores in India like Watasale in Kochi.

Digital transformation in retail is not only connecting thinks but it is all about converting data into insights, which helps to inform actions that drive better business outcomes. Retailers trying their best to provide shopping experience that are convenient, personalized and enjoyable. If retailers can get real time information through AI about consumers wants and need then they can improve demand forecasting, make pricing decisions, and optimize product placement. (Intel, 2022).

AI can give certain significant advantages in the retail sector are like better consumer experience, optimization of tasks, managing better demand forecasting, helping in pricing decisions, avoidance of long queues, optimizing product placements, extraction of valuable data these

features are calculated as most important advantages for retail sector. AI has no boundaries when it comes to new innovations and it will create tremendous impact of the future of retail business in India. (Somani, 2021)

Walmart Neighbourhood Market in Levittown, New York, has showing significant transformation. With artificial intelligence-enabled cameras, interactive displays and a massive data centre, this store implicate the future of retail just like science fiction. It's Walmart's new Intelligent Retail Lab (IRL). According to the article application of AI in e- commerce is now table stakes but they don't provide physical experience to the customers. But IRL is designed for that type of Innovation in offline retail sector. The store include various sensors, cameras and processors. The IRL store can automatically detect the product on the shelf, recognize the type of specific product, and compare quantities on the shelf to help in demand forecasting. (Matt Smith, Walmart, 2019)

According to research the market for global AI in retail is expected to climb from just under $5 billion to more than $31 billion between 2021 and 2028. SO,

LITERATURE REVIEW

If retailers are not prepare for this change then, they may soon be "left behind in the dust" of this digital revolution and transformation. (Smith, 2022)

PROBLEM STATEMENT

The digital transformation of the retail business has been moving on for ages. It has improved personalization, automation, smart store experience, conversational commerce, digital shopping as well as casher less store experience across every division of retail sector, scene AI is being used in retail industry it is necessary to understand its impact on Indian retail industry and consumers awareness and experience regarding application of AI in online and offline retail.

RESEARCH METHODOLOGY

This research is based on secondary data collected from various online sources which includes online journals and online articles from following websites such as Google Scholar, article posted on Google chrome.

OBJECTIVES

1. To analyze the impact of Artificial Intelligence in retail industry.
2. To study how AI in retail has impacted on consumers awareness and experience. (online & offline)

Title of The Paper	Factors Identified from the Paper	Main Pionts Highlighted in the Paper/ Discussion on Identified Factiors
Impact of AI on Retail Sector in India	Personalization , improvement in marketing, lack of understanding, require customers, Consolidation of data	could act as personalized virtual trial room for fashion retail. In offline segment it is noticeable that consumers purchase behaviour changes as per the new innovations takes place
The Integrati on of Artificial Intelligence in retail: Benefits, challeng es and a dedicated conceptual framework	Personalization, customer experience, cost benefit, virtual assistance, CECoR conceptual framework, General AI integration architecture, AI enabled customer profile management,	Use of chat-bots and virtual assistance is beneficial for cost reduction. It gives highly personalized offer to each consumers. AI can gives conceptual framework to retail. Voice assistance like Siri and Alexa both online and offline stores answer consumers about their specific goods, provide suggestion with possible combination with complementary product. (Ionut-Florin Anica-popa, 2021)

An Empirical Study of Consumer Perception towards Scope of Artificial Intelligence in Offline Grocery Retail	Artificial intelligence, perception of consumers towards scope of artificial intelligence, AI in offline grocery retail.	AI has its significant impact on grocery retail. AI will help to reduce scepticism. People are open to new experience which makes it easier for the grocery retail to adapt AI for better consumer experience. (Harshavardhini Patil, 2019)
Artificial Intellige nce : A Tool for Hyper Personali zation	Hyper-Personalization, Artificial Intelligence, AI impact on consumers, retail sector including healthcare, education, transportation	AI completely transformed some sector but still facing obstacles. Hyper personalization has its significant effect on consumer satisfaction as it brings the personalized experience to consumers. (Goyal, 2019)
Consumer Perception towards Artificial Intelligence in E- Commerce with Reference to Chennai City, India)	Personalized shopping experiences for online buyers, Real time product targeting, conversational commerce, virtual personal shoppers, customer centric advertisements	Virtual personal assistance provide moderns shopping experience to customer. Real time product targeting had highest score because companies offering best offline shopping experience. People are more aware about AI and they are using it. AI will create new evolution in retail industry. (Anil Surresh, 2020)
Artificial Intelligence Consumers and Industry Impact	Artificial Intelligence and consumers, AI implications in retail, Personalization	AI is playing significant role in monitoring consumer's sentiments and their choices through social media via observing their social activities so it could provide consumer their personalized recommendation. Consumers always looking for convenience and flexibility. (Nadimpalli, 2017)
Technology-enabled personalization in retail stores: Understanding drivers and barriers.	Smart retail, Personalization , Technology as an enabler of smart retail, Technology enables personalization, increase consumer interaction, Provides control over purchase	Customer believes that Technology enabled personalization (TEP) provides faster and better preference according to their need. TEP also gives them satisfaction and pleasure. They can control their retail exposure. (Anne-Sophie Riegger, 2020)
Consumer Acceptance of Artificially Intelligent (AI) Device Use in Service Delivery	Importance of social media influence on AI, Increased publicity for AI, Consumers willingness towards AI	According to the study people are willing to accept importance of AI in their life, social media had important significance on AI, But there is still lack of understanding. (Robin Nunkoo PhD, 2019)

Usability and responsiveness of artificial intelligence chatbot on online customer experience in e- retailing.	Online customer experience, Chatbots and the online customer experience, Chatbots customer satisfaction, increase customer experience.	Chatbots mainly influence quality of online consumers experience. Chatbots provide customer better shopping experience, solves customers problem and makes them comfortable, provides customer satisfaction (Ja-Shen Chen, 2021)
AI meaning and applications in the consumer sector of retailing Hospitality and Tourism.	AI optimization, consumer satisfaction, Personalized recommenda-tion, AI based customer services.	AI cans helps customers to discover new products. AI can help to monitor and manage inventory based on requirements, Personalized recommendation for customer increase customer satisfaction. (Sandra Maria correia Loureiro, 2021)
Ethical and legal considerations of artificial intelligence and algorithmic decision-making in personalized pricing	Personalized pricing, AI decision-making algorithm, Ethical consideration.	Artificial intelligence become the heart of decision-making and it can provide best outcomes for both organizations and consumers. Algorithms are bias and give predictions, third-party tampering and automous collusion. Organizations seems to adapt this algorithmic personalized pricing to influence consumer's purchase decision. (Joshua A. Gerlick, 2020)
The evolution and future of retailing and retailing education.	Big Data, Digital Pedagogy, Frontline Service Robots, Internet of Things.	AI in retail can optimize retailing strategies, including supply chain efficiency, inventory management, pricing, and virtual merchandising. Consumers beings less emerge with benefits and challenges because of insufficient education. (Dhruv, Grewal S. M.,2018)
The Future of Retailing	Technology & tools to facilitate decision making, Visual Display & Merchandise, Consumption & Engagement, Analytics and profitability, Big data collection and usages	AI may influence shopping behaviour, and the role of frontline employees. Engagement with retails, service providers can reduce human- human interaction and machines will take their place. AI can have huge impact on customers as well as shops whether it is online or offline. (Dhruv Grewal A. L., 2017)
The future of Retail: Trends for 2022	Personalized shopping services, Automation in pricing, customer engagement	Future of Retailing is in AI which provides personalized shopping experience and automation in cost reduction improving consumer retailing experience. (Martins, 2022)
Impact of AI for Customer Experience	AI re-humanizing customer experience, AI infused customer personalization	AI improve quality of life of an individual consumer. AI bring customers based personalization and re-humanizing the customer experience.

"How artificial intelligence is changing the retail game in Indian market"	Capillary technologies, artificial Intelligence, Campaign Personalisation	Bengaluru-based capillary technology is capable of offering offline retailers the power to utilize data for improving staff effectiveness and convert customer queries into product sales just by implementing AI. (Ahmad, 2018)
"How Artificial Intelligence (AI) Can Help Retail"	Customer preferences, Improving customer's experience, Improve Inventory turnover,	Application of AI is not obvious to the end consumers. By using various algorithms and customer data AI can easily predict customers buying preferences and hence customer purchase more. AI can also help by optimizing stocks and predict the future revenue. (Matthew Hudson, 2019)
The complete guide to AI in retail.	Self-learning algorithms, Personalization, Predictions, Improve communication	AI can actually predict what customer wants. In compare to AI human cannot predict what customer wants what post on social media they liked. Algorithms can learn from consumer's habits of buying and predict what customer will want in future. It will also help to create new communication channels just like voice-enabled assistants.(Cate Trotter, 2018)
Retail Tech M&A #5: Voice recognition gives retailers more ways to communicate	Voice and text-assisted technology	McDonald improving customer experience by utilizing IoT innovations. Voice and text-assisted technology is to take accurate orders from customers. (Diakantonis, 2019)
Top emerging Technologies transforming the retail experience.	Unlocking the full potential of retail with IoT increase retail experience, virtual shopping focuses on personalized experience, minimize customer friction, improve customer experience	Technology has taken place in all over the world with the help of IoT retailers can improve customer experience as well as retailers. It engage personalized experiences across the entire customer journey. (Durbin, 2020)
Retailers Race Against Amazon to Automate Stores	Completely automated checkouts, cashierless checkouts, competition between retailers.	Before amazon go there was AI in retail store but after amazons fully AI automated store has been introduced it started race between retailers to emerge new technology. (Nick Wingfield, 2018)
Impact of Artificial Intelligence in inventor y management with reference to watasale Kerala.	Just Walk-Out Technology, Computer Vision, Deep Learning, Sensor Fusion	Consumers are thrilled to experience new technologies provided by the "Watasale" store.It's completely brainstorming for consumers to experience such a technology just like Amazon. Go stores that has vision-cameras, sensors, computer vision.(Dr. S. Saravana Kumar, 2019)

FINDINGS:

Artificial Intelligence concept has completely changed the old retail techniques and now retailing became easier for retailers as well as consumers. AI did some changes in retail sector, these are as follows.

Personalization

The major change AI created in retail is personalization. Each consumers has their different preferences and choices, back then it was difficult for retailers to target each and every consumer but because of AI now retailers can identify which consumer prefer what type of items by monitoring their social activities and identify what consumers like to provide them personalized suggestion via advertising on various social Medias as well as online retail sites. Chat-bots, Personal assistance like Siri and Alexa is one of the example of personalization for attending consumer's queries personally and to resolve their concerns.

Automation

AI in retail can bring ultimate joy to consumers by various majors like better performance, accurate predictions etc.… Application of AI in online retail sector is very significant as it is all consumer interfacing but in offline retail sector the application of AI is mostly for inventory management or internal management, but the projects like Amazon. Go, watasale etc.… are the best example of consumer interfacing AI technology where the whole store is automated and there is no need for consumers to put extra efforts for shopping, you can just simply pick and go. Automation is the main goal for these retail store but in India there is long journey for retails to become completely automatic. There is lot more work to do behind the scenes and automation is being used for minimizing the load and makes it easier to manage the inventory as well as it can help in cost reduction.

Consumer's awareness and experience

Consumer's perception changes towards retail whenever there is a new technology in market, as everyone wants to experience the comfort and ease provided by these technology. From the above literature review we can found out that consumers are open to new changes. Artificial Intelligence can bring the joy of shopping to consumers as it can keep the consumer's sentiment and choices by personalization and automation etc.…. But according to studies it is found out that consumers are willing to experience AI importance but they lack in understanding. Those consumers who had experience the offline AI enabled stores like "Watasale" are thrilled by its features. These type of offline stores are very common in US because of "Amazon. Go" stores. In India these type of stores are not evident in number but stores like Walmart and D-mart are planning to launch its customer interfacing AI technology which will become consumer's personal shopping assistant, and will provide ultimate in-store experience to consumers in future by providing the digital display screens, virtual trial rooms, casher less check-outs etc. Consumer's buying habits changes according to the price of the product, with the help of AI retailers can forecast the demand and provide consumer the product with affordable prices by offering them alternative products.

AI had a lot of potential to change the overall experience of consumers towards retail. The technology will evolve according to time and AI will also reach to another level. With the help of AI online retail as well offline retail both will evolve, nothing is impossible.

CONCLUSION

From the above literature review we can conclude that Artificial Intelligence had a huge impact on Indian retail sector as it will continue to impact the retail sector in future as well. Consumers are open to new changes in the retail and ready to adapt technology but there is lack of understand about use of AI in retail. Online consumer interfacing retail had significantly personalized the retailing experience for each consumer according to their preferences and choices. Automation is being used to minimizing the load of retailers both online and offline as it is beneficial for cost reduction and in-store automated experience. AI can also help in demand forecasting, make near to accurate predictions, personalized suggestions as well as improve consumer interaction.

A Study on the Role of Cross-Cultural Training in Effective Management with Mediating Factor Cross-Cultural Competence Model for Expatriate Managers

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ABSTRACT

On the basis of a literature review, this research first develops a conceptual model of CC.

Cross-cultural Competence (CC) is referred to the knowledge, traits and abilities that individuals display under different cultural situations, and this knowledge, traits and abilities are closely related to work performance required by cross-cultural contexts. It then gathers data using questionnaire surveys from Indian Organizations and evaluates the model using the data. The four dimensions of CC model. Knowledge, Personal Traits, Behavioral Abilities, and Motives This study examines the Role of training on cross-culture effective management with respected variable "training on cross-culture". The study explores the why training on cross- culture is important in effective management. Benefits of training on cross-culture and challenges faced by the employees if the training on cross-culture is not provided by the management. The study is of a descriptive kind. The collected data obtain using online questionnaire with rating scale in 100 respondents from different organizations. SPSS software is used for the purpose of data analysis, chi-square test and Reliability Test are used for the effective results. The study found that majority of the managers and employees are not aware about the "Cross-cultural competence model". The cross-cultural training plays Significant role in effective management. "training on cross-culture" is the very crucial element of every effective management for the growth of the management.

KEYWORDS: *:Cross-cultural training, Management, Expatriate managers, Cross-cultural competence model*

INTRODUCTION

Defining Cross-cultural Competence (CC)

According to some academics (1993; Earley & Ang, 2003; Earley & Moakowski, 2004) [1] cultural cognition and understanding is the basis for CC. They defined CC as having the capacity to learn about other cultures, identify and comprehend other cultures, and analyse how other cultures perceive certain actions. Several academics used the adjustment technique to characterize CC (Adler, 1975, Campinha, 2002).

Training on Cross-Culture

Training on Cross-Culture is a strategy for managing workplace diversity. This is the primary technique for encouraging intercultural involvement and communication.

A technique or practice used to enhance a person's ability to deal with other cultures and perform well in such settings is called cross-cultural training.

Employees who are cross-culturally trained are better able to understand different cultures' values. People are more interested in learning about co-workers' backgrounds and cultures.

Expatriate Employees

An expatriate or ex-pat is someone who lives outside of their country of origin. Professionals or subject-matter experts regularly move away from their native nation for employment. Employers frequently allocate

expats to positions in other countries. Assignments are frequently short-term in global firms, where this is especially common. Expatriates can also operate on their own. Although expatriation is frequently only a temporary situation, many people who do it aim for permanent residence elsewhere. Some people even give up their nationality in their own country.

NEED TO STUDY

The intent of the study

The intent of this research is to determine the level of understanding of the Cross-Cultural Competence paradigm.

Objectives of the study

- Investigate the paradigm of cross-cultural competency for expatriate managers.
- Determine the esteem of training on cross-culture in effective management.
- Assess the effectiveness of cross-cultural training. on managerial productivity.
- To learn about the advantages of training on cross-culture.
- Determine the problems that the employee will experience if management does not give training on cross-culture.

LITERATURE REVIEW

1. Cross-cultural training and adjustment through the lens of cultural intelligence and type of expatriates. Sumeet Kour, Jeevan Jyoti. July 2021. –The study purpose is to determine the difficulties while adopting the cross-culture nature. Knowledge is one of them. The organization plays in various culture environment that's why cultural intelligence plays a crucial role for the expatriate managers.
2. Moderators and mediators of cross-cultural training effectiveness: literature review and development of a conceptual model. Christina Kempf and Dirk Holtbrügge, 2020. The aim of the study is to develop circumscribe model for training of cross culture with its effectiveness, the study is elaborate the relation between the training of cross culture and self-culture training.
3. Role of Prior Intercultural Learning in Chinese University Students' Cross-cultural Adaptation. Fan Fang, Shuyi Zhang and Tariq Elyas. September 2020. The purpose of the study is to priories the studied-on training on cross culture. The study of different is important to adopt the training on cross culture.
4. European Journal of Training and Development. Satish Pandey, 2012. The purpose of the study to know the reasons and the dynamic learning through the movies and it specially highlight the training on cross culture. With the classroom made for this study only for the students.
5. Building Cross-cultural Competence Model for Expatriate Managers in Low-to-middle levels. X. J. Xu Y. Li. 2012. The study is for china region and the purpose of the study is to determine the CC model for the expatriate managers of china region from different companies. The study shows the different results which changes through the regional changes.

HYPOTHESIS

H0-The managers/employees are not aware about Cross-Cultural Competence Model.

H1-The managers/employees are aware about Cross-Cultural Competence Model.

RESEARCH DESIGN AND METHODOLOGY

The study is descriptive in nature, as it will explain, A Study on the Role of Cross-Cultural Training in Effective Management with mediating factor Cross-Cultural cometence model for Expatriate Managers. The research is based on descriptive study.

Sample Design

The sample was created to aid in in-depth preparation of the tactics and procedures to be used for gathering pertinent data. The primary and secondary data types were both used in the study.

Simple random sampling provides the basis for the sample that is created. The proposed study's sample is a sort of probability sampling, and the respondents fall within this category.

Data Collection

A survey questionnaire with multiple choice, dichotomous, and Likert's five-point grading items was the research tool utilized to gather the primary data for this study. Around 149 questionnaires distributed among respondents and out of 100 responses filled together.

The secondary data is gathered from several online domains as well as various national and international periodicals.

Questionnaire Design

The questionnaire has been incorporated 12 questions in all which has been divided into 4 sections.

1. Personal Information.
2. Questions with several choices.
3. Close ended questions
4. It's five-point Likert scale for grading

Table 1: Questionnaire Design

Section	Variable has been considered	Questions included in each section
Personal Information	Gender only	Q.1
Questions with several choices	Benefits of cross-cultural training. Roles in effective management.	Q.5 Q.6
	Different impact on productivity. Different benefits of cross-cultural training.	Q.10 Q.11
	Challenges faced by managers.	Q.12
Close ended questions.	Awareness of cross-cultural conceptual model.	Q.2
	Awareness of training in other cultures	Q.3
	Importance of training in other cultures	Q.8
	Training in other cultures is beneficial.	Q.9
Its five-point Likert scale for grading	Impact on productivity Importance of role in an organization.	Q.7 Q.4

Source-Primary Data

DATA ANALYSIS

Hypothesis testing by Chi-Square Test

CC Model Refers to Cross-Cultural Competence Model.

- Total number of respondents are 100.
- Number of Male respondents are not aware about CC model. 59
- Number of Female respondents are not aware about CC model. 39
- Number of Male respondents are aware about CC model. 1
- Number of Female respondents are aware about CC model. 1

Table 2: Case processing summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Gender * Gender	100	100.0%	0	0.0%	100	100.0%

Table 3. Gender* Gender crosstabulation

			Gender		
			Unaware	Aware	Total
Gender	Female	Count	40	1	41
		Expected Count	40.2	.8	41.0
	Male	Count	58	1	59
		Expected Count	57.8	1.2	59.0
Total		Count	98	2	100
		Expected Count	98.0	2.0	100.0

Table 4. Chi-sqaure tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.068[a]	1	.794		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.067	1	.795		
Fisher's Exact Test				1.000	.654
N of Valid Cases	100				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .82.

b. Computed only for a 2x2 table

• Critical Value given by degree of freedom=3.841

The final Result chi-square test- By using SPSS (software version 29) The final Result chi-square test-Thus, the critical value is higher than calculated value the (H0) the null-hypothesis is accepted and the alternative hypothesis(H1) is got rejected. 3.841>0.794. Finally, the results are the managers/employees are not aware about Cross-Cultural Competence Model.

RELIABILITY

Scale: ALL VARIABLES

Reliability Statistics

Cronbach's Alpha	N of Items
.772	15

Case Processing Summary

		N	%
Cases	Valid	20	20.0
	Excluded[a]	80	80.0
	Total	100	100.0

a. Listwise deletion based on all variables in the procedure.

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
21.10	23.463	4.844	15

INTERPRETATION OF RELIABILITY

Interpretation

By using SPSS (software version 29) the interpretation is of The Cronbach's Alpha of The Total Questionnaire and the responded is 0.772 it is accepted because it is greater than the 0.7 as per the test conditions.

0.772>0.7 Therefore the test for the questionnaire and respondent's is accepted.

Findings collected by questionnaire-

As per the Q.1, The male respondents are more as compare to female respondents. The percentage of male respondents is 60% and 40% of female respondents.

As per the Q.2, 59% of the male respondents & 39% female respondents are not aware about cross-cultural conceptual model.

As per the Q.3, 98% of the respondents are aware about cross-cultural training in the organization.

As per the Q.4, 74% respondents are Strongly Agreed on the statement cross-cultural training plays an important role in an organization and 19% respondents are Agree also.

As per the Q.5, 91% respondents said that Help to overcome personal biases, help to avoid preconceptions, helps to stop labelling people these benefits of Organizational cross-cultural training.

As per the Q.6, 93% respondents said that Training on social cross culture, the work of training on cross culture in effective management includes training on cross culture businesses, training on cross culture security, and training on cross culture remote.

As per the Q.7, 60% respondents are Strongly Agreed on the statement cross-cultural training have impact on the productivity of the organization and 30% of respondents are Agreed to the statement also.

As per the Q.8, 99% respondents said Cross-cultural training is essential for expatriate executives.

As per the Q.9,100% respondents said that cross-cultural training is beneficial for an organization.

As per the Q. 10, 87% respondents said that Increase the Productivity of the organization and 82% respondents are said that Increases the performance of the employee these are the The effects of cross-cultural training on organizational productivity.

As per the Q.11, 87% respondents said that Increases the performance, Ability to learn different cultural, Different Language Speak these are the benefits of Expat managers receive cross- cultural training.

As per the Q.12. 86% respondents said that Fitting In, Language Barrier, Being Lonely, Finance and Money management, Housing and safety these all are the Challenges faced by the expatriate managers if the Management does not give cross-cultural training.

- The Human Resource Management sector forms the study's perimeter.
- The study is bounded with the cross-cultural training and CC model.

Item-Total Statistic s

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Do you aware about what is cross cultural training in the organization?	20.05	22.682	.343	.768
Do you aware about about what is the conceptual Cross-Cultural competence model for Expatriate Managers?	19.95	21.524	.374	.761
Cross-cultural Competence (CC) is referred to the which factors?	19.95	21.313	.596	.752
What are the dimensions of the cross-cultural competence model?	19.95	21.313	.596	.752
Does cross-cultural training plays an important role in an organization?	19.25	16.408	.709	.717
What are the benefits of cross-cultural training in the organization?	19.05	20.471	.591	.745
What are the role of cross-cultural training in effective management?	19.55	16.261	.720	.715
Do you think that cross-cultural training have any impact on the productivity of the organization.	18.95	17.945	.588	.735
Do you think that cross-cultural training is important for expatriate managers?	20.05	22.682	.343	.768
Do you think that cross-cultural training is beneficial for an organization?	20.10	23.463	.000	.776
Gender	19.70	23.379	-.035	.786
What are the impacts of the cross-cultural training on the productivity of the organization?	19.40	21.516	.150	.786
What are benefits of cross-cultural training on the expatriate managers?	19.80	22.484	.120	.778
Challenges faced by the expatriate managers if the if the cross-cultural training is not provided by the management?	19.55	16.682	.584	.738
Are you aware about Cross Cultural Conceptual Model?	20.10	23.463	.000	.776

CONCLUSION

The majority of managers and employees, according to the survey, are not familiar with the "Cross-cultural competency model." Both management and staff are aware of the need of training on cross culture. Training on cross culture program is crucial for effective leadership. Cross-cultural training is an essential part of any effective management for management development. Also, this report offers suggestions for Indian firms on how to raise the CC of foreign managers.

Managerial Implementation

The legislative body may plan additional opportunities, awareness events, and campaigns inside the organization for the prosperous future of the organization by recognizing the role of unknown individuals.

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Analytical Studies on Development of Monetary Aggregates in India During Post Liberalization

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ABSTRACT

Money aggregates are used to measure the amount of money in circulation within a nation or economy. This facilitates to measure the condition of the economy. It includes various components such as currency with the public, time deposit, demand deposit, reserve money, narrow money, broad money, other deposits with central bank and bank credit to various stakeholders. From the literature review it is found that very few numbers of researchers have attempted to study in this area and there is a gap of identifying the development of monetary aggregates in India from post liberalization to FY 2021-22. This study is conducted to analyze the development of monetary aggregates in Indian context. The duration for the study is considered from FY 1991-92 to FY 2021-22. Secondary data from various sources was collated for conducting the study which includes RBI reports, articles, journals etc. The result of the study shows that there is progressive increase in terms of money supply in the economy in all aspects of monetary aggregates. From the study it is found that, there has been a significant growth of monetary aggregates witnessed in the Indian economy during post liberalization.

KEYWORDS: *Monetary aggregates, Demand deposit, Term deposit, Narrow money, Bank credit*

INTRODUCTION

Money aggregates includes wide classifications that evaluate the money supply in an economy. In India, tags are assigned to standardization of monetary aggregates:

Broad Money (represented as M3) which is includes Narrow Money (represented as M1) and Time deposits with the Banking system. Whereas narrow money includes currency with public and demand deposits with the Banking system, any deposits with the Reserve Bank of India. M2 is the derived value from narrow money and post office savings deposits.

A monetary aggregate is a disciplined way of accounting for money, and they are used to measure the money supply in a national economy.

The monetary base is an aggregate that comprises total supply of currency in circulation and the stored portion of commercial bank reserves with the central bank. The Reserve Bank of India (RBI) uses money aggregates as a metric to know how the open-market operations affect to the economy.

Money Aggregates' Impact

Evaluating the monetary aggregates can facilitate required information on the financial stability and overall health of a country's economy. For example, monetary aggregates that grow too slowly may cause slow growth of nation's economy. If a high rate of inflation transpires, then central bank may be forced to stop the growth in the money supply or raise the interest rates.

It is observed that there has been given a less attention on the role of quantitative monetary aggregates in framing monetary policy (Rangarajan and Nachane 2021). The questions raised over the money multiplier mediated relationship between money supply and reserve money and debates over volatility in money velocity

(Woodford 1998). The "Barnett Critique" "The role of reserve money in managing money supply through the money multiplier structure is back in the limelight, thus highlighting the liquidity channel of monetary policy ." (Mohanty Deepak & A. K. Mitra, 1999) has done study on experience with monetary targeting in India in which they focused on stability of monetary policy.

METHODOLOGY

The objective of the study is to analyze the development of monetary aggregates of Indian economy between FY 1991-92 and FY 2021-22. This includes the analyzing the M1 and M3 aggregates and analyzing the bank credit disbursement in the economy. The secondary data was collected from the reports published by the Reserve Bank of India. Analytical type of research method was adopted to conduct the study.

Objective of the Study

- To analyze the development of money aggregates from FY 1991-92 to FY 2021-22. The objective of study focuses on comparing the progress of currency with public and demand deposits with banks; to study the progression of broad money, narrow money and time deposits, and to measure the advancement of demand deposits and time deposits; to evaluate the growth of net bank credits to the Government and commercial sector

Limitation of Study

- Selected money aggregates are analyzed in the study.
- Reliability of data is purely dependent on the available secondary data as retrieved from various sources.
- The period of the study is limited from FY 1991-92 to FY 2021-22.

RESULT AND DISCUSSION

Table 1: Values of Narrow Money (M1) from FY 1991-92 to FY 2021-22 (Currency with public + Demand deposits with the Banking system and other deposits with RBI)

(Amount in Crores)

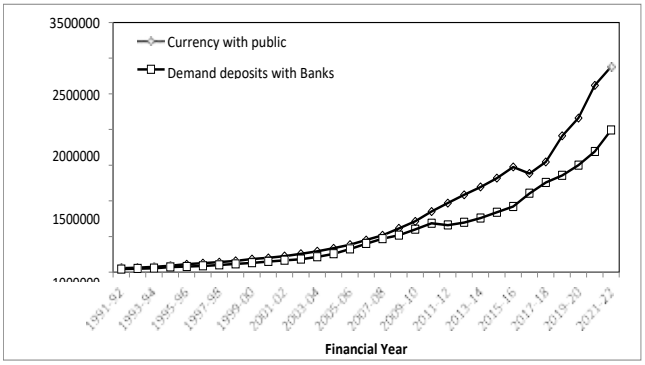
Financial Year	Currency with public	Demand deposits with Banks	Other deposits with RBI	Narrow Money M1
1991-92	57327	45299	1345	103970
1992-93	64450	51577	4023	120050
1993-94	76212	56841	3300	136353
1994-95	92282	73310	3608	169200
1995-96	112080	80278	5925	198283
1996-97	126712	89745	5307	221764
1997-98	142187	102244	4035	248465
1998-99	158854	117190	3594	279638
1999-00	184702	132348	3580	320630
2000-01	201581	151826	3182	356588
2001-02	227164	167505	3014	397683
2002-03	258675	183804	3034	445513
2003-04	294797	216196	3643	514636
2004-05	336528	259116	4700	600343
2005-06	385186	326438	4847	716470
2006-07	451325	401639	5711	858675
2007-08	517434	471324	6270	995028
2008-09	614796	518697	6113	1139607

2009-10	713395	601199	5257	1319851
2010-11	850449	686531	4546	1541527
2011-12	968975	660120	2148	1631242
2012-13	1085374	699034	1903	1786311
2013-14	1194454	759490	3386	1957330
2014-15	1318623	839596	6902	2165121
2015-16	1474220	920949	15020	2410190
2016-17	1382482	1105316	15385	2503182
2017-18	1546603	1258041	21727	2826371
2018-19	1910496	1357885	26045	3294426
2019-20	2160630	1500699	32405	3693735
2020-21	2618214	1691483	41838	4351535
2021-22	2880956	1993729	49096	4923780
Total	**24,407,163**	**17,519,449**	**300,889**	**42,227,497**

Source: Reserve Bank of India

Table 1 shows the details values of Narrow Money M1 (Currency with public + Demand deposits with the Banking system and other deposits with RBI) from FY 1991-92 to FY 2021-22. The total amount of Currency with public was INR 24,407,163 Crore between FY 1991-92 and FY 2021-22. It has grown with a Compound Annual Growth Rate (CAGR) of 13.28%. The total amount of Demand Deposits with banks was INR 17,519,449 Crore between FY 1991-92 and FY 2021-22. It has grown with a CAGR of 12.80%. The total amount of other deposits with RBI was INR 300,889 Crore between FY 1991-92 and FY 2021-22. It was increased with a CAGR of 12.10%. The total amount of Narrow Money was INR 42,227,497 Crore between FY 1991-92 and FY 2021-22. It was increased with a CAGR of 13.06%.

Graph 1: Values of Currency with Public and Demand Deposits with Banks (FY 1991-2022)



Source: Author's Creation

Graph 1 displays the values of currency with public and demand deposits with banks from FY 1991-92 to FY 2021-22. It is observed that the movement of currency with public and demand deposits are moving together in a same pace until FY 2010-11 then onwards it is found that the gap is widened between them. It is also noticed that there was an opposite movement between them during FY 2017-18 due to the impact of demonetization.

Table 2: Values of Broad Money M3*, Reserve Money from FY 1991-92 to FY 2021-22

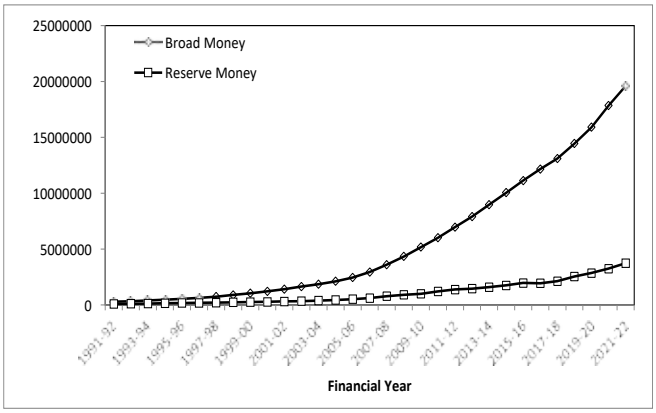
(Amount in Crore)

Financial Year	Narrow Money(M1)	Time Deposits with Bank	Broad Money (M3)	Reserve Money
1991-92	103970	188433	292403	94090
1992-93	120050	224188	344238	107740
1993-94	136353	262696	399048	125182
1994-95	169200	308996	478196	153165
1995-96	198283	354670	552953	178245

1996-97	221764	420868	642631	189524
1997-98	248465	503563	752028	208994
1998-99	279638	621656	901294	234625
1999-00	320630	735396	1056025	262307
2000-01	356588	867499	1224087	282678
2001-02	397683	1022324	1420007	314034
2002-03	445513	1202441	1647954	343038
2003-04	514636	1346944	1861580	390712
2004-05	600343	1521116	2121459	444861
2005-06	716470	1742454	2458925	515948
2006-07	858675	2091512	2950186	617286
2007-08	995028	2608416	3603444	786960
2008-09	1139607	3204058	4343664	913929
2009-10	1319851	3858031	5177882	996522
2010-11	1541527	4473638	6015165	1210801
2011-12	1631242	5337563	6968805	1381046
2012-13	1786311	6122631	7908942	1463829
2013-14	1957330	7024884	8982214	1592672
2014-15	2165121	7886635	10051756	1753773
2015-16	2410190	8720173	11130363	1966142
2016-17	2503182	9658102	12161285	1940597
2017-18	2826371	10279353	13105724	2126677
2018-19	3294426	11153372	14447798	2543148
2019-20	3693735	12215282	15909016	2857118
2020-21	4351535	13499361	17850896	3250214
2021-22	4923780	14668204	19591984	3737469
Total	**42,227,497**	**134,124,459**	**176,351,952**	**32,983,326**

*(M3 = M1 + Time deposits with the Banking system)
Source: Reserve Bank of India

Graph 2: Values of Broad Money and Reserve Money (FY 1991-2022)

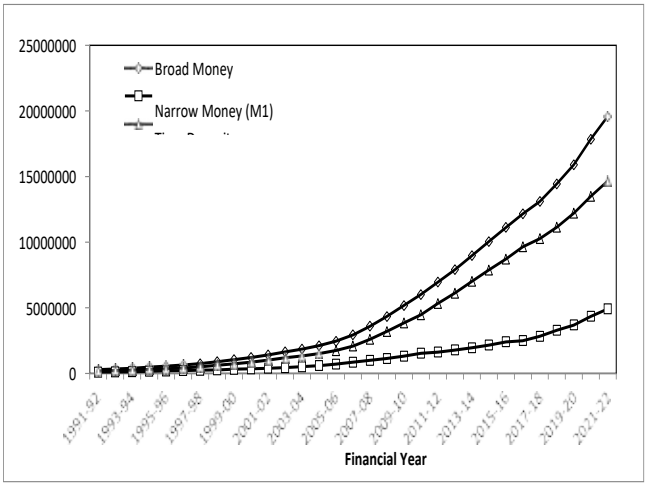


Source: Author's Creation

Graph 2 depicts the values of Broad Money and Reserve Money between FY 1991-92 and FY 2021-22. It is witnessed that there was no much gap found between them until FY 1998-99 and then onwards gap was widened slowly until FY 2007-08 then onwards huge gap was widened due to more rise in broad money than reserve money.

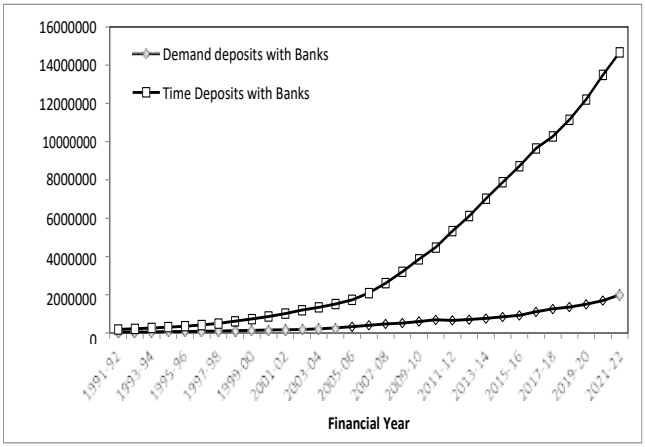
Graph 3 shows the values of the broad money, narrow money and time deposits with the banks. It is observed that broad money, narrow money and time deposits are moving together in same pace until FY 1999-00 there after the slowly gap is started widening between them until FY 2009-10. Later there was sudden surge in both broad and term deposits whereas narrow money rose in sluggish way.

Graph 3: Values of Broad Money, Narrow Money and Time Deposits (FY 1991-2022)



Source: Author's Creation

Graph 4: Values of Demand Deposits and Time Deposits with Banks (FY 1991-2022)



Source: Author's Creation

Graph 4 depicts the values of demand deposits and time deposits with banks from FY 1991- 92 to FY 2021-22. It is noticed that both the values of demand deposits and time deposits with the banks was moving in a same pace until FY 1997-98 there after the gap between them started widening slowly until FY 2005-06. Later the gap between them was widened in increasing mode until FY 2021-22. This shows that people were keen to depositing their money in the form of time deposits. One of the reason could be the earning power per capita was increased continuously.

Table 3: Values of Bank Credit (Bank credit to Govt. and other) from FY 1991-92 to FY 2021-22 (Amount in Crore)

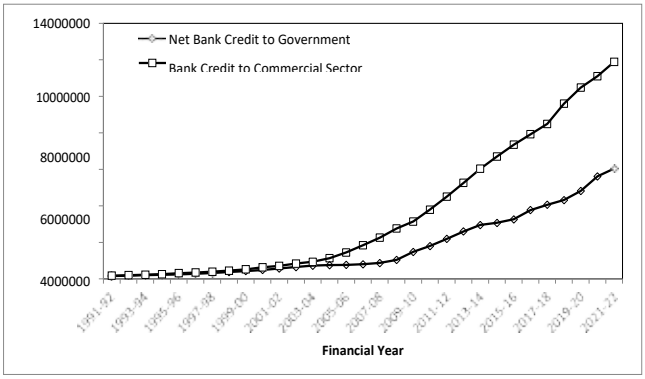
Financial Year	Net Bank Credit to Government	Bank Credit to Commercial Sector	GDP Growth Rate(Year wise 1991 to 2021)
1991-92	155834	175716	1.06
1992-93	170692	204164	5.48
1993-94	196982	226473	4.75
1994-95	215607	256410	6.66
1995-96	242199	309803	7.57
1996-97	278313	349493	7.55
1997-98	313099	391029	4.05
1998-99	369536	449640	6.18
1999-00	424990	524136	8.85
2000-01	483761	631875	3.84
2001-02	564639	710139	4.82
2002-03	641414	836014	3.80
2003-04	718705	934430	7.86
2004-05	749970	1130470	7.92
2005-06	763243	1448510	7.92
2006-07	799555	1844861	8.06
2007-08	863929	2256300	7.66
2008-09	1037045	2760648	3.09
2009-10	1478218	3142004	7.86
2010-11	1796221	3790363	8.50
2011-12	2188647	4503665	5.24
2012-13	2594654	5255518	5.46
2013-14	2949914	6033605	6.39
2014-15	3066422	6703029	7.41
2015-16	3258319	7351965	8.00
2016-17	3764456	7920328	8.26
2017-18	4055249	8488162	6.80
2018-19	4315872	9595648	6.45
2019-20	4810378	10477658	3.74
2020-21	5613697	11100840	-6.60
2021-22	6035944	11885411	8.68
Total	**54917504**	**111688307**	

Source: Reserve Bank of India

Table 2, includes the values of the net bank credit to the Government and commercial sector from FY 1991-92 to FY 2021-22. The net bank credit to the Government was INR 155,834 Crore during FY 1991-92 which rose to INR 6,035,944 Crore during FY 2021-22 which has increased with a CAGR rate of 12.32%. The net bank credit to the commercial sector was INR 175,716 Crore during FY 1991-92 which surged to INR 11,885,411 Crore during FY 2021-22, which has increased with a CAGR rate of 14.38%.

Graph 5 shows that values of net bank credit to the Government and commercial sector from FY 1991-92 to FY 2021-22. It is observed that until FY 2003-04 bank credits to both the Government and commercial sector was almost equal but there after the gap was widened between them and commercial sector got more bank credit than the Government. This shows that commercial sector has grown rapidly.

Graph 5: Values of Net Bank Credit to Govt and Commercial Sector (FY 1991-2022)



Source: Author's Creation

CONCLUSION

The result of the study shows that there is progressive increase in terms of money supply in the economy in all aspects of monetary aggregates. From the study it is found that, there has been a significant growth of monetary aggregates witnessed in the Indian economy during post liberalization. Impact of Global meltdown in 2008 and Demonetization 2016 was not severely affected on money supply in India. It is observed that although there was continuous growth in all aspects of monetary aggregates but GDP was not showing growth in same way. Hence this concludes that there is no strong correlation between monetary aggregates and GDP growth rates during the selected study period.

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Conceptualizing Green Performance in the Restaurant Industry: A Suggested Framework

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ABSTRACT

Restaurants are generally considered to be one of the largest contributors to the hospitality industry in the 21st century. Contribution is more often measured in terms of profitability, innovation, and consumer satisfaction. Restaurant operations drive in a huge amount of energy in different forms and as such affects the environment adversely. The aim of this paper is to consider the restaurant business and theoretically construct a model with hypothetical relationships among certain sustainable indicators which lead to Innovation and Green Performance. The study considers several research papers consisting of different models illustrating restaurant sustainable indicators and attempts to develop a conceptual model. Presently this paper gives the reader a basic understanding of innovative sustainable practices by the restaurant business operating in Assam. The first level of this framework, which consists of three tiers, illustrates the sustainable restaurant indicators. The second level elucidates innovativeness as well as green performance and the last level elucidates the restaurants' financial and non-financial green performance. Further testing of the model can be carried out later to validate the hypothetical relationships in the model.

KEYWORDS: *Sustainable indicators, Restaurant sustainability, Innovativeness, Green performance*

INTRODUCTION

Sustainable development is a holistic concept that explains the interdependence of humans as well as the natural environment. The primary goal of sustainable development is to advance civilization while intelligently utilizing the environment. The basic objective of the approach is to meet the demands of the present generation while preserving enough resources for future generations. There are several approaches to achieving sustainable development: A shift to renewable energy usage, wise usage of water, minimizing pollution, and reducing deforestation are some of the ways to name. Therefore, due to rising sustainability awareness among the various company stakeholders, maintaining a sustainable business is urgently necessary from a commercial perspective(Pipatprapa et al., 2017a). According to (Legrand et al., 2010) Sustainability is not a choice to be made as a strategy, but rather a business system infused with operations that have a lower impact on the environment, and enough resources are preserved for future generations. Restaurant regardless of their size and range of operation is one the water, energy, material, and food product users (Legrand et al., 2010). Therefore, the concept of sustainable business is important to this sector. Every step of the food service process has a high financial and environmental cost that needs to be reconsidered, especially in light of the environmental aspect (sustainability is already there in the folder). Through the Literature review, it is evident that the concept of sustainability in the restaurant sector has not been discussed adequately (Legrand et al., 2010). Since this research paper focuses on the sustainability of the hospitality industry with special reference to the restaurant business, therefore certain criteria are selected to indicate the sustainable practices of the restaurants. The seven criteria of green performance as given by the Green Restaurant Association are Energy, Water, Waste, Disposal, Chemical, Building, and Food(Green Restaurant Association | Education Site, n.d.) form the basis of this research work. These

criteria form the antecedents of the second level of the framework i.e., 'innovation,' and 'green performance.' A wider range of innovations, such as those in services, operations, management structures, and menu items, have not yet been the subject of studies in the context of restaurant enterprises(Hjalager, 2010). Due to resource constraints, small restaurants are unable to carry out innovations, because they perceive innovation as a cost as discussed by(Zeng et al., 2010), pollution prevention is considered as a cost to the firm. Hence, small changes i.e., adaptations or adoptions of improved processes and products will help to infuse sustainability in an innovative manner strategies for marketing.

LITERATURE REVIEW

Sustainable Indicators

"An indicator quantifies and simplifies phenomena and aids in our understanding of complex realities" (Pinter, 2013). Generally, to measure sustainable or sunstainable development, quantification is a necessary measure(Verma & Raghubanshi, 2018). Indicators act as reference points which allows us to monitor or evaluate something against that reference point as well it helps to quantify a phenomenon. There are 248 indicators developed by United Nations General Assembly at the UN Sustainable Development Summit, New York, September 2015 "Sustainable Development Goals". Some of the most frequent terms used as sustainable indicators: Energy Efficiency, Carbon footprint, Waste Disposal, and Reduce Plastic use (Banerjee et al., 2022). Sustainable indicators generally indicate how the business operates within an environment. It reflects the ethos of the company. Sustainability is generally discussed around three pillars: Social, Economic, and Environment(Legrand et al., 2010). As a result, there should be a complementary interaction between the environment, society, and restaurant operations at all stages, from development to profitability (Legrand et al., 2010). Sustainable Indicators are identified and framed in several research works. According to Legrand et al. (2010) the set of sustainable indicators that they framed consisted of (1) sitting, design, and construction; (2) furniture, fixtures, and fittings; (3) energy and waste; (4) corporate social responsibility; and (5) food and beverage. According to the National Restaurant Association's research, the eroding relationship between the environment and people has a significant impact on Americans. Present-day consumers are quite aware of the adverse effect of certain unsustainable usage of elements in a restaurant, they can include food as the number one Indicator, followed by (NRA) Disposables, Water usage, and Energy consumption (The State of Restaurant Sustainability, 2018).A literature review on Restaurant Sustainability research suggests that there are some commonly used indicator terms that reflect how restaurants grow innovative while procuring or processing them in their operations. Some of them are summarised below-

- Food sourcing, procurement, processing, and disposal techniques that are sustainable (Baldwin et al., 2011; Legrand et al., 2010; Salzberg et al., 2019) According to Lang & Heasman (2004) the challenge in the goal of the food economy is to supply food. to the rising population despite maintaining ecological balance.
- Several studies have raised concerns about energy use in restaurants. Generally, these studies suggest innovative ways of efficiently procuring and using energy in a restaurant (Baldwin et al., 2011; Ham & Lee, 2011; Hotelier, 2007).
- Waste produces environmental issues such regarding landfills' impact on habitat, and Pollution of the land, water, and groundwater if it is not recycled or composted (Legrand et al., 2010). According to GRA, 77.9 million tons of municipal solid waste is composed of containers and packaging and 40% of the landfills are covered with waste papers
- Sustainable procuring and usage of water: According to Green Restaurants Association only provide water upon request and install low flow aerators and high-efficiency pre-rinse spray valves. Up to 2 litres of water in each glass might be saved by just providing water when requested.
- Chemicals: According to Green Restaurant Association restaurants can use biodiesel or electric cars for delivery and can buy non-toxic candle substitutes (such as LED, beeswax, or soy) to promote sustainable business.
- Buildings: Several studies suggested that environmentally friendly foodservice operations

needed construction design (exterior and interior architecture, interior details), management systems, and services, such as reducing resource usage, recycling, using recycled materials, composting, and waste auditing.

Several organizations operating on a global basis conduct audits and certifications to promote sustainable business operations. Some of such organizations are mentioned below:

Table: Associations/Organisations working on Sustainability

Sustainable Restaurant Association (SRA)	Non-profit, membership, UK-based organization that provides accreditation to encourage and recognize sustainable practices in the food service industry. It evaluates the impact across the three pillars: Sourcing, Society, and Environment	(Association, n.d.; Da Costa Maynard et al., 2020)
Green Restaurant Association (GRA)	It is a non-profit United State based organization that evaluates and certifies a restaurant based on 7 indicators	(Da Costa Maynard et al., 2020)
American Dietetic Association (ADA	It is one of the greatest groups of food and nutrition experts worldwide. Its primary goal is to improve the nutritional well-being of the public while conserving natural resources and ecological balance.	(Academy of Nutrition and Dietetics, 2022)
Green Seal Certifications (GSC)	It is a non-profit organization that strives to develop rigorous standards for health, sustainability, and product performance.	(Green Seal, n.d.)
National Restaurant Association (NRA)	It is a US-based education foundation that aims to empower people with requisite skills and training for a better future focusing on the restaurant business.	(National Restaurant Association Educational Foundation - Home, n.d.)
ISO 14000 family	This family generally deals with sustainable approaches toward the environment. ISO14001 deals with guidelines for environmental systems. ISO 14004 deals with the process of developing and maintaining an Environmental Management system.	(Da Costa Maynard et al., 2020), (ISO, 2023)

Innovativeness

Innovation is viewed as a crucial component, particularly in the service sector, to remain in a competitive climate. (Mohammed Sabah Kaabi et al., n.d.), which facilitates increased sources of productivity, financial performance, and profitability (Husnaini & Energy, 2021). From the previous literature, innovativeness can be divided into three sections. (i) process innovation, which includes the procedure, process, and activities that can bring positive change in the form of quality, capability, and productivity (ii) Knowledge and competency which the management can use as a tool to develop and to create new ideas in an organization (iii) organizational support, which is a significant tool to support the process and knowledge required to make the innovation (Husnaini & Energy, 2021).Previous research has shown that green restaurant management standards include three main categories (green meals, green environment, and equipment, and green management and social responsibility), nine subcategories, and 81 indicators. In terms of sustainability, food production and consumption affect the world's greenhouse gas emissions among other things (Chou et al., 2016).

Green Performance

The performance of a business is generally measured in terms of its holistic and transparent approaches toward sustainable management(Hotelier, 2007).Fulfilling the sustainable environmental goals of an organization is all about performing green. Green Performance is more of a measurement than a concept. According to Yuan & Xiang (2018) initiating an operational change in the execution of business processes, be it a product or service's operation procedure results in green performance if the objective of the change is environmentally friendly. The intellectual foundation of CGP is found in Green Theory, which discusses the relationship between a

company's operations and the environment (Cancino et al., 2018). The term Green Theory is an umbrella term that encompasses concepts like Business Governance, Globalization, Social responsibility, Factors related to the environment, etc(Eckersley, 2007).

Financial performance/ Firm performance

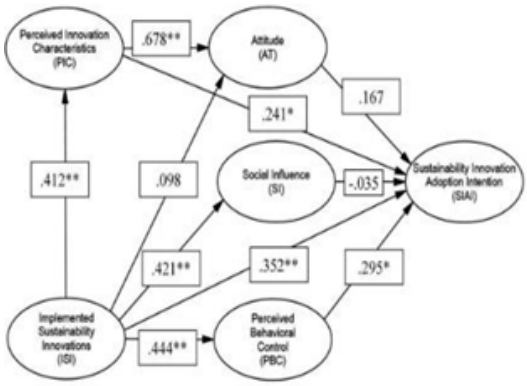
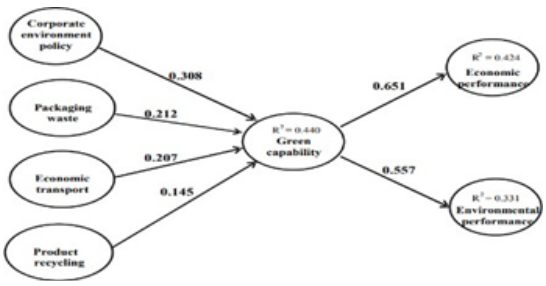
Previous studies have shown that implementing green practices enables businesses to increase their financial performance in two ways: directly or indirectly, through decreases in daily operating expenses and, accordingly, increases in competitiveness (Perramon et al., 2014). By employing techniques for recycling waste and using water and energy more efficiently, a firm may strengthen its overall position in the market, improve its reputation, attract new "green" customers, further satisfy existing clients, and so on.(Chiu & Hsieh, 2016). Furthermore, the adoption of green practices results in a decrease in overall operational expenses which leads to firm financial performance(Zeng et al., 2010).When green practices are used, organizational effectiveness, occupational health and safety, and environmental performance all see an immediate and noticeable improvement(Bagur-Femenias et al., 2013). According to previous research, there are two different types of indicators: operational performance and environmental condition. The former provides information on the environmental performance of an organization's operations, including the materials, energy, and services that support those operations. The latter provides information on the direct and indirect environmental impacts of those operations(Perramon et al., 2014).

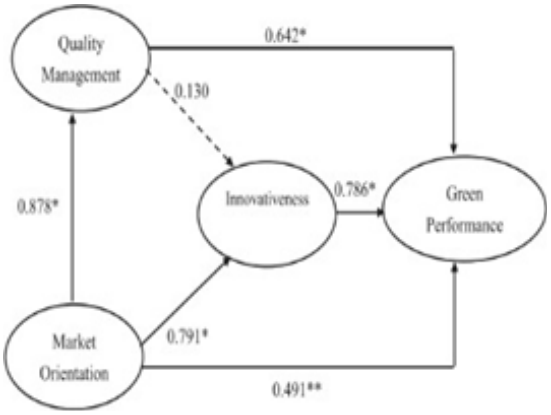
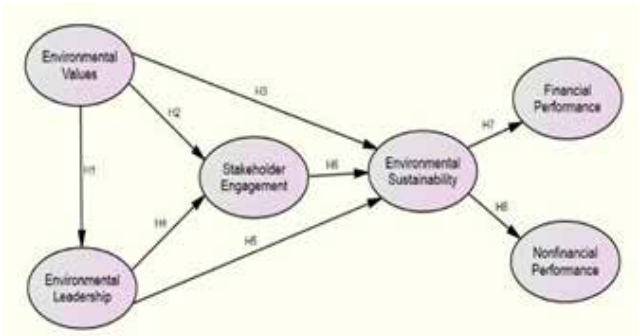
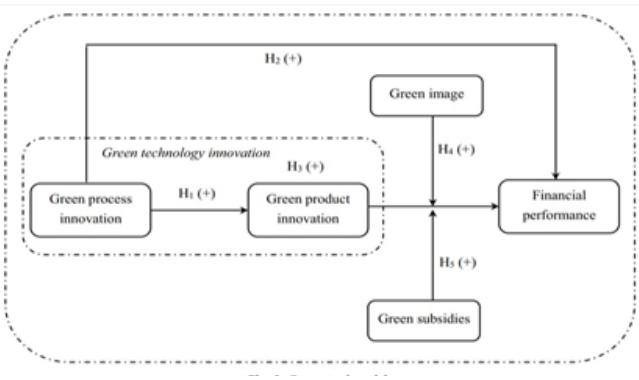
RESEARCH METHODOLOGY

After the identification of a research theme, the researchers extracted data from various relevant sources, for example, Research Articles, Websites, and reports of certain organizations. In addition to studying the sustainable elements/indicators listed by the organisations, several model-based studies were reviewed and analysed.

Finally, the researchers with enough evidence of proven relationships among different constructs, propose a new model with relationships among the sustainable indicators, Innovation, Green Performance which is further measured through financial and non-financial performance Research Methodology:

Table: Literature review of model-based articles

Author and Year	Model	Unique Contribution
(Salzberg et al., 2019)		The study helps to measure sustainability progress in the restaurant industry. The predictor variables-Past experience, perceived behavioural control and Perceived innovation character serves a guideline to the restaurant's future engagement in sustainable innovation. Study Area: Virginia
(Chiu & Hsieh, 2016)		This study investigated the dimensions of Green Supply Chain Management dimensions to measure green performance through firm green capabilities. Study Area: Taiwan

(Pipatprapa et al., 2017b)		This study contributed to academic scope of Green performance through the framework model depicting inter- relationship among Market Orientation, Quality Management, and Innovativeness. Study Area: Thailand
(Jang et al., 2017)		This study has a unique contribution wherein measures like non-financial performance such as takeholder (Customer/Employee) Satisfaction. Study Area: United States
(Da Costa Maynard et al., 2020)	1. Sustainability assessment of Food service 2.Menu and Food waste 3.Waste reduction, construction material, chemicals, employee, and social sustainability	This study developed a practical tool which is cheap and easy to understand. The versatile tool can be used by Nutritionist, Dieticians, Mangers, Owners of Foodservice establishment to classify whether they behave sustainable or not. Study Area: Brazil
(Xie et al., 2019)		A firm's green image moderates the association between green product innovation and financial performance, while green process innovation mediates the relationship between greenprocess innovation and a firm's financial performance.

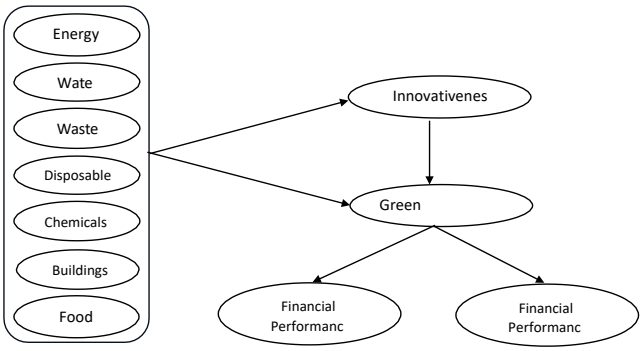


Figure 1: The proposed framework

The relationship of these indicators with innovation is proposed based on several studies (Chiu & Hsieh, 2016; Da Costa Maynard et al., 2020; Pipatprapa et al., 2017b), the relationship of the indicators with Green Performance is proposed based on studies (Chiu & Hsieh, 2016; Xie et al., 2019; Zeng et al., 2010), The relationship between Innovation and Green Performance is proposed based on innovativeness, (Pipatprapa et al., 2017b; Xie et al., 2019), Green performance. The relationship between Green Performance with the last level of the framework i.e., financial, and non-financial performance is proposed based on R paper 4,(Jang et al., 2017; Zeng et al., 2010).

CONCEPTUAL FRAMEWORK

Green Process is all about organizations finding efficient and sustainable ways to reduce the consumption of natural resources in various production processes whereby raw material is converted to a value-added product(Ma et al., 2017). Before proposing the relationships, literature review has revealed that the association between green process innovation and a company's financial performance is mediated by green product innovation, while the relationship between green product innovation and financial performance is moderated by a firm's green image. (Xie et al., 2019).

Therefore, this paper proposes certain relationships that might be well-supported:

Proposition 1(a): There is a positive relationship between sustainable use of energy and Innovativeness. Restaurants grow more innovative as they seek out more sustainable methods of obtaining their energy.

Proposition 1(b): There is a positive relationship between sustainable usage of energy and green performance. The more restaurants use energy in sustainable ways the more restaurant performs green.

Proposition 2(a): There is a positive relationship between efficient usage of water and innovativeness. Restaurants become more innovative as they make more conscious choices to use water wisely.

Proposition 2(b): there is a positive relationship between the efficient usage of water and Green Performance. The more effectively a restaurant uses water, the greener it becomes.

Restaurants might discover innovative, highly efficient technology like pre-rinse spray valves and low- flow aerators to help reduce water waste. (Green Restaurant, n.d.).

Proposition 3(a): There is a positive relationship between sustainable sourcing, locating and consumption of food by a restaurant, and innovativeness. The more innovative a restaurant is, the harder it works to discover sustainable methods for obtaining, storing, and consuming food.

Proposition 3(b): There is a positive relationship between sustainable sourcing, locating and consumption of food by a restaurant, and Green Performance. The more sustainably a restaurant sources locates and consumes food, the greener it becomes.

There are several environmentally friendly ways to eat at a restaurant. For instance, buying locally produced, regional, and certified foods, and including dishes like vegetarian or vegan fare that use less water (Green Restaurant, n.d.).According to

Hence the following propositions are hereby presented which may support the concept of sustainable ways of waste management, disposables, chemical usage, and construction of buildings.

Proposition 4(a): There is a positive relationship between the reduction of waste, reuse, and Innovativeness. Restaurants grow more innovative as they look for new ways to minimize and recycle garbage.

Proposition 4(b): There is a positive relationship between the reduction, reuse of waste, and green performance. The more restaurant tries to find sustainable ways of

reducing and reusing waste, the more their performance becomes Green.

Utilizing a thorough recycling and composting product, and implementing reusable incentive products are some of the ways to curb waste and reuse them for sustainable performance (Green Restaurant, n.d.).

Proposition 5(a): There is a positive relationship between sustainable choices of using disposables and innovativeness. The more sustainable disposables and reusables options restaurants have, the more innovative ways they discover to use them.

Proposition 5(b): There is a positive relationship between Sustainable choices of using disposables and green performance. The more restaurants find choices of reusables and environmentally preferred disposable, the greener it performs.

Incorporating reusable options like coasters, Pan liners, Coffee filters, Dishware, Chlorine free products, etc. wherever possible will significantly reduce pollution and will make the restaurant processes greener (Green Restaurant, n.d.).

Proposition 6(a): There is a positive relationship between the reduction of chemicals and innovativeness. That is the more restaurants find ways to reduce chemicals and pollution, the more innovative it becomes.

Proposition 6(b): There is a positive relationship between the reduction of chemicals usage and green performance. The more the restaurant find ways to reduce the usage of chemicals the less is pollution, and the greener it performs.

Generally, restaurants use a lot of chemicals for cleaning and sanitizing. Therefore, incorporating non-toxic chemicals like Chafing fuels, Low VOC, or no VOC paints, using green-certified pest companies will significantly reduce the impact of pollution (Green Restaurant, n.d.).

Proposition 7(a): There is a positive relationship between the sustainable construction of a building and innovativeness. The more restaurant tries to find sustainable i.e., reusable or recycled raw materials in constructing the more innovative it becomes.

Proposition on 7(b): There is a positive relationship between the sustainable construction of a building and green performance. The more restaurant tries to find sustainable i.e., reusable or recycled raw materials in construction the greener it performs.

To curb construction material waste, reusing materials from construction sites or closed buildings as well as using renewable or recycled construction materials can be used in the process (Green Restaurant, n.d.).

Before proposing the final relationships, the literature reveals restaurants' environmental sustainability performance has a favourable impact on both their financial and non-financial performance. (Jang et al., 2017)

Proposition 8: There is a positive relationship between Innovativeness and Green Performance. Innovative ideas for a sustainable strategy led to Green Performance.

Proposition 9: Green Performance of a firm is contributed by non-financial and Financial Performance.

To enable future testing of the model, all the variables will be specified and operationalized in aggregate terms.

CONCLUSION

- Energy: When choosing raw materials and energy, the use of energy-efficient and environmentally friendly technology as well as the use of renewable resources are all taken into account.,(Da Costa Maynard et al., 2020), Energy-efficient equipment (heating, cooling, and ventilation/cooking/lighting) Practise offsetting energy usage/renewable energy Reduction of energy use or gas use in generator (impact on financial performance) There are a few simple but efficient techniques to cut back on energy consumption. There are several techniques to reduce the consumption of traditional energy, such as using LED lights, Star appliances, occupancy sensors, strip curtains, and programmable thermostats (Green Restaurant, n.d.).
- Climate change and the imbalance ecosystem are constantly pushing the restaurant industry to adopt sustainable practices and as SDG 12 reflects or demands a broad range of actions from companies, decision-makers, and consumers to adopt sustainable practices hence This article tries

to propose a model for sustainability measures in the hospitality industry, more specifically in the restaurant business.

- The checklist is easy to understand and implement in Indian Context with special reference to Northeast India

Limitations and Future research aspects

For testing the constructs, more literature as well as interviews with restaurant managers/owner needs to be conducted, which will help find variables that have practical implementation. Finally, this paper is hoped to serve as a basis for conducting a sustainability study in the restaurant business of Northeast India and guides future researchers in the field of sustainability studies.

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A Comprehensive Review of Counterfeit Luxury Branded Products (CLBP) in India

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ABSTRACT

Counterfeit products- fake copies of the real thing, are frequently made with the intention of profiting from the greater quality of the mimicked good. Counterfeit market is affecting not only the companies in terms of loses of revenues and hampering of goodwill, but are also cheating government on tax and legal front, in short impacting economy at large. Among all counterfeit sold in India, one of the fastest rising categories in Indian market are the Counterfeit Luxury branded Products (CLBP). The paper addresses several research works on counterfeiting with a focus on luxury brand imitation in India and its current surge of popularity in the Indian market. A comprehensive review of counterfeiting of luxury goods is the aim of paper and also to review the factors that carry heavy weightage on demand in CLBP. The paper also touches briefly about supply side of counterfeiting.

KEYWORDS: *Counterfeit, Luxury brands, Indian economy, Deceptive and non-deceptive Counterfeiting.*

INTRODUCTION

Counterfeit Products are getting sold in absolute parallel manner in Indian markets now a days and is expanding on a magnanimous level and are being sold without any hiccups. World Trade Organization (WTO) defines product counterfeiting as: "Unauthorized representation of a registered trademark carried on goods identical or similar to goods for which the trademark is registered, with a view to deceiving the purchaser into believing that he/she is buying the original goods" (WTO, 2011). In these imitated products of packaging, spellings, fonts and sizes are duplicated on par with the original brand.

Products with trademarks that are identical to or nearly identical to those registered to another party and violate the rights of the trademark owners are considered counterfeits. (Bian and Moutinho, 2011).

In accordance with the survey conducted for gauging the spread of the counterfeit in Indian market, as much as 27% of customers are uninformed that items are fake at the time of buying, but 31% eagerly buy these counterfeit products. In FY 2019-20 Illicit goods trade of ₹2.6 trillion happened in India affecting almost all sectors and also the nation, industry and consumers by large. (Anand S. 2023)

According to the Authentication Solution Providers' Association (ASPA) and CRISIL- "State of Counterfeiting in India-2022" report, based on independent research conducted among consumers and retailers concluded that 25-30 percent of the market is of counterfeited goods, which is way higher than general industry expectations. Most prevalently sold counterfeits include FMCG, apparel and agrochemical sectors (~30%), followed by pharmaceutical, automotive, and consumer durables sectors (20-25%). With the strange part being the acceptance of consumers acknowledgement of presence of fake products in the markets which clocks at 89% and consumers compelled to purchase these products due to various reasons like sensitivity to desire to purchase luxury brands price, pressure amongst peers, demand-supply gap and social motivations. (Sarma D., 2023).

Product categories sold under counterfeiting as mentioned by ASPA & CRISIL includes fast moving

consumer goods, consumer durables, pharma sector, electronics etc., but amongst these one of the fastest sold category is the apparel category where in counterfeits being sold are 31% thanks to the advent of luxury branded products sales that are particularly leaching on the growing youth population of the nation. Some of the statistics even suggest that luxury branded products counterfeit market is running parallel to the original products market and the movement is goods are huge, which is a concern for the economy of nation at large.

The quality of counterfeits that are related to luxury goods varies widely between them.:

i. High-end counterfeits- Also known as "first copy" or replicas. These are the fake products, which are exceedingly hard for the average consumer to distinguish from the real thing. These are consequently more expensive as well.

ii. Knock-offs- These are low-quality knockoffs that frequently stand out from the genuine article. The fact that these products are not the genuine article, which is typically significantly more expensive, and are known by consumers before they make a purchase.

Investopedia defines Luxury Product as something that is not essential for survival, it is highly valued in a culture or society. When a person's wealth or income rises, the demand for luxury products also rises. Usually, the percentage rise in luxury goods purchases is inversely correlated with income growth. Due to their high cost, wealthy people consume a disproportionate amount of luxury products. People who are not fortunate typically don't purchase luxury items because living expenditures take up a larger portion of their money. Luxury goods can be categorized as extravagant consumption, which is the act of buying something primarily or exclusively to flaunt one's wealth. (Kenton W., 2021)

Luxury brands are typically associated with high-valued and high-priced products. Four basic criteria are related with luxury brand: (1) a luxury brand always possesses an artistic content (2) Luxury brand design is a result craftsmanship (3) A luxury brand is known internationally (4) A luxury brand contains a unique, recognizable, individual design (Chevalier and Mazzalovo, 2008). They are normally those products the products wherein mere use or display of them brings owner prestige. A surge in these counterfeit luxury branded products is witnessed not only due to the increased supply of them by the producers but mainly due to the buyers who are purchasing them knowingly. While buying luxury products, consumers give importance to the brand more than the product or products (Husic and Cicic, 2009). Despite the current desperate worldwide economic situation demand of luxury branded products is still going solid, with consumers willing to pay more to avail the benefits associated with luxury-branded products. As a result of social media influencers pushing websites that openly sell and advertise counterfeit luxury brands, India has developed into a thriving market for them. (Khosla, 2023). One of the highlighting points also has been the slow but steady improving quality of counterfeit products over the recent years, trying to get as near as possible to the real brand. This is largely due to the move of many retailers of luxury brands, in their quest to reduce production costs, towards the outsourcing of manure. (Phillips, 2005).

RESEARCH METHODOLOGY & OBJECTIVE OF THE STUDY

With the counterfeit luxury branded products expanding its barbs over Indian markets as pointed by Authentication Solution Providers' Association (ASPA), it is more than desirable to have a base study for the further detailed studies down the line.

Focus of the study will be:

- To provide a conceptual overview about the counterfeit luxury branded products by relying on the data from secondary sources for understanding the problem better with in-depth research knowledge.

A lot of research has been put forth in for exploring the range of issues that are responsible for counterfeiting and usage of these luxury branded products. Literature provides enormous data and also various cases at different places. The wide usage of CLBP is clearly evident from the literature and hence paper considers this sourced information as a working data.

LITERATURE REVIEW

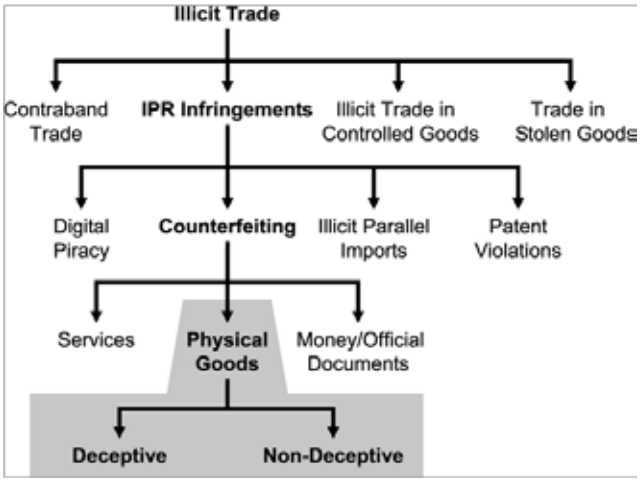
Many luxury enterprises throughout the world are increasingly coming under serious danger from the trade in counterfeit goods. Loss of sales revenue, harm to the brand image, and reputational damage are a few repercussions of counterfeiting on luxury enterprises (Berman, 2008). Among all counterfeit sold in India, one of the fastest rising categories in Indian market are the Counterfeit Luxury branded Products (CLBP). Plenty of researchers are exploring the various issues that is causing rise of counterfeit market. Despite the magnanimous amount of research that is happening, these luxury brands are unable to dissect a pin point solution to this ever-growing issue. The only thing that differs counterfeiting of luxury products from that of per say counterfeited pharmaceutical, electrical and automobile products is that they do not cause any physical harm to the consumer, but it surely does dent the luxury brand's image and its brand equity.

As per the literature that was studied, it is clear that comprehensive research on the topic can be broadly classified on the basis of two types: Demand side and Supply side. But in this study, we are largely going to focus on the consumer side i.e., the demand side of counterfeit luxury branded products and also deal in brief about the supply side.

Evolving Indian Luxury Brand Market

Nueno & Quelch (1998) outline luxury brands as those whose price to intangible and situational utility is high but whose functionality to price ratio is low. An increase in the population of rich class and upper middle class is proving out to be a boon for luxury brand industry in India. Adding to this the rise of disposable income, rising internet penetration leading to awareness about luxury brands and the growing youth population who are purchasing luxury brands are proving out to be the main drivers for the expansion of this industry. The size of the Indian luxury market is expected to reach about $200 billion in 2030 from the current US $30 billion. (Sharma R., 2021). Accelerated digital adoption and growing penetration in Tier 2 and smaller cities experiencing an economic recovery have been the main drivers of this growth. The most counterfeited categories in luxury brands include apparel which occupies the topmost echelon followed by shoes, watches, leather goods, and jewelry. (Abraham N., 2010).

Deceptive vs Non-deceptive Counterfeit Products



Buyers may purchase counterfeit goods either without realizing the underlying intellectual property violation (deceptive counterfeiting) or with full knowledge of the product's illegal status (non-deceptive counterfeiting). Consumers can quickly identify non-deceptive counterfeit goods by their price, quality, and place of sale, such as an expensive brand-name product sold by a street vendor for a very low price. On the other hand, deceptive counterfeits frequently match the genuine goods in terms of pricing and packaging but not quality. To uninformed customers who are tricked into risky and frequently fatal purchases, they are indistinguishable. Over time, counterfeits have become of higher quality, making it more challenging for customers to recognize them. The consumer's awareness, knowledge, and experience appear to influence the degree of deception. (Staake T., 2009)

Legal Regulations

In contrast to wealthy nations, India has a very restricted range of rules regarding counterfeiting. The IP Rights (Imported Goods) Enforcement Rules, 2007, the India Customs Act, 1962, and the Trademarks Act of 1999 are the only laws that are absolute. The Authority will notify the rights holder of any imported goods, which will be destroyed in front of the rights holder if determined to be false because counterfeit products are per se prohibited items under the Customs Act. (Deb A.,

2021). Reflecting the onus completely lying on supplier side but not on the buyers side, like in major countries of European Union wherein even purchasing and usage of counterfeit products especially those related to Luxury brand can invite legal proceedings against consumers.

Mix of factors leading to surge in CLBP

As normally depicted price/ economical factor i.e., low pricing of CLBP is not the only factor leading to rise of usage in India especially amongst youth, but it is the mix of various factors like Societal factors, Economic factors, Utility factors & Socialistic factor which is resulting in the exponential rise of sell in CLBP's. (Bangde N., 2023). Eisend M. and Guler P. (2006) came at the conclusion that consumers with greater incomes also purchase counterfeit goods, demonstrating that there are other factors besides price that contribute to the demand for counterfeit goods.

Supply Side of Counterfeits

Counterfeit market in India is being operated in a very systematic manner, like any other business and they are milking every possibility of money making. They mainly operate via Hub and Spoke system with big shots of Tier-I cities like Delhi, Mumbai, Hyderabad and Chennai serving as a Hub, and these supplying their counterfeited goods to vendors of Tier-II cities. Thus, building a network of individuals engaging in similar or activities related to it. If Heera Panna market of Mumbai is the fountainhead for the sale of high-quality counterfeit luxury branded products like watches and footwear, then Delhi's- Gaffar market is famous for counterfeit mobiles, Both Nehru Place and Kashmiri Gate are infamous for their counterfeit computer accessories and auto parts, respectively. While Chennai's Kasimedu Street and Burma Bazaar are recognized for counterfeit electronic equipment such as mobile phones, LCD TVs, imported cameras, etc., Hyderabad's Chenoy Trade Center and Hong Kong Bazaar are well-known for counterfeited computer hardware and software.. (Raj S., 2022)

CONCLUSION

The paper presents a comprehensive review on Counterfeit Luxury Branded Products (CLBP) in India, sketching an overview of its current market scenario in India and how it is affecting the Indian economy at large. The paper then discusses about various research work carried out in areas of counterfeiting and that too CLBP's in particular. Paper also focuses on the further need for study in CLBP due to increasing demand of them from customer's side for these products. The paper clearly stresses on the point that economic/ price related factor is not the only factor for consumers in purchase of CLBP, but other factors like societal, utility & socialistic are equally important.

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On-the-Job Training in Non-IT Companies in India: A Comprehensive Analysis

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ABSTRACT

This research paper examines On-the-Job Training (OJT) in non-IT companies in India, providing a comprehensive analysis of its current state. The study aims to uncover the benefits, challenges, and effective strategies associated with OJT implementation in non-IT sectors. It also explores the impact of OJT on employee performance, job satisfaction, and organizational success. The findings enhance our understanding of OJT practices in non-IT sectors, offering insights for optimizing training programs and fostering a skilled workforce. This paper serves as a valuable resource for organizations, trainers, and policymakers seeking to enhance OJT practices in the Indian non-IT industry.

RESEARCH OBJECTIVES

a) Explore training approaches, duration, and frequency of OJT programs in non-IT companies.

b) Analyze resource allocation, trainer roles, and evaluation methods for assessing training effectiveness in OJT.

c) Identify benefits of OJT in non-IT companies, such as skill enhancement, improved job performance, and employee retention.

d) Investigate challenges faced by non-IT companies in implementing OJT programs and propose strategies for overcoming them.

e) Examine the impact of OJT on employee performance, job satisfaction, and organizational success in non-IT companies.

RESEARCH QUESTIONS

a) Prevailing approaches, duration, and frequency of OJT programs in non-IT companies in India.

b) Resource allocation and the role of trainers in non-IT companies.

c) Evaluation methods used to assess OJT effectiveness in non-IT companies.

d) Benefits of OJT in non-IT companies and their impact on skill enhancement, job performance, and employee retention.

e) Challenges faced by non-IT companies in implementing OJT programs and strategies to overcome them.

f) Impact of OJT on employee performance, job satisfaction, and organizational success in non- IT companies in India.

SCOPE AND LIMITATIONS

This paper comprehensively analyzes OJT practices in non-IT companies in India, focusing on multiple sectors while acknowledging the absence of industry-specific details. The analysis relies on existing literature, empirical studies, and case studies. The scope is restricted to non-IT companies in India, excluding IT-related training practices. However, limitations such as sample size, data availability, and potential biases in self-reported information from respondents should be considered.

LITERATURE REVIEW

Conceptual Framework of On-the-Job Training: Here, a conceptual framework defines and describes

OJT in non-IT companies, including key components, processes, and relevant theories.

Theoretical Perspectives on On-the-Job Training: This section explores theoretical foundations informing the design and implementation of OJT programs, drawing from theories such as adult learning, social learning, and cognitive apprenticeship.

Benefits of On-the-Job Training: Highlighting the advantages of OJT in non-IT companies, this section discusses skill enhancement, improved job performance, employee motivation, knowledge transfer, and organizational success. It also emphasizes the role of OJT in promoting continuous learning.

Challenges in Implementing On-the-Job Training: Identifying obstacles faced by non-IT companies, this section examines resource constraints, resistance to change, trainer expertise, and difficulties in measuring training effectiveness. It offers insights into unique challenges and potential barriers.

Strategies for Effective On-the-Job Training: Effective strategies for designing and implementing OJT programs are discussed, including job rotation, mentoring, simulation-based training, and creating a supportive learning environment. The section also explores the use of technology to enhance OJT.

Role of On-the-Job Training in Employee Performance and Job Satisfaction: Investigating the relationship between OJT, employee performance, and job satisfaction, this section explores how OJT improves competence, productivity, engagement, and career development. It further explores its impact on job satisfaction and overall organizational success.

RESEARCH METHODOLOGY

This research paper utilizes a qualitative research design to comprehensively analyze on-the-job training (OJT) in non-IT companies in India. The qualitative approach focuses on collecting and analyzing non-numerical data to gain a deep understanding of the subject matter.

Research Design: The research design solely incorporates qualitative components. Interviews and focus groups will be conducted with key stakeholders, including employees, trainers, and HR personnel, to gather rich and contextual insights into OJT practices.

Sampling Technique: Purposive sampling will be employed to select participants with direct experience in non-IT companies' OJT. This approach allows for the selection of individuals who can provide valuable insights and diverse perspectives. The sample will include employees from various non-IT companies across sectors and hierarchical levels.

Sample Size: The sample size will be determined by reaching data saturation, where new insights or themes no longer emerge. Approximately 100-150 participants are estimated to be sufficient to achieve saturation and capture a representative range of experiences and perspectives.

Data Collection Methods: Qualitative data will be collected through semi-structured interviews and focus group discussions. These methods will explore participants' experiences, perceptions, and challenges related to OJT in non-IT companies.

Data Analysis Techniques: Thematic analysis will be employed for qualitative data analysis, involving coding, categorizing, and interpreting data to identify patterns, themes, and commonalities. This will provide meaningful insights into the collected data.

Current State of On-the-Job Training in Non-IT Companies in India

Overview of Non-IT Companies in India: This section discusses the size, diversity, and contributions of non-IT companies to the Indian economy. It explores the unique characteristics and challenges faced by these companies in implementing effective OJT programs.

Analysis of On-the-Job Training Practices: This section presents a detailed analysis of OJT practices in non-IT companies in India. It examines approaches, duration, and frequency of OJT programs, as well as the diverse training methods employed across sectors and organizational sizes.

Duration, Frequency, and Approaches of On-the-Job Training: This subsection focuses on the duration, frequency, and approaches used in OJT programs within non-IT companies. It explores the varying duration, frequency, and approaches, such as practical training, shadowing, and simulations.

Resources Allocated to On-the-Job Training: This

subsection explores the resources allocated to OJT programs in non-IT companies, including investments in trainers, materials, equipment, and infrastructure. It discusses challenges faced in resource allocation and strategies to optimize resource utilization.

Evaluation Methods for On-the-Job Training: This subsection discusses evaluation methods employed to assess the effectiveness of OJT in non-IT companies. It explores pre- and post- training assessments, on-the-job performance evaluations, employee feedback surveys, and supervisor assessments. The section highlights the importance of evaluating training outcomes and shares insights into evaluation challenges and best practices.

Benefits of On-the-Job Training in Non-IT Companies in India: This section explores the advantages of OJT in non-IT companies, emphasizing skill enhancement, improved job performance, employee retention and motivation, and fostering a learning culture within organizations.

Challenges in Implementing On-the-Job Training in Non-IT Companies in India

Resource Constraints: Limited resources, including finances, infrastructure, and training facilities, pose challenges for non-IT companies. Allocating sufficient resources for training materials, equipment, and dedicated space is difficult. Finding innovative ways to optimize available resources and seeking external collaborations can help overcome these constraints.

Lack of Trainer Expertise: Finding trainers with the required technical knowledge and experience is challenging. Inadequate trainer expertise compromises training quality and outcomes. Addressing this challenge involves investing in trainer development, providing opportunities for skills enhancement, and promoting continuous learning.

Resistance to Change: Employees and management may resist OJT due to fear, workload concerns, or skepticism. Overcoming resistance requires effective communication, articulation of benefits, involving key stakeholders, and fostering a supportive organizational culture.

Measuring Training Effectiveness: Evaluating OJT programs is a challenge. Establishing evaluation methods, relevant metrics, and allocating sufficient time and resources for assessments is difficult. Overcoming this challenge involves clear evaluation criteria, utilizing assessment tools, and integrating evaluation into training design.

Strategies for Effective On-the-Job Training in Non-IT Companies in India

Job Rotation: Rotating employees across departments develops cross-functional skills, adaptability, and a holistic view of the organization.

Mentoring and Coaching: Pairing experienced employees with new hires facilitates knowledge transfer, skill development, and professional growth.

Simulation-Based Training: Creating realistic scenarios allows employees to practice skills in a safe environment, enhancing proficiency and confidence.

Supportive Learning Environment: Encouraging continuous learning, collaboration, and recognition of employee development efforts fosters engagement and a culture of improvement.

Leveraging Technology: Utilizing e-learning platforms, VR simulations, and gamified modules enhances accessibility, flexibility, and learner engagement.

Impact of On-the-Job Training on Employee Performance and Job Satisfaction

Relationship between On-the-Job Training and Employee Performance: OJT enhances employee performance by providing job-specific skills, practical knowledge, and the ability to apply concepts to real work. It improves competencies, efficiency, productivity, and work quality, leading to meeting targets and organizational success.

Influence of On-the-Job Training on Job Satisfaction: OJT positively impacts job satisfaction by demonstrating organizational commitment to employee growth. Training reduces stress, enhances skills, and fosters a sense of accomplishment and personal growth. This satisfaction improves engagement, retention, and overall performance.

Linking On-the-Job Training and Employee Engagement: OJT enhances employee engagement by offering skill development, career advancement, and

personal growth opportunities. Engaged employees contribute their best efforts, driving innovation, improvement, and organizational success.

SUMMARY OF FINDINGS

1. Prevailing Approaches: OJT programs utilize job rotation, mentoring, coaching, and simulation-based training.
2. Duration and Frequency: OJT programs vary in duration, from short-term to long-term, and in frequency based on job requirements.
3. Resource Allocation: Resource constraints hinder OJT implementation, requiring innovative approaches to optimize resource utilization.
4. Trainer Expertise: Non-IT companies struggle to find trainers with necessary expertise, emphasizing the need for development programs.
5. Benefits of OJT: OJT enhances skills, job performance, retention, and motivation while fostering a learning culture.
6. Challenges: Resource constraints, lack of expertise, resistance to change, and evaluating training effectiveness are challenges faced in OJT implementation.

Implications and Recommendations for On-the-Job Training in Non-IT Companies in India

1. Optimizing Training Programs: Companies can tailor OJT programs based on prevailing approaches, benefits, and challenges.
2. Resource Management: Innovative approaches and collaborations can overcome resource constraints.
3. Trainer Development: Investing in trainer development programs addresses expertise gaps.
4. Cultivating a Learning Culture: Emphasizing continuous learning and knowledge sharing fosters a culture of skill enhancement and innovation.

Recommendations for improving OJT programs

1. Assess Training Needs: Conduct thorough assessments to design targeted OJT programs.
2. Enhance Trainer Expertise: Provide development opportunities for trainers and keep them updated.
3. Utilize Technology: Incorporate simulation-based training and e-learning platforms for interactive learning experiences.
4. Evaluate Training Effectiveness: Implement robust evaluation methods to measure impact and improve outcomes.

Future Research Directions

1. Sector-Specific Analysis: Conduct industry-specific analyses for deeper insights into OJT practices.
2. Long-Term Impact of OJT: Investigate the long-term effects of OJT programs.

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Application of IoT in Logistics & Supply Chain Management

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ABSTRACT

The Technology boon to mankind or the next wave of Internet of things (IOT) & its development is growing incredibly with advancement in artificial intelligence(AI), new capabilities of sensing & auto-functioning, edge-computing process, accelerates towards the ability to maintain, develop & optimise. IOT is an emerging & revolutionary concept of social, technical & economic significance. IOT engages a broad set of ideologies that are interwined & at the same time complex enough from different perspectives. IOT-a technology embodied in a wide spectrum of networked sensors, products & system. With a combined advancement in interconnections of network, power computing & miniaturization of electronics to offer new opportunities that were previously not possible. Right from consumer goods & products, automobile industry, sensors & industrial & utility components to other various objects-all are combined with internet connectivity & powerful analytic data capabilities that promise to transform the way we dwell, play & work. The overview of this document is designed in a manner to help the Internet society community(ISC) navigate the dialogue surrounding the IOT in luminance of the predicting competition about its promise & perils.

KEYWORDS: *Digitalisation, IOT in Logistics, SCM.*

INTRODUCTION

IoT converges the representation of wide range of connectivity & computing trends that have been evolving for many decades. Meanwhile at present, a huge range of industry sectors including home & consumer electronics, logistics, healthcare, retail management, automotive, supply chain management, engineering aspect & way beyond are considered for incorporating IOT technologies into their services, products, operation & systems.

"Digitalisation"-a most effective & powerful medium for firms facing challenges due to additional flow of goods & insufficient information flow for timely decision. Digitalisation aims to form a new society of information & communication technologies that detects, gathers & proceeds to distribute data through world wide telecommunication networks . The internet-spread of global competition, consumers demand, volatility of market imposes many challenges to firms & their supply chains system to propose new approach of value creation. The phenomenon of IOT-led auto-functioning & digitalisation in logistics & supply chain has been in use for a while now. The demand & pressure in the areas of logistics is rapidly increasing resulting in IOT to become most important element in solving the issues of transport companies. Warehousing & management of inventories of a business are two of the essential parts of the corresponding logistics ecosystem . IOT sensors can be brought in use to monitor & track inventory & provides a full-fledge information that helps to predict future inventory needs. Inexpensive sensor will allow firms to carryout easy monitoring of condition & location of stock, track inventory & create a smart warehouse system. Therefore, IOT ensures safe storage of commodities, excludes loss & help us to find right product. On other hand, IOT is a booming technology & widely used to capture diverse traits & role in Supply Chain Management which includes inventory tracking, data sharing, collecting real time growth data from local vendors, quality monitoring logistic, exploring reverse logistics etc. to maximise revenue opportunities. The

study, therefore visions to experience challenges & explore opportunities of IOT acceptance & use in logistic & supply chain management for better work-performance.

METHODOLOGY

The modelling & implementation of IOT in logistics gives us a instant & impactful result. It provides a opportunity to monitor the position of real time assets, people & packaging throughout all value chain using IOT. It is to be considered as a source or tool to ensure the smooth going of operations & increment of profit gains.

Accordingly, the supply chain management & inventories storage are also influenced by this trend. IOT in supply chain management has relied on Grounded Theory to start the process of researching with an open mind. A ground theory gives researchers to manipulate an open mind to discover various new ideas & concepts influenced by emerging patterns. It centres on the collection & analysis of information to carry opportunities for future propositions. Ground Theory also helps researchers to decode the human perception of supply chain management & illustrate the meaning of current human experiences, discussions & code of conduct to enhance relationships that constitute strategies & follow up actions of a particular company.

PROPOSED WORK

There are several parameters while choosing an application for logistics & supply chain management such as:

- Level of accuracy.
- Infrastructure.
- Total cost.
- Tag cost.
- Battery life of tag.
- System security.

In supply chain management (SCM), IOT devices are an effective means to monitor & locate product & dispatchment using Global Positioning System i.e. GPS & other various technologies. We can also track the products storage condition which improvises the quality management during the conduct of supply chain.

While in logistics, IOT offers more information resulting in managing assembly of remote assets, forecasting of traffic congestion, ensure cargo handling. Internet of things collaborated with technology blockchain consists of finished visibility of manufacturing & packages.

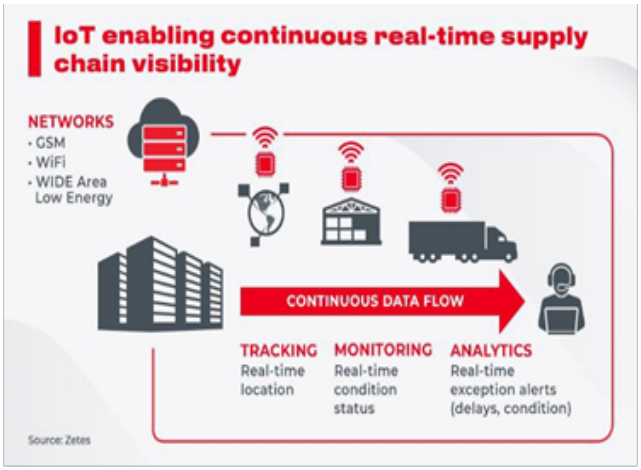

Fig 1. IoT in Supply Chain Management

APPLICATION OF IOT IN SUPPLY CHAIN (SCM)

Tracking the location of goods

Storage containers are attached with IOT devices or to raw products/materials themselves & device will send its location, which then be detected by GPS in order to locate motion of goods.

Monitoring & Judging of movement speed & arrival of Goods

Flow of products & speed movement monitoring enable us to predict movement of goods throughout SCM. Centres can prepare to receive collectables from retailers, distributors, manufacturers & suppliers, which minimizes the risk of handling & ensures efficient process of products.

Tracking of storage conditions for products/ materials

Certain goods like preservatives & staple foods need ideal storage condition. This makes quality monitoring easy & reduce spoilage. IOT devices can track atmosphere exposure, change in temperature, light intensity etc & trigger emergency alarm if breaching of threshold happens.

Assembling Problematic motion of goods

Locating goods & planning of route through IOT devices helps to detect & recognize upto when & where goods are procrastinated in transit. It allows the routes to speed up supply chain.

Monitoring of Goods storage

In a distribution centre, IOT devices remains connected with goods, which makes it easier to allocate products within a huge warehouse & assures accurate management of goods.

Quick administration of goods upon receipt

Checked & proceeded locating through IOT devices implies supply chain management can validate precisely arrival of goods. It boosts other tasks of administration such as pay-scale of supplier or dispatching requests.

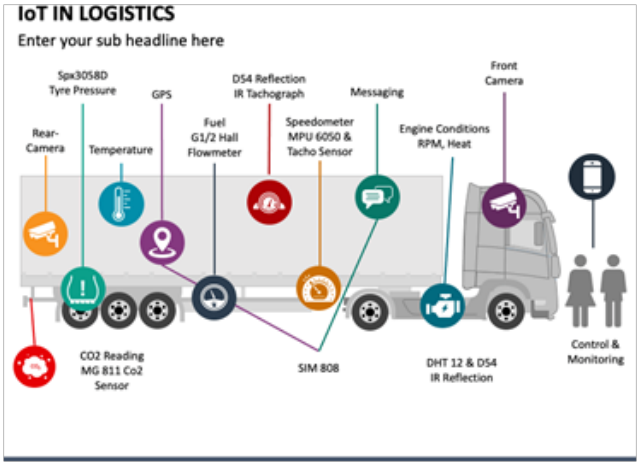

Fig 1. IoT in Logistics

APPLICATION OF IOT IN LOGISTICS:

Tracking of Route

This solution is quite popular. It helps a logistic manager to trace the location of their vehicles/trucks in real time. With the help of Geofencing or GPS, the path taken by the trucks is also traced from farther locations which helps the companies to allocate driver actions & assures timely delivery.

Stock allocation & Warehousing

This type of solution facilitates the storage & management of inventories. It also facilitates the building up of smart warehouses which helps a firm to avoid losses, assuring goods safety & tracking of items. It also helps revamping of operations of warehousing, which in turn reduces cost of labour & increases efficiency.

IOT for Digital Bill of Lading

Combining IOT with blockchain technology farms a digital Bill of Lading (BOL). BOL gives supply chain a new transparency, which enables a company to locate the transportation of shipped products. In this solution GPS trackers & sensors plays a vital role.

Delivery by using Drone based technology

Using Drones for delivering of products is a new technology adopted by firms. Implementation & application of drones in IOT assures execution of auto-functioning & instant goods delivery.

Prevention or Avoidance of Breakdown:

Applications of IOT not only helps us in tracking or management of assets, but also helps to identify barriers that cam breakdown assets. It helps firms to reduce downtime risks which results in timely delivery operations & execution. This enables companies to exercise decision- making process & provide inspection strategies.

Auto-Functioning Cars

This type of solution requires a blend of Artificial Intelligence(AI) &Machine Learning by connected infrastructures in IOT. Here, information responding to different shipment parameters are observed & proceeded to explore smart routes of driving & directions.

CONCLUSION

The worldwide connected logistics market is highly booming & additional to it, new technologies adopted by companies prove to be beneficial for managing supply chain management & system of distribution. Using IOT applications in logistics & supply chain management is emerging at an incredible rate. By using these solutions, it becomes easy for a firm/business to gather & process data to form valuable insights, which encourages the mobility as well as speed for conveying of goods. IOT in logistics & SCM creates new platforms & opportunities for existing real time aspects. IOT researchers are continuously working on different solutions of IOT to

expand the technology on commercial scale to benefit the mankind to the possible level.

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A Review on Cattle Transportation and Available Facility: A Special Emphasis on Indian Continent

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ABSTRACT

India is one of the major developing countries in the world. Agriculture plays a major contributor role in the development of India. Resource development against the contributing sectors is always carried out through their research. Cattle are used for various activities in daily life in Indian farming and cattle carriers. Indian society culture develops relational and emotional attachment with cattle. The aim of this article is to review research work carried out on cattle transportation also highlight different issues that occurred in Indian cattle transportation. This review highlights the research on cattle transport around the world and the Indian continent. Also this paper tries to find a need and the scope for technological development in cattle transport issue in India. From this review research, it can be concluded that after having governing laws in India, accidental life damage through cattle transportation was caused due to the non-availability of safe cattle transport facilities. The review study shows that transport cost, the quantity of transportation, breed development, diseases transferred, animal behaviour and stress development etc. considered as main objectives for research by researchers. Indian continental needs for cattle transportation differ from the developed countries like America, Europe, and Australia. New safe transportation facility development consider as one of the scope for new areas in research. Safe transport facility affects not only on the safe transportation of cattle but also on issues like road accidents, disease transfer, cattle life and behaviour.

KEYWORDS: *Cattle transportation, Resource facility development, Issues in cattle transportation.*

INTRODUCTION

Cattle transport is major issue in the rural side of India may because of the non availability of safe transport facility and peoples view towards the safety and animal life. In transport animals injuries, diseases transfer, accidents and death cases in India are very high. As per the governmental accidental reports and findings it shows that the major issue of safety during cattle transportation in Indian scenario is present.

INDIAN SCENARIO

Cattles death during transportation and on transport accidental issues is around 6 % [36]. Major reasons of accidents are due to non availability of separate facility for cattle transportation. The research problem is practically faced by users of society. Life of cattle's and accidental damage can be minimized by the outcomes we expected from the project.

Major accidental damage, injuries and death of cattle's are due to non availability of safe cattle transport facility. As per the current status less work was found on said issue of rural India. Need of cattle transportations in developed countries and developing countries like India are different [25].

The study on cattle transport in foreign countries is not that much beneficiary because of change in requirement of users in Indian continents.

After survey of main beneficiaries like farmers, veterinary support, milk producers and cattle transports it is observed that practical issues were found because of non availability of technical facility solution for cattle transportation in transport vehicle.

In cattle transportation main problem observes are,

- More Road Accidents during transportation
- Non proper handling of Cattles during transportation
- In transport Cattle safety issue
- Lack of Loading and unloading adjustment
- Lack of Transport Facility available in vehicles
- Carry much more than sanctioned numbers by transporter.
- Lack of transport rule awareness
- View towards the life of cattle's.

In India around 6180 accidents out off 4,80,652 are due to animal transport on road and during accident injured and killed percentage is up to 3% . In India around 11% animals injured and killed during the transport [36].

As per the reviewed literature it found that many of the research in international platform on quantity based transportation, improvement in vehicle facility, separate vehicle design, diseases transfer issues, breed improvement, milk and beef quality improvement.

The research not majorly fit for the Indian continental issues. Indian continental research is mostly towards breed improvement, preservation, deceases, handling but not on the technical facility solution towards the cattle transportation.

CATTLE TRANSPORTATION

An effect of transportation on cattles

Stress developed during cattle transportation by road and transport consideration during veterinary support for farm animals affect on life saving [25]. Transportation and handling affects on both physical and psychological stress development on cattle. Various remedial strategies like preconditioning, administration of vitamins, vaccines, feeding high-energy diets, and electrolyte therapy suggested decreasing cattle response to transportation stress [19].

Transportation and the occurrence of the bovine respiratory disease complex relational factors highlighted and suggested release from the bone marrow, a decrease in neutrophil margination by proper transportation [7]. Significant stress can be developed by road transport in cattle. During the transportation mainly thermal stress producing factors is more among the main stresses. Inside the temperature increment, as could be expected from theory, increased with reduced ventilation and increased animal density [48].

On transport cattle's reacting differently. Adapt transport schemes to the needs of the animals. Appropriate feeding regimes develop for long distance transportation. Loading and unloading stresses in staging posts (injuries, infectious diseases) [17]. The effect of the space between the withers and the compartment ceiling on freedom of movement affect on stress development in cattle's during transportation. Study based on biochemical, physical and behavioral measurements during commercial transports [28].

Study of accidents characteristics, the animals involved and injuries to humans from reports about livestock vehicle accidents in Spain highlighted with characteristics of livestock vehicle accidents vary according to species. Fatigue developed due to poorly designed route plans, intense workdays or high pressure levels from companies on transportation [11].

Interrelation between culture, social with political and religious factors that led to the phenomenon of the sacred cow, a restriction on slaughters and the advancement in the new designed gaushalas also on the animal's life consideration during transportation need of safety [23].

Table 1 shows the primary and secondary objective considerations by researchers. The researchers mostly concentrate on cost, health deceases and behavioral aspects. Transportation facility development and consideration, researchers mostly consider for large quantity base transportation. As a users difference the need of cattle transportation in India also differ.

Table 1. Primary and secondary objective consideration

SI No.	Primary and secondary Objectives	Reference
1	Cost of transportation	Schwartzkopf (2015) [39] Swanson (2018) [19] Earley (2017) [7] Hartung (2003) [17] Govindaraj (2021) [14] Bhatt (2021) [3]

		Rahman (2020) [35] Manisha (2020) [30] Singh (2020) [42] Kerekoppa (2020) [24] Gunjan (2020) [16]
2	Stress during transportation	Knowles (2000) [25] Wikner (2003) [48] Lambooij (2012) [28] Genaro (2019) [11]
3	Safety consideration	Govindaraj (2021) [14] Hartung (2003) [17] Ashenafi (2018) [2]
4	Road Transportation / accidents	Knowles (2000) [25] Wikner (2003) [49]
5	Health disease	Earley (2017) [7] Kennedy (2018) [23] Ashenafi (2018) [2] Shashi (2020) [40] Niranjan (2018) [50] Kumar (2021) [27] Choudhary (2020) [4] Giri (2020) [12] Bhatt (2021) [3] Rahman (2020) [35] Kerekoppa (2020) [24]
6	Quality consideration	Swanson (2018) [19] Wikner (2003) [48] Genaro (2019) [11] Bhatt (2021) [3] Singh (2020) [42]
7	Transport System Design	Hartung (2003) [17] Lambooij (2012) [28] LRTA Report (2017) [15] European Guide Report (2018) [5]
8	Quantity/ Utilization	Mpakama (2013) [51] Knowles (2000) [25] Kennedy (2018) [23] Bhatt (2021) [3]
9	Animals behaviour science	Swanson (2018) [19] Swanson (2001) [44] Earley (2017) [7] Wikner (2003) [49] Ashenafi (2018) [2] Mawani (2020) [32] Choudhary (2020) [4] Giri (2020) [12] Manisha (2020) [30]
10	Other Breed preservation, Beef, feed	Mpakama(2013) [51] Swanson (2001) [44] Earley (2017) [7] Genaro (2019) [11] Mawani (2020) [32] Choudhary (2020) [4] Singh(2020) [42] Jurhamid (2021)

Indian Continental cattle transport

Indian continental issues during cattle transportation problem and the need also get highlighted which impact on the transportation and breed species development [20] [10].Cattle transportation safety, economical issue, production of milk and decease transfer during transportation main concerns in Indian continents and the improvement in transport facility affect on issues. [39],[26],[34].

The feeding habitats impact on behavior of cattles and transportation also a consideration for improvement impact [30].Contagious decease infection are due to non proper handling of cattles during transportation impact more and effect on cattles life [27].

The transport of young calves from producer of cow calf to cattle carrier or seller is a general concern for the cattle market because of its negative documented impact on the cattle welfare, health and performance [33]. Proper management of cattles during the handling, transportation will result positively on milk production, breeding and health [42].

Figure 1 shows the graph on objective based literature reviews of 58 papers were most of work on cost of transportation, animal behaviour, health deceases are found. The transportation issues in consideration of Indian continents are not found addressed through researchers. This research proposal targeted same gap with said aims and objectives. In the graph horizontal axis represents the objective function and vertical axis number of researchers. The graphical plot for the primary and secondary objective consideration by the researchers is represented. Cost and animal behavior science has given more weight as a primarily objective and the transport facility design and safety has less.

Preliminary results of a compromised cattle benchmarking project has released by cattle transport

Alberta Farm Animal Care, the condition of animals arriving at auction markets, a federal meat plant and provincial abattoirs and were evaluated for a year.

Figure 1: Graph showing objective based literature review

Agriculture Canada researcher Karen Schwartzkopf-Genswein at Lethbridge Research Centre, studies the cattles behavior and fitment during the transportation to auction or slaughter[39]. Countries like Germany, Europe, Australia, Russia works on facility development as a quantity base, milk and beef quality improvement.

Figure 1 shows the objective based research graph. Which shows that the safe transport is area were much less work in Indian scenario on cattle transport issues was found. However, there are definite areas for improvement and scope to work on technical safe facility development for current users.

CONCLUSION

From this review research, it can be concluded that after having governing laws in India, accidental life damage through cattle transportation caused due to non availability of safe cattle transport facility. Review study shows that transport cost, quantity of transportation, breed development, deceases transferred, animal behavior and stress development etc. considered as main objectives for research by researchers. Indian continental needs for cattle transportation differ than the developed countries like America, Europe, and Australia. New safe transportation facility development consider as one of the scope for new area in research. Safe transport facility affects not only on safe transportation of cattle's but also on issues like road accident, decease transfer, cattle's life and behavior. Review shows that technological development of safe and chipper solution on cattle transportation with development of special adjustment like flexible adjusted cage in consideration of current transport vehicles of Indian continents will be a future scope for researchers. Design of special transport vehicle with safe loading and unloading adjustment is also a need observed by this review.

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A Review on Energy Conservation Techniques for Cold Storage System

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ABSTRACT

Cold storage system integrates a refrigeration system and maintained designed indoor conditions required to store product or products over specified period of time. Cold storage systems runs on both VARS & VCRS systems (1). High Power consumption is the major issue in case of Cold storage. So there is a need to employ certain techniques to reduce power consumption. Energy conservation potential depends upon system design, Methods of operation, certain techniques used to save energy. This paper discussed different techniques used to develop & design energy efficient cold storage system. Cold storage system integrated with solar system, Use of different phase change material (2) etc.

KEYWORDS: *Cold storage, Energy consumption, Solar energy, PCM.*

INTRODUCTION

India is one of major agricultural countries producing verities of fruits & vegetables depends on different climate conditions, type of soil. Every product has certain life period so most important task is to preserve the perishable commodities of food items for longer period without changing of the original flavour & taste. By refrigeration process heat is removed from products which are to be stored for long duration, results in slow down decay and natural metabolic processes within products. Cold store consumes large amount of electric energy every year. So there is a need to find out energy conservative techniques to minimize running cost of the system. Use of renewable energy sources for power generation are best technique to reduce running cost.

How Energy Conservation is possible by reducing the heat load for cold storage system

i. Orientation and building form:- As India stands closure to the equator with the tropic of cancer so heat enters from Eastern and Western direction. So E-W walls should have good shading. Surface to volume ratio should be less

ii. Design of Building :- If roof is exposed to sun then it will increase heat load so roof must be insulated by undertake insulation.

iii. Heat generated by electric appliances: - As Tube light adds heat, natural light should be used, Natural light should not be directly exposed from sun.

iv. Insulation: - Insulating panels to walls & ceiling supported from structure.

LITERATURE SURVEY

Yang et al.(3) studied the application of latent heat storage in a refrigerated warehouses integrated with latent heat cold storage system. Daily power consumption of refrigerated ware house measured

by experiment also temperature distribution and heat transfer characteristics in a refrigerated warehouse simulated and analyzed found out by technique that there was energy and cost saving.

Lin et al.(4) reviewed PCM integrated with solar energy running cold storage system. Identified performance of Air conditioning system using solar energy for power generation & PCM Material as energy storage. Author reviewed different types of air conditioning system running on solar power and compared system progress with simple systems.

Butala et al.(5) experimentally investigated total save in energy with PCM for cold storages, conducted experiment by using paraffin as a phase change material to supply cool air during night time concluded that proper PCM is most important for free cooling.

Bharj et al.(6) investigated Energy efficient solar cold storages with hybrid system as power generation source in remote areas. Author presented photovoltaic solar energy processing with application in the DC inverter technique used in hybrid cold storage air conditioning areas. Concluded that the combination of PVT system is the way to improve using of energy efficiency.

Manish Rathod (7) studied on phase change material and their applications reviewed thermal properties like stability for various groups of Phase Change Material for very less temperature applications and found from the result that most studied PCM were those whose melting point temperature was in the range of 40^{O} C – 60^{O}C and latent heat of fusion in the range 150 – 225 KJ/KG. After deep research, researchers found out that most of sodium hydrates had melting point neat 20^{O} to 30^{O}C.

Basu et al.(8) Designed & analysed Solar Photovoltaic power generation system to stock potatoes at 10^{O}C. The system was integrated with water lithium bromide absorption system. It was concluded that 165 modules of pm-150 in parallel with 50 number of FPC's power cold storage system successfully on yearly basis. Integrated power system had provided net energy annual surplus of 36MW hr over calendar year.

Sarbu et al.(9) studied different thermal energy storage techniques. The most important technologies were associated with sensible and latent heat storage systems.

The various methods of TES such as Underground thermal energy storage (UTES) which uses soil, sand, rocks etc for both heat and cold energy storage. Packed bed storage system (PBS) uses beds of loosely packed particulate materials as rocks, pebbles. To add or remove energy air was circulated over bed, Phase change material storage system PCM material absorbed or released latent heat converting from solid - liquid - gas vice versa. PCM material is used in cold storage plant having operating temperature range (7^{O}C to 15^{O}C).

The classification of PCM as –

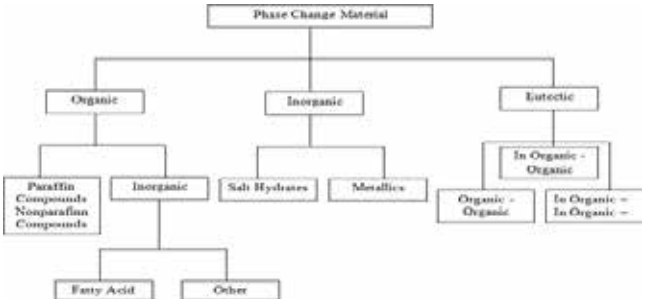

Fig 1. Classification of PCM

Properties of different PCMs

Table 1. Properties of PCM

PCM	Melting	Melting Enthalpy	Density (g/ m^3)
Ice	0	333	0.92
Na – acetate-	58	250	1.30
Paraffin	-5-120	150-240	0.77
Erytritol	118	340	1.30

By studying overall phase change material it is concluded that salt hydrates which has high temperature range was most preferred PCM for building applications.

Table 2. Types of PCM

PCM Type	Name	Melting tempera-ture (0C)	Latent Heat of Fusion (kJ/kg)	Company
Hydra-ted salts -eutectic PCM	Freezer salt Preser-vation	-16 4 7 7 10 15	330 105 135 300 170 175	TEAP PCM

Hydra-ted Salts	S15 S10 S10 S8 S7	15 13 10 8 7	160 160 155 150 150	
Organic	A15 A9 A8 A6 A4 A3 A2	15 9 8 6 4 3 2	130 140 150 150 200 200 200	Plus ICE PCM Products

Aniruddha et al.(10) designed and developed low cost based solar cold system for farmers which uses photovoltaic panels for power generation, PV panels was installed on roof of cold storage also to supply power during night time's battery bank and Local electricity was used. The proposed system was compared with conventional system and found that proposed system was cost effective based on yearly performance.

Yogesh et al.(11) Designed & developed cold storage having storing capacity of 10 Tons. To reduce running cost of cold storage system and to save energy HS01 PCM was used. PCM refrigerated truck chamber was designed so that effective use of PCM could be done.

Mishra et al.(12) Designed and developed solar operated cold storage which uses Solar Polycrystalline PV Panels, 2 ton Split AC, Batteries, Inverter, sensor etc. Cold room having storing temperature of 6.880 C and Relative Humidity 95 %, to store 10 tons of different variety of products. It was found that designed cost system was very effective as compared to same capacity of conventional cold storage system; total saving for formers for a year was calculated as $ 7449.

RESEARCH GAP

- As the Installation and Running cost of cold storage system is very high so it is not affordable to common farmers.
- If running cost of cold storage is reduced by using alternate methods of power generation then group of farmers combinable can store their products and can sell during peak period. Which ultimately increase in economic gain of farmers.

CONCLUSION

- To save energy in cold chain system most of the researchers used solar energy as a source of power generation which used both Polycrystalline and Môn crystalline panels. During night time or cloudy days power was supplied through battery backup, some of the researchers used different PCM for cooling effect.
- It is found that the system using Alternative source of energies for power generation & to run cold storage plant is the cost effective method as compared to conventional cold storage systems.

FUTURE SCOPE

- By applying other alternatives methods to use renewable energy such as Biogas, Biomass for power generation, we can reduce installation cost & running cost of cold storages. Which tends economic growth of farmers.

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Applications on Injection Molding Technique using Non-metals: Review

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ABSTRACT

The injection molding process is in progress for the last 10 decades. It is the molding process in which metal melts and by adding non-metals, polymers, and resins which are heated by external heating appliances and then injects into a mold to form the required product as the mold reaches environmental temperature. In injection molding, different types of materials are used to prepare products. As per the requirement and problems, many types of injection molding processes are developed. Injection molding is used in various fields, from daily purposes to the parts and equipment which are used in aerospace, automobile, industry, and farming fields. Injection molding is still facing many problems so reduce this need continuous research and development in injection molding. A review is done on Non-metals and problems faced while injection molding.

KEYWORDS: *Non-metals, Injection molding, Parameters of molding.*

INTRODUCTION

The injection molding process involves several important factors that must be carefully maintained to produce high-quality products. These parameters include injection pressure, injection speed, melt temperature, mold temperature, cooling time, and holding pressure and time. In addition, the design of the mold is crucial to ensure the proper filling and ejection of the product.

One of the advantages of injection molding is its high production efficiency. Once the mold is designed and the process parameters are optimized, the injection molding machine can produce a large number of identical parts in a relatively short amount of time. This makes injection molding an attractive option for mass production.

However, injection molding also has some disadvantages. The initial cost of designing and manufacturing a mold can be expensive, and the process may not be cost-effective for producing small quantities of parts. In addition, the process can generate significant amounts of waste material, and the disposal of this waste can be a challenge.

Overall, injection molding technology is an important and widely used method of industrial processing that offers numerous benefits for the production of plastic products. As technology continues to advance, it is likely that injection molding will become even more versatile and efficient in the future.

Injection molding machine:- The injection system is responsible for melting and injecting the raw material into the mold. It consists of the injection unit, which includes the barrel, the screw or plunger, and the nozzle. The barrel is heated to melt the raw material, while the screw or plunger conveys and compresses the molten material into the mold. The nozzle controls the flow of the molten material into the mold.

The mold clamping mechanism is responsible for holding the two halves of the mold together during the

injection process. It consists of the mold platen, which is fixed to the injection machine, and the movable mold platen, which is attached to the mold. The mold is opened and closed by a hydraulic cylinder, which is controlled by the hydraulic system.

The hydraulic system provides the power to operate the mold clamping mechanism and the injection system. It consists of a hydraulic pump, hydraulic valves, and hydraulic cylinders. The pump pressurizes the hydraulic fluid, which is then directed to the cylinders to control the movement of the mold and the injection unit.

The electrical control system is responsible for controlling the operation of the injection machine. It consists of a control panel, which includes a programmable logic controller (PLC), and other electrical components such as motors, sensors, and switches. The PLC controls the sequence of the injection process, including the temperature of the barrel and the mold, the injection speed, and the pressure.

The procedure of Injection molding

There are two types of injection molding technology: precision and conventional. Precision injection molding is better than conventional injection molding because it can control the process more accurately and produce products that are more consistent in size and quality. Researchers have studied factors like design, process, and materials to improve precision injection molding. Other researchers used simulation software for large-size products. They successfully predicted and corrected any problems with the mold design.

Fig.1. Types of Precision Molding

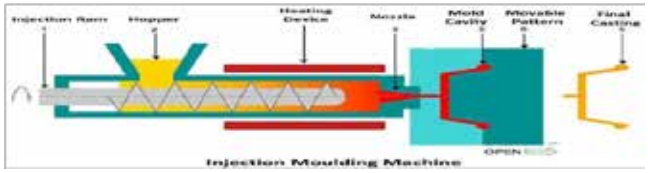

Fig.2. Procedure of Precision Molding

Multi-material injection molding is an advanced technique that allows the production of complex parts with multiple materials. This technique enables the combination of different materials and their unique properties to create a final product with superior performance characteristics. Injection compression molding is a key method used in multi-material injection molding. These advantages of multi-material injection molding ensure that the performance of the product is guaranteed, making it an ideal method for producing high- quality, complex parts with multiple materials.

Fig.3. High Precision Molding

Piston diameter	14 mm
Volume (injected)	9 cm^3
Injection Pressure	1340 Kg/cm^2
Clamping Force	6.250 Kg/cm^2 62.5 KN
Opening Force	4 KN
Opening Stroke	30 – 110 mm
Ejection Force	5 KN
Ejection Stroke	45 mm
Hydraulic Pressure	130 Kg
Oil Tank Capacity	16 L
Dry Cycle	2,4s
Power	2.9 KW
Weight	120 Kg

Fig.4. Technical Specification of Injection Molding

Second injection molding, also known as two-shot injection molding, is a process that involves injecting two different polymers in an order. These polymers are chemically and rheological compatible, and the resulting products offer special properties not found in traditional single resin injection molded products. The secondary injection molding technology is a promising method for reducing production costs and promoting ecological sustainability through the use of recyclable materials. Second injection molding technology has since evolved and is widely used in the production of a variety of products that require multiple materials with distinct properties. This technique has proven to be a reliable and efficient method for creating high-quality, multi-material products with unique performance characteristics.

Parameters:- Injection pressure, material temp, holding time, mold temperature. Conventional Injection molding machine:-

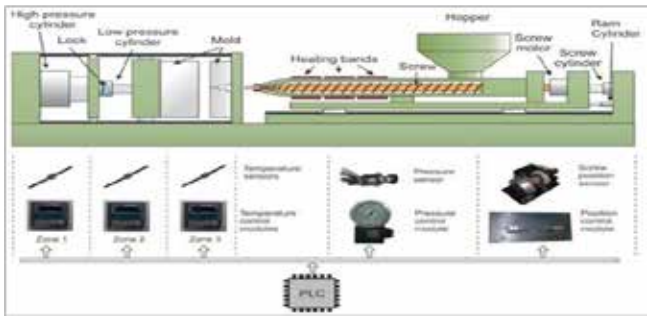

Fig.5. Procedure of Injection Molding

Fig.6. Industrial molding Machine

Conventional injection molding machines use a reciprocating screw to melt and inject the material into the mold. The basic parameters of a conventional injection molding machine are as follows:

Clamping Force: This is the force applied to the mold to keep it closed during the injection process. The clamping force is determined by the size and shape of the mold, the material being used, and the required part strength.

Injection Pressure: This is the pressure at which the molten material is injected into the mold. The injection pressure is determined by the material being used, the part geometry, and the desired part strength.

Injection Speed: This is the speed at which the molten material is injected into the mold. The injection speed is determined by the material being used, the part geometry, and the desired part strength.

Injection Time: This is the amount of time it takes for the material to be injected into the mold. The injection time is determined by the material being used, the part geometry, and the desired part strength.

Cooling Time: This is the amount of time the part spends in the mold to cool and solidify. The cooling time is determined by the material being used, the part geometry, and the desired part strength.

The working of a conventional injection molding machine is as follows:

Material Preparation: The material is first prepared by heating it to its melting point and then loading it into the machine's hopper.

Injection: The material is then fed into the injection unit of the machine, where it is melted by a reciprocating screw and injected into the mold under high pressure.

Cooling: Once the material has been injected into the mold, it is allowed to cool and solidify in the mold cavity.

Ejection: After the part has cooled and solidified, the mold is opened, and the part is ejected from the mold.

Repeat: The process is then repeated to produce additional parts.

Traditional injection molding machines are typically made up of several main components, including a hopper, a heating cylinder, a screw or plunger, a mold, and a clamping mechanism. The hopper holds the plastic pellets or granules, which are fed into the heating cylinder. Inside the cylinder, the plastic is heated to a temperature that allows it to melt and become fluid.

The screw or plunger is then used to move the molten plastic from the heating cylinder into the mold cavity. The mold is typically made of two halves, which are joined together by the clamping mechanism. Once the plastic is injected into the mold cavity, it cools and solidifies to form the desired shape.

Here are some important parameters that are commonly used in traditional injection molding machines:

Injection Pressure: This is the pressure used to inject the molten plastic into the mold cavity. It is typically measured in PSI.

Injection Speed: This is the speed at which the plastic is injected into the mold cavity. It is typically measured in millimeters per second (mm/s).

Clamping Force: This is the force required to hold the two halves of the mold together during the injection molding process. It is typically measured in tons or kilonewtons (kN).

Cooling Time: This is the amount of time required for the plastic to cool and solidify inside the mold cavity. It is typically measured in seconds.

Cycle Time: This is the total amount of time required to complete one injection molding cycle, It is typically measured in seconds.

Fig.7. Industrial View of Molding

LITERATURE REVIEW

The runner pressure and cavity pressure within an injection mold are related to each other as they are part of the same system. The runner pressure is the pressure in the channel that leads melted plastic from the injection molding machine to the mold cavity. The cavity pressure is the pressure inside the mold cavity where the plastic is being molded into the desired shape. The runner pressure influences the cavity pressure, and the cavity pressure affects the filling and packing of the melted plastic. The pressure difference between the runner and cavity is also important for controlling the flow of melted plastic and ensuring consistent filling and solidification. A proper correlation between runner and cavity pressure is crucial for ensuring high-quality, consistent, and efficient injection molding.(1)

The paper focuses on the runner pressure and cavity pressure within an injection mold are related to each other as they are part of the same system. The runner pressure is the pressure in the channel that leads melted plastic from the injection molding machine to the mold cavity. The cavity pressure is the pressure inside the mold cavity where the plastic is being molded into the desired shape. The runner pressure influences the cavity pressure, and the cavity pressure affects the filling and packing of the melted plastic. The pressure difference between the runner and cavity is also important for controlling the flow of melted plastic and ensuring consistent filling and solidification. A proper correlation between runner and cavity pressure is crucial for ensuring high-quality, consistent, and efficient injection molding. (2)

Response surface methodology is a statistical approach used to model the relationship between process parameters and the output response of a process. In this study, RSM is used to determine the injection molding process window for lens form accuracy. The process parameters are varied and the resulting lens form accuracy is measured. This information is used to construct a mathematical model that can predict the form accuracy of lenses as a function of the process parameters. The RSM model is then used to identify the optimal process window that maximizes lens form accuracy.(3)

This article focuses on the use of artificial neural networks (ANNs) to predict fiber orientation in long fiber compression molded composite materials. The goal of the study is to develop a model that can accurately predict fiber orientation based on the processing conditions of compression molding, such as temperature, pressure, and time. They use response surface methodology and ANNs to build the model, which is then validated using experimental data. The results of the study show that ANNs can effectively predict fiber orientation in long fiber compression molded composite materials and can be useful in optimizing the compression molding process.(4)

The study of the phenomenon of birefringence in polymers when subjected to the injection-compression molding process. Birefringence occurs when the refractive index of a material varies in different directions and causes polarized light to split into two different rays. The study aims to understand the effects of injection-compression molding parameters on the birefringence of amorphous polymers. This study involves both simulation and experimentation to validate the results.(5)

The study focuses on modeling and evaluating the filling stage of the injection/compression molding

process. The aim is to understand and analyze the flow of polymer melt in the mold cavity and how it affects the final part quality. The filling stage is a crucial step in the injection molding process and has a significant impact on the part quality and dimensional accuracy. A numerical simulation approach using computer-aided design and engineering software can help in predicting the flow behavior of polymer melt during the filling stage and in optimizing the process parameters for a better quality of the molded part.(6)

This paper focuses on the ductility and tensile properties of blends of low-density polypropylene and polyethylene. The results show that the blends exhibit a range of properties that depend on the composition and processing condition, with some blends showing improved ductility and tensile strength compared to the individual polymers. The blends may be useful in applications such as blown film, injection molding, and extrusion.(7)

In this paper, research is done on the feasibility of a sequential injection process for metal co-injection process parameters, including the holding time, melt temperature, and injection speed on the quality and properties of the molded parts are evaluated. The results suggest that the sequential injection process can effectively produce metal co-injection molded parts with improved quality and mechanical properties. (8)

In this article the development of a numerical mold to simulate and study highlights the importance of understanding the bonding mechanism and optimizing the process parameters to improve the bonding strength in over-molded hybrid parts. (9)

The article describes the investigation of birefringence in polycarbonate plastic induced by cooling stresses. The process used is a variety of techniques including optical microscopy, polymer, and X-ray diffraction to study the molecular orientation of polycarbonate samples that were quenched at different cooling rates. They found that birefringence was highest in samples that were quenched rapidly and that molecular orientation was related to the direction of cooling stresses.(10)

This paper uses both experimental and computational techniques to study the formation and relaxation of residual stresses in polystyrene (PS) and poly(methyl methacrylate) (PMMA) during injection molding. They compare their simulation results with experimental data obtained by birefringence measurements, which allows them to validate their simulation models and gain a better understanding of the underlying mechanisms involved in the formation of residual stresses. They then present their methods and results in a logical and concise manner, with detailed explanations of the simulation models used and the parameters involved in their calculations. The results presented in the paper are significant and contribute to a better understanding of the mechanisms involved in the formation and relaxation of residual stresses in amorphous polymers during injection molding. (11)

The research paper by Pantani et al. investigates the effect of packing pressure on the morphology evolution of a polypropylene (PP) polymer during injection molding. They use scanning electron microscopy (SEM) to analyze the changes in the morphology of the molded samples at different packing pressures. The authors also use rheological measurements to determine the viscosity of the PP during molding. (12)

This research paper focuses on the impact of binders on the viscosity of low-pressure powder injection molded Inconel 718 superalloy. The goal of the study is to understand how different binders affect the Inconel 718 powder mixture during the injection molding process. The research evaluates the performance of different binders in terms of their effect on viscosity and the results show that the choice of the binder has a significant impact on the viscosity of the incocel 718. (13)

In this paper, the effect of packing pressure on refractive index variation in injection molding of precision plastic optical lenses can vary depending on the specific parameters used in the molding process. In general, however, higher packing pressures may lead to greater variations in refractive index. This is because the higher packing pressure tends to produce a more uniform polymer melt, resulting in a more uniform refractive index.(15)

The study investigated the effect of different injection molding types on the birefringence distribution in polycarbonate discs. The injection molding types tested were conventional, shear controlled, and packing-

controlled. The results showed that the birefringence distribution was significantly different for each molding type with the shear-controlled and packing-controlled moldings exhibiting reduced birefringence compared to the conventional molding.(14)

The research paper by Ulsoy et al. validates their simulation results by comparing them to experimental measurements of the mold-filling process. The paper is well-written and structured, with a clear introduction that motivates the study and outlines the research questions the authors seek to answer. The authors provide a thorough explanation of their simulation methodology and the assumptions made in their mathematical model. (15)

The research paper by Su et al. presents a study of the use of variotherm systems in microinjection molding, which is a process for fabricating micro-sized parts with high precision. The authors investigate the effects of different heating and cooling strategies on the microstructure and properties of the molded parts. They use a variotherm system, which allows the mold to be heated and cooled at different rates in different regions, to optimize the molding process and improve the quality of the parts. The paper is well-written and structured, with a clear introduction that provides an overview of the importance of microinjection molding and the challenges associated with it. The authors provide a thorough explanation of the variotherm system and how it can be used to control the temperature of the mold during the molding process. They also present their results in a clear and concise manner, with detailed explanations of the effects of different temperature profiles on the microstructure and properties of the molded parts.(16)

The research paper by Zhao et al. investigates the effect of vacuum venting on mold surface temperature during micro-injection molding. The study aims to determine the optimal vacuum venting conditions for micro injection molding and to understand the underlying heat transfer mechanisms that occur during the process. The authors conducted a series of experiments using a micro injection molding machine and a polypropylene (PP) material to create micro-sized parts. The experiments were conducted with varying levels of vacuum venting, and the temperature of the mold surface was measured and analyzed using infrared thermography. The paper is well-organized and presents the experimental procedure and results in a clear and concise manner. The authors provide a comprehensive explanation of the vacuum venting process and how it affects the mold surface temperature during micro- injection molding. They also provide a detailed discussion of the underlying heat transfer mechanisms that occur during the process. (17)

The research paper represents a method for measuring the fiber orientation in the part using imaging techniques. They have also developed a method for quantifying the fiber orientation distribution using an image analysis algorithm. This information is crucial in understanding the mechanical properties of the part as the orientation of the stiffness of the material. The method is effective in measuring fiber orientation distribution and this provides a valuable tool for quality control and optimization of the production process. (18)

The paper investigates the fabrication and properties of composite foams made from polypropylene (PP) and fibrillary polytetrafluoroethylene (PTFE) using foam injection molding. The authors present their findings on the effects of PTFE content and foam cell size on the mechanical and thermal properties of the resulting composite foams. Overall, this research paper presents a valuable contribution to the field of composite foam materials and provides useful insights for the development of lightweight and strong materials for various industrial applications. The findings are well-supported by the experimental data, and the conclusions are well-justified. However, it should be noted that further research is needed to fully understand the long-term durability and environmental impact of these composite foams. (19)

The paper investigates the accuracy and reliability of micro-injection molding process simulations by comparing simulation results with experimental data obtained from high- precision measurements. The authors present their findings on the effects of various processing parameters on the flow behavior, filling pattern, and part quality of micro- injection molded parts. This research paper presents a valuable contribution to the field of micro injection molding and provides useful insights for the development of high-precision manufacturing processes for microscale components.

The findings are well-supported by the experimental data, and the conclusions are well-justified. However, it should be noted that further research is needed to fully understand the complex interactions between the various processing parameters and their effects on the final part quality. (20)

The paper presents a detailed investigation of the dielectric properties of aeronautical composite matrix resins using terahertz spectroscopy. The authors explore the effects of different chemical structures and compositions on the dielectric properties of the resins, and discuss the implications for the development of high-performance composite materials for aerospace applications. The paper also presents a thorough discussion of the potential applications of terahertz spectroscopy in the field of composite materials, such as in the optimization of resin formulations and the detection of defects and anomalies in composite structures. The authors suggest some future research directions for the development of terahertz spectroscopy as a tool for the characterization and quality control of composite materials.(21)

The paper presents an optimization study on the wear behavior of AA6061/Al2O3/SiC metal matrix composites fabricated using the squeeze casting technique. The authors investigate the effects of various process parameters such as applied pressure, pouring temperature, and stirring time on the wear behavior of the composite material, and use statistical analysis to optimize the process parameters for maximum wear resistance. Paper presents a valuable contribution to the field of metal matrix composites, and provides useful insights for the development of high-performance materials for various engineering applications. The findings are well-supported by the experimental data and the statistical analysis, and the conclusions are well-justified. However, it should be noted that further research is needed to evaluate the impact of other factors such as particle size and particle volume fraction on the wear behavior of AA6061/Al2O3/SiC metal matrix composites. (22)

CONCLUSION

The advancement in injection molding technology will likely lead to the development of new and improved injection molding equipment, materials, and processing techniques. For instance, advancements in materials science and engineering will likely lead to the development of new types of polymers that are more durable, lightweight, and environmentally friendly. Additionally, the use of artificial intelligence and machine learning in injection molding equipment can optimize the process parameters for each individual part, leading to better quality products and faster cycle times. Furthermore, the acceptance of Industry 4.0, can lead to better monitoring and control of the injection molding process, leading to increased efficiency and reduced waste. Overall, the future of injection molding technology looks promising, with continued research and development efforts focused on improving the process and expanding its capabilities to meet the demands of various industries.

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To Evaluate the Impact of CuO Additives in Argemone Mexicana Biofuel to Reduce the Harmful Emission of Diesel Fuel on 4-Strokes Diesel Engine

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ABSTRACT

Natural resources contained in the crust of the planet are regarded as non-renewable and are only present in small amounts. This study intends to assess the feasibility of producing biodiesel from Argemone Mexicana seed oil with CuO 4ppm as a nano additive in the biofuel. The addition of the nano particle is done with the help of magnetic stirrer instrument. The role of additive is to increase the turbulence inside the engine cylinder. The testing of the biofuel is done on single cyl 4S DE on a computerised attached engine. The fuel used for the testing of performance and emission characteristics is blended as B00, B08, B16, B24, B30 and B36. The blends are tested and the result shows that the BP and IP of all the blends is greater than the neat diesel fuel. The important characteristics of performance BSFC is minimum or nearly same as like diesel fuel. The different parameter that is measured is vibration of engine cylinder showing less vibrations than the diesel for Mexicana blends. The emission properties like CO, NOx, soot particles have less emissions than the pure diesel blend. This Mexicana fuel with B24 blending can surely replace the diesel fuel is its land area and production increases in future.

KEYWORDS: *Biodiesel production; Transesterification process; Argemone mexicana; CuO Nanoparticle. Vibration*

INTRODUCTION

The In India, where energy demands are high and the population is dense, natural fuels are limited and researchers have been searching for alternative sources for more than 50 years. The demand for energy in India has led to a continuous increase in hydrocarbon consumption, prompting investigators to search for unconventional causes of energy, including non-edible vegetable oils [1] Researchers have been exploring unconventional causes of energy for decades due to the limited availability of natural fuels and the need to rise the quality of biodiesel. Vegetable oils have been investigated as a cause of energy, but their properties, such as high viscosity and poor low-temperature pour ability, have caused challenges. For scientists in this subject, the transesterification process, which involves the conversion of vegetable oils into Fatty acid methyl ester (FAME) or biodiesel, has been a prominent topic of research. [2][3]

Argemone Mexicana is a plant that produces oil, which can be used to produce biodiesel. The oil is extracted from the seeds of the plant and undergoes a process called transesterification to convert it into biodiesel. The production process for biodiesel from Argemone

Mexicana oil involves several steps including seed preparation, oil extraction, and transesterification. The seeds are first cleaned and dried, and then the oil is extracted using a mechanical press or solvent extraction method.[4]

The extracted oil is next transesterified, which involves reacting the oil with an alcohol, usually methanol or ethanol, while a catalyst, such as sodium hydroxide or potassium hydroxide, is present. As a result, biodiesel and glycerin are produced as byproducts. With some changes, the resulting biodiesel can be used as a fuel in diesel engines and has been demonstrated to have qualities similar to petroleum diesel fuel. More investigater is needed, however, to define the economic feasibility and scalability of employing Argemone Mexicana oil as a biodiesel feedstock. [5]

Non-renewable natural resources are available in limited amounts within the earth's crust. study intends to examine if producing biodiesel from Argemone Mexicana seed oil is feasible using crystalline manganese carbonate as a highly effective catalyst[4]. In this study, pure, crystalline, ash-colored manganese carbonate is used for the first time as a heterogeneous catalyst to produce methyl esters from Argemone Mexicana seed oil as a fuel. To produce biodiesel with a 99,99% purity, the transesterification process needs a 1% manganese carbonate catalyst and a 4:1 alcohol to oil ratio at 60 OC. Gas chromatography analysis was used to monitor the methyl esters produced. Additionally, the study will examine the impact of adding Cu nanoparticles to different blends of Argemone Mexicana biodiesel, ranging from 8% to 36%, and compare the emission and performance characteristics to those of pure diesel at various loads and constant speed.[6]

BIODIESEL PREPARATION

Argemone Mexicana, also known as prickly poppy, is a plant that has been studied for its potential to produce biodiesel. The production process for biodiesel from Argemone Mexicana involves the following steps:

- Collection and preparation of the plant material: The plant is harvested, and the seeds are separated from the rest of the plant material. The seeds are then cleaned and dried.

Figure 1. Mexicana Plant

Figure 2. Mexicana Seeds

- Oil extraction: The extracted oil is then put through transesterification, a process that turns it into biodiesel and glycerin by reacting with an alcohol (often methanol) and a catalyst (such as sodium hydroxide or potassium hydroxide).[1]
- Transesterification: The extracted oil is then treated with an alcohol (typically methanol) and a catalyst (such as sodium hydroxide or potassium hydroxide) to make biodiesel and glycerin. The reaction takes many hours to complete at a temperature of roughly 60-70°C. [4] [7][8]
- Separation and purification: After allowing the biodiesel and glycerin combination to settle, a centrifuge is used to separate the glycerin from the biodiesel. The residual contaminants are subsequently removed by washing the biodiesel with water.[9]
- Drying: The biodiesel is then dried to remove any residual water, and the quality of the biodiesel is tested to ensure that it meets the necessary specifications for use as a fuel.

Figure 3.Various Blends [B00 to B36]

Overall, the production process for biodiesel from Argemone Mexicana is similar to the process used for other vegetable oils, with the main difference being in the characteristics of the oil itself. The use of Argemone Mexicana for biodiesel manufacture is still in the experimental stage, and more research is needed to determine its potential as a viable source of renewable fuel.

ENGINE SETUP

CRDI (Common Rail Direct Injection) and VCR (Variable Compression Ratio) engines are two different types of diesel engines commonly used in automotive applications.[10] Testing Argemone Mexicana biodiesel on these engines would involve conducting experiments to determine the fuel's properties and performance on the engine. To test the Argemone Mexicana biodiesel on a CRDI or VCR engine setup, the following steps can be taken:

- Fuel preparation: The Argemone Mexicana oil would need to be extracted and processed into biodiesel. This can be accomplished by the transesterification process, which involves combining the oil with a catalyst like sodium hydroxide and an alcohol like methanol to create biodiesel and glycerin.
- Fuel characterization: The biodiesel produced from Argemone Mexicana would need to be characterized to determine its properties, such as viscosity, flash point, CN, and density. These properties can be measured using standard testing methods.

Table 1. Properties of Blends

Sr.	Test description	Ref. Std. ASTD 6751	Reference		diesel	Mexicana Blends				
			Unit	Limit	B00%	B8%	B16%	B24%	B30%	B36%
1	Density	D1448	gm/cc	0.800-	0.830	0.831	0.833	0.835	0.836	0.839
2	Calorific	D6751	MJ/kg	34-45	42.50	42.46	42.41	42.30	42.21	42.18

- Engine setup: A CRDI or VCR engine setup would need to be prepared for the tests. This would involve installing the engine on a test bed and connecting it to various sensors to measure Various aspects of an engine's performance, including torque, power, fuel use, emissions, and exhaust gas temperature.. [10] [2]

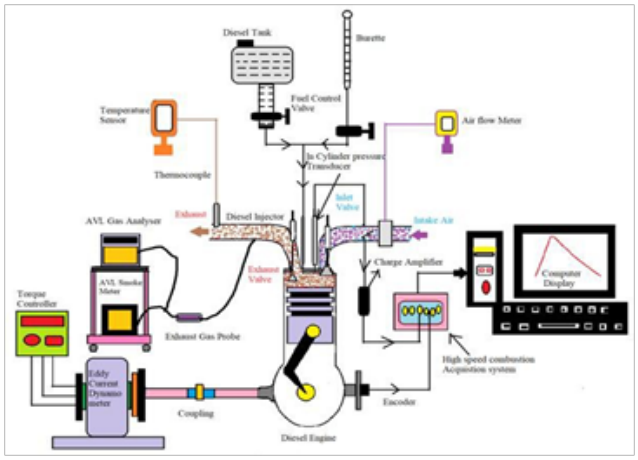

Figure 4. Experimental Setup Diagram

- Testing: The Argemone Mexicana biodiesel would be tested on the engine at various speeds and loads. The engine's performance would be monitored, and the data would be recorded and analysed to determine the appropriateness of the fuel.
- Data analysis: The data acquired during the testing will be analysed to assess the performance of the gasoline in terms of power output, fuel efficiency, pollutants, and engine wear. This would aid in establishing whether the fuel was suitable for use in CRDI or VCR engines.

Overall, determining the characteristics and performance of Argemone Mexicana biodiesel on a CRDI or VCR engine setup would include a series of trials. These tests would give important information about the viability of employing Argemone Mexicana biodiesel as a sustainable alternative to fossil fuels.[11][12]

The following parameters are commonly evaluated during the testing of biodiesel:

- Power output: The output power of engine would be measured during the tests to determine the fuel's ability to produce power. If the power output of engine is similar or better than that of conventional diesel, it can be considered a good sign.

- Fuel efficiency: The fuel depletion rate of the engine would be measured through the tests to determine the fuel's efficiency. If the fuel consumption rate is similar or better than that of conventional diesel, it can be considered a good sign.[13]
- Emissions: The emissions from the engine, including particulate matter, carbon monoxide, HC, and nitrogen oxides, would be measured during the tests to determine the fuel's impact on the environment. If the emissions are lower than those of conventional diesel, it can be considered a good sign.[14][15]
- Engine wear: The engine's wear would be evaluated after the tests to determine if the fuel had any adverse effects on the engine's components. If the engine wear is similar or less than that of conventional diesel, it can be considered a good sign.

Based on the above parameters, the testing of Argemone Mexicana biodiesel on a CRDI VCR engine setup would provide results indicating the fuel's suitability for use as an alternative to fossil fuels. However, the specific results may vary depending on the test conditions and the quality of the biodiesel.

EXPERIMENTAL RESULTS

One investigation into the potential of Argemone mexicana oil for biodiesel synthesis was published in the journal Fuel in 2017.[10] The oil was extracted from the seeds of Argemone mexicana by the researchers using a solvent extraction procedure.which they further transesterified to make biodiesel. The research discovered that the biodiesel made from Argemone mexicana oil has qualities that complied with the requirements for biodiesel given by The European Standard (EN) and the American Society for Testing and Materials (ASTM) are two of the most widely used standards in the world.The biodiesel had a high cetane number, low sulfur content, and low viscosity, which are all desirable properties for biodiesel. However, the study also found that the yield of biodiesel from Argemone mexicana oil was relatively low compared to other vegetable oils commonly used for biodiesel production. The researchers suggested that further optimization of the process of transesterification could improve The biodiesel yield from Argemone mexicana oil. Overall, while the experimental results of using Argemone mexicana for biodiesel production are promising, further research is needed to fully explore its potential as a biodiesel feedstock.

Break Power

Break power is the amount of power required to bring a vehicle or a machine to a complete stop from its maximum speed. It is a measure of the braking system's ability to stop the vehicle or machine under maximum operating conditions. In simpler terms, it's the power needed to stop something quickly and safely. Fig. shows demonstrates how the BP (KW) for mixes B00, B08, B16, B24, B30, and B36 varies with load at CR16 and 18. It has been noted that the brake power for CR16 and 18 for blends B08, B24, and B30 is almost identical to natural diesel.[16]

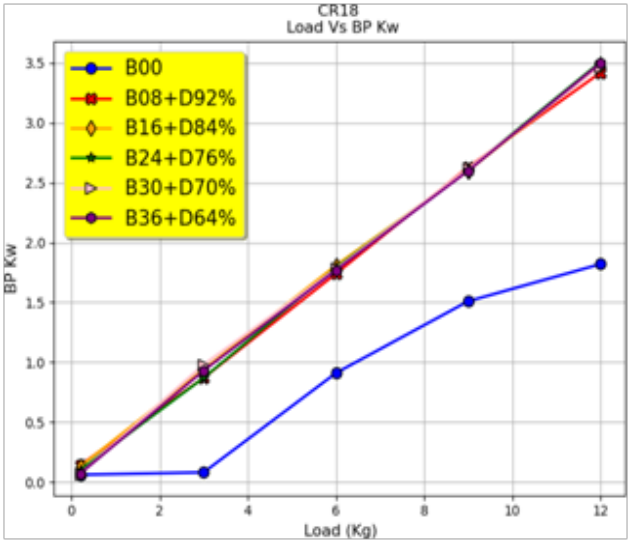

Figure 5: Load VS Break Power

Friction Power

Friction power is the power that is lost due to the frictional forces between two surfaces in contact that are in relative motion. It is the energy that is converted into heat as a result of the resistance that one surface applies to the other. In simpler terms, it's the power that is consumed by friction when two objects rub against each other, and this power is usually lost in the form of heat. B30, B36, B24, and B16 all have a same IP. Further blending B24 towards pure diesel.

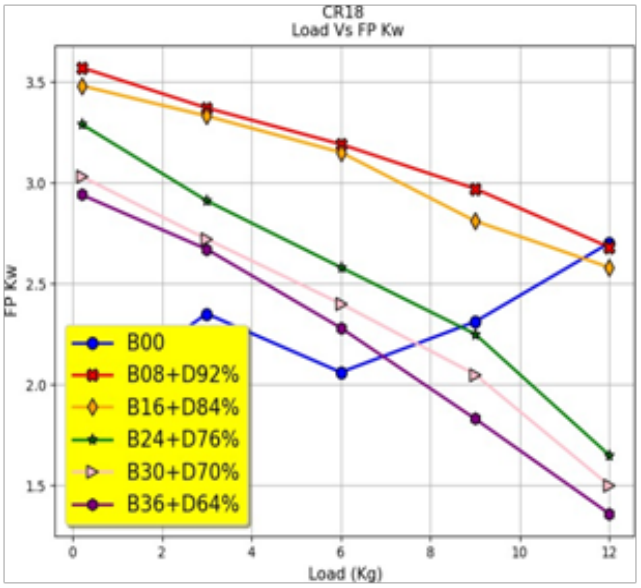

Figure 6: Load VS Friction Power

Indicated Power

Indicated power is the power developed by an engine cylinder from the combustion of fuel. It is a measure of the power produced inside the engine cylinder by the combustion process. In simpler terms, it's the power output of an engine measured by the pressure generated during the combustion process inside the engine cylinder B30, B36, B24, and B16 all have a same IP. Further blending B08 towards pure diesel.

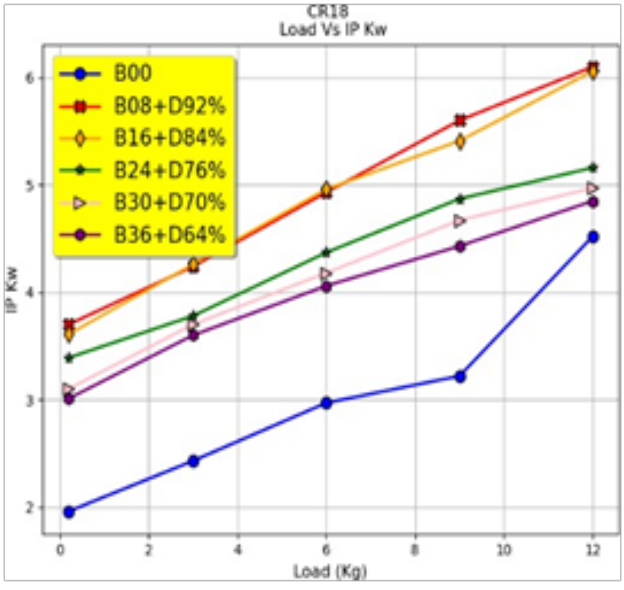

Figure 7: Load VS Indicated Power

Mechanical efficiency

Mechanical efficiency is when expressed as a percentage, mechanical efficiency is the ratio of a machine's output power to its input power. It is a measure of how effectively a machine converts the input power into useful output power, taking into account losses due to friction, heat, and other inefficiencies in the system. The following graphs show that the mechanical efficiency of each blend is the same up to a weight of 6 kg, but as the load grows beyond that, there is a noticeable decline in the mechanical efficiency of blends B16, B24, and B30, although blend B08 is substantially closer to pure diesel in terms of efficiency.

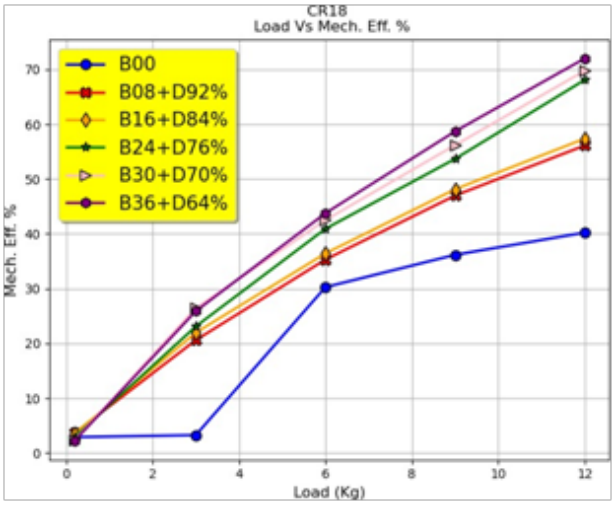

Figure 8: Load VS Mechanical Efficiency

Brake specific fuel consumption (BSFC)

Brake specific fuel consumption (BSFC) is the amount of fuel an engine uses for each unit of power it produces is known as brake specific fuel consumption, or BSFC. Typically, it is expressed in terms of the mass of fuel used per unit of energy produced, such as blends of fuel per kilowatt- hour (g/kWh). BSFC is a gauge of how effectively an engine turns fuel into power. Higher efficiency is directed by a lower BSFC. Implying that the same amount of power is being produced by the engine with less fuel. When compared to pure diesel, it can be seen that BSFC for blends like B08, B16, B20, and B30 is lower, but as load increases, specific fuel consumption for all blends becomes nearly identical. Additionally, blend B24 uses less fuel than pure diesel, as can be seen.

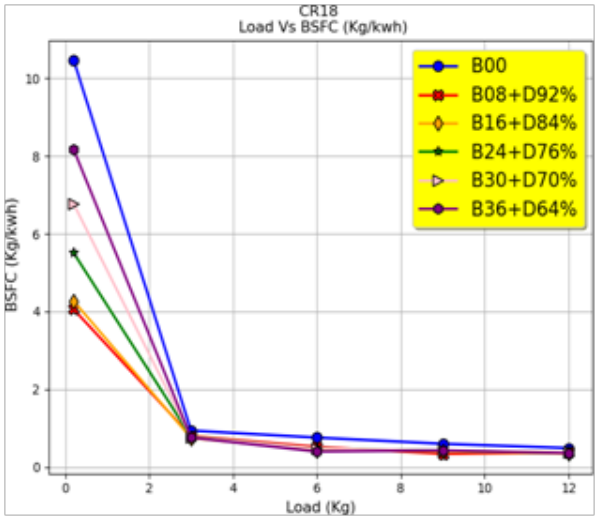

Figure 9: Load VS BSFC

Brake thermal efficiency (BTE)

Brake thermal efficiency (BTE) is a measure of an engine's ability to transfer the energy in its fuel into useful mechanical energy is called BTE. It is the ratio, stated as a percentage, between the engine's output power and the energy released during fuel combustion, expressed as a percentage. A higher BTE means that more of the energy released by burning fuel is converted into useful mechanical work. Above figure show for CR 16 and 18, the aforementioned figure depicts the fluctuation of brake thermal efficiency vs. load. It has been found that as CR increases, brake thermal efficiency grows as well. B08 shows higher BTE than pure CI for CR 16 and CR 18 mixes.

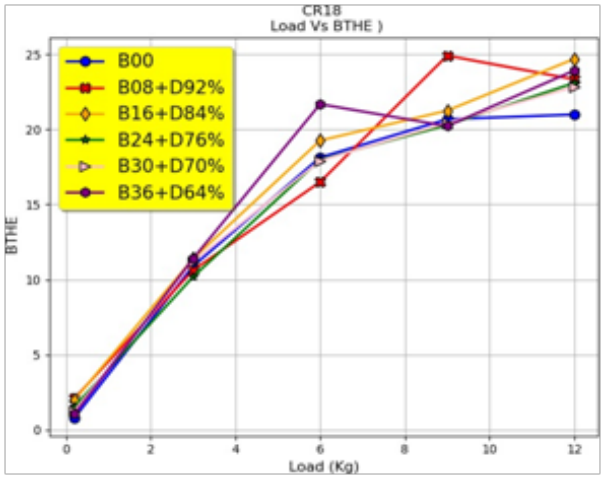

Figure 10: Load VS Break thermal Eff.

Vibration

Vibration refers to a system of items moving repeatedly or oscillatory around a fixed point is said to as vibrating. There are many different types of vibrations, including mechanical, electromagnetic, and acoustic ones, and they can be caused by external forces or internal sources, such as unbalanced or misaligned components. Vibration can have both positive and negative effects. Compression ratio increases say CR16 and CR18 with increasing load all the other blends produce less vibrations than that of pure diesel. B30 being the best blend so far.[17]

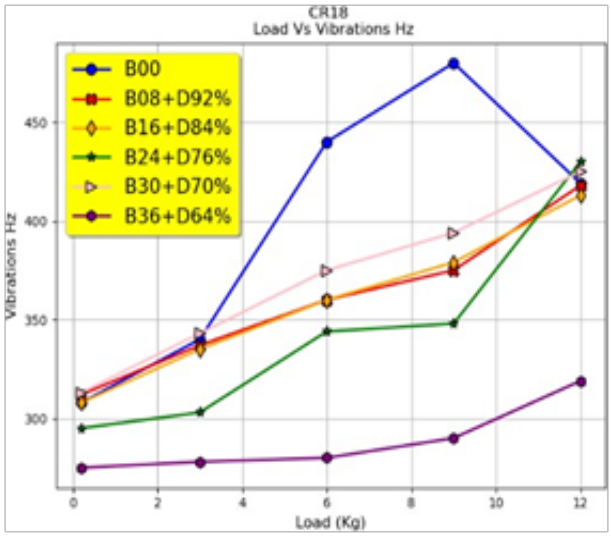

Figure 11: Load VS Vibrations

Carbon monoxide (CO)

Carbon monoxide (CO) is fatal gas called carbon monoxide (CO) is released into the atmosphere when fossil fuels or other organic materials are burned partially. CO is a colorless and odorless gas that can be harmful to humans and animals when inhaled in large quantities, as it binds to the hemoglobin in blood and reduces the amount of oxygen that can be transported to vital organs. CO emissions can be caused by various causes, such as car engines, authority plants, manufacturing processes, and even residential causes like gas stoves or heaters It displays the CO (% volume) Vs load variation for the blends BOO, B08, B16, B20, B24, and B30 at CR16 and 18. When compared to pure diesel, it has been found that as load increases, CO emissions for the blends B08, B16, and B30 are reduced.

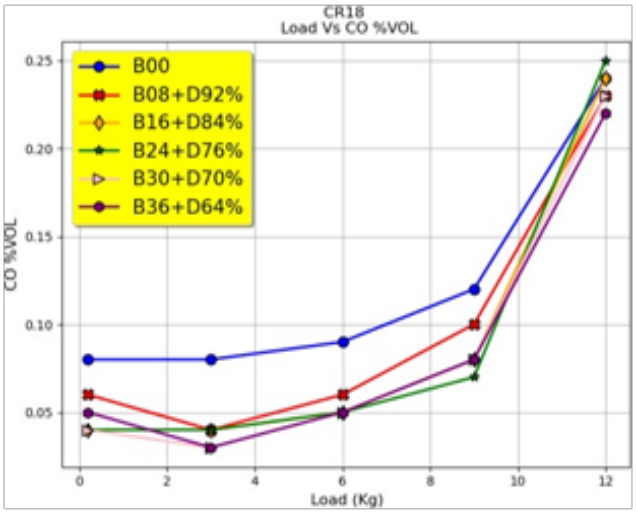

Figure 12: Load VS Carbon Monoxide Emission

Hydrocarbons (HC)

Hydrocarbons (HC) are a group of organic compounds that contain only carbon and hydrogen atoms. As a result of incomplete burning of fossil fuels or other organic materials, they may be released into the atmosphere.. HC emissions can have harmful things on human health and the environment, as they can react with other pollutants to form ground-level ozone and other harmful compounds. When equated to pure diesel at CR of CR16 and 18, it is seen that the emission of HC for the blends B08, B16, B20, B24, and B30 increases with an increase in load.

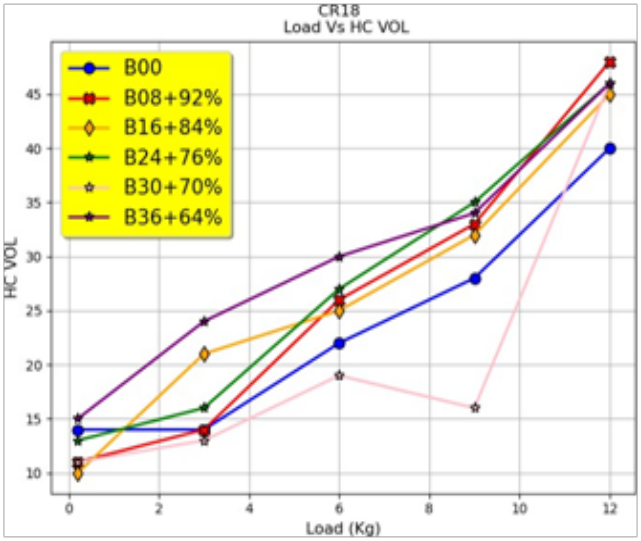

Figure 13: Load VS Hydrocarbon Emission

Nitrogen oxides (NOx)

Nitrogen oxides (NOx) are the extremely reactive gases known as nitrogen oxides (NOx) are released into the atmosphere as a result of high-temperature combustion processes, such as those that take place in automotive engines. Power plants, and industrial processes. Due to their ability to contribute to the creation of ground-level ozone and fine particulate matter, which can result in respiratory disorders and other health problems, NOx emissions can have a harmful impact on both human strength and the atmosphere. NOx emissions for blends B08, B16, B24 are more as compared to pure diesel. But as compression ratio increase blend B16 and B24 show lesser emission.

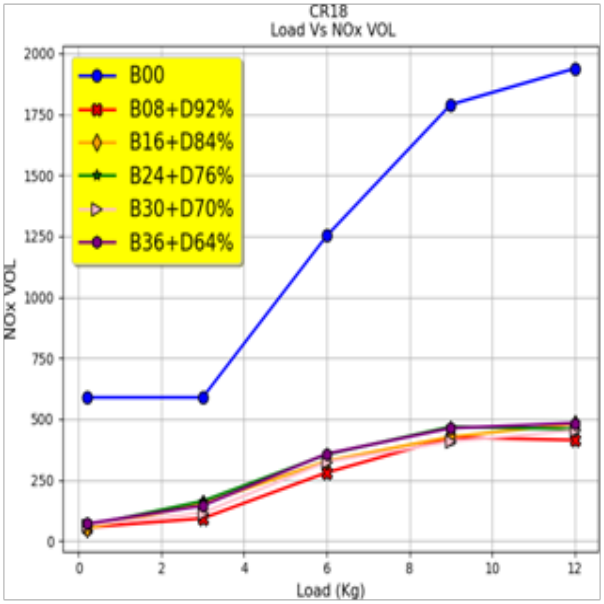

Figure 14: Load VS Nitrogen Oxide Emission

Smoke opacity

Smoke opacity is a measure of the degree to which smoke produced by combustion obstructs the passage of light. It is typically measured using a smoke meter, which measures the amount of light that is detect or scattered by the smoke. High smoke opacity can be caused by a variety of factors, such as incomplete combustion, poor fuel quality, or inadequate air-to-fuel ratio. The graph illustrates how smoke opacity varies with load for the blends BOO, BOS, B16, B24, B30, and B36 at CR 16 and 18. It has been noted that smoke opacity rises with load.

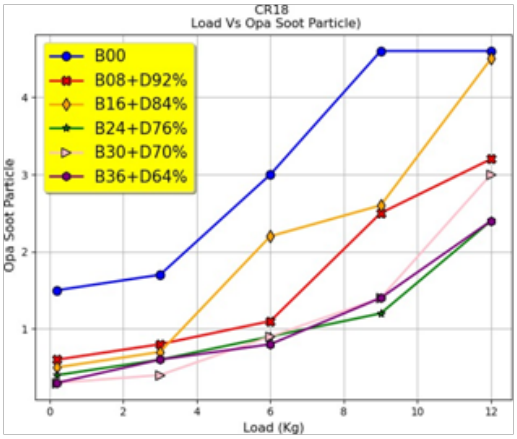

Figure 15 Load VS Smoke Opacity

Exhaust gas temperature (EGT)

Exhaust gas temperature (EGT) is the temperature of the gases released by an engine or during a combustion process is known as the exhaust gas temperature (EGT). Important data on the ignition process and engine performance can be obtained through EGT, as it reflects the temperature and energy content of the exhaust gases. High EGT can indicate a high degree of combustion efficiency and/or high power output, but it can also be an indicator of potential engine damage or overheating. The exhaust gas variation for blends and pure diesel at CR 16 is shown in Fig. It demonstrates that, for the equal load, the exhaust gas temperature for blends B24 and B16 is lower at low loads than it is for pure diesel. Figure 23 depicts the difference in exhaust gas temperature between blends and natural CI at CR18; it demonstrates that blends B16 and B24 have lower exhaust gas temperatures than pure diesel.

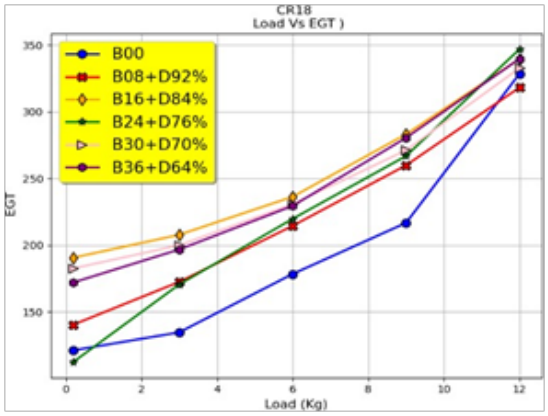

Figure 16: Load VS Exhaust Gas Temperature

Based on the available literature, the specifications of biodiesel produced from Argemone Mexicana oil generally meet the criteria set by ASTM and EN[18]. The following are some of the typical specifications reported in studies: Density: The density of Argemone Mexicana biodiesel is generally reported to be around 0.87 g/cm3 at 15°C, which is similar to the density of CI fuel. Calorific value: The CV of Argemone Mexicana biodiesel is generally reported to be around 34-45 MJ/Kg. It should be noted that these specifications may vary contingent on the specific methods and conditions of biodiesel production, as well as the quality of the Argemone Mexicana oil used as feedstock.[19]

CONCLUSION

- The experimental investigation uses Argemone Mexicana biodiesel blends and CuO additives with diesel in one-cylinder, 4-stroke CI Engine with various CR. Running the engine at various compression ratios, such as 16 and 18, while adjusting the load allows for the evaluation of the emission analysis and performance analysis. The performance parameters that are measured are BP , specific fuel consumption, and consume gas temperature.[20] The discharge parameters that are calculate are CO, HC, and NO. The observations made based on the experimental studies are listed below.
- Braking power (KW) variation with load for the mixes BOO, B08, B16, 824, and B30 at CR16 and 18. Braking performance for blends BO8, B16, and B24 is found to be roughly similar to or superior to that of pure diesel for CR16 and 18.
- As the load on an engine increases, the engine brake power also tends to increase. CI fuel is known to provide more heat than most blends, except for B16. However, the efficiency of biodiesel blends is often greater than that of CI fuel due to their earlier ignition, which is facilitated by the presence of oxygen.
- Brake thermal efficiency is affected by various factors such as the composition of the fuel, the engine design, and operating conditions. However, it is generally expected that biodiesel blends, including B16, would have higher thermal

efficiency than standard diesel fuel due to their earlier combustion and higher oxygen content. Further research and testing would be necessary to determine the exact brake thermal efficiency of a B16 blend under various conditions.

- In relationships of emissions, B16 made from biodiesel derived from causes such as Argemone Mexicana has been shown to discharge expressively less CO, CO2, HC, NOx, and O2 pollutants compared to CI fuel. This makes it a more environmentally-friendly option. [21]
- However, it is generally expected that the exhaust gas temperature of biodiesel blends, including B16 and B24, would be lower than that of standard diesel fuel due to their lower carbon content and higher oxygen content. The exhaust gas temp. is influenced by various features such as the composition of the fuel, the engine design, and working conditions.

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