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Prof. Satyajit Chakrabarti
Dr. Rintu Nath
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About conference

We live in an inter-connected world. In the era of Industry 4.0, technology is getting embedded more and more in the way **'we learn, live, work and play'**. This progression is accelerating at a pace never seen before. Inter disciplinary and collaborative research across disciplines within the Technology domain and Management domain, and across the Technology — Management interface is opening up exciting new possibilities for solving problems whose solutions are beyond the scope of a single discipline, domain or practice, and helping to create a brave, new world.

The goal of this conference is to bring together scholars, researchers, consultants and practitioners to share their interdisciplinary research and consultative work in Technology and Management.
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We invite papers for this conference, which will be peer reviewed and authors of the selected papers will be invited to present their work in the conference.

The accepted and presented papers will be published in open access e-book format by Taylor and Francis, which is the Knowledge Partner for this international conference.

The presentation of papers will be interspersed with **Keynote Talks** by eminent experts on the theme of the conference or individual domain areas.

Papers are invited in the following areas; but this is **indicative** only and authors may also submit their research on topics which are relevant to the theme and goal of the conference.

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Tracks:

Track #1: Internet of Things (IoT) & Data Science

- IoT and Big Data
- Block chain
- Next-generation infrastructure for IoT
- Cloud computing and IoT
- Edge computing and IoT
- IoT platforms, tools, and applications
- IoT systems development methodologies
- IoT applications

Track #2: Mechatronics

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- Mechatronics Systems
- Mechanical Systems
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Track #3: System Management

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KEYNOTES SPEAKERS :

Prof. G. Raghuram

Prof. G. Raghuram has a PhD from Northwestern University, Illinois, USA, a Postgraduate Diploma in Management (PGDM) from IIM Ahmedabad (IIMA) and a BTech degree from IIT Madras.

Prof. G. Raghuram served as Director, Indian Institute of Management, Bangalore (IIMB) from 2017 to 2019. Prior to taking over as Director of IIM Bangalore, he was Professor and Chairperson of the Public Systems Group at IIMA from 1992 to 2012. He was Dean (Faculty), IIMA, from September 2013 to December 2015. He had been a faculty member of IIMA since 1985.

He has teaching experience at universities in India, USA, Canada, Yugoslavia, Singapore, Tanzania and UAE.

He specializes in infrastructure and transport systems, and logistics and supply chain management. He conducts research on the railway, port, shipping, aviation and road sectors. He has published over 35 refereed papers in journals and written over 155 case studies. He has published six co-authored books.

He was awarded the 'MC Puri Memorial Award' for Contribution to Operational Research in India, 2016; 'Academician of the Year' by the Chartered Institute of Logistics and Transport in 2012, and 'Lifetime Achievement Award' for contribution to logistics and infrastructure by EXIM News in 2014. He is a Fellow of the Operational Research Society of India, and Chartered Institute of Logistics and Transport.

He has served on various government policy making and advisory committees for the Ministry of Civil Aviation, Ministry of Consumer Affairs and Public Distribution, Ministry of Railways, Ministry of Road Transport and Highways, Ministry of Shipping. He was recently appointed as Principal Academic Advisor at National Rail & Transportation Institute (NRTI).

Prof. Solomon Darwin

Prof. Solomon Darwin is the Director of the Garwood Center for Corporate Innovation and the Executive Director of the Center for Growth Markets at the Haas School of Business, University of California, Berkeley, USA. Previously he was an Associate Professor at the University of Southern California from 1996 until 2005 before joining UC Berkeley.

He received his B.A. degree from San Francisco State University, his MBA from Golden Gate University, his MCCP from Harvard University, Graduate School of Business.

Professor Solomon Darwin comes with broad Leadership Experience in Corporate Management & Academia. He is an international speaker and has been recognized by peers and students with numerous awards for his innovative leadership, curriculum development and passion for teaching. He inspires students from both business and engineering disciplines in his courses for open innovation, business models, smart cities, scalable smart villages, IBM Watson, and business models for emerging economies. He is also known as the father of the Smart Village Movement.

As an expert in Open Innovation, he consults and advises senior executives, multinationals and governments around the world. The list includes Google, Genentech, HP, Health Net, J&J, Toyota, NHS of UK, UCSF, Royal Caribbean, Autodesk, Nestle and government entities in Mexico, China, Russia, India, Colombia and Europe.

He has conducted workshops and programs in over 18 countries. His current project, "Building Scalable Smart Villages," was commissioned by the government of India.

Dr. Sajal K. Das
Professor and Daniel St. Clair Endowed Chair,
Missouri University of Science and Technology

Sajal K. Das is the Daniel St. Clair Endowed Chair Professor at the Computer Science department at Missouri University of Science and Technology (S&T). During 2008-2011 he served the US National Science Foundation as a Program Director in the division of Computer Networks and Systems. His research interests include wireless and sensor networks, mobile and pervasive computing, smart environments and smart health care, pervasive security, biological networking, applied graph theory and game theory. His research on wireless sensor networks and pervasive and mobile computing is widely recognized as pioneering. He is a Fellow of the IEEE.

Prof. Sudipto Banerjee

Professor and Chair, Department of Biostatistics, University of California, Los Angeles, USA

Dr. Sudipto Banerjee joined UCLA as Professor and Chair of the Department of Biostatistics in 2014. Prior to that, he spent 14 years in the University of Minnesota, Twin Cities. He has done his B.S. (Honours) from Presidency College, Calcutta, India in 1994, followed by M.STAT. from Indian Statistical Institute, Calcutta, India in 1996. Then he completed his Ph.D. degree in Statistics from University of Connecticut, Storrs, Connecticut, USA in 2000. His research centers around spatial statistics, developing theory and methods related to Bayesian modeling and inference for geographic data with wide-ranging applications in public and environmental health sciences, ecology, forestry, real estate economics and agronomy. In 2015, he was awarded with the Distinguished Achievement Medal from ASA Section on Statistics and the Environment. In 2017, he got the ASA Outstanding Application Award, followed by George W. Snedecor Award from the Committee of Presidents of Statistical Societies (COPSS) in 2019. Some of the books written by him are Hierarchical Modeling and Analysis for Spatial Data, Linear Algebra and Matrix Analysis for Statistics and Handbook of Spatial Epidemiology published by Chapman and Hall/CRC.

Dr. Nakul Parashar

Dr. Nakul Parashar,a doctorate in Applied Physics and masters in Computer Science & Physics, Dr Nakul Parashar has successfully set up three start-ups and taken them to plausible profitability. Dr Parashar has worked in Academia, Government & Corporate, Information Science, KPO, Legal Information sectors.

He has run diverse-domain service set-ups with lowest-possible costs infrastructure to produce highly plausible EBITDA. He has been a University-level researcher & teacher, business development leader, operations risk manager and SME for content management for various domains like Legal, STM and General content. He has hands-on experience of working in various geographies like North America, EMEA and Asia-Pacific.

Currently designated as Director, Vigyan Prasar, Dr Parashar has been entrusted with the responsibility of propagating Science & Technology Communication, Popularization and Extension across the nation and beyond the national boundaries. In his past assignments, he has worked as an Assistant Editor to Vigyan Pragati, a popular science monthly published by CSIR, and later as an Associate Editor of Computers Today from India Today group of magazines. He has authored a number of award-winning books in the science-popularization domain and also more than a couple of hundred articles. He continues to follow his passion by bringing new thoughts, processes and workflows relevant to Science & Technology Communication Strategies.

Having travelled extensively across the globe, Dr Parashar brings to the fore best practices in science communication that could assist him in applying them at his current place of work. Leveraging the power of latest communication techniques, Dr Parashar intends to apply them to existing S&T communication channels thereby expanding the outreach and achieve a meaningful outcome.His current research interests includes machine learning and natural language processing with use cases like automated metadata extraction and content summarization.

Dr. Ankita Singh

Senior Vice President & Global Head of HR, IT, Travel & Admin
CIGNEX Datamatics

Senior Vice President and Global Head of HR at CIGNEX Datamatics. She has over 19 years of progressive experience in managing and leading various aspects of Human Resources spanning across high paced business domains of ITES. In addition to all functions of HR, Ankita overseas other enabling functions like Administration, Travel and Resource Management.

Ankita holds a PhD in Management and is a Gold Medallist in BBA as well as MBA. She has done HR and Business Strategy related Executive Management Programmes from IIM-A, ISBHyderabad and XLRI. She is a certified PPA (Thomas Profiling) Practitioner.

Plenary speaker :

Prof. Manas Chatterji

Binghamtown University

State University of New York & Guest Professor, Peking University, Beijing, China.

Professor Chatterji previously taught at the Wharton School of Business, University of Pennsylvania, and held visiting appointments at Cornell University, Erasmus University, University of Karlsruhe, University of Munster and other universities in United States, Europe, Asia and South Africa.

Professor Chatterji authored/edited more than thirty books and published about eighty scholarly articles in the areas of Peace Science, Military Spending, Disarmament, Economic Conversion, Conflict Management, Regional Science, Technology Management, Health Care Management, and Energy, Environmental and Urban Management.

He is a General Editor of two leading book series: A. Conflict Management Peace Economics & Development, Emerald Publishing UK, B. International Studies in Peace Economics and Peace Science, Cambridge Scholars, UK.

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Comparative Study of Sentiment Analysis Techniques

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Abstract: Sentiment Analysis (SA) is an active area of study in the field of text mining. SA is the computational treatment of thoughts, emotions and literary subjectivity. This paper addresses a detailed summary of the latest update in this area. The related fields of SA (transfer learning, emotional detection, and resource building) that attracted researchers have recently been explored. The paper provides a description of the various approaches to sentiment classification and methods used for sentiment analysis. Starting from this summary, the paper introduces a classification of methods with respect to features, advantages and limitations.

Keywords: Sentiment analysis, Social media, Machine learning approach, Lexicon-based approach, Sentiment classification

I. INTRODUCTION

Sentiment Analysis (SA) or opinion Mining (OM) is a computational study of people's thoughts, perceptions, and feelings towards an individual or entity. The entity may represent persons, activities, or issues. The two words SA or OM are synonymous. They're sharing a shared sense.

However, there are several researchers who claimed that OM and SA have slightly different notions [2]. Opinion Mining collects and analyses the opinion of the people about the entity, while Sentiment Processing detects the sentiment reflected in the text and then analyses it. The purpose of SA is, therefore, to locate views, to define the feelings they convey, and then to characterize their polarity as depicted by the figure 1.

The word sentiment analysis first appeared in first decades of twentieth century [13] but studies on feelings/opinions appeared earlier [5]. The literature on sentiment analysis centred on various areas, from management sciences to computer science, social sciences, and industry, owing to its relevance to society as a whole and on different tasks such as subjective expressions.

II. SENTIMENT ANALYSIS STAGES

Sentiment analysis is a dynamic method involving five separate stages in the analysis of sentiment results (Fig. 1) [12]. These are the following steps:

Data collection: the first phase of sentiment analysis consists of gathering data from user generated material found in blogs, forums, social networks [4]. These details are disorganized, represented in various ways by using different vocabulary, slang, writing context, etc. Manual research is almost difficult. Text interpretation and natural language processing are also used to retrieve and classify.

Processing of text: consists of cleaning the collected data prior to review. Non-textual contents and contents that are not important to the study are detected and deleted [9];

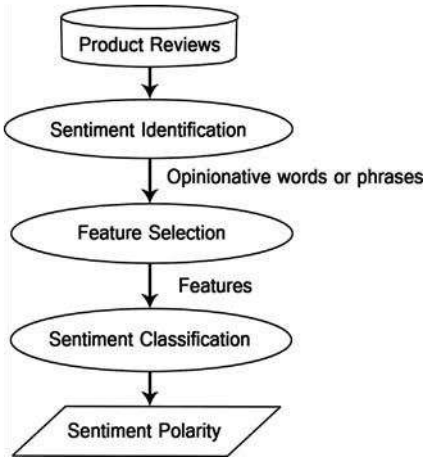

Fig 1 Sentiment analysis process on product reviews

Emotion detection: the sentences derived from the ratings and viewpoints are analysed. Sentences with emotional expressions (opinions, views, and opinions) are maintained, and sentences with impartial communication (facts, accurate information) are rejected.

Emotion classification: In this stage, subjective sentences are categorized as positive, negative, good, bad, like displeasure, but classification can be made using multiple points.

Performance presentation: The key goal of sentiment analysis is to turn unstructured text into useful information. When the analysis is completed, test results are shown on graphs such as pie charts, bar charts, and line graphs. Time may also be measured and graphically displayed, creating a sentiment timeline with the preferred value (frequency, percentages, and averages) over time.

III. SENTIMENT ANALYSIS METHODS

The current paper offers a summary of the studies on the sentiment classification

- Sentiment classification methods with respect to features/techniques and advantages/limitations
- Tools with respect to the various techniques used for sentiment analysis.

Sentiment analysis is a modern area of study born in Natural Language Processing (NLP) with the goal of detecting subjectivity in text and/or capturing and classifying thoughts and sentiments [8]. Sentiment research analyses people's thoughts, views, behaviours, assessments, assessments, and emotions regarding programs, goods, persons, organizations, problems, incidents, and their attributes. Sentiment classification methods can be classified as follows [12]:

- Machine Learning based
- Lexicon based
- Hybrid

The machine learning methods are used to predict the polarity of emotions depending on both the educated and the test data sets. The lexicon-based approach does not require any prior preparation to mine the data. It uses a predefined set of terms, where each word is correlated with a particular feeling. Finally, in the hybrid approach, the integration of machine learning and lexicon-based methods has the potential to enhance the efficiency of emotion classification (Fig 2.).

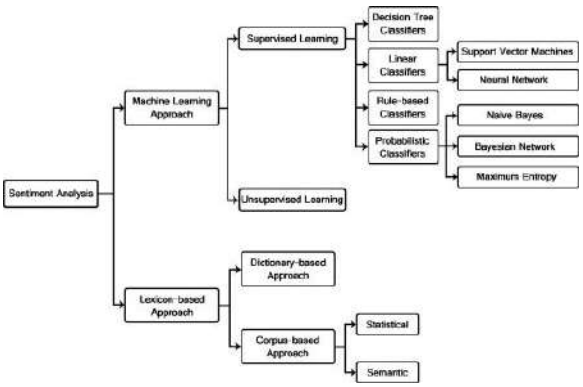

Fig 2: Sentiment Classification Techniques (Source:[12])

The most commonly used tools for identifying polarity emotions are Sent WordNet, Sentic Net, Happiness Index, AFINN, PANAS-t, Emoticons, LIWC, SentiStrength, Sentiment140, NRC, EECA, and FRN. Sentiment analysis is primarily used in a number of areas, such as marketing, political and sociological.

The text of emotion analysis is categorized according to the following different criteria:

• the polarity of the emotion conveyed (positive, negative and neutral);
• the polarity of the result (e.g., change over mortality in medical texts) [7]
• support or disagree with the topic (e.g., political debate) [9]
• good news or bad news [11]
• support for or resistance [11]
• for pros and cons [1]

The machine learning method is used to predict the polarity of emotions depending on both the educated and the test data sets. It applies ML algorithms and uses linguistic features [12]. The key benefit of this approach is the ability to adjust and construct trained models for unique uses and situations, the main drawback of which is the poor applicability of the method to new data since the supply of labelled data is required, which may be expensive or even prohibitive. It can use supervised and unsupervised processes.

Machine learning uses a supervised approach when there is a finite set of classes available (positive and negative). This approach includes labelled data for the training of classifiers . In a machine-based classification, a training set is used by an automated classifier to learn the various characteristics of the documents, and a test set is used to verify the output of the automatic classifier. Unattended approaches are used because it is impossible to locate labelled training documents.

Unsupervised learning does not require prior experience to mine data. Unsupervised approaches to document-level sentiment analysis are focused on the assessment of the semantic orientation (SO) of a given expression Within the text. If the average SO of these phrases is above any predefined threshold, the document is labeled as positive, otherwise, it is called negative.

Few of the most commonly applied approaches to machine learning is:

Bayesian Networks: it is a probabilistic approach that models the interaction between features in a very general way. It is based on a directed acyclic graph in which nodes are variables and arcs

Naive Bayes Classification: This method is especially suitable when the dimensionality of inputs is high. Despite its simplicity, it can also outperform more complex classification methods.

Maximum Entropy: this approach is mostly used as an alternative to Naive Bayes classifiers since it does not presume statistical independence from random variables (features) that act as predictors [13]. The theory behind Maximum Entropy is to find the best possible distribution of probability between the previous test results.

Neural Networks: this approach is based on the set of natural/artificial neurons used for mathematical and numerical model analysis

Supporting Vector Machine: A supervised learning model that analyzes data and patterns that can be used for classification and regression analysis. The fundamental principle behind this is to find the maximal margin of the hyperplane defined by the vector. It's finding an optimal solution. Although the lexicon-based approach does not require any prior preparation to mine the data. It uses a predefined set of terms, where each word is correlated with a particular feeling. They are based on the number of positive and negative terms. These techniques differ based on the context in which they were developed. Lexical does not require labelled details, but it is difficult to construct a specific lexical dictionary that can be used for various purposes. For e.g., slang used in social networks is rarely backed by lexical methods [3].

Among the most commonly used lexicon-based methods are:

Dictionary-based approach: a tool that expresses word by word as a dictionary without correlating the context of terms between them.
Innovative Machine Learning Approach: incorporates essential linguistic features into automatic learning
Corpus-based approach: has been commonly used to investigate both written and spoken texts in order to allocate a sentiment factor to words that depend on the frequency of their occurrence.
***Ensemble Approaches in Sentiment classification*:** improve the precision of classification by integrating arrays of advanced learners.

IV. SENTIMENT CLASSIFICATION APPROACHES

Machine learning based approach uses a classification method to interpret text; it consists of two sets of documents: a testing set and a test set. The training set is used to learn the differentiating characteristics of the text, while the test set is used to verify how well the classifier performs [1]. The attributes of machine learning based on a sentiment classification method are:

Presence and frequency of the term: that includes uni-grams or n-grams and their presence or frequency.
Part of speech information: used to disabling the context used to direct the selection of features
Negations: has the power to reverse feelings Words/phrases of opinion: that expresses a positive or negative opinion.

The lexicon-based approach uses the sentiment dictionary with the words of thought and compares them with the data for polarity determination [11]. There are three approaches for constructing a sentiment lexicon: manual construction, corpus-based methods and dictionary-based methods. Manual building is a time-consuming and challenging task.

Corpus-based approaches can yield words of opinion with reasonably high precision. Finally, in dictionary-based approaches, the idea is first to compile a limited collection of terms of opinion manually with known orientations, and then to extend this set by looking for their synonyms and antonyms in the WordNet dictionary. Lastly, in the hybrid approach, the integration of machine learning and lexicon-based methods has the potential to enhance the efficiency of emotion classification.

Table : CLASSIFICATION OF SENTIMENT ANALYSIS APPROACHES

Sentiment Classification Approaches		Features/ Techniques	Limitations and Benefits
Machine learning	Bayesian Networks Naïve Bayes Classification Maximum Entropy Neural Networks Support Vector Machine	Presence of term and frequency, Part of the information on speech Negations: Words and phrases of opinion	**ADVANTAGES** The ability to adjust and build qualified models for unique uses and contexts; **LIMITATIONS:** Low applicability of new data due to the need for the availability of labeled data that could be expensive Or prohibitive
Lexicon based	Dictionary-based approach Novel Machine Learning Approach Corpus-based approach Ensemble Approaches	Manual construction, Corpus-based, Dictionary-based	**ADVANTAGES** wider term coverage **LIMITATIONS** A finite number of words in the lexicons and the assignation of a fixed sentiment orientation and score to words
Hybrid	Machine learning Lexicon based	Sentiment lexicon constructed using public resources for initial sentiment detection Sentiment words as features in the machine learning method	**ADVANTAGES** lexicon/learning symbiosis, the detection and measurement of sentiment at the concept level, and the lesser sensitivity to changes in the topic domain **LIMITATIONS** noisy reviews

There are certain benefits and disadvantages in the use of these various methods, based on the intent of the study. We're offering a summary of the primary. The key benefit of machine learning techniques is the ability to modify and construct trained models for particular uses and situations, whilst the drawback is that it is difficult to incorporate into a classifier, generic information that cannot be obtained from training data. Furthermore, trained models also have low adaptability between domains or various text genres, since they also depend on unique domain features from their training results. Lexicon-based approaches have the advantage that general awareness emotion lexicons have broader term scope, but these approaches have two major drawbacks. Second, the number of terms in the lexicons is finite, which may pose a challenge in the extraction of emotion from very dynamic situations. Second, sentiment lexicons prefer to assign a set orientation of sentiment and score to words, regardless of how they are used in a text.The key benefits of hybrid methods are the lexicon/learning symbiosis, the recognition and evaluation of conceptual emotions, and the lower exposure to changes in the subject domain. Although the key drawback is that there is a lot of noise in the feedback (irrelevant terms for the topic of the review) a neutral score is always assigned because the system does not detect any emotions

V. CONCLUSION

The different approaches and tools analyzed in the paper can be applied in different fields, such as: business, politics, public action and finance. The business domain sentiment analysis is mainly used to detect consumer voice, brand reputation, and online advertising and on-line business trends. Finally, with regard to the finance domain, the sentiment analysis is used to detect trends in commodity and share prices and the evolution of financial risks. A future difficulty in applying sentiment classification approaches and methods for social media sentiment analysis is to

resolve the uncertainty that really poses a specific problem as it is not easy to make use of coreference knowledge. Usually, the examined posts contain irony and sarcasm, which are especially difficult to spot. Therefore, an advancement of methods and resources is required to address this constraint.

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AI,Biometry and Blockchain Powered User Athentication

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***Abstract*—User authentication mechanism is a complex subject considering its varying demand. Various technology aspects need to be considered to handle such varying demand. Security, data protection, comfort and convenience are few important criteria which are inherent demand from any good authentication mechanism. In spite of technological advances achieved in various areas, there are still concerns around security, overall user comfort and conveniences. The mechanisms used by fraudsters have seen lots of changes how to steal customer information and misuse it. Customer expectation around whole authentication process is now loaded with expectation of quickest turn-around time. AI, blockchain and biometry powered authentication handles dynamic need of authentication while keeping the user comfort and convenience factor in consideration. This is targeted without compromising the demand of maintaining security level. Artificial intelligence manages the dynamic need of authentication and it targets to be flexible with biometric and non-biometric authentication parameters. Blockchain implementation makes it immutable and strongly safe for handling confidential data of users. Biometric authentication handling makes it secure and non-biometric authentication makes it suitable where security need is not so high.**

Keywords—Artificial Intelligence, biometry, blockchain, authentication, security

I. INTRODUCTION

User authentication is always complicated considering the different aspect associated with it. Whatever mechanisms are adopted to handle it, one size doesn't fit all. Technologies handling user authentication have also gone through lots of changes with the evolution of whole eco-system. In spite of these technological advances, there are still concerns around security, overall user comfort and conveniences. The mechanisms used by fraudsters have seen lots of changes how to steal customer information and misuse it. Customer expectation around whole authentication process is now loaded with expectation of quickest turn-around time. Considering all these aspects, it is quite complex how user authentication needs handling at what situation and to what extent. Technologies like blockchain has shown the way to enhance security which can't be compromised and recent research work also suggests to use it for various scenarios. In this paper we analyse different aspects associated with user authentication and how AI and Biometry coupled with blockchain technology can be a powerful solution.

II. RECENT ISSUES WITH USER AUTHENTICATION

A. Financial Loss

According to World Economic Forum, global economy is going to suffer $2.9 million every minute because of cybercrime and major percentages of these are related to password. It is always a headache for users to remember and manage so many passwords. Not only for users just but it is also headache for organizations to manage it. There are lots of queries related to password and other knowledge based authentication details from customers which need substantial money from organization to manage customer queries and fix the issues around.

B. Data breaches

As per recent report published by IBM security, the United States witnessed the highest data breach costs in the world at $8.64 million on average country cost [5]. Protecting customer data is considered to be compromised a lot with an authentication mechanism which is not robustly secure. Thus it raises the demand to have an authentication mechanism which is not just strongly secure but is also customer friendly and flexible to meet future demands.

C. User experiences

User experience around authentication for banking, social media, online shopping etc. are revolving around technology advancement. Knowledge based authentication to biometry authentication, user experience is getting richer year by year with technological essence. Technology impact tries to create comfort for customer without compromising security. Although technological advances have created comfort for users in the whole authentication process, frauds are happening with advancement of technology. So it is actually technology vs technology where one side technology helping to improve the experience of customers and on another side technology is helping fraudsters to deceive individual or organization.

D. Regulatory aspects

Different countries have set up GDPR like regulations to protect the users' confidential data from the target of fraudsters or hackers. In essence these regulatory norms enforce service providers to follow and implement certain measures to protect user confidential data. Many countries have enforced open banking norms where customer data is shared with third party service providers. Complete data security is maintained where customer data is shared with such external service providers. Most importantly customer controls it where and when to share data with whom [14].

III. AI,BIOMETRY AND BLOCKCHAIN

In recent times, we have seen use of blockchain technology in the process of user authentication. The primary aspect is the immutability and distributed nature of blockchain technology. Lot of research work is happening how blockchain can be utilized more effectively considering the different challenges exist in user authentication and

amount of frauds are happening. In the similar line, spread of mobile has also opened up many other ways to secure user authentication robustly. One such way is biometry authentication where user biometry like finger print, iris etc. are validated. Biometry authentication is robustly secure and is poised to be the way forward for user authentication. However biometry authentication needs certain set up on the user side which makes it difficult to use it widely. Also it is very much dependent on which medium i.e. desktop or smart phone or feature phone user is accessing the feature or service. So there are challenges and concerns around user authentication which still persist even if there technical advances achieved. From that perspective, artificial intelligence has a very significant role to play to remove the existing obstacles and making the user authentication fraud-proof and side by side user friendly and scalable in nature [8]. In this paper we elaborate our research approach on combining Artificial Intelligence (AI), biometry and blockchain technology to make a robust, secure, and scalable and user friendly authentication mechanism. Below sections highlight different aspects of each technology pillars which is the base of our approach

A. *Behavioural biometry*

It starts with creating unique profile for each user. There can be several ways to create and update this unique profile continuously how user is interacting the system [6-7]. User behaviour, IP Address of the device, Geolocation etc. are some parameters for example which helps to create and maintain the profile. While creating and updating profile is a continuous process, applying it for authentication is a different challenge altogether. There is always a consideration on the service provider side whether to compromise the usability in order to enhance security [1]. We focus on to create one solution approach which intends to manage this trade-off by intervention of AI.

B. *Decentralized control*

Use of blockchain technology for user authentication is gaining lots of attention as it offers various benefits. Primary benefit is obviously the enhanced robust security without causing much inconvenience to users [9][15]. It will not cause much damage to entire user confidential data when one authentication server is compromised. This is because of its distributed nature through various consensus mechanism. User data being immutable is another aspect which makes it suitable for user authentication. However a simple user activity like login into the system and doing a very high value transactions can't get the same treatment from blockchain technology implementation perspective. That is where AI brings a new aspect when to put the user data into block and apply the consensus mechanism.

C. *Customer comfort*

This is the most crucial aspect as no solution could be targeted if user doesn't feel comfortable with it. In this age of information where average users are comparably more informed about various different available options what was the scenario in a few decades ago. So solution will not survive if customer doesn't like [10]. Considering this, it is really important to draft an authentication solution which is user friendly on one side and robustly secure on another side. What becomes really difficult for customer when some authentication mechanism demands too much complex password to remember, demands perfect presentation of biometry all the time to be captured by system.

D. *Compromizing security*

User comfort factor and security can't be compromised in any of the user authentication solution approach. The question is whether these two relatively contradictory aspects go hand in hand. AI has the power to create the bonding factor between these two aspects. AI has the power to understand the user need and apply security mechanism accordingly. In our solution approach we elaborate more how this could be achieved in a continuous manner.

IV. RELATED WORK

Though AI, Biometry and blockchain powered authentication not explored much, biometry and blockchain based solution approaches have been researched by many. One such attempt is biometric e-ID system based on blockchain suggested for utilization in notary, registration and basic health services etc. [3]. Different state-of-the-art blockchain based authentication solutions like MyData, Waypoint, BlockStack, CertCoin from year 2014 to 2018 are summarized and open issues, main challenges highlighted [4].

V. SOLUTION APPROACH

Our solution approach for user authentication is built around AI, Blockchain and biometry technology. Before we see the impact of these technology aspects, it is required to state the complexity around authentication process. Every organization has their unique need of authentication which can be attributed as various authentication parameter e.g. under the biometry authentication there can be various types which are IRIS, Face, Finger print, Voice etc. Table 1 elaborates such different types of authentication parameters:

TABLE I. AUTHENTICATION PARAMETERS WITH WEIGHTAGE

Authentication Parameter	Weightage (scale 10 Highest secure and 1 Lowest secure)
Biometric	
Face	**10**
IRIS	**10**
Voice	**8**
Finger Print	**10**
Behaviour based- keystroke	**9**
Non-biometric	
Device based- Mobile-IMEI number	**6**
Device based- Laptop- IP	**6**
Device based- Desktop- IP	**6**
Location based -Geolocation	**5**
Knowledge based- Password	**6**
Knowledge based- Secret Question Answer	**6**
Secret Information based- OTP	**8**
Secret Information based- Card CVV	**8**

Based on the nature of process or transaction, organization can set the required score which should be achieved in the process of authenticating any user e.g. in case of banking just login and checking balance requires minimum 5 to be achieved. Similarly doing high value transaction requires minimum 12 score to be achieved. This can go higher for a customer where risk is high e.g. customer is travelling abroad. So all these are different controlling parameter-type of transaction, customer profile, medium of transaction, location of transaction origination which decides the minimum score to be achieved.

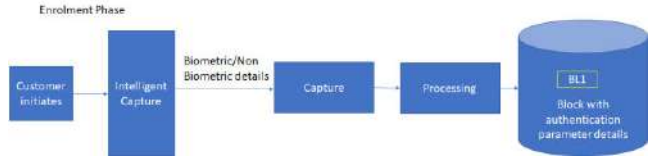

Fig. 1. Step1 when customer does registration/enrolment

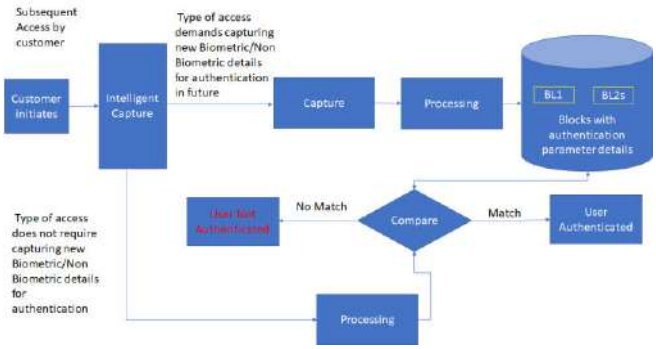

Fig. 2. Subsequent access by customer

As shown in the figure 2, user first does the registration where authentication parameter gets added into a block of the blockchain. This blockchain is manged at the user level. Whenever the same user logs in next time, it will be validated against this block which can have biometric authentication parameter or non-biometric authentication parameter. If the same user tries to do some new activity in the system which demands more score to be achieved minimum then user will be again redirected to capture another authentication parameter. Intelligent capture layer will identify if new biometric or non-biometric details to be captured or not based on the type of access request by user [11-13].

A. Artificial Intelligence

Intelligent capture layer manages the dynamic need of authentication which varies from organization to organization and system to system and also varies time to time for same system and same organization. Summarized details managed by this layer:

1) Managing the need to maintain new authentication parameter: Based on user authentication need after user does initial registration, it starts routing to the capture process so that authentication parameter details can be stored in the added block

2) Routing to the verification process: In this case there is no need to capture new authentication parameter as user access request which doesn't need new authentication parameter storage.

a) Identifying the exact authentication need: It identifies exact authentication parameter verification need based on the score required for user access request.

B. Blocks with authentication parameters

For every user who does enrolment, blocks are created with authorization parameter details. As and when there are demands for capturing more authentication parameters, it will capture new authentication parameter and will add as a new block in the blockchain. As shown in figure 3, it will be the state of the authentication parameter storage for few users:

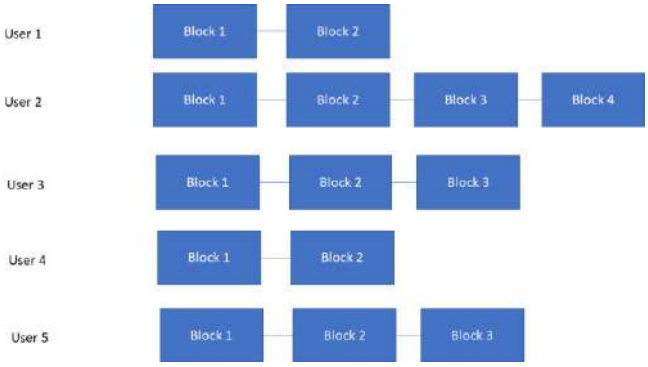

Fig. 3. Authentication parameter data manitenance view of users

As shown in the above diagram, there is no need to maintain fixed mechanism of authentication which doesn't match the needs of different users. This solution approach manages it dynamically based on the different types of access request posed by different users. For this reason, user2 has maximum requirement of authentication parameters maintenance in blocks.

VI. ISSUES AND CHALLENGES

Our research focuses on the dynamic need of user authentication. The main challenge is to maintain the robustness of the solution covering the vast exposure of users into various systems which can be online or device based. The solution approaches to maintain authentication blocks at the user level. It needs to be performing at the desired level when the number of users are considerably high. The solution targets to cover both biometric and non-biometric authentication parameters. Solution needs to be flexible in capturing and maintaining both biometric and non-biometric authentication parameters inside blocks of blockchain.

VII. CONCLUSION

AI, blockchain and biometry powered authentication handles dynamic need of authentication while keeping the user comfort and convenience factor in consideration. This is targeted without compromising the demand of maintaining security level. It targets to be flexible with biometric and non-biometric authentication parameters. Blockchain implementation makes it immutable and strongly safe for handling confidential data of users. Biometric authentication handling makes it secure and non-biometric authentication makes it suitable where security need is not so high.

VIII. FUTURE SCOPE

In the future scope of taking ahead this research proposal is to make it scalable for very high volume of user handling. Also the system will be robust if it can handle significant numbers of authentication parameters. Future target need to be less and less user direct interaction with the system while capturing user authentication parameters but this aspect brings some regulatory aspects into consideration.

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Railway traffic lights recognition system

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***Abstract* — The article deals with the problem of collecting information about railway traffic lights located on the territory of the Russian Federation. To solve this problem, a trained neural network is used that detects railway traffic lights in high-definition images. These images were taken by a camera installed on a train carriage, continuously photographing the area around the track on the right side towards the train. As a result, a detector model of the specified objects was obtained on high-precision images. The paper proposes algorithms for determining the marking and GPS coordinates at a previously detected railway traffic light. The architecture of the information system has been developed, which will have to store complete information about railway traffic lights. The system should be able to quickly search for information and use this data to plan the maintenance of railway traffic lights.**

Keywords— railway traffic lights, neural networks, object detection, information system, computer vision

I. INTRODUCTION

Currently rail transport plays an important role in ensuring the delivery of goods. The Russian railway has a long length (it ranks third in the world) and its history begins in the 1830s. Railways are a complex engineering object. It includes various means of automatic control of railway transport. Railway traffic lights are one of the important elements of rail traffic control. A large number of operated railway traffic lights, the difference in their technical characteristics leads to the need to develop an automated system for storing and keeping up-to-date information about railway traffic lights, their technical characteristics, scheduled times for checking and repairing traffic lights. Information about the type of railway traffic light is placed on the identification plate located on the traffic light mast. The data from the marking plate is continuously read from images taken by a camera mounted on a railway locomotive. On the received images, it is necessary to detect the traffic light and recognize the information with a marking plate.

Nowadays, to solve this problem deep learning methods are used. Deep neural networks are currently becoming one of the most popular machine learning methods [1]. They show better results compared to alternative methods in areas such as speech recognition, processing natural language [2], computer vision [3], medical informatics, etc. One of the reasons for the successful application of deep neural networks is that the network automatically extracts from the data important features necessary for solving the problem.

Tasks related to the recognition of traffic signals are considered in works [4, 5]. To detect traffic signals, machine learning methods are used. For instance, in papers[6, 7] the authors solve the problem of detecting the color of traffic lights by using the Adaboost algorithm. Beside detecting objects on images, some authors worked on video object detection [8]. The problem of recognizing traffic lights as railway objects and their labels is relevant. The development of algorithms for recognition of traffic lights and a system for storing information about traffic lights is of practical importance and can be used in transport companies.

II. PROBLEM STATEMENT

In railway transport traffic lights are used as permanent signaling devices. For the detection of railway traffic lights, it is necessary to describe their characteristics. Traffic lights are classified by purpose as [9]:

- entrance - allowing or prohibiting the train to follow from the stretch to the station;

- weekend - permitting or prohibiting the train to go from the station to the track;

- route - allowing or prohibiting the train to proceed from one area of the station to another;

- checkpoints - permitting or prohibiting the train to proceed from one block section (inter-post haul) to another;

- and etc.

One traffic light can combine several purposes (input and output, output and shunting, output and route, etc.). Also, railway traffic lights by location are subdivided into mast, dwarf, and also installed on bridges, consoles, bridge trusses, tunnel walls, and on non-public railway tracks also on the walls of industrial premises.

In this paper the most common traffic lights are detected - dwarf (hereinafter - small) and mast (hereinafter - large).

At a traffic light there must be a marking plate containing its designation. Self-blocking traffic lights are designated by numbers all other traffic lights - by letters or letters and numbers. The type of the marking plate of the railway traffic light is shown in Fig. 1

Fig. 1. Marking plate of the railway traffic light

The problem described in this paper is to detect the railway traffic light and its marking plate to the specific track they belong to. The input receives photos from the front camera installed on the locomotive.

III. Neural Network Model for Railway Traffic Light Detecting

This section describes a method for collecting real-world data in different weather conditions and geographic locations.

A. Data

The images were obtained by continuous photographing with cameras installed on carriages - flaw detectors of long-distance and short-distance trains. As the carriages - flaw detectors moved, cameras took pictures of the near-track space on the right side, since the objects of interest to us (railway traffic lights) are to the right of the train at a distance of one meter.

The data were obtained in the amount of 59930 images of the near-path space with a resolution of 1920 x 1080 and a color rendering system RGB.

B. Preprocessing

The subject of our interest in the images are small and large railway traffic lights. Among the obtained images were selected those on which objects of interest to us are visible and distinguishable. Thus, 500 images were selected for marking.

To train a neural network, two sets of images are required as initial data. In this regard, 500 images were divided into two samples: train and test. Since the number of selected images is not large enough, the proportion of 90% for the training sample and 10% for the test sample was chosen so as not to lose valuable observations.

C. Neural network training

This section describes the neural network training technique used for detecting large and small railway traffic lights. The training was performed using the TensorFlow library [10] in a Jupyter laptop at Google Colaboratory (Colab) [11].

Preparing to train a neural network: Our learning process uses transfer learning [12], which is the application of a pretrained model to train on new data. That is, it is an optimization that allows you to quickly improve performance and progress when learning a new task. Thus, this process takes less time and is more likely to produce better results.

This study uses a faster_rcnn_inception_v2_coco model pretrained on a large and varied COCO dataset. When loading this model, the last checkpoint that was previously trained in the COCO dataset is retrieved [13]. Training a new model begins by using the reference point obtained as the starting point for training.

Training: After preparing all the necessary files, the process training started. It lasted 6 hours using a GPU accelerator. Below in Fig. 2 is presented a graph of the loss function, which shows how accurately the neural network finds the object in the image. The graph shows the number of thousands of steps horizontally, and the classification error value vertically.

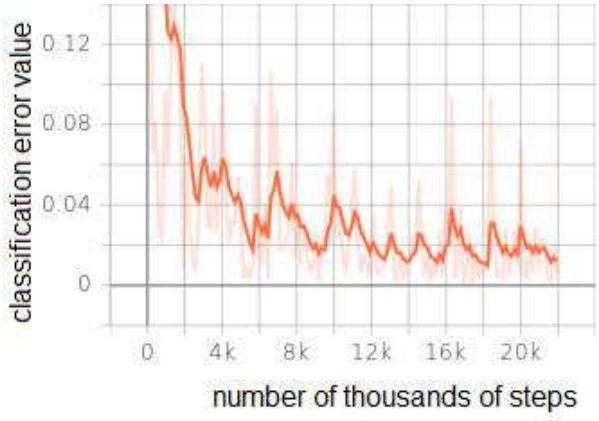

Fig. 2. Classification loss function

Each step of the training communicates a loss. During training, checkpoints are periodically saved, approximately every five minutes. The checkpoint with the highest number of steps will be used to generate the output graph.

IV. Computer Simulation Results

In this section, we will check the accuracy of the results obtained by the trained neural network on images that were not involved in the training process.

In the Table I are presented the errors of the first and second type after the work of the trained neural network. Errors of the second type are of interest, since the task of the next study will be recognition of markings at railway traffic lights. However, the shooting is carried out continuously, therefore, the presence of a small number of errors of the second kind is not critical: in one of the images [14], during the visibility time, the traffic light will be recognized.

Table 1. Errors of the first and second type for traffic lights detecting

	Type I error	Type II error
Small railway traffic lights	20%	2.5%
Large railway traffic lights	12%	1.3%

The Fig. 3 and Fig. 4 show that the large and small traffic lights are correctly identified with 99% and 99% accuracy, respectively.

Fig. 3. An example of detecting a large railway traffic light

Fig. 4. An example of detecting a small railway traffic light

In the following Fig. 5 it can be seen that a railway traffic light is detected even in poor visibility conditions: snow, rain or fog, with an accuracy of 98%, which means that the trained model is able to determine the objects of interest to us in images taken under different weather conditions.

Fig. 5. Photo taken in rain and fog

We also calculated the quality metric indicator — accuracy. Its value is equal to 87%, from which we can conclude that the model quite accurately determines the specified objects in the image and it has not achieved overfitting.

V. Railway Traffic Lights Information System

Currently, information about railway traffic lights is stored not only in electronic form, but also in the form of paper documents. This greatly complicates the search for the technical characteristics of a particular traffic light. In addition, the information may not be up to date. This requires the development of a specialized information system for storing and processing traffic light data.

The primary information about the traffic light in the form of a photo image is sent from the camera to the video server. Traffic light images are loaded from the video server according to the schedule to the data center for further processing in order to detect traffic lights and mark them. The processed image and marking data are loaded into the database of the information system for further use.

The core of the system is a complex of image processing programs, which implements an algorithm for detecting large and small railway traffic lights based on a convolutional neural network, as well as an algorithm for recognizing the text of the marking on them [15]. The information system diagram is shown in Fig.6.

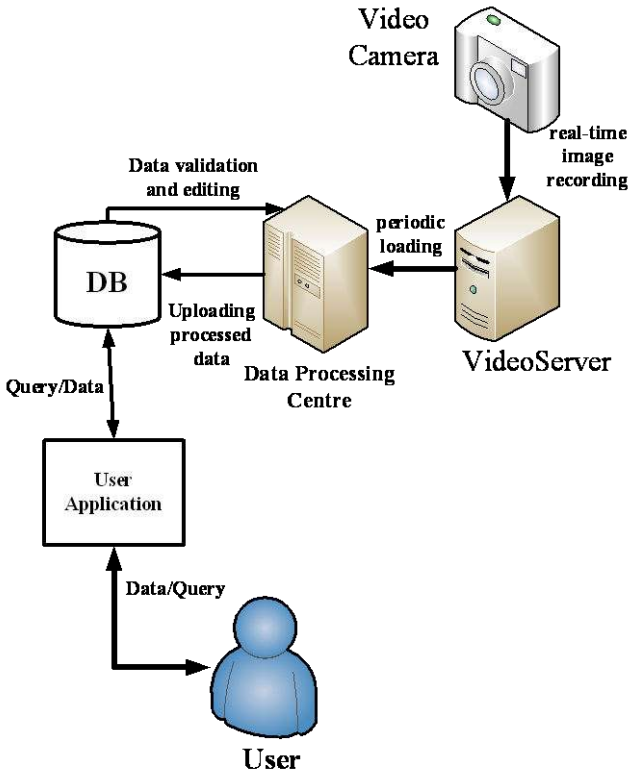

Fig. 6. The information system for railway traffic recognition recognition

The database stores images of traffic lights, as well as contextual information about railway traffic lightsThe central object in the database is the railway traffic light. The attributes of this object are presented in Table. 2.

Table 2. Railway traffic light information structure

Attribute Name	Description

ID	unique identification number, consisting of marking and traffic light position in km
Marking Plate	traffic light number
Traffic light type	small / large
Bbox size	size of the frame framing the object when it is detected
Bbox position	coordinates of the lower left corner of the frame framing the object
Marking	variable of bool type
Date and time of recording	the date and time of recording the attributes in the table
Position	the position of the traffic light in km corresponding to this track

The information system is implemented using a DBMS MySQL and development tools MS Visual Studio.

VI. Conclusion and future works

This paper proposes a new solution to solve the problem of recognizing traffic lights on railways. A neural network has been developed and trained to predict the traffic lights size and their marking. Also, a system was proposed to record, store, process and analyze data about detected objects.

In the future, it is planned to continue this research: to develop and implement an application that will recognize not only small and large railway traffic lights, but also other types, determine the location of railway traffic lights, the color of their signal and detect the fault in the traffic lights. It will be necessary to check the possibility of using other architectures of neural networks to improve the detection accuracy and reduce the computational complexity of algorithms.

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Detection of Lung Nodules in Chest Radiographs Using Wiener Filter and D-CNN Model

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***Abstract*—The automatic and accurate detection of lung tumours or nodules plays a vital role in diagnosing lung cancer. Radiologist have to study multiple chest x-rays to diagnose lung cancer. Since it is a very tedious and time-consuming task, lots of automatic nodule detection and classification techniques based on deep learning have been proposed in recent years. As the previous methods completely rely on deep networks, it increases the computational complexity of the nodule detection process, so in this work, we have proposed a modified wiener filter to remove the adaptive noise from the Chest X-Ray (CXR) images which has not been attempted by any researcher, further to make nodules clearer and contrasting we have enhanced the filtered CXR image by using adaptive histogram equalization (AHE). Later, we have performed classification using the simplified VGG network for Deep Convolutional Neural Network (D-CNN) model to detect and classify the lung nodules from CXR images. As a result, we got an accuracy of 92% in training and 94% on validation, which is then compared with the latest state-of-art works to prove the novelty of our proposed method. The dataset used in our study is taken from the Japan Society of Radiological Technology (JSRT). Finally, we have introduced a Computer Interface (CI) through which the proposed work can be implemented in real-time nodule detection applications in the near future.**

***Index Terms*—Lung nodules, Chest X-rays (CXR), Wiener filter, Adaptive Histogram Equalization (AHE), Simplified VGG network, Deep Convolutional Neural Network (D-CNN), Computer Interface (CI)**

I. Introduction

In 1895 [1] Wilhelm Conard Röntgen has discovered the X-rays, which drastically altered the field of medical diagnosis. At present, X-rays are replaced by ample of other medical imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI). However, this is surely not the situation for the chest radiography or chest X-ray (CXR). Despite what might be expected, the conventional chest study is still by a long shot the most widely recognized kind of radiological method, making up, at any rate, 33% of all tests in a typical radiology department. The basic radiographic image of the malignant nodule is shown in Fig. 1.

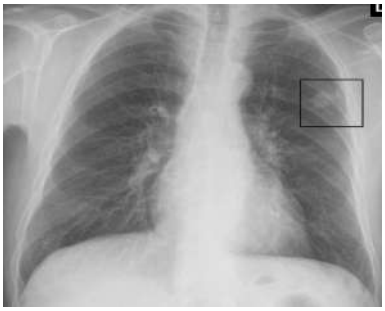

Fig. 1. Chest X-ray (CXR) containing malignant nodule

Though CT scan is more expensive and is not commonly available at local hospitals, CXR's have it's own upper hand in diagnosing the clinical lung cancers. So, detection of lung nodules automatically by computer-aided diagnosis (CAD) can ease the task of radiologists from manually examining the CXR's.

In recent years, due to plenty of CXR's, deep learning (DL) algorithms have emerged into a major part in analysing the CXR images [2] [3]- [4]. Wang [5] utilizes a feebly regulated multi-label image classification and illness confinement framework to distinguish the regularly happening thoracic infections. In [6] Irvin tried different things with different existing profound designs and ways to deal with the vulnerability in the manual labels to classify the 12 ordinarily happening pathologies in their CXR dataset. Different examinations have investigated the materialness of breaking down such datasets utilizing deep learning to help with radiological imaging analysis. In [7] Taylor utilized deep learning to identify pneumothorax in CXR images and received an accuracy of 94%. Yao [8] utilized long short-term memory (LSTM) to use interdependencies among target names in CXR images. Similarly, Zech [9] examined the generalizability of deep learning models with respect to images gathered at various

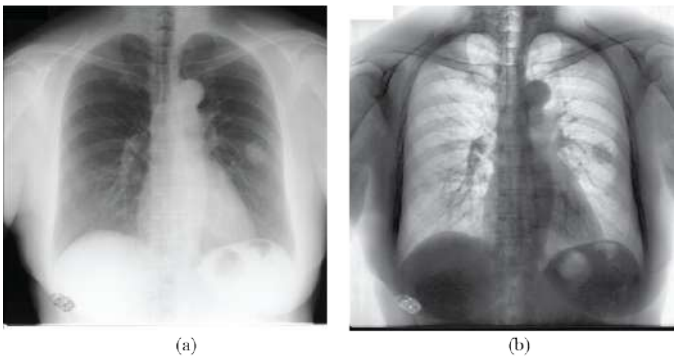

Fig. 2. Preprocessing output (a) Original Chest X-ray image, (b) Adaptive histogram equalization output

clinics to recognize pneumonia and acquired an accuracy of 93% when the model was prepared on images taken from a similar location, and altogether got lower accuracy of 75% when prepared on images from different locations.

So to overcome the problem of computational complexity and to acquire high accuracy in detection and classification of lung nodules, we have proposed a technique which uses modified wiener filter and AHE to enhance the nodules in CXR image. And for classification between benign and malignant nodules we have used simplified VGG network for D-CNN model which clearly gave promising results when compared with the present state-of-art works.

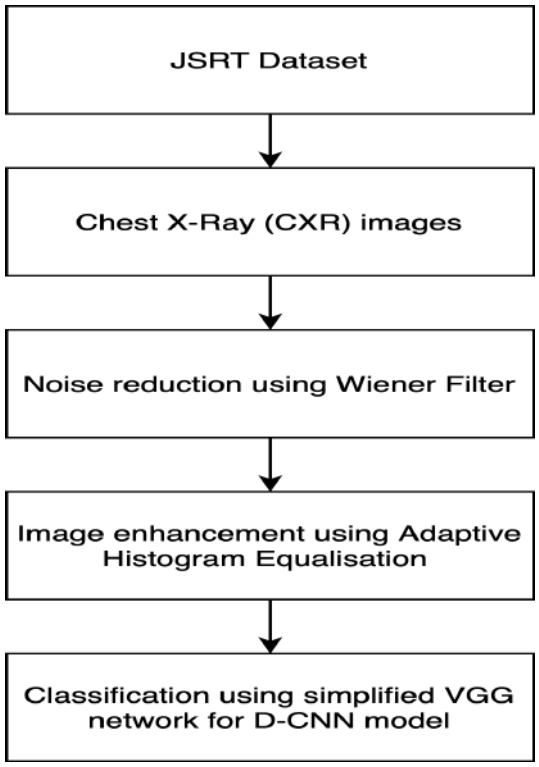

Fig. 3. Flowchart of the proposed work

II. Proposed Methodology: Detection of Lung Nodules and Classification using D-CNN

A. Data Description

For this study we have used the dataset recorded at Japanese Society of Radiological Technology (JSRT) [10]. It is a standard digital image database containing radiographic images with and without chest lung nodules. This dataset consist of 154 images with lung nodules and 93 non-nodule images. Each image is of high resolution with 2048×2048 matrix size and with a pixel size of 0.175mm. This dataset can be used for training and testing the deep learning model for the diagnosis of lung cancer.

B. Pre-processing using Wiener filter

To prepare the CXR images for classification, we need to reduce the noise and enhance the images so that the nodules are identified by the deep learning model. Previously, for doing the preprocessing part lots of frameworks have been proposed such as U-Net and mask R-CNN. The main drawback of these methods is that they require high GPU computers to implement the networks and moreover they are not feasible to apply on radiographic images as they are widely used in computed tomography (CT) images.

To overcome these limitations we have proposed a simple and efficient preprocessing technique to enhance the lung nodules. In this work, we have used modified wiener filter to remove the adaptive noise present over CXR images [11]. Wiener filter uses the least square and its an universal approach to reduce the mean square error in the images. It is often defined as an optimal and non-linear filter. Wiener filter is designed as given in the equation below:

$$G = \frac{\mathbb{H}^*}{|\mathrm{H}|^2 + 1/SNR} \tag{1}$$

Where, H is degradation function and $\mathbb{H}^*$ is its complex conjugate.

C. Nodule enhancement using adaptive histogram equalization

After performing the wiener filtration the CXR image loses its brightness and clarity. So to enhance and de-haze the image we have applied adaptive histogram equalization. After this process lung nodules were clearly visible and the outputs are further forwarded for classification using D-CNN model. The output of the preprocessing part is shown in Fig. 2 and flow chart of our proposed work is shown in Fig. 3.

D. VGG architecture for D-CNN model

In the proposed method, we use the simplified VGG network as the architecture for D-CNN model, which has one layer less than the original VGG network. It comprises of 6 convolution layers excluding the first with the inputs and 3 max-pooling layers stacked on each other alternatively. Each of the 11 convolution layers has 16, 32 and 64 filters respectively with a common kernel of size 3×3. All the 4 max-pooling layers have a window of size 2×2 and a Global Max Pooling layer before

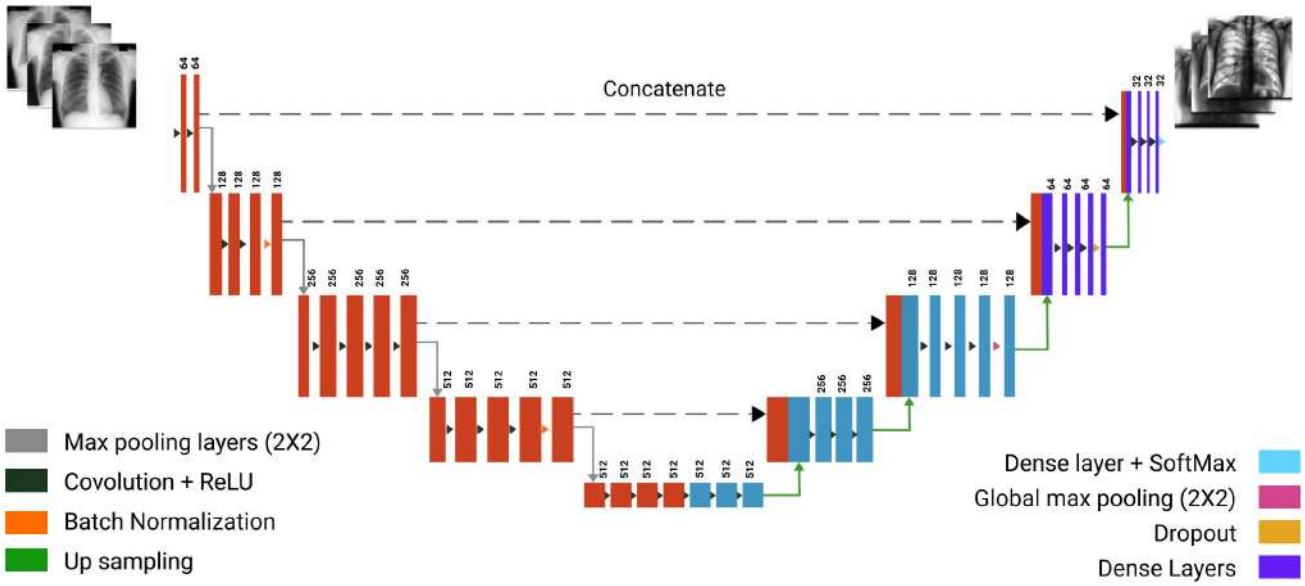

Fig. 4. Simplified VGG network

the first dense layer. The fully connected layer have 1 hidden layer with 32 nodes and 1 output layer. Finally, the output layer has 2 classes which represent Benign and Malignant nodules.

III. Experimental Results

Initially, the CXR images were sorted into different folders based on the presence of nodules. Since all the X-ray images contain a considerable amount of noise, in our work, we have applied wiener filter of size [5,5] to suppress the undesired noise. While removing the noise in the image, few pixels related to nodule also gets hazed, So, in order to enhance the visibility of nodule we have applied adaptive histogram equalization on the filtered image which is then forwarded to the VGG network for classification.

A. Classification using D-CNN

The CNN architecture comprises three layers, namely Convolutional Layer (CL), Max Pooling Layer (MPL), and Fully Connected Layer (FCL). In the provided D-CNN network architecture; We have used 6 CL excluding the first layer with the inputs of kernel size 3, 4 MPL with window size [2,2], 1 Global Max Pooling Layer and 2 FCL with 32 and 3 nodes respectively.

The network is trained to detect important features of lung cancer such as nodules. The output is then passed through a non-linear activation function known as a rectified linear unit (ReLU). Later, the obtained image is passed through the MPL to down-sample the image for accelerating the training process and to reduce the amount of memory consumed by the network. A detailed architecture of the proposed work is explained in the block diagram shown in Fig. 3.

IV. Future Application in Real World

In this section, we have designed how the concept can work in the real world. In the following diagram Fig. 6, the patient's scan will take place to get the CXR data of the lungs. This data will be sent through the proposed algorithm to perform the task of pre-processing and classification. The system's analyzed result is then being accessed through a computer interface and shown to the user. This method reduces the time for initial diagnosis, which can be proved vital for patient's treatment. Designing the whole application for it will be the future scope. The application will output if the lung nodule is cancerous or not based on the classification i.e., malignant and benign. This will help people by instantaneously giving the diagnosed results on their hands and not depending on further radiography procedures. It will enable patients to quickly consult a doctor and go for further medical procedures without delay. In hospitals, this can allow them to prioritize patients for medical treatments. Those who have more chances of developing cancer cells can immediately be taken care of, and others can follow up the rest.

V. Discussion

In this study, we have compared the performance of our proposed method with existing approaches for the classification of LN or non-LN from the CXR's. In the recent study, M. S. Majdi et al. [12] have proposed a deep learning network for classification of pulmonary nodules and cardiomegaly based on ROC analysis in CXR images. They obtained a moderate area under the curve (AUC) of 0.73 for nodule classification and high AUC (0.91) for cardiomegaly classification.

Moreover, A. Siamak et al. [13] have used the VGG-16 architecture to develop a deep convolutional neural network

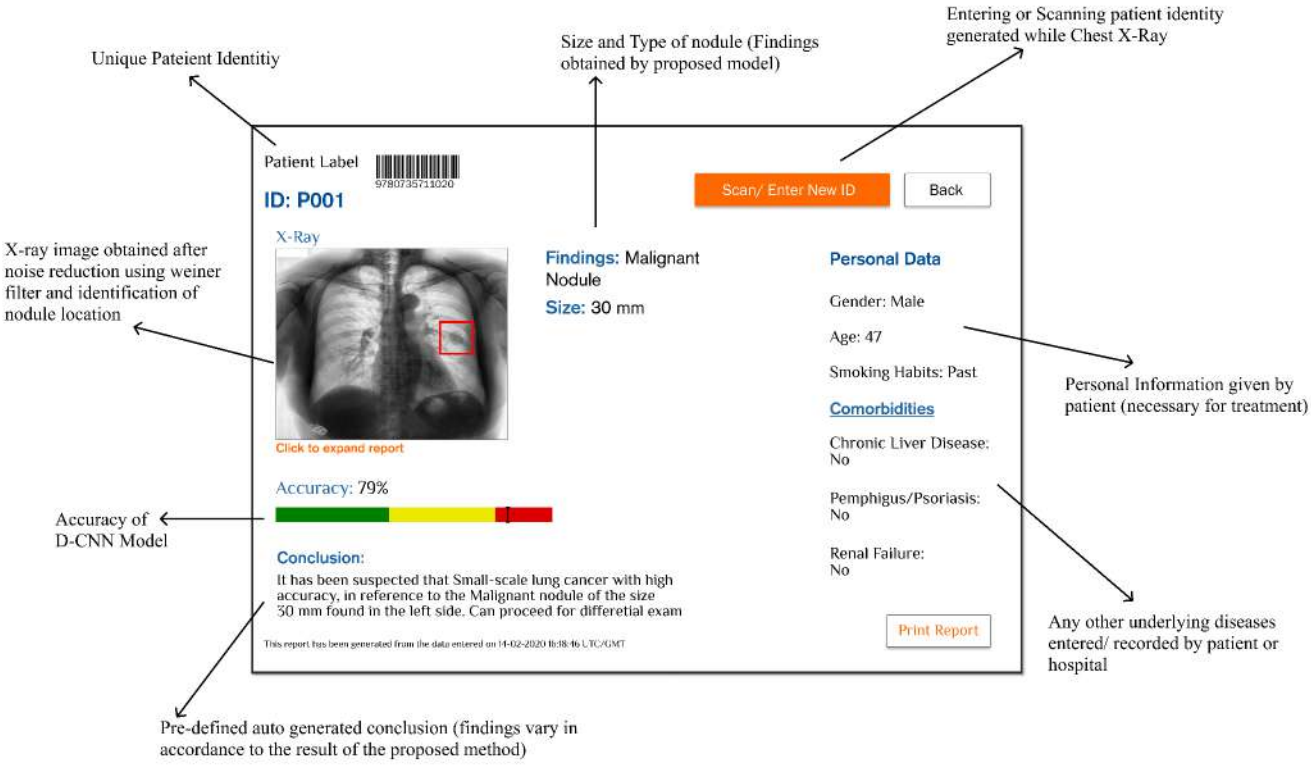

Fig. 5. Proposed computer interface for proposed method

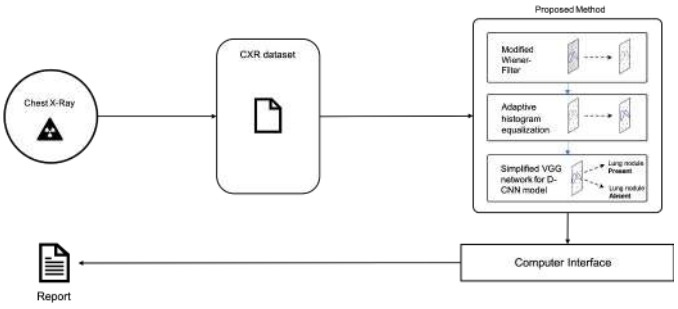

Fig. 6. Flow chart of the application design

(D-CNN) for the classification of 14 different diseases. The D-CNN classifier has obtained an accuracy of 89.06% for 2749 nodule samples. Similarly, P Rajpurkar [14] have developed an algorithm that can detect pneumonia from CXR's at a level exceeding practising radiologists. The algorithm, CheXNet, is a 121-layer convolutional neural network trained on CheXNet to detect all 14 diseases in CXR's. Moreover, L. Utkin et al. [15] have implemented a lung cancer CADx system based on applying the ensemble of TrNNs. They have obtained an accuracy of 63.8% by the ensemble of random forests and accuracy of 91% by the ensemble of TrNNs respectively.

All the works mentioned above presents complex algorithms with less accuracies in detection and classification of lung nodules in CXR images. Moreover, previous papers didn't emphasise the importance of design interface which is a key aspect to implement the proposed work in real life clinical use. In our work we proposed a new algorithm which combines wiener filter with the VGG networkl to detect and classify lung nodules with less computational complexity and high accuracy of 92% . The plots representing our training and validation accuracy are shown in Fig. 6.

The parameters used for evaluating the classifiers in this study are sensitivity, and accuracy as can be calculated by equation (2) to (3).

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FN}} \tag{2}$$

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{FP} + \text{TN} + \text{FN}} \tag{3}$$

where, TP=True Positive, TN=True Negative, FN=False Negative, FP=False Positive

The ROC curve which is plotted with TPR against FPR is shown in Fig. 7.

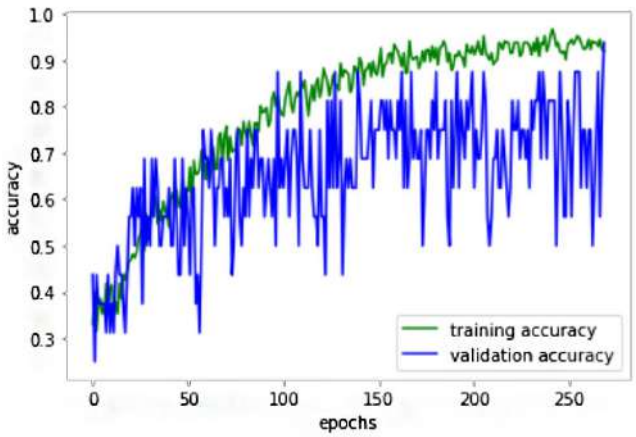

Fig. 7. Graphical representation of training and validation accuracy

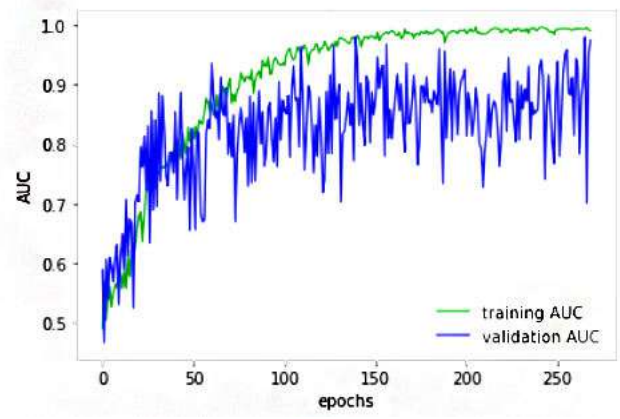

Fig. 8. Area Under Curve (AUC) for VGG network

TABLE I
COMPARISON OF ACCURACY AND RECALL BETWEEN VARIOUS CLASSIFICATION TECHNIQUES AND PROPOSED TECHNIQUE.

Classification techniques	**Lung nodule classification**	
	Accuracy (%)	***Recall (%)***
DL Network [12]	91	73
VGG-16 [13]	89	91
CheXNet [14]	63	57
CADx [15]	91	76
Proposed Method	**92**	**91**

VI. CONCLUSION

In this paper, we have proposed an automatic algorithm for lung nodule recognition and classification. To begin with, we utilized the wiener filter to remove the undesired noise from the CXR images. and enhanced the images using adaptive histogram equalisation. Secondly, we performed classification on CXR images using simplified VGG framework. Finally, we have introduced an interface which will be developed in our future works so that our proposed algorithm can be used by the physicians in understanding and diagnosing the intensity of lung cancers. To prove the novelty of our proposed work we have compared our work with the latest state-of-art works as shown in Table I. The proposed method achieved 91% sensitivity and 92% accuracy on training subset and accuracy of 94% on validation subset.

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Factors influencing selection of Restaurants: An Empirical Study

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Abstract— India is known for its cuisine food and it is a very big part of our Indian Culture. India is also known for its cultural heritage and variety of foods. Every State has its specialty in terms of food and snacks. Indians do believe in dining out and taking snacks from food truck and restaurants. Indore is an education hub where students come from various parts of the country and they off and on go to restaurants or hotels. Indore is known for Poha, Jalebi, Samosa, Kachouri, Daal- Bafla and many more. Indore has places like Chhappan Dukan, Sarafa bazar, Rajbada etc which are full of small restaurants and Gumties having snacks and food stuff. This study is exploratory in nature in which factors have been identified which influence selection of restaurants. It is confined to Indore MP India which is the cleanest city of India for the fourth time consecutively. Sample size is 200 and Self-designed questionnaire has been used to collect data. For data analysis, Factor Analysis has been applied and seven factors have emerged after analysis.

Keywords— ***Restaurants, Service quality, Price, Training, Location, Quality of food, Facility.***

I. CONCEPTUAL FRAMEWORK

Restaurants and hotels are essential part of our lives. Generally, every individual likes to move out for lunch, dinner etc . Even people visit hotels and restaurants when they are invited in party/reception. Development of culinary skills has relationship with fine dining restaurant establishment. World's first restaurant opened by the soup seller in Paris. Food and place were provided to travelers with to rest in India in early 250 BC. The rapid urbanization, change in lifestyle, nuclear family culture are some main parameters responsible for the progress of the restaurant industry in India. Over a period of time people increased exposure of international cuisine like Chinese, Italian, Mexican etc. As awareness got increased about these cuisines, people are expecting for experiencing fine dining. Theory of fine dining is not only going out and having eatables but it is all about experiencing dinning through, decor, ambience, service quality of food etc. Consumer's behavior changing towards the restaurant sector positively due to the growing economy.

The Indian food market monitoring report 2002/2003 (www.restaurant.org,2019) shows a growing tendency for dining out as a consequence of higher income and increasing in dining out is a significant part of lifestyles.

A. Healthier Options

Many diners look forward for such options which can offer them healthy food for quality life. Customers pay more attention to nutrients rather than its appearance. Diners expect more from restaurants , 81% of adults believe that restaurants give more nourishing eatables than they did two year ago.

B. Eco Friendly Dining

When customers think of a restaurant, they also keep in mind that it should be eco friendly which makes them comfortable. Around two thirds of consumers say that they are expecting to have restaurants who are having eco friendly practices.

C. Technology

At this point of time customers believe that there should be in a position to use technology while paying bills with the help of smart phone. Within a year use of technology has gone up to 25% from roughly which was 20% a year ago.

D. Local Food

People have craving for local food as well including trends in breakfast, appetizers , deserts and favorite food stuff. No doubt customers try out food or snacks of other states/country. It can be based on others recommendation or sometimes their own previous experience as well.

E. Quality, Innovative Food

Out of 10, nine consumers prefer food which is safe to eat, and out of 10, six claim to be more exciting diners then there were two years ago. Around 50% plus people are looking for new meals which they can not prepare at home.

F. Price

Most of the customers consider price as most important factor which affects the customer preferences towards restaurants. Everybody cannot afford to have food in 3 star or above category hotel.

G. *Ethnic Cuisine*

People occasionally go for ethnic food. Around 65% plus consumers say, at a restaurant they would like to order for ethnic foods instead of trying to cook it at home.

H. *Mobile Options*

Consumers are purchasing snacks and food from food trucks also. Forty seven percent reported condescending a food truck, off from forty percent previous year. And seventy percent, all adults confirm that they had bought from a food truck if their favorite restaurant had one.

I. *Service Quality*

Service quality plays a pivotal role in hotel industry and customers are tempted to visit the same hotel because of its service quality keeping in mind quality of food also. Time taken by hotel personnel from taking order to serving food matters a lot. It is a general phenomenon that customers do not want to wait for a long period of time when they have already placed an order.

J. *Restaurant Environment*

The ambience of any place has a positive effect while opting a hotel for dining. Location of hotel plays an important role in selecting a hotel.

K. *Location*

Generally people prefer to go to the restaurants/hotels which are near to their house or its location is good enough hence, location is very important factor in selecting a hotel. Now a days people prefer to go to a long drive for dining and try to have dining in a noise free environment.

L. *Trustworthiness*

Some of the people go to the same restaurant again and again because they have trust for the safety of their articles, place, food, quality, quantity etc. They understand that what is promised is offered to them.

II. LITERATURE REVIEW

Sohrabi et al. (2012) have done a study to know a practical pointers that illustrates the most noteworthy factors for selecting a hotel and found that "Promenade and Comfort, Security and Protection, Network connection, Pleasure, News and Recreational Information, Expenditure ,hotel personnel and the services, Car Parking, Cleanliness and Room Comfort and Room Facilities. Results reveal that the most vital feature for tourists in choosing Tehran hotels is Hotel Comfort followed by Hotel Compensatory. It appears that costumers are looking for more services like car parking area, improved quality connection and e-banking." [36] Hsieh et al. (2008) found that "the most important hotel selection factors in hot-spring tourism industry at Taiwan are the Price level , the Ability of the Service Personnel to solve problems fast, Convenience of Reservation process, Suitability of Traffic route, Food and Beverages Service and Special Promotions,." [16] Kaura (2011) identified "quality of food does not play most imperative reason for restaurant customers who are young; customers who are above sixty years of age show quality of food as the most significant trait defining their experience". [21] Auty (1992) tried to study the effect of demographical variable on customer satisfaction. It is found that that "restaurants' selection is grounded on four occasions: social occasions , celebration, , convenience/quick meal, business meal. Food quality, food type, excellence and worth for money were considered as the important attribute for consumers when they select a restaurant." [03] Kivela et al. (2000) found that "a noteworthy variance in experiences of the service quality for customers of males and females in which females were more alert about spending money on dining out in Hong Kong". [24] Rahman et al. (2012) identified in the study that "customers' experience for food is greatly affected by age groups. Well established restaurants' customers are having concern for quality of food and health." [31]. Sulek, J.M. and Hensley, R.L (2004) found in the study that "food quality was of prime importance, but restaurant's ambience and the equality of the seating procedures had a significant impact. Additional healthy menu items were the concern for diners." [38] Turgeon, L. and Pastinelli (2002) identified that "the multi cuisine restaurants are preferred more in place of different type of food because they provide the scope to taste variety of exotic cultures at one place." [41] Angelo and Vladimir (2011) found in their study that "The hospitality industry is very systematic. It is very needed on the service and employees' performance. Type of service, demands promptly creation and provision of the products and services. Apart from selling a tangible product, has a key attention on serving intangible service, so service delivery influences view and understanding which are patron expectations centric rather subjective". [02] Haghighi et al. (2012) studied that "customer satisfaction is based on price. Additionally service's price is important factor in influencing visitor's satisfaction. Restaurant's staff comes to second level in satisfaction level of guests." [15] Jung et al. (2015) found that "food's quality, price and service as significant parameters. Physical evidence, food and service provided by the staff of restaurant are accepted as vital components that greatly impacts the opinion of the guests in quality of restaurants".[20] Geissler and Rucks (2011) have found in their study that "demographics show a pivotal role in influencing dining experiences of customers. Customers

appraise food's quality, the sociability and graciousness of personnel and the way interior décor is done." [14]

Spielberg (2005) identified that "education influences experiences of people and forms their beliefs, values, interests, attitudes, activities and also lifestyle. "Food's quality is regarded as the most significant attribute which powers decision on restaurant selection" [37] (Soriano, 2002). "food of various cultures are acknowledged if they have familiar preparation styles and ingredients" [35] (Bailey and Tian, 2002). "When it is a matter of selecting a restaurant, exclusive taste of food and ingredients show an important character for consumers." [04] (Josiam and Monteiro, 2004).[19] "Generally consumers think that restaurant's service should be attentive, courteous, and have a sound knowledge of the menu" (Hensley and Sulek, 2004). [17] "To attract consumers big number of restaurants are including items in the menu and amending their menus considering nutritional worth of a meal" (Mill, 2007).[28] DeFranco, Jackson and Titz (2004) found in their study that "Coupon promotions are benefitting High-priced restaurants to a larger degree as compared to restaurants having lower price"[12] ."Presentation and appearance of food helps to have customer's satisfaction in restaurants" [17] (Jang and Namkung, 2007).[18] "Diners prefer a unique cuisine restaurant to understand different cultures"(Boyce J.B. and Sukalakamala P, 2007).[9]. Clark (1998) in his work found that "Flavour and taste are very important parameters in consumer's food choice. Food choices can be altered by continuous consumption of food".[11] Ananth et al. (1992) came across that "Price and food's quality was rated as the most imperative attributes. These parameters are related to security and convenient location of hotel are also of great importance." [01] Deivanai (2013) explained that "Dominos pizza commonly strives on location, price, and food quality. Taste and cleanliness is playing an essential role in the buying process of eatables. Outings of families, celebrating special occasions and convenience are crucial factors in buying pizza. Customers believe that their outing is solely because of taste for a change but they also believe that fast foods do not have good nutritional value". [13]

III. Methodological Approach

A. The Universe

For the study, Universe is Indore MP India, cleanest city of India. Indore is also known as Commercial capital of Madhya Pradesh and Indore is known for its variety of food zones and hotels and restaurants.

B. The Study

The study is exploratory in nature.

C. The Sampling Unit

The sampling unit is males and females of Indore M.P. irrespective of their age, family income and occupation. Respondents were students, businessmen, service class people and house wives.

D. The Sample Size

Questionnaire was distributed to around 219 respondents but finally 200 filled questionnaires were received which were complete in all aspect.

E. Tools for Data Collection

Primary data has been collected by self designed questionnaire after going through literature review. Journals, magazines and websites are source of secondary data.

F. Tools for Data Analysis

Normality test, Reliability test, Factor Analysis has been applied to fulfill objective.

IV. IV OBJECTIVE OF THE STUDY

To identify the factors which affect the customer preference towards restaurants.

A. RESULTS AND DISCUSSION

A. Normality Analysis

KMO and Bartlett's test results shows that if the data is suitable for analysis or not. High value (between 0.5-1) of KMO indicates that the factor analysis is appropriate and the result is .000 thus data is appropriate. The value (**see table 1**) is .718 which is comparative high.

B. Reliability Test

To check reliability, Cronbach's coefficient alpha (a) is applied to newly constructed evaluation tool. Coefficient alpha value of all 27 items has been taken and was calculated on SPSS and it was high i.e. 0.887 (**see table 2**).

C. Factor Analysis

Factor analysis was applied to predict the factors which contribute in selection of hotels in Indore city. On the basis of the load of variables on components we categorize the variables into 7 groups.

Factor 1: Convenient Timing and Popularity

"More people prefer Convenient timing to select a restaurant" with a factor load 0.779. "People are more conscious about the distance from their place" with a factor load 0.777. "Buffet system "with a factor load 0.615. "People check the popularity of the restaurant in the city" with a factor load 0.536. "Family clientage" with a factor load 0.510. "Way the value its customer" with a factor load 0.500. Ritesh Shinde, Pravin Chavan and M.M. Ali (2018) [33] found that "Convenience and Affordability is the sole factor of customers' satisfaction of restaurant (fast food)which explains 7.6 percent variance. It has variables as parking, billing time, delivery system, price offers and discount. Hence the availability of quick parking, fast delivery and minimum billing time at affordable pricing is imperative".

Factor 2: Preference and Billing

"Billing facility" has a high factor load 0.815. "Membership of Restaurant" has a factor load 0.738. "A restaurant Contains bar" has a factor load 0.582. "A la carte " has a factor load of 0.541. Bhatnagar and Kushwah (2013) [05] ,explained that "Domino's realizes customer's need the Domino's brand with emergence of novel products and usage of technology. Satisfaction, Predilection (liking), excitement, services and influence".

Factor 3: Quality and Service

"Quality of food" has a high factor load 0.818. "Cleanliness" has a factor load 0.713. "Quick service" has a factor load of 0.647. "Taste of food" has a factor load 0.646. "Sometimes people are more interested about the variety of food available in the restaurant" has a factor load of 0.600. "In order to provide exceptional customer service for hoteliers, there is a need to provide training of hotel front line personnel are consider as semi-skilled or unskilled. Maintaining good customer relationship is a crucial factor in is fast and effective response to a customer" (Kidwai, 2017).[22] "Expectation and preferences differ each customer. Hoteliers should know customer's requirements and should supply tailored service in order to surpass expectancies and spread constructive view about the experience" (Tounta, 2014). [40]

Factor 4: Ambience and Offers

"Play zone for kids" has a high factor load 0.812. "Discount offers are often a point of selecting any restaurant" has a factor load 0.778. "It is important for me that the Washroom facility should be proper" with a factor load 0.489. "As I am a music lover I always look for a good orchestra in the restaurants" has a factor load 0.453. "For me it is important that the restaurant is renowned and has a brand name" has a factor load of 0.409. "The appearance of the restaurant like restaurant's ambience, atmosphere, furniture, decoration and other amenities can have a high impact on the experience of dining" (Sloan, 2004).[34] "Diners usually feel that ambience and style are important for maintaining esteem needs" (Peters, 2005).[30]"Restaurants often improve menus and offer a range of different tariff items to draw attention of customers".

Factor 5: Price and Location

"Price is considered as one of the most vital parameter which impact the decision of consumer while selecting any restaurants" has a high factor load 0.867. "When I chose a restaurant I always see that it should be reasonable in price" has a factor load of 0.719. "Location also affects the decision of people while selecting any restaurant" has a factor load 0.625. "customers generally don't remember the money that they spent and time has come when hotels should make sure that they have to see equilibrium in accurate price offered that will give benefit to consumers and hotel . There is noteworthy association in the price that while choosing hotel a business traveler does to stay in as cited earlier there are several researches that depict that business travelers are picking hotel on the basis of complete work needed. While selection process of hotel if the apparent total price is higher, then business travellers will not do booking but they search for more reasonable discounts and price. Customer will go for the price which he had paid for a hotel if the real price is lesser than expected price" (Lie and Zhang, 2014). [27] Pan et al. (2002). [29]"Tourist hotel location selection is based on convenience of traffic, well visual opinion and facilities for public available in near-by of a hotel". "it is very imperative for a hotel management to mention their site properly

while they go for promotion of selecting their hotel" (Chou et al, 2008).[10]

Factor 6: Facility

"People also choose different methods for bookings in the restaurants" has a high factor load of 0.837. "For Me there should be proper parking place in the restaurant" has a factor load 0.462. Kuckusta (2017) [25], measured the approaches of guests towards various hotel facilities. Study revealed that Wi-Fi is considered as the most valuable hotel feature for Chinese consumer and least valuable hotel amenity i.e. telephone. It was found that guest's willingness to spend is affected by providing luxury-brand room amenities. Once luxury facilities are positioned in the room, guests' opinion of room rent instantly creates higher bar for their readiness to pay.

Factor 7: Trained Staff

"I always prefer the restaurant which has good and soothing ambience" has a high factor load of 0.793. "Well trained staff" has a factor load of 0.481. "Much literature talks about efficiency through training " (Thomas and Long, 2001), [39] "identifying that human capital affects the efficiency of firms positively" (Blake et al, 2006).[06] Kilic and Okumus (2005) [23] found that "recruitment of staff, staff's training, fulfilling visitor outlooks and quality service are the main productivity parameters in the hotel sector".

TABLE I.

Table 1	**KMO and Bartlett's Test**	
Kaiser Meyer-Olkin Measure of Sampling Adequacy.		***.718***
Bartlett's Test o Sphericity	***Approx. Chi-Square***	***945.883***
	Df	***351***
	Sig.	***.000***

Cronbach's Alpha	N of Items
.887	***27***

V. Conclusion

Though during Covid 19, people are little reluctant to visit restaurants and hotels but it is growing sector. In this cut throat competition, restaurants are attracting their customers with various means and ways. Some believe that only Quality of food is enough but some believe that additional things are also very much essential to attract and retain customers. It has been observed now days that ambience of restaurant plays a pivotal role in selection of location of restaurants. At this point of time some restaurants are focusing on hygiene more than any other factor. Customers also observe that whether restaurants are having sanitizers at places or not and staff is using mask or not? Staff who is serving food, is wearing gloves or not? This research says that the different parameters affect the preference of the customers while selecting any restaurant in which some factors play important role like Convenient timings and popularity, Preference and billing, Quality and service, Ambience and offers, Price and location, Facility and Trained Staff. In the modest and uncertain nature of the prevailing restaurant environment in world, the key issue for restaurants' survival and accomplishment is to keep the customers happy. Customers are very much alert about the food stuff and the way in which it is served. Now-a-days in restaurants customers expect far beyond food. Customers' preferences may get change over a period of time. There may be more factors which may come in the way of selection of a restaurant.

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Application of Topic Modelling for literature review in management research

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***Abstract*—The paper proposes topic modeling as an efficient method for an exploratory literature review for management research. The model has been built to analyze research contributions of Game Theory predominant in the area of management research. The study primarily caters to 2 objectives, first, to build a topic model using the Latent Dirichlet Allocation (LDA) method. Secondly, the study presents one of the optimization methods to build the improved topic model. The results for both models are compared in terms of statistical measures (coherence scores in this case), semantic coherence, and interpretability. A considerable improvement from the base model is observed in the optimized version of the base model. Solution concept of Nash Equilibrium, Market games and Market competition, Allocation games, and Network games are found to be predominant sub-themes in the extracted topics.**

Keywords—Exploratory Literature Review, Game Theory, Text Mining, Topic Modelling, Optimization, Management Research

I. INTRODUCTION

Management research by nature is interdisciplinary as it draws in from multiple domains of research. To better understand the concepts of a research area, the interdisciplinary nature of management research calls for in-depth knowledge of contributions to the domain, i.e., through a review of the existing literature. An efficient way to initiate the study of such a vast body of contributions is through an exploratory literature review (ELR). The traditional ELRs had suffered from the biases of a researcher in terms of selection of articles under study and also have been very time-consuming to conduct [14]. It has also received criticism due to a lack of replicability and validity. To curb these short-comings and to ensure replicability and validity, the author proposes a systematic topic modeling based exploratory literature review. To illustrate, the author conducted a topic modeling based ELR on Game Theory. The reason for selecting Game Theory is primarily to exhibit its interdisciplinary background and multifaceted applications. Another reason for the selection was the author's expertise with the topic to better interpret the model results. Topic modeling is an efficient and scalable text mining tool that had been used in this paper to analyze articles to extract major research themes of Game Theory. These extracted themes are treated as the output of the ELR, which provides a general idea of the discipline [3]. These individual themes then could be subjected to further in-depth structured/ systematic study [10].

The objectives of this study are twofold. The first is to conduct a proper exploratory literature review of an interdisciplinary topic through the Latent Dirichlet Allocation (LDA) based topic modeling method [1][3]. The second objective is to build an optimized topic model for better interpretation. Contrary to the usual iterative optimization method, here in this paper, the optimized model had been built on the base model using a wrapper function. This approach aids in the efficient utilization of CPU resource and time compared to the iterative method of tweaking model parameters to find the best fit.

The purpose of ELR is to obtain broader research themes of a domain. Since topic modeling operates with the bag of words, i.e., analyses the textual corpus based on frequency and co-occurrences of keywords, it helps to extract important words indicative of the aforementioned themes of an ELR. It has to be kept in mind that the topic modeling is an unsupervised machine learning method. The underlying computational mechanism can extract keywords for the desired number of topics. But they might not be semantically coherent or useful at all. Hence, it requires human judgment and the expertise of the researcher to interpret the results successfully [9].

II. METHOD

The paper builds a framework (Figure 1) to conduct topic modelling for an exploratory literature review. The study utilizes the open-source topic modeling library Gensim, available in Python, to create the program [15]. The entire analysis can be segregated into three stages: pre-processing, topic modelling, and post-processing [3].

The pre-processing handled the data clean-up and data preparation to build topic models in the next step. The preparation followed the standard process of tokenization followed by building N-grams, removal of Stopwords, and finally, Lemmatization.

The final corpus was then used to build topic models, beginning with the base model and then derive the optimized model. Here, the author employed the LDA method to build the topic models since it has several advantages over other topic modeling methods like LSA (Latent Semantic Analysis) [12]. LDA is a generative model, allowing to group the articles in the corpus into distinct themes [20]. Moreover, it is possible to employ the fitted model to analyze a new document/ text [4]. Also, LDA is useful for large scale corpus, making it suitable for exploratory literature review on the bulk of research articles [8][11].

The post-processing catered to understanding and interpreting the latent themes from the keywords extracted in the topic modeling step. The objective of a researcher in a topic modeling based study is to obtain the best fit model which is statistically valid and semantically coherent.

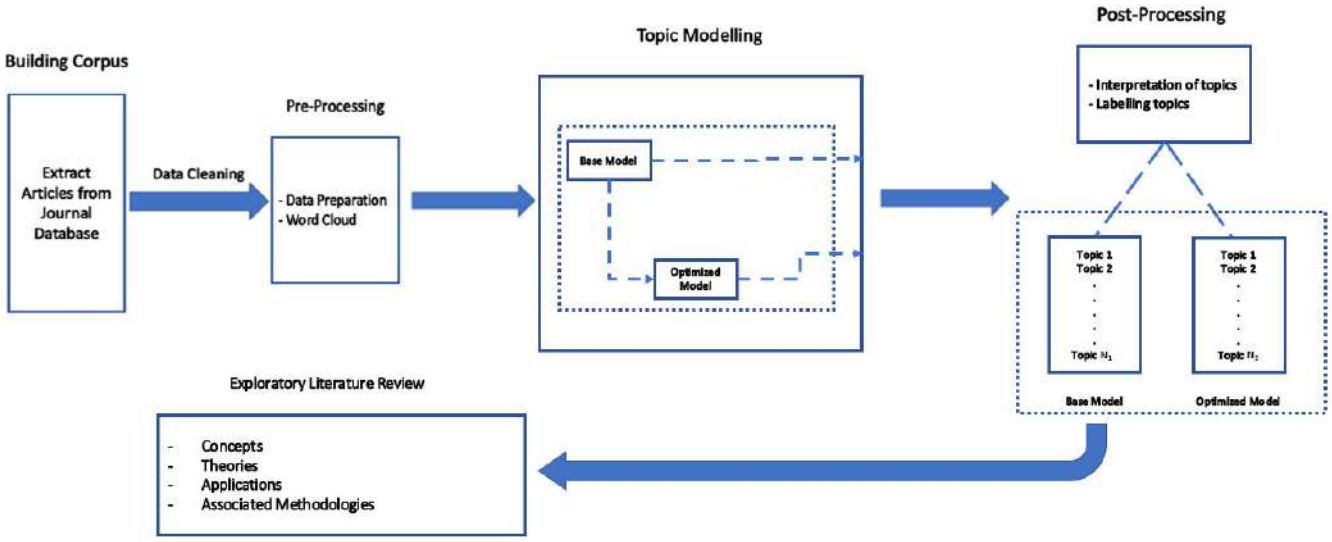

Figure 1 Schematic representation of the topic modeling based exploratory literature review framework (Figure prepared by author)

III. RESULT

The result section is spread over in subsections to present the outcomes of pre-processing, topic modeling, and post-processing operations. The details of each subsection are as follows:

A. Pre-processing

Game Theory as a discipline deals with the strategic interaction between 2 or more agents. The agents have payoffs for each action taken by them and the other players. This interaction can be translated to represent cases in different disciplines. For example, in 1944, game theory was formally introduced as a mathematical solution concept in economics [18]. However, researchers soon found its applications in areas other than Economics, like Social Science, Computer Science, Biology, etc. Management studies had incorporated learnings from Game Theory to study the interaction among players in the market, price and quantity competition, business strategy (M&A, expansion, internationalization).

Since the study focuses on the literature pertaining to management research, the search criteria to extract research articles were restricted to Economics, Business Management, Decision Science, and Social Science domain. Furthermore, the result was filtered for articles only in English. It is necessary to specify the source language since the program has to handle language-specific nuances, parts of speech, and default stop word list.

Using the aforementioned search criteria in the SCOPUS database, the search resulted in 15,103 articles. The extracted data contained information on the respective research article spread across 25 columns like Authors, Title, Year, …, Abstract, …, etc. A sample of the data headers is as shown below Table 1.

This raw data was then cleaned and arranged for further processing. First, the problems with missing data and erroneous data were handled, which resulted in the removal of 410 entries, thereby leaving 14,693 entries for the next step of pre-processing.

An overview of the selected articles is as follows:

A gradual increase in Game-Theoretic studies was observed over the years from 1953 to 2020 (till October), with a peak of 1203 in 2019, as shown in Figure 2. Till October 2020, 948 articles were published, with the possibility of more publications by the end of the year.

The top 10 most cited works are presented in Table 3. It can be observed that all these articles broadly fall under the scope of Game Theory. However, conceptually, they are from different backgrounds. For example, mathematical modeling, supply chain management, decision strategies (at the political and institutional level), behavioral or sociological phenomena (preference, reciprocity), and experimental studies were the most prominent research areas. The results are tabulated in Table 2.

Hence, there are ample sub-topics under the game theory that could be the focus of the next level of in-depth literature review. In order to find the major themes under Game Theory, this exploratory literature review is performed. This study can be considered as precedence to conducting an in-depth survey of the literature in the future.

From the extracted data (25 columns), only the fields Authors, Title, Year (of publication), Cited by, and Abstract are essential for the analysis in this paper. The abstracts of the papers act as the corpus for this study.

Table 1 Overview of the extracted data

Authors	Author(s) ID	Title	Year	Source title	Volume	Issue	Art. No.	Page start	Page end	Page count	Cited by	DOI
Leifer E.M	164210975	Trails of ir	1988	Sociologic	3	4		499	524		8	10.1007/B
Brams S.J.	660373962	National s	1988	Synthese	76	2		185	200		5	10.1007/B
Marte A.L.	700338945	How does	1988	Journal of	19	4		166	168		21	
Judice J.J.	700489439	Reformula	1988	Journal of	57	1		123	149		13	10.1007/B
Pachter M	700501540	An optima	1988	Journal of	56	2		179	204		5	10.1007/B

Table 1 Overview of the extracted data (Contd.)

Link	Abstract	Author Keyword	Index Keyword	ISSN	ISBN	CODEN	Document Type	Publication Stage	Access Type	Source	EID
https://w	Game theory seeks solutions tl			8848971			Article	Final		Scopus	2-s2.0-0007246863
https://w	Issues that arise in using game			397857			Article	Final		Scopus	2-s2.0-0141844225
https://w	[No abstract availabl	aged; agir		220124			Article	Final		Scopus	2-s2.0-0024043805
https://w	A family o	absolute v	COMPUTE	223239			Article	Final		Scopus	2-s2.0-0024000344
https://w	We consic	Collision a	KINEMATI	223239			Article	Final		Scopus	2-s2.0-0023964872

A corpus is essentially a collection of documents/ text which serves as the input for topic modeling. This corpus was further processed to derive the topic models to extract the latent themes of Game Theory.

Continuing with the pre-processing step, the clean-up procedure of the corpus catered to the four following purposes:

1) Conversion of the corpus to lowercase,
2) Removal of punctuations,
3) Removal of URLs, and
4) Removal of STOPWORDS (includes default stopwords in English and a Customized list).

A wordcloud was built to observe the most frequent words in the corpus. The program was designed to fetch the top 200 words (Figure 3).

The largest words are Game Theory (as expected), model, games, strategies, equilibrium, information. These are indicative of key terminologies in game theory. Looking closer, the smaller terms represent economic games, with terms like behavior, network, decision, price, conditions, management, competition, agents, product, price. It can be interpreted as narrowing down scope from a general broader perspective of game theory to application in the areas pertaining to Economics, consistent with the aforementioned search criteria.

B. Topic Modelling and Post-Processing

This processed data (i.e., corpus) was carried forward to the next stage to build the topic models. The topic models were built using the LDA (Latent Dirichlet Allocation) Method. It is an unsupervised and probabilistic modeling method that generates topics from an unlabelled corpus [1][2]. Following the bag of words approach, the frequency of occurrences of the words is computed instead of analyzing the semantics and meaning of the sentences in the corpus. The built-in functionalities of the Gensim library were utilized to build the topic models.

The post-processing is the analysis phase, where topics are interpreted from the keywords derived from each model. These themes are represented with brief one- or two-word labels or with a single sentence description where required.

For ease of presentation and comparability, each model is explained below, followed by their post-processing themes and labels.

1) Base model

The base model was prepared using the Gensim library [15] and estimated with 10 topics. The coherence score was computed for both base and optimized models [19]. In the newer literature, this external model quality parameter is considered a better measure to evaluate model quality. There are multiple ways to compute coherence, for example, C_v, C_{UCI}, C_{UMass}, C_A, and C_P.

Here, coherence is measured by C_v, which is computed on a sliding window [16]. It is a single set segmentation of the most frequently occurring words and an indirect confirmation measure using NPMI and the cosine similarity [16]. The perplexity is computed as -18.6922972369299, and the coherence score is 0.391309635621936. The keywords for the 10 topics of the base model are presented in Table 3.

From an analyst's point of view, there is no fixed good or bad coherence (C_v) score since the score is highly dependent on the nature of the corpus. Nevertheless, an improvement in the coherence score is an indicator of better topic interpretability. The program is designed to fetch only the top 10 words for each topic. From the keywords, it is evident that some topics are interwoven, e.g., topic 3 and topic 7. Also, there are topics like 4, 6, and topic 9, with some redundant words, which compromises the interpretability of the themes. The labels for the interpretable topics are presented in Table 5.

The dynamic visualization of the model in Figure 4 shows that there are much overlap among the topics [17]. It represents the repetition of keywords in multiple themes, which results in closely related topics. Hence there exists a need for optimization of the model.

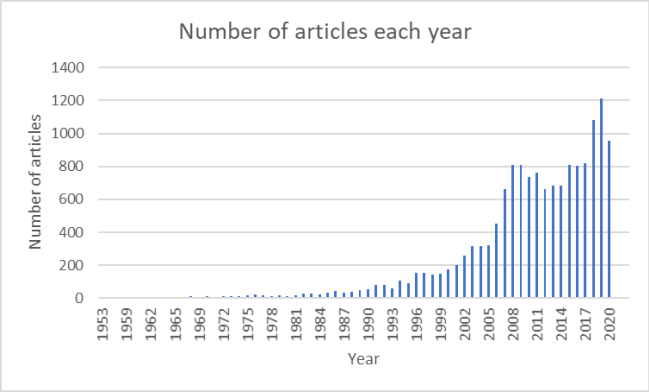

Figure 2 Number of articles published in each year

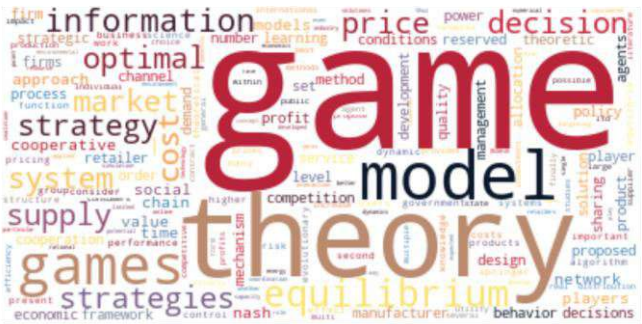

Figure 3 WordCloud of top 200 words in the corpus

Table 2 Top 10 highest cited articles

Title	Authors	Year	Cited by
On the acceptability of arguments and its fundamental role in nonmonotonic reasoning, logic programming and n-person games	Dung P.M.	1995	2735
The digitization of word of mouth: Promise and challenges of online feedback mechanisms	Dellarocas C.	2003	1788
Veto players: How political institutions work	Tsebelis G.	2011	1786
Supply chain coordination with revenue-sharing contracts: Strengths and limitations	Cachon G.P., Lariviere M.A.	2005	1544
Understanding institutional diversity	Ostrom E.	2009	1358
Democracy and redistribution	Boix C.	2015	1071
Predicting How People Play Games: Reinforcement Learning in Experimental Games with Unique, Mixed Strategy Equilibria	Erev I., Roth A.E.	1998	1009
A theory of reciprocity	Falk A., Fischbacher U.	2006	998
Direct marketing, indirect profits: A strategic analysis of dual-channel supply-chain design	Chiang W.-Y.K., Chhajed D., Hess J.D.	2003	898
Preferences, property rights, and anonymity in bargaining games	Hoffman E., McCabe K., Shachat K., Smith V.	1994	884

2) Optimized Model

From the computational point of view, it is assumed that an improvement in coherence score is an indicator of a better model. The base model has been iteratively evaluated for improved coherence score. But due to the nature of the corpus, the best fit model extracted only 2 topics with a better coherence score. These topics were very generic, which is also expected intuitively. The model quality parameters like perplexity (hence loglikelihood) and topic coherence are often found to be uncorrelated or, perhaps, negatively correlated [6]. Hence, at least for this type of corpus, a different optimization method is required. There are multiple optimization methods available to enhance a topic model [forthcoming working paper by author].

In this paper, an enhanced version of LDA is implemented using Mallet (Machine Learning for Language Toolkit) wrapper to build the optimized model [13].

The model is tested for 10 topics. The resultant coherence score is 0.468953550346569, which is an improved estimate compared to the previous models 1 and 2. The keywords for this model are given in Table 4.

The inter topic distance map in Figure 5 shows a comparatively balanced spread of topics across the plane. As the model has improved on coherence score and a good balance of topics as seen from the map, the semantic analysis is performed on the optimized model to identify the major themes hidden in the corpus [Table 5]. It was found that this model covers a set of 10 diverse themes. The themes cover aspects from market games in the context of economic theories, the study of social behaviour. It also proposes experimental methods to understand game-theoretic concepts. The relevance of these sub-themes was validated and confirmed from domain expertise.

Each of these themes is worth pursuing a focused study. Hence, this model serves the original purpose of conducting a literature review.

IV. Discussion

It was found that both models extract at least one topic that is indicative of the central idea or definition of game theory. The topics in the base model cover the broader application area (topic 2, 5) of game theory. The other topics catered to the key terminologies and the popular solution concept of Nash Equilibrium. Strangely, the latter context did not surface in the optimized model. The base model's point of concern is that 3 topics are incomprehensible from the top 10 keywords extracted to identify the topic. Hence, the need for an optimized model arose.

The optimized model performed much better in extracting the most discussed sub-topics in Game Theory (Topics 2, 3, 5, 6, 7, 9, and 10). Management research fields such as business strategy, public policy, international relations, microeconomics, and macroeconomics heavily rely on these research contributions.

The point to be highlighted here is that this study has three parts for analysis. First, the python program efficiently extracts keywords from the corpus. Each set of keywords represent each topic. The second part of the analysis is the trickiest as it is subjective, depends on human judgement and the researcher's expertise [7]. The researcher first checks for the semantic coherence of the group of keywords assigned to a topic. If they made sense, then based on domain expertise, the researcher chose 'labels' to indicate the themes [8]. This two-step process completes the topic modeling part. The final part is about conducting the ELR. The purpose of an exploratory study is to extract themes from a broad discipline of research. It allows to obtain an overview of the contents of the discipline as well as familiarizes the researcher with the seminal works in the area. The researcher then can draw from these extracted themes to proceed with a more focused and systematic study. For example, taking a cue from this study, one could narrow down the research area to one of the topics extracted by the models [9].

V. Conclusion

The paper fulfilled its objectives by presenting topic modeling as an efficient tool for an exploratory study. It had also displayed one of the optimization methods to prepare a better model. The paper used LDA and its Mallet wrapper to build the models. The inherent advantage of LDA lies in its capability to handle large scale corpus efficiently [11]. Since the management research is interdisciplinary in nature, a full-fledged well-defined literature review requires analysis of many research contributions. The manual method of conducting a literature review is not devoid of the researcher's biases and suffers from a lack of replicability and validity, and also very much time-consuming [14]. Therefore, an LDA based method aids in handling these concerns.

A systematic study of the literature on the selected topic(s) from the topic modeling based ELR would complete the process of a rigorous literature review [forthcoming working paper by author].

The lack of a one-size-fits-all optimization method could be considered a drawback of this method. As the nature of the data, co-occurrences of words, key terminologies could

affect the program output. One way to handle the disruption from unwanted keywords is by having a good custom stopword list. Alternatively, the base model can be tested with a different combination of hyperparameters to test for best fit.

In conclusion, this is a new and efficient way of conducting a literature review. Recent literature by authors from multiple domains has presented their findings and effectivity of similar methods to conduct a literature review [5]. The scope of this method is promising and would be benefitted from future contributions to the area.

FIGURES AND TABLES

The relevant tables and figures pertaining to topic models are presented as follows.

Table 1 Topics of the base model

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7	Topic 8	Topic 9	Topic 10
Game	Revenue	Game	Agent	Product	Game	Game	Network	Government	Model
Model	Innovation	Theory	Belief	Manufacturer	Cooperative	Player	Propose	Policy	Market
Theory	Regulation	Design	Communication	Retailer	Value	Equilibrium	System	Cooperation	Price
Decision	Provider	System	Build	Profit	Solution	Strategy	User	Finding	Firm
Approach	Participation	Approach	Group	Cost	Energy	Set	Resource	Incentive	Strategy
Risk	Urban	Method	Individual	Demand	Method	Payoff	Allocation	Subsidy	Consumer
Social	Land	Optimization	Trust	Decision	Model	Nash	Power	Relationship	Level
Process	Consumption	Application	Behavior	Channel	Algorithm	Dynamic	Scheme	Public	Increase
Behaviour	Heterogeneous	Present	Play	Contract	Member	Solution	Platform	Country	Information
Economic	Driver	Development	Path	Supplier	Capacity	Mode	Low	Reveal	Effect

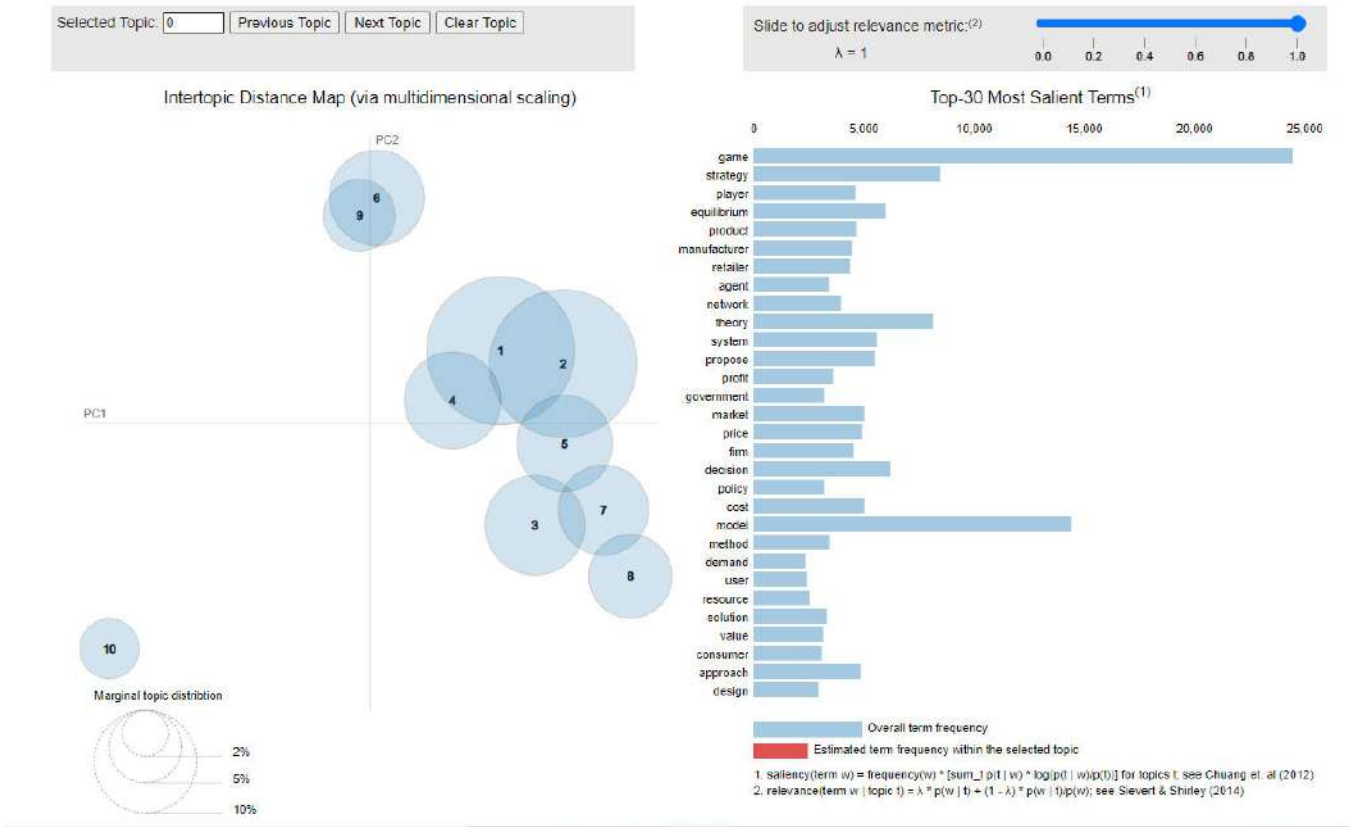

Figure 2 Intertopic distance map of the base model

Table 2 Topics of the optimized model

Topic 1	Topic 2	Topic 3	Topic 4	Topic 5	Topic 6	Topic 7	Topic 8	Topic 9	Topic 10
Model	Cost	Theory	Game	Policy	Market	Game	Strategy	Network	Price
Decision	Cooperative	Social	Solution	Group	Firm	Design	Game	System	Product
Process	Mechanism	Economic	Set	Conflict	Information	Learn	Equilibrium	Propose	Retailer
Management	Cooperation	Individual	Function	Country	Increase	Knowledge	Player	User	Manufacturer
Risk	Game	Behaviour	Method	Level	Model	Present	Agent	Resource	Profit
Theory	Allocation	Approach	Introduce	Political	Strategic	Play	Model	Time	Demand
Enterprise	Share	Interaction	Solve	State	Effect	Experiment	Dynamic	Control	Consumer
System	Order	Explain	Player	Government	Investment	Test	Payoff	Performance	Quality
Government	Benefit	Make	Present	Public	Competition	Subject	Behaviour	Approach	Contract
Develop	Distribution	Trust	Concept	International	Technology	Application	Time	Power	Supplier

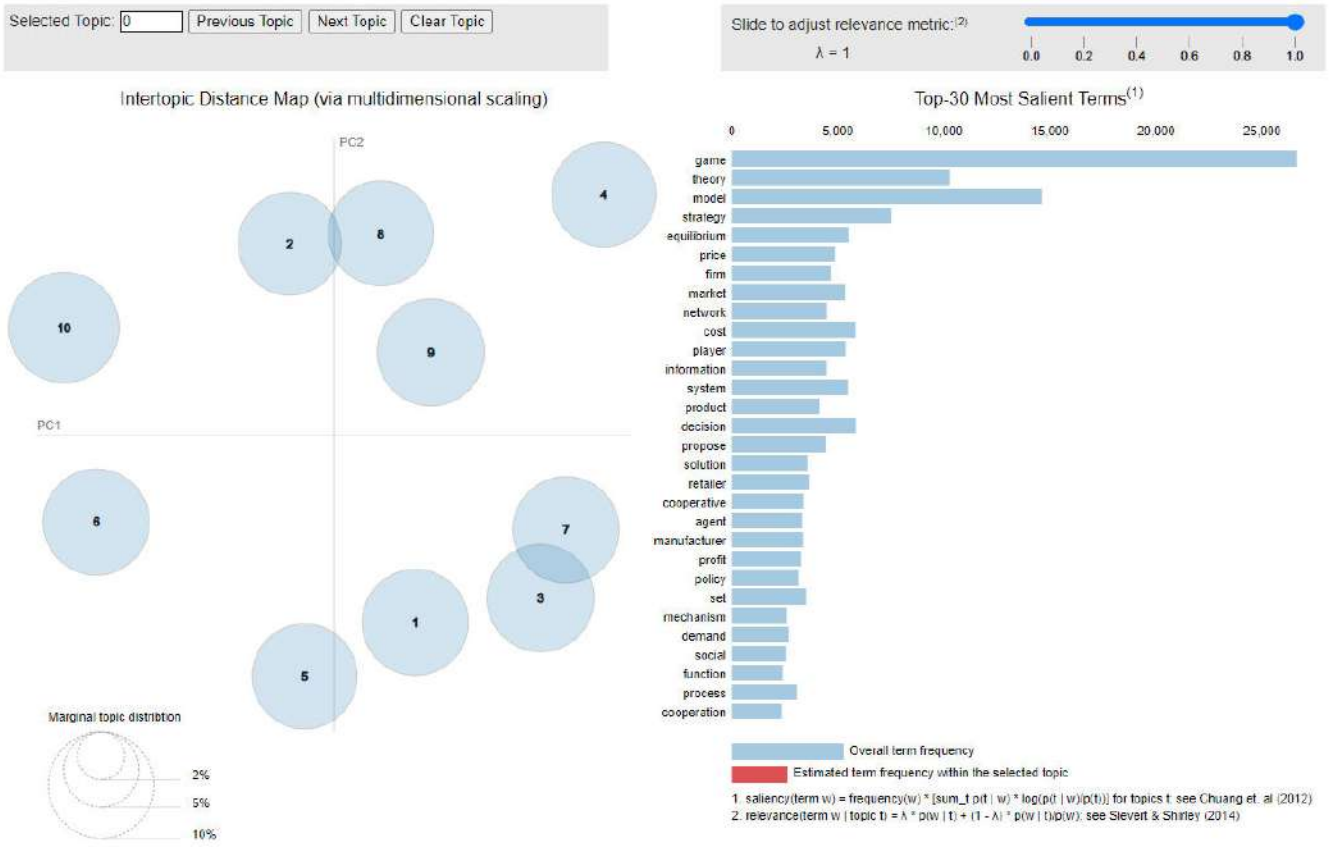

Figure 3 Intertopic distance map of the optimized model

Table 3 Topic labels of base and optimized model

		Top 10 keywords										Topic Label
Base Model	Topic 1	Game	Model	Theory	Decision	Approach	Risk	Social	Process	Behaviour	Economic	Key terminologies of Game Theory
	Topic 2	Revenue	Innovation	Regulation	Provider	Participation	Urban	Land	Consumption	Heterogeneous	Driver	Application in regulations
	Topic 3	Game	Theory	Design	System	Approach	Method	Optimization	Application	Present	Development	Related terminologies in Game Theory
	Topic 4	Agent	Belief	Communication	Build	Group	Individual	Trust	Behaviour	Play	Path	Incoherent*
	Topic 5	Product	Manufacturer	Retailer	Profit	Cost	Demand	Decision	Channel	Contract	Supplier	Market Games
	Topic 6	Game	Cooperative	Value	Solution	Energy	Method	Model	Algorithm	Member	Capacity	Incoherent*
	Topic 7	Game	Player	Equilibrium	Strategy	Set	Payoff	Nash	Dynamic	Solution	Mode	Solution concept of Nash Equilibrium
	Topic 8	Network	Propose	System	User	Resource	Allocation	Power	Scheme	Platform	Low	Allocation Game
	Topic 9	Government	Policy	Cooperation	Finding	Incentive	Subsidy	Relationship	Public	Country	Reveal	Incoherent*
	Topic 10	Model	Market	Price	Firm	Strategy	Consumer	Level	Increase	Information	Effect	Related terminologies in Game Theory
Optimized Model	Topic 1	Model	Decision	Process	Management	Risk	Theory	Enterprise	System	Government	Develop	Managerial decision making
	Topic 2	Cost	Cooperative	Mechanism	Cooperation	Game	Allocation	Share	Order	Benefit	Distribution	Allocation Games
	Topic 3	Theory	Social	Economic	Individual	Behaviour	Approach	Interaction	Explain	Make	Trust	Game theory to study social Behaviour
	Topic 4	Game	Solution	Set	Function	Method	Introduce	Solve	Player	Present	Concept	Concept of Game Theory
	Topic 5	Policy	Group	Conflict	Country	Level	Political	State	Government	Public	International	International Policy
	Topic 6	Market	Firm	Information	Increase	Model	Strategic	Effect	Investment	Competition	Technology	Market Competition
	Topic 7	Game	Design	Learn	Knowledge	Present	Play	Experiment	Test	Subject	Application	Experimental game design
	Topic 8	Strategy	Game	Equilibrium	Player	Agent	Model	Dynamic	Payoff	Behaviour	Time	Dynamic games
	Topic 9	Network	System	Propose	User	Resource	Time	Control	Performance	Approach	Power	Network Games
	Topic 10	Price	Product	Retailer	Manufacturer	Profit	Demand	Consumer	Quality	Contract	Supplier	Market Games

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Model Predictive Control for Smart Buildings: A Simulated Approach

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***Abstract*— This paper proposes a simulation-based control strategy where a multi-variate Model Predictive Control (MPC) system has been developed, considering Indian geographical, climatic and building characteristics, for optimization of building energy consumption, vis-à-vis maintaining building's thermal comfort levels.. Using the proposed control strategy, an optimum trade-off between energy savings and occupants' comfort levels is achieved through a dual objective function. A Multi-Input Multi-Output (MIMO) predictive controller has been developed for simultaneous control of indoor room temperature, indoor relative humidity and indoor illumination through control variables such as cooling and lighting power and automated window roller blind actuation. Three disturbance variables such as outdoor air temperature, outdoor relative humidity and solar irradiance have been considered here. Simulation analyses reveal that by changing the occupants' thermal comfort level minimally and by selection of desired adjustment levels of indoor temperature, indoor relative humidity and indoor illuminance, significant energy savings can be done. This novel approach can be efficiently implemented in smart buildings' energy management system.**

Keywords*— *Model Predictive Control Strategies, ARMAX models, Building Energy Optimization, Indoor Room Temperature Control, Simulations Modeling, Thermal Comfort

I. INTRODUCTION

The rapid population surge and urbanization in India has resulted in ever increasing energy demands, which in turn, is increasing the carbon footprints at alarming levels. This rapid urbanization has led to the adoption of smart buildings concept. According to Indian Bureau of Energy Efficiency (BEE), more than 70% of the total energy consumed in building structures is attributed to heating, cooling and lighting systems. Researchers are working on the novel concepts and designs for efficient and greener buildings where the methods of optimized energy consumption are being evaluated. The focus of the research is to save building's energy and environment through greener solutions, in turn to maintain occupants' solace and comfort levels. This study proposes certain pre-emptive measures that can help in minimizing the energy costs, ensuring acceptable thermal comfort for occupants. In past few years, due attention has been given to the Model Predictive Control (MPC) strategies. In MPC, solution of an optimization or minimization problem is done over a given time horizon through calculations of optimal control inputs to the system [1]. MPC strategies are being used in many industrial applications and have found significant interest among academicians and researchers ([2], [3]). A novel closed loop control strategy using Model Predictive Control methodology has been proposed here, which would maintain the indoor temperature, indoor comfort levels and illuminations at an optimum level such as to minimize energy costs with minimal occupants' discomfort. MPC strategies can handle multiple constraints very easily in the Multi-Input Multi-Output (MIMO) systems [4]. The input or control variables used in the present study are heating/cooling HVAC power, lighting power and window roller blinds position controls. The forecasted variables are indoor room temperature, indoor relative humidity and indoor illumination. The disturbance variables chosen are outdoor air temperature, outdoor relative humidity and solar irradiance. Various constraints pertaining to input and output variables have been incorporated in a systematic manner. The paper has been organized in the following manner. Section 2 provides the details of the literature review. In Section 3, the methodology used, and its mathematical formulation has been described. This section also explains how these mathematical formulations are adopted in the current problem scenario. Section 4 gives the results and findings from the analysis conducted. Section 5 provides a detailed discussion of the obtained results. Finally, Section 6 gives the conclusions.

II. REVIEW OF LITERATURE

Indoor room temperature, indoor humidity and illumination forecasting results in significant energy savings, keeping in mind that, during peak usage cycle, occupants' comfort levels are maintained and are not violated significantly [5]. A detailed survey on the theoretical and practical aspects of the MPC was presented [6]. Reference [7] presented an automated demand response MPC for energy saving potential of household appliances. Reference [8] presented a novel MPC methodology by using the weather forecasts to keep the room temperature within the comfort levels. Reference [9] proposed different indoor thermal comfort strategies/algorithms for thermal comfort as well as energy optimization. Reference [10] presented a Multi-Input Multi-Output (MIMO) MPC based controller for prediction of the indoor environmental conditions of building structures in Hania, Greece. Reference [11] proposed the effectiveness of an economic Multi-Input Single Output (MISO) MPC for building HVAC systems. Reference [12] presented the temperature control of multivariate system of office building through MPC strategy. Reference [13] analysed several MPC methods which are applied for indoor microclimate controls. Reference [14] presented an MPC control strategy which makes the use of passive thermal storage of the building. Reference [15,17] developed a novel Stochastic Model Predictive Control (SMPC) algorithm.

References [3,16] presented a critical review of the MPC for building indoor climatic control. Any inaccuracy within the predictions can worsen the performance of the overall system thus making the system unstable and unusable [18].

The comprehensive analysis presented here is a unique kind of work within Indian context and includes all important control variables in the analysis.

III. METHODOLOGY

The theoretical framework for the proposed model predictive control can be represented in Fig. 1.

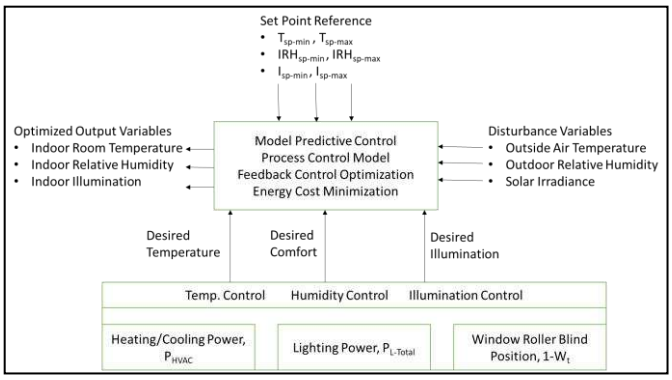

Fig 1: *Schematic Diagram of the Proposed Model Predictive Control System*

A Multi-Input Multi-Output Constrained Dynamic Matrix Control (MIMO-CDMC) approach has been adopted in the presented paper [6].

$$\min \sum_{i=1}^{p} ||\hat{y}(k+l|k) - r(k+l)||_{rl}^2 + ||\Delta u(k+l-1)||_{Bl}^2 \quad (1)$$

Step 1: *Choice of Disturbance Environmental Variables*: Fig. 2 shows the correlation analysis for April-2017 and December-2017 months.

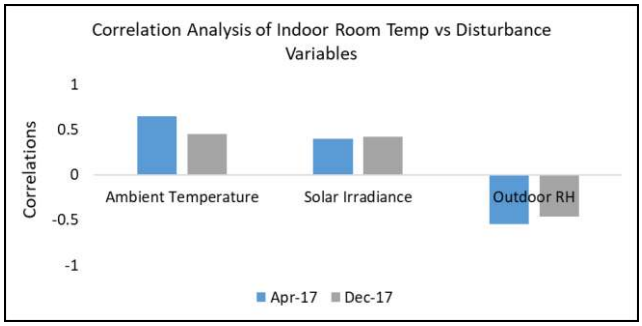

Fig 2: *Correlation Analysis for selection of disturbance variables*

Step 2: *Auto-Regressive Moving Average Model with Exogenous Inputs (ARMAX):* A modified form of ARMA model [19].

$$Y_t = \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{i=1}^{b} \beta_i X_{i_t} + \sum_{i=1}^{q} \theta_i \epsilon_{t-i} + \epsilon_t \quad (2)$$

1. **Temperature Model:** The empirical equation used for the Indoor Room Temperature model is based upon ARIMAX model:

$$T_{t+1} = \phi_{T0} + \phi_T T_t + \gamma_1.(T_t^{amb} - T_t) + \gamma_2.\eta.P_t^{HVAC} + \gamma_3.SI_t + +\gamma_4.ORH_t + \gamma_5.(1 - W_t) + \theta_T \xi_t + \epsilon_t \quad (3)$$

2. **Humidity Model:** The empirical equation based upon ARIMAX model:

$$IRH_{t+1} = \phi_{H0} + \phi_H IRH_t + \alpha_1.(ORH_t - IRH_t) + \alpha_2.\eta.P_t^{HVAC} + \alpha_3.SI_t + \alpha_4.T_t^{amb} + \theta_H \xi_t + \epsilon_t \quad (4)$$

3. **Lighting Model**: The lighting model in this study has been adopted from [20]. Total Number of T-8 fluorescent lamps = N. Total electric power consumption at full illumination is given by:

$$P_{L-Total} = \sum_{i=1}^{n} P_i \quad , n = 1,2 \dots \dots N \quad (5)$$

From Fig. 3, the layout of the room is divided into a grid of spots., each one for a light fixture. The dimension of the room is 10m X 10m X 6m with window dimensions as 4m X 2m. For spot A, the illumination I_A can be represented as:

$$I_A = f(P_1, P_2, \dots \dots, P_N, L_s) \quad (6)$$

$$f(P_1, P_2, \dots \dots, P_N, L_s) = \sum_{i=1}^{N} \alpha_{A,i} P_i + \beta_A L_s + \lambda_A \quad (7)$$

From above equation, $\alpha_{A,i}$ is calculated using inverse square law.

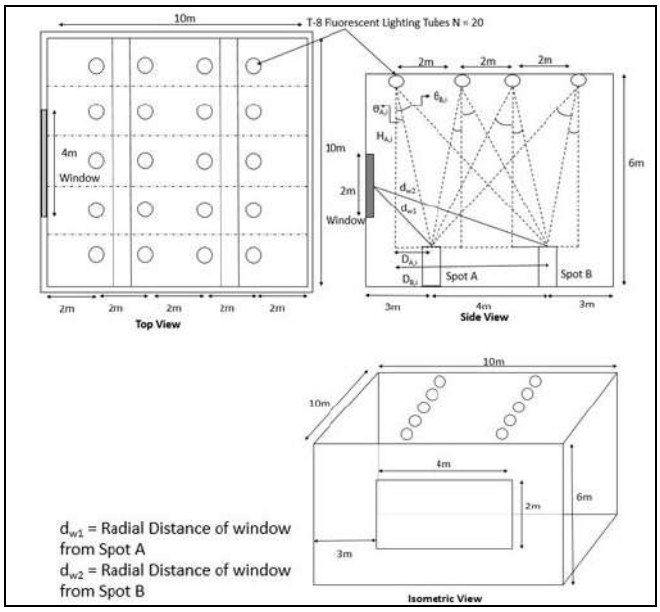

Fig 3: *Top, Side and Isometric view of the simulation room*

Light intensity of the lighting source can be calculated as:

$$I_{A,i} = \frac{C_i.cos^3(\theta_{A,i})}{H_{A,i}^2} = \frac{C_i.H_{A,i}}{(D_{A,i}^2 + H_{A,i}^2)^{1.5}} \quad (8)$$

Where C_i = light intensity in candle power

$H_{A,i}$, $D_{A,i}$ = Vertical and Horizontal distance between light source i &Spot A,

$$I_t = \sum_{i=1}^{N} \alpha_i P_i + \sum_{i=1}^{N} \lambda_i + \tau_l \phi (1 - W_t) L_s \quad (9)$$

Step 3: *MPC State Space Model:* The final state space equation for MPC can be represented as:

$$\begin{bmatrix} T_{t+1} \\ IRH_{t+1} \\ I_{t+1} \end{bmatrix} = \begin{bmatrix} \phi_T - \gamma_1 & 0 & 0 \\ 0 & \phi_H - \alpha_1 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} T_t \\ IRH_t \\ I_t \end{bmatrix} + \begin{bmatrix} \gamma_2\eta & 0 & \gamma_5 \\ \alpha_2\eta & 0 & 0 \\ 0 & \sum_{i=1}^{N} \alpha_i & \tau_l \phi L_s \end{bmatrix} \begin{bmatrix} P_{HVAC} \\ P_{L-Total} \\ (1 - W_t) \end{bmatrix} + \begin{bmatrix} \phi_{T0} & \gamma_1 & \gamma_3 & \gamma_4 \\ \phi_{H0} & \alpha_4 & \alpha_3 & \alpha_1 \\ K & 0 & 0 & 0 \end{bmatrix} [1 \quad T_t^{amb} \quad SI_t \quad ORH_t]^T + \begin{bmatrix} \theta_T \\ \theta_H \\ 0 \end{bmatrix} \epsilon_t \quad (10)$$

$$X_{k+1} = \begin{bmatrix} T_{t+1} \\ IRH_{t+1} \\ I_{t+1} \end{bmatrix}, X_k = \begin{bmatrix} T_t \\ IRH_t \\ I_t \end{bmatrix}, A = \begin{bmatrix} \phi_T - \gamma_1 & 0 & 0 \\ 0 & \phi_H - \alpha_1 & 0 \\ 0 & 0 & 0 \end{bmatrix},$$
$$B_\epsilon = \begin{bmatrix} \theta_T \\ \theta_H \\ 0 \end{bmatrix}, B_u = \begin{bmatrix} \gamma_2\eta & 0 & \gamma_5 \\ \alpha_2\eta & 0 & 0 \\ 0 & \sum_{i=1}^{N}\alpha_i & \tau_l\phi L_s \end{bmatrix}, U_k = \begin{bmatrix} P_{HVAC} \\ P_{L-Total} \\ (1 - W_t) \end{bmatrix},$$
$$B_d = \begin{bmatrix} \phi_{T0} & \gamma_1 & \gamma_3 & \gamma_4 \\ \phi_{H0} & \alpha_4 & \alpha_3 & \alpha_1 \\ K & 0 & 0 & 0 \end{bmatrix},$$
$$W_k = [1 \quad T_t^{amb} \quad SI_t \quad ORH_t]^T$$

(11)

Where L_s is an assumed daylight illumination during the clear summer day and can be represented as [21]:

$$L_s^k = \begin{cases} L_{smax}\left(-\frac{1}{36}k^2 + \frac{2}{3}k - 3\right) & for\ 6 \le k < 18 \\ 0 & for\ 0 \le k < 6, 18 \le k < 24 \end{cases}$$

(12)

Step 4: *Objective function*: The objective function to be derived will control the P_{HVAC}, $P_{L\text{-}Total}$ (Lighting) and W_t such that overall power consumption is minimized.

Formulation of Augmented Model: Assuming m inputs, q outputs and n1 states. [22]

$$x_m(k+1) = a_m x_m(k) + b_m u(k) + b_d w(k) + b_\epsilon \xi(k)$$
$$y(k) = x_m(k)$$

(13)

The above equation can be represented for time t = k as,

$$x_m(k) = a_m x_m(k-1) + b_m u(k-1) + b_d w(k-1) + b_\epsilon \xi(k-1)$$

(14)

The final augmented model can be represented as:

$$\begin{bmatrix} \Delta x_m(k+1) \\ y(k+1) \end{bmatrix} = \begin{bmatrix} a_m & 0_m^T \\ a_m & I_{qXq} \end{bmatrix} \begin{bmatrix} \Delta x_m(k) \\ y(k) \end{bmatrix} + \begin{bmatrix} b_m \\ b_m \end{bmatrix} \Delta u(k) + \begin{bmatrix} b_d \\ b_d \end{bmatrix} W(k) + \begin{bmatrix} b_\epsilon \\ b_\epsilon \end{bmatrix} \epsilon(k)$$
$$[y_k] = [0_m \quad I_{qXq}] \begin{bmatrix} \Delta x_m(k) \\ y(k) \end{bmatrix}$$

(15)

Where I_{qXq}= Identity Matrix with dimensions q X q. 0_m= zero matrix with dimensions q X n1

Formulation of Prediction Control Model: If N_p is the prediction horizon and Nc is the control horizon, then future control trajectory and future state variables are [22]:

$$\Delta u(k_i = t), \Delta u(k_i = t+1), \Delta u(k_i = t+2), \dots, \Delta u(k_i t + N_c - 1)$$
$$x(k_i = t+1|k_i = t), x(k_i = t+2|k_i = t), .., x(k_i = t+N_p|k_i = t)$$

(16)

From Equation (16),

$$x(k_i = t+1|k_i = t) = Ax(k_i = t) + B_u \Delta u(k_i = t) + B_d W(k_i = t) + B_\epsilon \epsilon(k_i = t)$$

(17a)

$$x(k_i = t+2|k_i = t) = Ax(k_i = t+1|k_i = t) + B_u \Delta u(k_i = t+1) + B_d W(k_i = t+1) + B_\epsilon \epsilon(k_i = t+1)$$

(17b)

Replacing (17a) into (17b) gives below,

$$x(k_i = t+N_p|k_i = t) = A^{N_p}x(k_i = t) + A^{N_p-1}B_u\Delta u(k_i = t) + A^{N_p-2}B_u\Delta u(k_i = t+1) + A^{N_p-1}B_d W(k_i = t) + A^{N_p-2}B_d W(k_i = t+1) + A^{N_p-1}B_\epsilon \epsilon(k_i = t) + A^{N_p-2}B_\epsilon \epsilon(k_i = t+1) + \dots \dots A^{N_p-N_c}B_u\Delta u(k_i = t+N_c-1) + A^{N_p-N_c}B_d W(k_i = t+N_c-1) + A^{N_p-N_c}B_\epsilon \epsilon(k_i = t+N_c-1)$$

(17c)

$$Y = [y(k_i = t+1|t) \quad y(k_i = t+2|t) \dots . \quad y(k_i = t+N_p|t)]^T$$
$$\Delta U = [\Delta u(k_i = t) \quad \Delta u(k_i = t+1) \dots \dots \quad \Delta u(k_i = t+N_c-1)]^T$$
$$W = [W(k_i = t) \quad W(k_i = t+1) \dots \dots \quad W(k_i = t+N_c-1)]^T$$

(18)

$$Y = Fx(k_i = t) + \phi\Delta U + \rho W + \nu\epsilon$$

(19)

And the objective function is defined as,

$$J = (R_{sp} - Y)(R_{sp} - Y)^T + \Delta U^T \bar{R} \Delta U$$

(20)

Where $\bar{R}$ is the weight factor, with defined as,

$$\bar{R} = r_w \overline{I_{Nc\ X\ Nc}} (r_w \ge 0)$$

(21)

And R_{sp} is a matrix of set-point values defined as,

$$R_{sp} = [T_{sp-min} \quad IRH_{sp-min} \quad I_{sp-min} \quad T_{sp-max} \quad IRH_{sp-max} \quad I_{sp-max}]$$
$$= [23^oC \quad 50\% \quad 340\ lux \quad 25^oC \quad 60\% \quad 700\ lux]$$

(22)

So, combining all the constraints, the minimization of the objective function for minimum power consumption and optimum thermal comfort looks like,

$$\frac{\partial J}{\partial \Delta U} = \frac{\partial (R_{sp} - Y)(R_{sp} - Y)^T + \Delta U^T \bar{R} \Delta U}{\partial \Delta U} = 0$$

(23)

Consider, $F'x(t) = Fx(t) + \rho W + \nu\epsilon$.

$$\frac{\partial J}{\partial \Delta U} = \frac{\partial (R_{sp} - (F'x(k_i = t) + \phi\Delta U))(R_{sp} - (F'x(k_i = t) + \phi\Delta U))^T + \Delta U^T \bar{R} \Delta U}{\partial \Delta U} = 0$$

(24)

Solving Equation (24) gives the optimal solution for ΔU as,

$$\Delta U_{min} = (\phi^T\phi + \bar{R})^{-1}\phi^T(R_s - F'x(k_i = t))$$

(25)

The final minimized objective function can be formulated as,

$$J_{min} = (R_{sp} - Y)(R_{sp} - Y)^T + ((\phi^T\phi + \bar{R})^{-1}\phi^T(R_s - F'x(k_i)))^T \bar{R}(\phi^T\phi + \bar{R})^{-1}\phi^T(R_s - F'x(k_i))$$

(26)

Subject to constraints,

$$\Delta u(k+j|k) = 0, \quad for\ j = N_c, \dots \dots \dots, N_p$$
$$u_{min} \le u(k+j|k) \le u_{max}, \quad for\ j = 1, \dots \dots \dots, N_c$$
$$T_{min} \le T(k+j|k) \le T_{max}, \quad for\ j = 1, \dots \dots \dots, N_p$$
$$IRH_{min} \le IRH(k+j|k) \le IRH_{max}, \quad for\ j = 1, \dots \dots \dots, N_p$$
$$I_{min} \le I(k+j|k) \le I_{max}, \quad for\ j = 1, \dots \dots \dots, N_p$$

Equation (26) gives the final objective function for the derived model predictive controller. Four levels of control zones have been chosen in the analysis ([5],[11]):

1. Pre-Cooling
2. Strict Comfort
3. Mild Comfort
4. Loose Comfort

Fig. 5 and 6 display the hourly comfort zone mechanism for heating and cooling power P_{HVAC} and Lighting Power $P_{L\text{-}TOTAL}$.

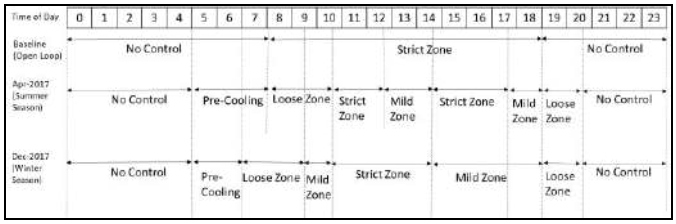

Fig 5: *Hourly Comfort Zone Mechanism for P_{HVAC}*

TABLE I. MINIMUM AND MAXIMUM THRESHOLD VALUES FOR P_{HVAC}

Temperature Model	Month	Pre-Cooling	Strict Zone	Mild Zone	Loose Zone
Tol. Change	Apr-17	1ºC	0ºC	0.5ºC	1ºC
Thres. Min		23ºC	23ºC	23.5ºC	24ºC
Thres. Max		24ºC	23ºC	24ºC	25ºC
Tol. Change	Dec-17	1ºC	0ºC	0.5ºC	1ºC
Thres. Min		23ºC	23ºC	24ºC	24ºC
Thres. Max		24ºC	23ºC	24.5ºC	25ºC

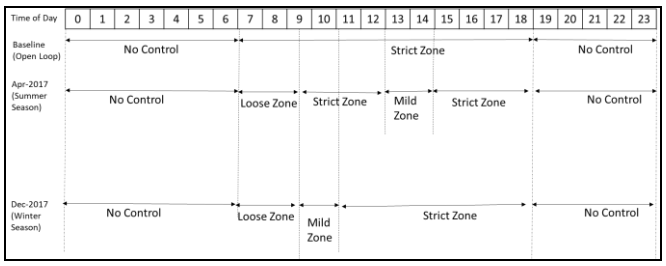

Fig 6: *Hourly Comfort Zone Mechanism for $P_{L\text{-}TOTAL}$*

Data Collection: This pilot study has been done in the city of Bhubaneswar, India. A corporate building structure's room is considered for simulation analysis. The working days are from Monday till Friday and peak occupancy of the building is from 8:00 AM till 6:00 PM. Several variables included in the analysis are presented in Table II.

TABLE II. LIST OF VARIABLES

S.No.	Variable Description	Unit of Measure (UoM)	Variable Type
1.	Indoor Room Temperature, T	^{0}C	Forecasted, Continuous
2.	Indoor Relative Humidity, IRH	%	Forecasted, Continuous
3.	Illumination, I	Lux	Forecasted, Continuous
4.	P_{HVAC} (Power)	kW	Control, Continuous
5.	$P_{L\text{-}Total}$ (Lighting Power)	Watts	Control, Continuous
6.	Window Roller Blind Control	0,1	Control, Categorical
7.	Outdoor Air Temperature, T_{amb}	^{0}C	Explanatory, Continuous
8.	Outdoor Relative Humidity, ORH	%	Explanatory, Continuous
9.	Solar Irradiance, SI	W/m^2	Explanatory, Continuous

TABLE III. CONSTRAINTS USED IN THE ANALYSIS

S.No.	Parameter	Details	Value
1	R	Thermal resistance of the room	2.5
2	C	Thermal capacitance of the room	2.5
3	τ_r	Window solar radiation transmittance	0.6
4	A_w	Area of the window	8m^2
5	A_r	Area of the room	120m^2
6	τ_l	Window solar illuminance transmittance	0.6
7	P_{HVAC}	Installed capacity of cooling HVAC system	10kW
8	$P_{lighting}$	Installed capacity of lighting system	300 Watts
9	γ_i ,κ_i	T-8 fluorescent light Parameters	0.89, 14.87
10	λ	Cooling Efficiency of HVAC system	2.5
11	N_p	Prediction Horizon	72 Hours
12	N_c	Control Horizon	24 Hours

IV. RESULTS AND FINDINGS

The resultant state space equation for optimal solution for Apr-2017 month can be represented as:

$$\begin{bmatrix} T_{t+1} \\ IRH_{t+1} \\ I_{t+1} \end{bmatrix} = \begin{bmatrix} 0.812 & 0 & 0 \\ 0 & 0.567 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} T_t \\ IRH_t \\ I_t \end{bmatrix} + \begin{bmatrix} 0.145 & 0 & 0.96 \\ 0.076 & 0 & 0 \\ 0 & 5.113 & 0.0013L_s \end{bmatrix} \begin{bmatrix} P_{HVAC} \\ P_{L-Total} \\ (1-W_t) \end{bmatrix}$$
$$+ \begin{bmatrix} 0.835 & 0.207 & 0.116 & -0.23 \\ -0.084 & 0.356 & 0.896 & 0.088 \\ 83.76 & 0 & 0 & 0 \end{bmatrix} [1 \quad T_t^{amb} \quad SI_t \quad ORH_t]^T + \begin{bmatrix} 0.111 \\ 0.410 \\ 0 \end{bmatrix} \epsilon_t \quad (27)$$

Fig. 7 and 8 represent the next 24 hours forecasted indoor room temperature and humidity profiles for April-2017.

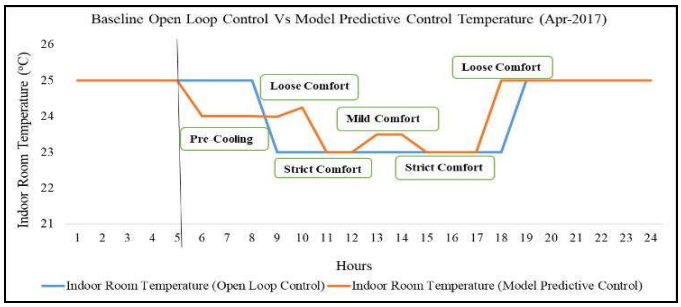

Fig 7: *Temperature Profile of Baseline vs MPC (Apr-2017)*

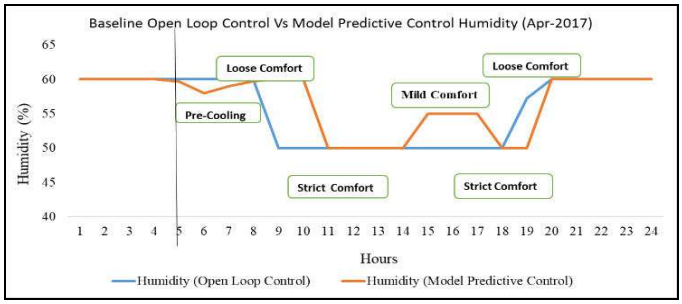

Fig. 8: *Humidity Profile of Baseline vs MPC (Apr-2017)*

The resultant P_{HVAC} control mechanism for open loop as well as model predictive controllers for Apr and Dec-2017 months can be represented in Fig. 9.

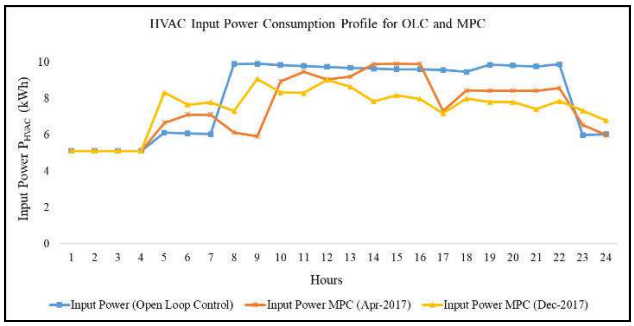

Fig 9: *Input Cooling Power Control Variable Profiles of Baseline vs Model Predictive Control Models*

Assuming INR (Indian National Rupees) 6 as the electricity charge rate per kilowatt hour, Table IV gives total energy savings (in Rupees) obtained (assumption: 22 working days).

TABLE IV. TOTAL ENERGY SAVINGS

Month	Apr-17	Dec-17
HVAC Energy Savings/Day (%)	7.60%	9.00%
Lighting Energy Savings/Day (%)	3.40%	1.80%
HVAC Cost Savings/Day (INR)	89.81	107.75
Lighting Cost Savings/Day (INR)	5.78	3.15
HVAC Savings/Month (INR)	1975.82	2370.43
Lighting Savings/Month (INR)	127.13	69.19
Total Savings /Month (INR)	2102.95	2439.62
Total Savings (INR)		**4542.57**

V. DISCUSSION

The proposed MPC model has been simulated on a 72-hour prediction horizon with a control horizon of 24 hours. For each of the output variable, a time-series ARMAX model has been developed: Temperature model, Humidity model and Lighting model. Also, four levels of control zones: pre-cooling, strict, mild and loose have been promoted in the present study. Pre-Cooling is done by cooling the room prior to its peak occupancy period. During early morning times, since the occupancy period is minimal, an appropriate threshold pre-cooling window is available. Due to thermal inertia law of thermodynamics, pre-cooling effect keeps the room at a satisfactory comfort level. Since the room is already pre-cooled during morning time, user comfort level increases significantly. Inclusion of pre-cooling control zone adds to the energy costs since the actuators are turned on earlier than they are expected to be turned on, but this pre-cooling effect adds to the savings in later time of the day. The control variable, input cooling/heating power has direct influence to the indoor room temperature profile as well as occupants' comfortability in the room. Window roller blinds position, another control variable, has direct influence on the room illumination profile. When they are fully open during summer and during sunny days of winter season, the illumination profile of the room increases thus reducing the lighting load demand. During summer days and during sunny days of winter season, in the fully open roller blind position, ample amount of sunlight reaches inside the room, thus providing increase in heat energy inside the room. As a result, indoor room temperature as well as humidity increases thus creating a discomfort to the occupants' comfort levels. During sunny winter days, due to cold season, the indoor room temperature and comfort levels remain less, and thus, fully open roller blind position increases the desired temperature as well as comfort level of the room. Considering heating and cooling power, it can be seen that using the proposed MPC control methodology, a savings of 7.6% for Apr-2017 and 9% energy savings for Dec-2017 is achieved. Similarly, considering lighting power, a saving of 3.4% and 1.8% per day is achieved for Apr and Dec months respectively.

V. CONCLUSIONS

A novel model predictive control approach has been proposed for controlling indoor temperature, comfort levels and illumination, so as to optimize the building's energy consumption, keeping the occupants' thermal comfort within acceptable limits. The analysis presented here has useful practical implications as it provides a consolidated control mechanism which can decide the trade-off between energy savings and comfort levels quite significantly thus helping in the daily prediction of indoor room temperature, humidity and illumination profile and also help in determining the appropriate HVAC and lighting systems for the building. These models can be easily adopted by smart buildings.

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Security and Well-being in Tech-Savvy Urban Communities

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***Abstract*— An assortment of nearby and provincial specialists works with better wellbeing and security in broad daylight places. The advancement and support of wellbeing and security require multi-player collaboration between open, private and third divisions just as dynamic disapproved of residents. A positive consequence of this multi-on-screen character participation is that wellbeing and security issues are overseen and seen from an assortment of points of view. This makes it conceivable to execute very much demonstrated arrangements in the new environment or to grow considerably increasingly pertinent arrangements together with different partners. Wellbeing and security are a critical piece of well-being and builds the allure of the living condition.**

Keywords— Safety, Well-being, Security, Urban Community, Smart City

I. INTRODUCTION

In future major issues for populace, just as for the entire biological system. Those may be air contamination, a dangerous atmospheric deviation, populace development, etc. These progressions lead to calls for creative arrangements of progress, that would bring maintainability of humankind and nature along. There is a push to discover prospects, that will keep society pushing ahead, and yet they will attempt to limit or dispose of dangers and harm towards society and environment. From this way of thinking comes up the term of feasible improvement to fulfill fundamental living needs of ages of today and those to come, while the assorted variety of nature isn't hurt, and regular elements of environments are protected. Be that as it may, from our perspective, concerning just the essential living needs isn't the manner in which we should see what's to come. We consider it to be an opportunity to develop, to improve our lives, even to manage the cost of extravagance, however all in the sheltered, innocuous way, depicted above by the methodology. Advances, that empower economic improvement in urban areas and their application are matters of the Smart City idea.

Wellbeing and security are a noteworthy piece of well-being and builds the engaging quality of the living condition. A top-notch living condition gives an assortment of administrations and amusement decisions just as chances to utilize and appreciate them without feeling dread. The sentiment of wellbeing influences individuals' practices and developments. A sheltered and happy with living condition urges occupants to partake out in the open and private administrations and invest their energy out in the open spots like strip malls, advertise territories and multi-practical focuses. The development of individuals expands the casual characteristic observation and thus the sentiment of security. So as to accomplish supportable advancement, wellbeing and strength of occupants with the target expanding the personal satisfaction of residents, close to network and condition.

II. THE ENVIRONMENTAL SUSTAINABILITY

Urban areas face various natural manageability challenges, produced by the city itself or brought about by climate or topographical occasions. To diminish the effect of the city on the earth asset it is critical to advance the proficient and canny organization of innovation and to coordinate frameworks. Ecological concerns are developing in urban areas. Three weights emerge. The first is on asset restrictions, for example, water shortage and quality, or fuel prerequisites. The second is on Quality of Living also, wellbeing. Not exclusively are residents and specialists all the more naturally mindful, yet the monetary ramifications of contamination can be not kidding, because of the effect on wellbeing and the appeal for organizations to work from the city. The third is hazard the executives and flexibility to ecological stuns, (for example, heat waves and flooding brought about by environmental change). One of the principal stages to deliver maintainability is to expand asset productivity in all spaces, suchas vitality effectiveness in structures and systems, eco-friendliness in transport, water proficiency and new techniques to change waste to vitality. Innovation isn't the main viewpoint required for maintainability, however is a significant and essential advance forward. Efficiency increases can require significant speculations, and the joining of various advances can be mind boggling. Versatility and hazard the executives should be coordinated in city arranging, in light of assessed future dangers. The brilliant city is basic and potentially our most logical option to move towards manageability. The mix of various advancements in the zones of ICT, transport, vitality, water and so forth, which structure the foundation spine of urban communities, right now offers the best possibility for supportability.

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Same target yet various difficulties, patterns and needs

The future difficulties of urban regions will rely upon numerous elements, which will influence the sort of speculations required. A few variables will be connected to the topographical position and the presentation of the city to climatic occasions, for example presentation to impacts from an ascent of ocean level, flooding from changes in waterway streams, expanded dangers of warmth islands, and so on. Area may likewise make significant requirements for the city. Numerous urban areas in created just as in rising and creating nations are thinking about their hinterland in the arranging stage, however a few urban communities like

Singapore or Honk Kong are profoundly obliged in their territory assets. At last, the degree of relocation to urban communities and the sort of existing foundation or building stock will decide whether speculations are predominantly green field or dark colored field. A green field approach is regularly identified with rising as well as creating nations, for example areas where new urban areas or financial locales are worked from scratch. Nonetheless, this methodology can likewise happen in industrialized and created nations where new regions and towns are arranged in a coordinated manner. Models are Songdo in Korea and Seestadt Aspern in Vienna, Austria. In the last case, a whole new quarter of a current city has been arranged and constructed, leaving customary systems behind. The dark colored field approach characterizes the procedure and the related activities to transform a current urban framework into a keen city/city of things to come. Right now, for progress is the change/substitution of existing foundations, considering the requirements of residents and the character of the city. In industrialized and created nations this methodology is the typical one. Because of the need to coordinate or amortize existing foundations, the entire procedure could extend past 10 years. Regarding the conclusive outcome, there are on a fundamental level no significant contrasts between darker field and green field approaches for keen urban communities as the definition and parameters of the last item don't change. In any case, the way and time to accomplish the destinations can be totally different.

The composite virtual association (city) needs to accomplish a harmony between the accompanying two objectives:

Effective and effective utilization of its regular habitat and constructed condition.

Improving and keeping up the wellbeing, security, security, prosperity, accommodation, and solace of its occupants.

Accomplishing and keeping this equalization over the entire virtual association supports the basic offer of the inward worth chain. A comparable offer is shared over an outer worth chain shaped by different networks and sovereign districts which direct trades of data, vitality, and materials with a savvy city virtual undertaking.

III. Review of Inhabitants Gives Data on Wellbeing and Security

Numerous urban communities gather inhabitants' perspectives, remarks and advancement recommendations on current issues. The occupants' remarks are gathered comparable to, for instance, wellbeing and security in their living surroundings. The overview can be completed as a guide-based Internet application in which the encounters of wellbeing or uncertainty are effectively confined to a specific spot. Accumulated data on unreliable spots can be utilized to improve the auxiliary or lighting conditions in such places. It is likewise critical to know about spots that are organized and positive for occupants and their prosperity.

A. Survey occupant's fulfillment level with the accompanying:

1.Their current lodging and related indoor and open-air spaces

2.Treatment of inhabitants by their proprietor's upkeep and the executive's staff and staff of the Voucher program (where appropriate) with respect to: Responsiveness, Timeliness, Effectiveness

3.Home examination process

3.1 Measure the inhabitant's impression of wellbeing and security

3.2 Obtain data about components in picking their lodging area

3.3 Assess inhabitant tobacco use and enthusiasm for without smoke structures

IV. Different and Top-notch Administrations Make Prosperity and Security

Security and prosperity can be improved with a flexible help supply. Excellent parks, close by resorts, great open-air offices and different recreation openings likewise make security and prosperity. Occupants data and thoughts regarding their own living surroundings can be utilized in the distinguishing proof of the business openings identified with wellbeing and security enhancements. The inhabitants can likewise be utilized for the assessment and determination of thoughts. They can give criticism on effectively accessible wellbeing and security items or administrations. This will prompt arrangements that accomplish a level past the inhabitants' most out of control desires.

A. Inventive answers for counter security challenges

The view of security by urban residents can be expanded by initiating their support in networks. Data and mediations can be given in a straightforward and manageable manner. This can ensure residents proactively just as responsively give increasingly compelling reactions and help. New creative innovations like city foundations, web-based social networking and cell phones can bolster the expanding and aggregate suspicion that all is well and good.

Lessen the dread of wrongdoing and improve the view of security of the occupants of huge urban conditions.

1. Better tending to security challenges in enormous urban situations.

2.Increase the impression of security of residents by enabling them, cultivating their feeling of having a place with a more noteworthy network.

3.Facilitating the commitment of residents to improve the security states of shrewd urban communities.

4.Providing new market openings, particularly for SMEs and business people, to create and deliver imaginative advancements for urban security.

The activity is relied upon to proactively focus on the necessities and prerequisites of clients, for example, residents and nearby police powers.

V. CONCLUSION

Practical, savvy urban communities empower progress when the joining of innovation is guided into a key way to deal with reasonable improvement (vitality productivity, contamination, assets), resident prosperity (open wellbeing, instruction, medicinal services, social consideration) and financial advancement (venture, occupations, development). Keen city and reasonable improvement strategies and objectives must be founded on shrewd ventures and administrations (savvy vitality, water, transport, structures and government) and bolstered by brilliant framework (sensor systems, information examination, clever gadgets, control frameworks, correspondence stages, web administrations). A manageable, keen city is both a spot to live and a financial region that gives supportable improvement through the orderly arrangement of creative innovations, materials and administrations. This includes creation procedures, administrations and advancements just as foundations which, by methods for the new, "clever" data and correspondence innovations, just become practical at all since they are coordinated, arranged and commonly strong.

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Examining Sigmoid vs ReLu Activation Functions in Deep Learning

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Abstract - In recent years, deep learning has been considered to be a solution for many different problems such as natural language processing, pattern recognition, image detection and image classification. Artificial neural networks (ANN) are one of the deep learning models developed to address these problems. This study presents a Convolutional Neural Network (CNN) with LeNet architecture for image classification. Tests were conducted on the Caltech-101 datasets to determine the effectiveness of the CNN model. Over 1260 images were used and results indicate that the CNN with LeNEt was more accurate in image classification.

Keywords- Neural Networks, Machine Learning, Deep Learning, Convolutional Neural Network, LeNet, Gradient Descent Algorithm, Activation Function, Open CV, Keras etc.

I. Introduction

Humans can distinguish and classify images quite easily due to years of training and the natural complexity of the human brain. The objective and goal of neural networks is to build and train computers to be able to process and function image classification as well as humans. It is very difficult for computers to recognize images due to viewpoint-dependent object variability, and the high in-class variability of many object types.

Deep neural network mimics the nature of mammalian visual cortex in image recognition. Convolutional Neural Networks (CNN) have been proven to be successful as a machine learning method in image classification problem in many public datasets. The CNN is a type of deep learning neural networks that is designed to work better with structured arrays such as images and computer vision. The concept of the CNN is rooted in biological process and that is why the networks are good at picking up on patterns such as gradients, or eyes and faces. The CNN term refers to the mathematical operation call a convolution which is different from a general matrix operation. The CNN uses multiple layers and has pooling between layers. It also shares weights among neurons in the same layer. The more layers used the more sophisticated the processing and recognition. For example, a CNN with 25 layers can distinguish handwriting and human faces.

For the task of image classification, a new type of neuron, Rectified Linear Units (ReLU) and Sigmoid can be used to speed up training and dropout can be employed to prevent overfitting. The rest of this paper is structured as follows. First is discussion of relevant literature along with research questions and methodology. This discussion is followed with the results of the system testing. The last section contains limitations and future research possibilities.

II. Literature Review

Kang et al. [7] proposed using a Convolutional Neural Network (CNN) to learn features from raw image pixels to a document image classification. They used a CNN architecture with a hierarchical nature of document and used rectified linear units and dropout, Their CNN model performed well even when document layouts present large inner-class variations.

Chan, T.H et al. [5] discussed using a simple deep learning network called Principal Component Analysis Network (PCANet) for image classification in which it will recognize faces, classify digits, and texture images based on three basic data processing components, which were binary hashing, block-wise histograms, and cascaded principal component analysis. Their study showed that the PCANet Principal Component Analysis Network can be very effective with recognizing faces and classifying digits and texture images.

Zhao et al. [6] used a new architecture network based on CNN and tuned with Visual Geometry Group (VGG) model to improve results accuracy for facial expression recognition. Their network architecture model considered facial images as the input and classified them into six facial expressions: angry, disgust, happy, neutral, sad and surprise. They claimed that the recognition rate outperforms other models such a multi-layer perceptron and support vector machine.

Li et al. [8] designed a customized Convolutional Neural Networks (CNN). Authors generated a shallow convolution layer to classify lung image patches. They claimed that the results demonstrate that their design can extract discriminative features automatically. Furthermore, their method does not require manual feature design and continues to achieve good performance against various benchmarks. Adapting CNN to ILD image classification has the caveat that indistinct visual structure and limited size of training data caused major issues in training.

Ciresan et al. [1] presented a high-performance, fully parameterized GPU-based convolutional neural networks variants trained by on-line gradient descent method for image classification. They used both feed forward and back propagation to adjust the parameters of the neural network. They applied their networks to benchmark datasets for digit

recognition (MNIST), 3D object recognition (NORB), and natural images (CIFAR10) datasets. Their results on the MNIST dataset had a test error rate of 0.35%, on NORB datasets 2.53% and on CIFAR10 dataset was 19.51%.

Spanhol et al. [2] conducted some preliminary experiments to classify breast cancer histopathological images from BreakHis, a publicly dataset available at http://web.inf.ufpr.br/vri/breast-cancer-database. They proposed training the CNN with a method based on the extraction of image patches. They then combined these patches for final classification. This allowed for using the high resolutions histopathological images from BreakHis. Their study found that by using simple fusion rules to the CNNs architecture could achieve some improvement in recognition rates.

Makantasis et al. [3] proposed a 'deep learning' based classification method maximizes the best features of CNN and MLPs to hierarchically construct high-level features that are able to combine spatial and spectral information. The compared their method other more commonly known, used, and respected SVM-based classifiers. There results provided evidence that their method could be scaled to very large datasets and potentially detection of human behavior.

Levi et al. [4] proposed a simple convolutional neural network architecture that can be used even when the amount of learning data is limited. They designed a deep-learning architecture to avoid overfitting due to the limitation of limited labeled data. This network is "shallow" compared to other network architectures, thereby reducing the number of its parameters and the chance for overfitting. The method was evaluated on the Adience benchmark for age and gender estimation. The results of their tests indicated that their architecture of CNN with less training than other models was more accurate and effective in age and gender classification.

Krizhevsky et al. [13] trained a deep convolutional neural network to categorize 1.2 million high-resolution images in the ImageNet LSVRC-2010 dataset into the 1000 different classes. Their network had 60 million parameters and 650,000 neurons, and it consisted of five convolutional layers. Some of the layers were followed by max-pooling layers, and three were fully connected layers with a final 1000-way softmax. Their results show that a large, deep CNN can achieve record-breaking results (top-1 and top-5 error rates of 37.5% and 17.5%) on a highly challenging dataset using purely supervised learning.

III. Research Methods

To compute the algorithm in python, at first the anaconda3, anaconda navigator, and Jupyter notebook packages were downloaded. The model was built using Keras, a high-level neural network application programming interface (API) that supports both Theano and Tensorflow backends. Here, at first the data was loaded with necessary packages to plot some example images. Then those were converted to one-hot vectors. This is a standard output format for neural networks. With Keras simply adding layers one after another the models were quickly and neatly generated. After the hyper parameters of learning rate, momentum, and optimizer were defined the model could be complied and then the network could be used to for use with training data. In this architecture of our CNN, we have used a max-pooling layer which can lead to faster convergence, select superior invariant features, and improve generalization. We used ReLu as activation function in the second and third hidden layers and softmax in the fourth hidden layer just before the output layer.

In our architecture all the images were compressed in 28 X 28 pixels and then data was portioned into training and testing sets. We used 75% of the data training and the remaining 25% for testing. An image generator constructed Once the image generator was constructed for data augmentation, the model was initialized and trained. The results were saved and used to plot a training loss accuracy graph for 25 epochs. There were eleven main components (A-K) of the model that are briefly described in the ensuring narrative.

A. CNN for Image Classification

Kernel convolution is a key element of many other Computer Vision algorithms and is also used in CNNs. It is a process where a small matrix of numbers (called kernel or filter), are passed over an image. The image is then transformed over the values from the filters. Subsequent feature map values are calculated according to the following formula:

$$G[m,n] = (f * h)[m,n] = \sum_j \sum_k h[j,k] f[m-j, n-k]$$

Unfortunately, the image shrinks each time a convolution is performed resulting in a loss of some information in the picture. Eventually if too many convolutions are preformed then the image disappears completely.

B. Image Feature Extraction Using Convolution

Image pixels could be directly used as input to solve image classification problem in feed-forward neural networks. The challenge with using image pixel that most images have thousands to millions of pixels which present significant challenges when training the network. This would result in many weight parameters which, according to the VC dimension theory, would results in a much more complex system to avoid over-fitting the problem. In contrast, CNN models can combine weights into much smaller kernel filters that dramatically simplify the learning mode. As a result this study focused on using a CNN networks given that they are faster and more robust than traditional fully connected neural networks.

C. Pooling layer

Another way CNN's deal with the weights and the calculation is to add a pooling layer to help reduce the computation load on the network. There are a couple of

different pooling methods, average and max pooling. This study used several max pooling layers.

D. Fully connected layer

The LeNet architecture was selected because it east to train without requiring a large GPU. This study implemented this network architecture using Keras and Python.

E. Image Preprocessing

AI models can benefit from the improvements that digital processing provides. The goal of digital image processing is to create a better image by suppressing unwanted distortions. AI models also have challenges with large image resolutions ae they require more computing resources and lead to overfitting.

Digital image processing can also help with large image resolution. Higher resolution contains more data (also referred to as pixel per inch) and also provides a better image. Digital image processing can down sample and resized images to 150 X 150 bilinear interpolation. At the resolution of 150 × 150, some information about the images is lost.

F. Gradient Based Algorithm

To train a neural network one needs to handle many parameters or weights which need to be adjusted to minimize loss function. The loss function is one of the main causes of many neural network challenges. It is easier to minimize a reasonably smooth function continuous function by gradient based algorithm than a discrete function. The gradient based algorithm can help to better measure and estimate the impact of the variation of the values of the parameters. It is also important to minimize the loss function which can be accomplished by measuring the impact of the variation of the values of the parameters.

G. Gradient Back Propagation

The weights that need to be adjusted to minimize loss function and this adjustment happen from output layers to input layers which is called backpropagation. Backpropagation is an algorithm by which we can calculate a very complicated gradient and thus adjust the parameters in different layers. One important variable in backpropagation is learning rate and there is no hard and fast rule directing what rate to select.

H. Activation Functions

Activation functions are important neural network element as they help determine accuracy, efficiency, and speed. There are approximate 19 different types of activation function and this study only focuses on ReLu and Sigmoid.

I. ReLu (Rectified Linear Unit)

Rectified Liner Unit (ReLu) is a popular activation function in neural network because it efficient, cheap to compute, and it allows the network to converge quickly. Following is the mathematical form of ReLu:

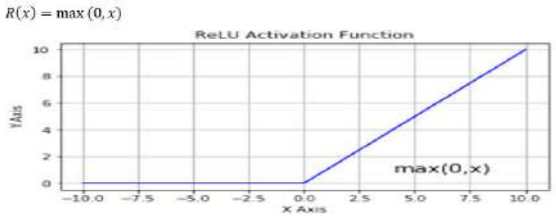

Figure-1: Rectified Linear Unit Activation Function

J. Sigmoid (Logistic Activation Function)

Sigmoid is another poplar activation function in neural networks. It is nonlinear and it good for dense processing. It was selected as a comparison activation function because of the dying ReLu problem which refers to the network evaluation to 0 and dying off. T Following is the mathematical form of Sigmoid:

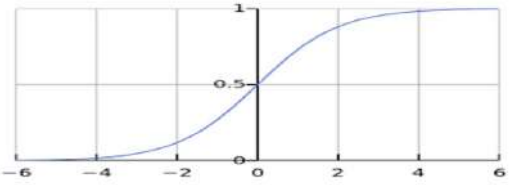

Figure-2: Sigmoid Activation Function

K. Loss function (Binary Cross Entropy/Log Loss)

The loss function is a method of assessing the progress of the learning process of the network. For the most part, the loss function is designed to provide a way to see how far off the optimum solution is. This study used binary cross-entropy. The function used by this study is described by the following formula:

H(p,q)=-1/N Σ _(i=1)^N y_i .log(p(y_i))+(1-y_i).log(1-p(y_i))

IV. Results and Discussion

We passed our network architecture through the activation functions ReLu and Sigmoid. This study found that the overall network worked better for the activation function Sigmoid than ReLu (see Table 1). This was interesting given the activation function ReLu is nonlinear in nature and generally the important benefit of ReLu is computationally more efficient than Sigmoid. Since for ReLu we just need to pick maximum of (0,x) and no need to perform expensive exponential operations as in Sigmoid. The other benefit of ReLu is the sparsity. Sparsity arises when x<0, that means when x<0 the y values are always 0 (figure 3). The more such units that exists in a layer the sparser resulting representation become.

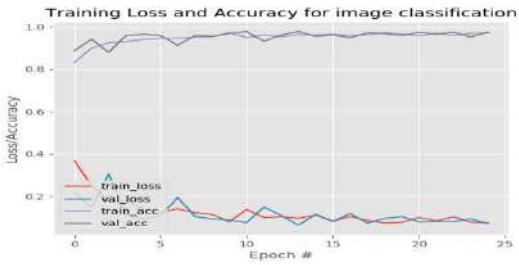

Figure 3: Loss and accuracy graph when activation function ReLu has been used

There can also be problem with the horizontal line in ReLu when the gradient can go towards 0. When this occurs the neuros stop responding to variations in errors and inputs. This problem is called dying ReLu resulting in dense representations. The sigmoid activation function generates values between 0 and 1 for the corresponding values of x in the domain [-∞, ∞]. Figure 4 illustrates the concept of small or 'vanishing gradients which is when the y y values respond less to changes in x. When this happens the network refuse or unable to lean and or get remarkably slow.

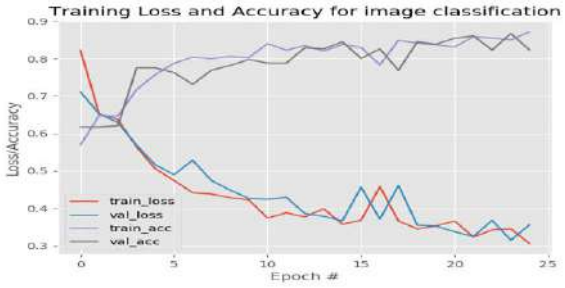

Figure 4: Loss and accuracy graph when activation function sigmoid has been used.

Sparsity of the activation function is another significant consideration in large neural network. Different activation functions utilize a different number of neurons. This can have a vital impact on computational cost and efficiency. For example, if a large network uses a sigmoid function most of the neurons are used to compute y values. This. That means almost all activations will be processed to describe the output of a network. In other words, the activation gets dense due to the processing of the network out. The optimum solution is to minimize some a few neurons and have them not activate which would create a sparse, cheaper and more efficient solution.

As our network is not a big network, when we use ReLu activation function to our network, it suffers by dying ReLu problem. On the other hand, if we use sigmoid activation function to our network, it doesn't get too dense to cause computationally costly and inefficient.

As we have been doing binary classification and have taken airplane and 'not airplane' two categories of images, when we have passed the images pixel through Sigmoid activation function, we have found that our network more confidently and accurately classifies whether is it airplane or not than when we have used ReLu activation. We have found some interesting result for the classification of 'Not airplane' and we have got opposite result to the label airplane (test result has been shown in Table 1). Therefore, from our test result we may assume that Sigmoid works better if the network is small than ReLu on the other hand, ReLu works better in case of a big network than Sigmoid.

S.No	Image_Type	When ReLu is used	When Sigmoid is used
1	Airplane_01	76.99% Confident	98.99% Confident
2	Airplane_02	83.60% Confident	97.01% Confident
3	Airplane_03	73.23% Confident	98.85% Confident
4	Airplane_04	95.69% Confident	96.02% Confident
5	Airplane_05	91.55% Confident	93.89% Confident
6	Not_Airplane_01	99.99% Confident	98.00% Confident
7	Not_Airplane_02	100% Confident	80.14% Confident
8	Not_Airplane_03	99.99% Confident	59.33% Confident

Table-1: Test result of some example images in our LeNet-CNN architecture

V. Conclusion

This study used a relatively simple deep neural network architecture by which we have performed image classification task using Keras, numpy, Python Open cv etc. The network model was tested on the Caltech 101 data set, which the data was divided in two categories. In one category there are 800 images all are the airplane and in other category there 460 images which are not airplane. Our aim was to classify two label data that is, whether it is airplane or not airplane? In this regard the network's performance was tested to determine how accurately the model could classify these two categories of image data. Overall if the Sigmoid activation function was used in the network architecture, then the model gets better accuracy (that means, more confidently classify that the image is airplane or 'not airplane') than when the network uses ReLu activation function. Other research could be useful in determine the exact value of data size and accuracy between the two models.

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The Age of Screen-The Impact of Internet of Things and 5G Wireless Broadband on Digital Marketing

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Abstract- **With the projection of 75 billion connected devices around the world by 2025 and 2billion connected device alone in India by 2021 which accounts for almost 5% of the worldwide users and the expansion of 5G network around the globe, data is going to be new blood to keep throbbing the heart of mankind. And with data mining marketing comes along. This exponential amount of data is a blessing to the renaissance of the screen ager. From governance to economy to education this blood can rejuvenate the Ichor.**

Key Words- **Marketing, Digital Marketing, Internet of Things, IOT,5G, Cloud Computing, Augmented Reality, AR, Virtual Reality, VR**

I. Introduction

From quite a lot of time we see the rise of the digital presence of the brands through various methods like email, SMS, social media, billboards and what not. A few years back this digital presence seemed extremely promising and was also delivering amazing results but today with increasing user base and abundance of technology time has come to reinvent the ways to digital marketing. The traditional marketing methods are still prevalent these days but the dominance is being captured by the cutting-edge methods of digital presence. Digital marketing is an entire domain under which there are a lot of branches which fuels it. With time consumers have become more tech enthusiastic and the blooming age where we believe that "the world is our home" which is practical either here is an emphatical study on how Internet of things and fifth generation mobile network can become edge to get hold with the market.

II. Methodology applied

2.1 Primary Data- The research is done through collection and observation of various open source data and articles

2.2 Secondary Data- Secondary data is collected through various journals, articles and blogs and books to develop the theory

2.3 Sample Size- The sample size is determined using the opinion of more than 100 customers who are currently purchasing digitally or have potentials to become digital shopper.

2.4 Objectives- To uphold a comparison how the attitude of digital marketing has changed

To study the usefulness of IOT and 5g in terms of digital marketing

III. Conventional marketing versus digital marketing

Traditionally marketing is done by promotions, billboards, placards, affiliation programs and various other means of offline mediums. Digital marketing is a new way to reach the potential buyers by means of electronic medium, be it the tv advertisement or social media or any other digital media. Digital marketing is a sub brand of traditional marketing and utilizes cutting edge digital instruments for the product display e.g. Downloadable music, Primarily for the purpose of communication with stakeholders, Customers and investors about brand products or business development.

3.2 Various elements in digital marketing

Online advertising- Online advertising is the most popular form of digital marketing. We see a lot of ads while browsing through the web. And there are some ads which surprises us with the appearance of the kind of product or services we may have looking for, for a long time and compels us to click on that ad. The most common vendor for displaying and through the web is google ads. Generally, the web browsers we use e.g. Google chrome, Mozilla Firefox, Microsoft edge etc stores our activity and search history in the forms of cookies and then those data are fed to the ad catering algorithm which is designed to show appropriate ads to the appropriate kind of customers.

3.3 E-mail marketing

When message about products or services are directly sent through the email it is called email-marketing. It is used to create brand awareness, promotion of new products and services, creating brand equity etc.

3.4 Affiliate Marketing

It is a kind of performance-based marketing where affiliates get rewarded on bringing new customers on the behalf of the company. The market gone into severe complication and that led to the emergence of second tier of players including affiliate management agencies, super affiliates and third-party vendors. Company's goal here is to enter into virgin markets and spread there.

3.5 Social -media

Social media sites are the bull's eye for the digital marketers. Because today's generation is tech savvy and they spend a significant amount of their time in social media where they share and explore their ideas and try out new things. And that has become an ideal place to sneak into people's point of interests and deliver the right kind of ad so that it is noticed.

3.6 An analysis of digital marketing

Digital media is so easily accessible and convenient and the amount of data it gives access to public that those days when the people had access for a specific set of data made available to them intentionally are gone. Here is a small data that shows the effectiveness of digital media.

Model	R square	F
People who are up to date with products and services	.718	122.117
Better Engagement	.516	51.276
Proper information	.629	81.254
Easy comparison	.639	85.141
24x7 shopping	.749	142.868
People who shares contents of products and services	.656	91.498
Apparent pricing	.636	83.962
Enables instant purchase	.667	96.028

The above table leads us to a conclusion that all the variables carry weightage greatly with its relationship to digital marketing. For example, staying updated with product and services is explained by 71.08% of digital marketing and the remaining 28.20% is explained by other factors. Greater engagement is shown as 51.60% of digital marketing and the remaining 48.40% is explained by other factors. Proper information about product and services is explained by 62.90% of digital marketing and the remaining 37.70% is explained by another factor. From the table we can see that most of the f values are more than 80 that shows the strength of the model.

IV. What is IOT?

IOT or Internet of things is the constellation of devices apart from mobile phones and computers that uses data to improve their performances and make our life better. Like smart bulb, smart refrigerators etc. Now modernization has led us to make the scientific inventions smarter by connecting those wonderful gifts of science to neural networks and give them a chunk of artificial intelligence.

4.1 Magic of IOT

Till now we used to use our refrigerators for keeping our foods fresh or to satisfy our midnight craving for a delicious spoon of butterscotch. Now those things have become smarter. Connected refrigerators can sync with your google calendar and send you a notification as soon as you finish your meeting or you are driving towards your home that you still have that delicious bowl of butterscotch remaining. Same as washing machines it can remind you to wash your clothes on a specific interval by learning your washing patterns and can also suggest you wash time depending on your schedule.

4.2 How we can use the power of IOT as a tool for digital marketing

Super-easy exchange of sales data sales or customer usage data is one of the most crucial factors for any business. And with easy access to the information such as how why and when to offer a product to a customer a brand can make their strategies a lot better. With the significant number of smart devices available today the transition of customer experience in the form of data takes place in real time which helps the brands in better decision making for their future sales and marketing strategies.

Devices are self-sustainable with the implementation of IOT the regular devices have got even smarter. Like for cars especially if take the example of Elon Mask's Tesla supercars they are so intelligent that if there is a lot of IOT enabled cars in the road they will talk within themselves obviously we won't be able to hear them but they will talk and try to utilize the traffic as much as possible by using their algorithms. And another magical thing about IOT is that these devices are coded so brilliantly that they can heal themselves if any software error occurs or can call the service centre if it cannot be solved by its own.

4.3 Instant customer analysis with smarter CRM (Customer Relationship Management)

When these IOT enabled devices are clubbed with reliable customer relationship management tool IOT becomes a superman. It not only collects user data but also analyses them properly and can be a huge breakthrough if it implemented properly. Like it can suggest you a milkshake if it sees or hears you thirsty. It has that much of potentiality.

4.4 Supports Social Media

A few years back when the social medias just started emerging, the marketers were not sure about how these things will work out but with time internet traffic took a turn and took the social media sites like Facebook, twitter by storm. Now the ai is so efficiently implemented that it can show posts according to the user's interest.

4.5 A Hundred Percent click-through rate

The main goal of IoT in Marketing is to enable a smarter relevant and powerful brand of advertising. With the growing number of devices, they are being provided with hi tech sensors and consistent network accessibility, which is changing the advertising scenario for both marketers and customers as well. The dependency on pop up ads and banners on the websites has ended because those are outdated to cope up with the modern IOT algorithms.

4.6 From key-word based SEO (Search Engine Optimization) content to interest-based content

SEO is one of the most extensively used medium for website promotion for decades. It also created a lot of jobs in the field of digital marketing. Now with the arrival of IOT enabled devices the whole system will be changed to intention-based writing. The smart devices we use on daily basis collets our usage patterns, here's what we say often recognizes those words and then it delivers the appropriate ad instantly on the device. The process has already become so efficient that it works in seconds but still there is a lot of room to make it more stable and efficient.

4.7 IOT radicalizing the product development

Traditionally product development depends on customer feedback and that feedback takes time to be generated now with the rise of IOT that data can be fed o the manufacturer in real time which cuts the product development cost and time by a huge number.

4.8 New job opportunities

It is true that IOT is replacing some human jobs but it is also true that the countries who are implementing IOT are seeing a boom in online job creation. With the work from home a new normal the IOT in digital marketing becoming a reality.

4.9 Some key-facts about IOT

4.9.1 It is projected that the global spending on IOT will touch 1.1 trillion dollars by 2023

4.9.2 The revenues from the IOT sensor market amounted to 11.9 billion dollars in 2019 which is estimated to increase to 43 billion by 2021

4.9.3 The industrial Internet of Things (IOT) market size worldwide in 2020 is estimated to reach some 77.3 billion U.S. dollars.

4.9.4 It is expected that 749 billion us dollars will be spent on IOT technologies worldwide in 2020. Despite the market has seen growth but the growth is lesser than the estimated because of the global coronavirus outbreak.

V. What is 5G?

5G or Fifth generation mobile network basically is a clous based network. Many small cell towers are wirelessly fed the link from a hub and the small towers work as a range extender to boost those signals and deliver internet to customer's cell phone. It significantly reduces the fibre cable laying costs and downtime.

5.1 How 5G will impact digital marketing

5.1.1 Mobile ecommerce will accelerate

Mobile e commerce sales in India was 58.5% in 2015 and with the emergence of digital freedom it gradually grew to 77.6% in 2019 which us projected to touch 80% by 2020. Though customers in India are still experiencing lot of issues while shopping online the majority of the people complained of facing latency issues which bars them from getting their favourite product during "flash" sales or "lightning" deals while at the same time an ofc (optical fibre cable) broadband users stays ahead by this few millisecond. As networks speed up with 5G it is expected to deliver connections with almost zero latency. That alerts the companies, developers and network engineers and marketers to streamline their apps for seamless operations and huge traffic handling. The online shopping industry is expected to grow significantly with the arrival of 5G.

5.1.2 Personalized ads and cx will get easier

With the increase in connection speed the number of wireless data users will also increase. This means increase data collection as it will be more tangled with the lives of the people and will result in garnering more higher quality hyperlocal and granular data that looks more prominent by the projection of 75 billion IOT device being online by 2025. With ultra-fast 5G data speeds possibilities for hyper-personalized experiences with real time analysis of customer data is practically endless. While IOT and high-speed data already paved the way for abundance of digital ads 5G will take the concept of ads one step further with the customer engagement. While previously it was impossible to make interactive ads due to technical limitations the fifth generation zero latency network will enable users to interact with it and the brand and the marketers a huge door to get into customer's mind.

5.1.3 AR/VR will get even more realistic

It is possible to tell if your favorite car will fit into your garage or not by the power of AR. With VR a product-based company can train people to use their product in a 4 by 4 room. Now imagine a new electric car company marketing its brand by training users to learn and experience their car without even having a prototype. If implemented correctly it can help people by enabling with skills at a significantly lesser cost and time.

VI. Conclusion

It's been a job pf the marketer to analyse a trend before it becomes a trend and to know what the customer is going to want before they know themselves. And this is done by gathering data analysing them and making predictions of the customer behaviour. The marketing data can be totally customized for targeted customers ad campaigns and sales etc. If I take an example that a customer is at the near areas of your client's retail store you can set up an entirely customized ad delivery system depending on their distance from the store, the weather, their previous purchase records from the same store and how those prices compare with other stores, events set on their google calendar etc. and this will be utterly a surprising piece of event for the customer if they see a retailer remembered the birthday of someone close to him or her and suggested a perfect gift or while you are driving off in a rainy evening a notification in your phone tells you to taste some hot snacks from your nearby eateries . It will be a perfectly streamlined marketing system where the possibilities are endless.

With efficient governance and skilled people comes a robust economy. Now with a declining automobile sector in India if we just take it as an example, a lot of people who cannot drive a car can be safely trained to become a good drive with the help of VR now the question comes who will gain what by providing free driving training to people? If I just take a strike through rate of 10% if I train 10 crore people there is a huge possibility that at least 10 lakh people will buy a new vehicle by which you have a humongous boost to industry govt earns both from the car manufacturers in the form of tax and through the insurances, road taxes and fuel taxes. The entire insurance industry (money market) gets a boost, thousands of people gets jobs in the various sectors gets skilled in their relevant field and you are passively enabling a way to circulate crores of rupees in the subsequent industries all by training people inside a room with a chance of zero collateral damage. This just an example of what we can make out of IOT and high-speed data. And to strategically present this initiative to the people Digital marketing will play a key role.

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An approach to avoid Meet in the Middle Attack in 2 DES

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***Abstract*— Cryptography is evolving with new and better algorithms. The existing DES provides security but is vulnerable on account of its smaller key. An attacker can easily break through DES with a minimal number of operations. 2 DES or double DES uses a longer key but is highly vulnerable due to Meet in the middle attack, which reduces the brute force time by almost a factor of 2. In this paper, we introduce a better algorithm that incorporates the best features from DES and 2 DES. The new algorithm is essentially a modified version of DES. It is operational over blocks of size 128 bits. The key used is of 112 bits and thus ensuring better security over DES. We use single encryption, unlike 2 DES that uses double encryption, ensuring edge over Meet in the Middle attack. The algorithm makes use of the Feistel cipher algorithm. The plaintext is divided into blocks of size 128 bits. Each block is further divided into two sub-blocks say L and R 64 bits each. We divide these L and R blocks again, say L_0 and R_0 (from L), and L'_0 and R'_0 (from R). In the next step, we perform Feistel cipher over L_0 and R'_0 on one hand and L'_0 and R_0 on the other. Multiple divisions and inter Feistel between left and right blocks ensures better mixing and provides a better avalanche effect. Everything combined ensures better security of the plaintext involved.**

Keywords—*DES, 2 DES, Feistel cipher, Meet in the Middle attack, key.*

I. INTRODUCTION

Cryptography is the science of transmitting data securely over an unsecured transfer channel. The process involves encryption of the data using various encryption algorithms such that only authentic recipients (with valid ***'key'***) can decipher the message. Cryptography is divided into two broad groups – Symmetric and Asymmetric key cryptography. In symmetric cryptography, the same key is used for both the encryption and decryption process. While in asymmetric key cryptography, two separate keys are used – Public key (for encryption purpose) and Private key (for decryption purpose). Symmetric cryptographic algorithms are further divided into 2 groups – Stream cipher and Block cipher. In the case of stream ciphers, the encryption algorithm and key are used on each binary bit of data stream. Whereas in the case of a block cipher, the encryption is performed over a block of particular sizes. Cryptographic algorithms like DES, 2 DES, 3 DES are all block ciphers.

II. ALICE,BOB,EVE STRUCTURE

The Alice-Bob-Eve structure is often used in the context of explaining cryptography. Here Alice represents the sender of the message and Bob, a valid recipient of the message. Eve in this context is an attacker, an unauthorized person trying to steal data by intercepting transmission. Alice and Bob both have access to the secret *'key'* whereas Eve is unaware of the *'key'*. The whole point of cryptography is to ensure the safe transmission of a message between Alice and Bob. Alice encrypts the message with standard cryptographic algorithms and a secret *'key'* to which Bob has access. Eve incorporates various cryptanalysis attacks over the ciphered text to extract the real message. The main aim of cryptography is to ensure that attackers like Eve take the maximum time to decrypt the message.

III. KEY

Key is the most important component of any cryptography algorithm, specifically for a symmetric cryptography algorithm, the secreacy of the data is the solely dependent on the secreacy of the key. Here in our algorithm we use a 112 bits of key, and used it to encrypt a 128 bits data.

IV. FEISTEL CIPHER

Feistel cipher is a design model used in the construction of many block ciphers. Developed by Horst Feistel, the Feistel cipher provides an effective way of implementing ideal block cipher. It consists of dividing the blocks into two equal halves followed by repetitive XORing with a given key and interchanging the blocks in successive rounds. One

advantage of Feistel Cipher is that the same structure can be used for encryption and decryption purposes

V. DES

DES is an existing cryptographic algorithm. It makes use of the Feistel cipher along with some permutation over the plaintext in performing the encryption. DES uses a key of the length of 56 bits and hence provides less security. Multiple encryption algorithms like 2 DES and 3 DES increases security.

VI. 2 DES

2 DES is an existing cryptographic algorithm. It performs two successive DES operations on a block size of 64 bits. 2 DES was introduced as an alternative to existing DES but was susceptible to Meet in the Middle attack, which decreased its security to a great extent.

VII. MEET IN THE MIDDLE ATTACK

In multiple encryption algorithms (block ciphers), the time complexity for normal brute force is reduced using the Meet in the middle attack. Meet in the middle attack is a generic plaintext attack in which keys are found using both the ciphertext and plaintext. The intermediate values from encryptions and decryption are stored, and the attacker checks for pairs of keys, that give the same intermediate value.

2 DES can be broken with 2^{57} encryptions and decryptions operation using the MITM attack where the normal brute force on 2 DES requires 2^{112} encryptions and decryptions operation.

Symbolically a 2 DES algorithm is represented as:

$C = ENC_{k_2}(ENC_{k_1}(P))$ --------> Encryption process

$P = DEC_{k_1}(DEC_{k_2}(C))$ --------> Decryption process

Here, ENC and DEC denote the encryption and decryption functions. DEC is the inverse of ENC.

Normal brute force on 2 DES requires 2^{112} operations (both k_1 and k_2 are of 56 bits each). MITM attack uses a different strategy:

Consider the operation $DEC_{k_2}(C)$ it reduces to

$DEC_{k_2}(C) = DEC_{k_2}(ENC_{k_2}(ENC_{k_1}(P)))$

Or, $DEC_{k_2}(C) = ENC_{k_1}(P)$

The attacker stores all possible results from $DEC_{k_2}(C)$ and $ENC_{k_1}(P)$ of a known plaintext-ciphertext pair comprising 256 operations for each. Thus the total number of operations performed is $2^{56}+2^{56} = 2^{57}$. Once a match is found against a particular pair of keys, k1 and k2 such that DECk2(C) = ENCk1 (P). K1 and K2 are the required keys.

VIII. OUR APPROACH

Here we present a better version of the existing DES that takes 128 bits blocks of plaintext as input performs encryption on the block. The key used in this case is of size 112 bits. The methodology of the algorithm consists of 4 steps.

1. Initial permutation:
   The 128 bits of plaintext are passed through a permutation box that shuffles the 128 bits based on a fixed permutation array.

2. Feistel structure:

   The initial 128 bits of plaintext are first divided into two halves of 64 bits, say LEFT and RIGHT. The LEFT block is further divided into two halves of 32 bits (L0 and R0); similarly, the Right block is divided into two halves of 32 bits (L'0 and R'0). Then we perform 16 round Feistel cipher over L0 and R'0 one on hand and R0 and L'0 on the other hand. Finally, the LEFT and RIGHT blocks are interchanged.

3. Final permutation:

   The plaintext is processed through another permutation box that shuffles the 128 bits based on a fixed permutation array.

A. *Round key generation:*

We use a 128 bit key of which 12 bits are reserved for parity checking. For generating keys for successive rounds, we first remove the parity bits reducing the key length to 112 bits. Next, the key is split into two halves of 56 bits (two keys for two halves of plaintext block). A loop is run for 16 rounds. In each round, the two keys are round shifted based on a fixed array. A final permutation is performed, and keys for each round are stored.

B. *Using padding*

A check is done at first beforehand and padding is added according to general standards.

IX. SOURCE CODE FOR OUR ALGORITHM(PYTHON)

```
import time
#Initial permut matrix for the datas
PI = [58, 50, 42, 34, 26, 18, 10, 2,
    60, 52, 44, 36, 28, 20, 12, 4,
    62, 54, 46, 38, 30, 22, 14, 6,
    64, 56, 48, 40, 32, 24, 16, 8,
    57, 49, 41, 33, 25, 17, 9, 1,
    59, 51, 43, 35, 27, 19, 11, 3,
    61, 53, 45, 37, 29, 21, 13, 5,
    63, 55, 47, 39, 31, 23, 15, 7,
    122, 114, 106, 98, 90, 82, 74, 66,
    124, 116, 108, 100, 92, 84, 76, 68,
    126, 118, 110, 102, 94, 86, 78, 70,
    128, 120, 112, 104, 96, 88, 80, 72,
    121, 113, 105, 97, 89, 81, 73, 65,
    123, 115, 107, 99, 91, 83, 75, 67,
    125, 117, 109, 101, 93, 85, 77, 69,
    127, 119, 111, 103, 95, 87, 79, 71]

#Initial permut made on the key and drop all multiple of 8th
bit
CP_1 = [57, 49, 41, 33, 25, 17, 9,
      1, 58, 50, 42, 34, 26, 18,
```

```
        10, 2, 59, 51, 43, 35, 27,
        19, 11, 3, 60, 52, 44, 36,
        63, 55, 47, 39, 31, 23, 15,
        7, 62, 54, 46, 38, 30, 22,
        14, 6, 61, 53, 45, 37, 29,



        21, 13, 5, 28, 20, 12, 4,
        121, 113, 105, 97, 89, 81, 73,
        65, 122, 114, 106, 98, 90, 82,
        74, 66, 123, 115, 107, 99, 91,
        83, 75, 67, 124, 116, 108, 100,
        127, 119, 111, 103, 95, 87, 79,
        71, 126, 118, 110, 102, 94, 86,
        78, 70, 125, 117, 109, 101, 93,
        85, 77, 69, 92, 84, 76, 68]

#Permut applied on shifted key to get Ki+1
CP_2 = [14, 17, 11, 24, 1, 5, 3, 28,
        15, 6, 21, 10, 23, 19, 12, 4,
        26, 8, 16, 7, 27, 20, 13, 2,
        41, 52, 31, 37, 47, 55, 30, 40,
        51, 45, 33, 48, 44, 49, 39, 56,
        34, 53, 46, 42, 50, 36, 29, 32,
        70, 73, 67, 80, 57, 61, 59, 84,
        71, 62, 77, 66, 79, 75, 68, 60,
        82, 64, 72, 63, 83, 76, 69, 58,
        97, 108, 87, 93, 103, 111, 86, 96,
        107, 101, 89, 104, 100, 105, 95, 112,
        90, 109, 102, 98, 106, 92, 85, 88]

#Expand matrix to get a 48bits matrix of datas to apply the
xor with Ki
E = [32, 1, 2, 3, 4, 5,
    4, 5, 6, 7, 8, 9,
    8, 9, 10, 11, 12, 13,
    12, 13, 14, 15, 16, 17,
    16, 17, 18, 19, 20, 21,
    20, 21, 22, 23, 24, 25,
    24, 25, 26, 27, 28, 29,
    28, 29, 30, 31, 32, 1]

S_BOX = [
 [[14, 4, 13, 1, 2, 15, 11, 8, 3, 10, 6, 12, 5, 9, 0, 7],
 [0, 15, 7, 4, 14, 2, 13, 1, 10, 6, 12, 11, 9, 5, 3, 8],
 [4, 1, 14, 8, 13, 6, 2, 11, 15, 12, 9, 7, 3, 10, 5, 0],
 [15, 12, 8, 2, 4, 9, 1, 7, 5, 11, 3, 14, 10, 0, 6, 13],
],
[[15, 1, 8, 14, 6, 11, 3, 4, 9, 7, 2, 13, 12, 0, 5, 10],
[3, 13, 4, 7, 15, 2, 8, 14, 12, 0, 1, 10, 6, 9, 11, 5],
[0, 14, 7, 11, 10, 4, 13, 1, 5, 8, 12, 6, 9, 3, 2, 15],
[13, 8, 10, 1, 3, 15, 4, 2, 11, 6, 7, 12, 0, 5, 14, 9],
],
[[10, 0, 9, 14, 6, 3, 15, 5, 1, 13, 12, 7, 11, 4, 2, 8],
[13, 7, 0, 9, 3, 4, 6, 10, 2, 8, 5, 14, 12, 11, 15, 1],
[13, 6, 4, 9, 8, 15, 3, 0, 11, 1, 2, 12, 5, 10, 14, 7],
[1, 10, 13, 0, 6, 9, 8, 7, 4, 15, 14, 3, 11, 5, 2, 12],
],

[[7, 13, 14, 3, 0, 6, 9, 10, 1, 2, 8, 5, 11, 12, 4, 15],
 [13, 8, 11, 5, 6, 15, 0, 3, 4, 7, 2, 12, 1, 10, 14, 9],
 [10, 6, 9, 0, 12, 11, 7, 13, 15, 1, 3, 14, 5, 2, 8, 4],
 [3, 15, 0, 6, 10, 1, 13, 8, 9, 4, 5, 11, 12, 7, 2, 14],
],

[[2, 12, 4, 1, 7, 10, 11, 6, 8, 5, 3, 15, 13, 0, 14, 9],
 [14, 11, 2, 12, 4, 7, 13, 1, 5, 0, 15, 10, 3, 9, 8, 6],
 [4, 2, 1, 11, 10, 13, 7, 8, 15, 9, 12, 5, 6, 3, 0, 14],
 [11, 8, 12, 7, 1, 14, 2, 13, 6, 15, 0, 9, 10, 4, 5, 3],
],

[[12, 1, 10, 15, 9, 2, 6, 8, 0, 13, 3, 4, 14, 7, 5, 11],
 [10, 15, 4, 2, 7, 12, 9, 5, 6, 1, 13, 14, 0, 11, 3, 8],
 [9, 14, 15, 5, 2, 8, 12, 3, 7, 0, 4, 10, 1, 13, 11, 6],
 [4, 3, 2, 12, 9, 5, 15, 10, 11, 14, 1, 7, 6, 0, 8, 13],
],

[[4, 11, 2, 14, 15, 0, 8, 13, 3, 12, 9, 7, 5, 10, 6, 1],
 [13, 0, 11, 7, 4, 9, 1, 10, 14, 3, 5, 12, 2, 15, 8, 6],
 [1, 4, 11, 13, 12, 3, 7, 14, 10, 15, 6, 8, 0, 5, 9, 2],
 [6, 11, 13, 8, 1, 4, 10, 7, 9, 5, 0, 15, 14, 2, 3, 12],
],

[[13, 2, 8, 4, 6, 15, 11, 1, 10, 9, 3, 14, 5, 0, 12, 7],
 [1, 15, 13, 8, 10, 3, 7, 4, 12, 5, 6, 11, 0, 14, 9, 2],
 [7, 11, 4, 1, 9, 12, 14, 2, 0, 6, 10, 13, 15, 3, 5, 8],
 [2, 1, 14, 7, 4, 10, 8, 13, 15, 12, 9, 0, 3, 5, 6, 11],
]
]
P = [16, 7, 20, 21, 29, 12, 28, 17,
    1, 15, 23, 26, 5, 18, 31, 10,
    2, 8, 24, 14, 32, 27, 3, 9,
    19, 13, 30, 6, 22, 11, 4, 25]
PI_1 = [40, 8, 48, 16, 56, 24, 64, 32,
        39, 7, 47, 15, 55, 23, 63, 31,
        38, 6, 46, 14, 54, 22, 62, 30,
        37, 5, 45, 13, 53, 21, 61, 29,
        36, 4, 44, 12, 52, 20, 60, 28,
        35, 3, 43, 11, 51, 19, 59, 27,
        34, 2, 42, 10, 50, 18, 58, 26,
        33, 1, 41, 9, 49, 17, 57, 25,
        104, 72, 112, 80, 120, 88, 128, 96,
        103, 71, 111, 79, 119, 87, 127, 95,
        102, 70, 110, 78, 118, 86, 126, 94,
        101, 69, 109, 77, 117, 85, 125, 93,
        100, 68, 108, 76, 116, 84, 124, 92,
        99, 67, 107, 75, 115, 83, 123, 91,
        98, 66, 106, 74, 114, 82, 122, 90,
        97, 65, 105, 73, 113, 81, 121, 89]
PI_1_tmp = [40, 8, 48, 16, 56, 24, 64, 32,
        39, 7, 47, 15, 55, 23, 63, 31,
        38, 6, 46, 14, 54, 22, 62, 30,
        37, 5, 45, 13, 53, 21, 61, 29,
        36, 4, 44, 12, 52, 20, 60, 28,
        35, 3, 43, 11, 51, 19, 59, 27,
        34, 2, 42, 10, 50, 18, 58, 26,
        33, 1, 41, 9, 49, 17, 57, 25]
#Matrix that determine the shift for each round of keys
SHIFT = [1,1,2,2,2,2,2,2,1,2,2,2,2,2,2,1]
def string_to_bit_array(text):#Convert a string into a list of
bits
    array = list()
    for char in text:
```

```
    binval = binvalue(char, 8)#Get the char value on one byte
    array.extend([int(x) for x in list(binval)]) #Add the bits to the final list
  return array

def bit_array_to_string(array): #Recreate the string from the bit array
  res = ''.join([chr(int(y,2)) for y in [''.join([str(x) for x in _bytes]) for _bytes in  nsplit(array,8)]])
  return res
def binvalue(val, bitsize): #Return the binary value as a string of the given size
  binval = bin(val)[2:] if isinstance(val, int) else bin(ord(val))[2:]
  if len(binval) > bitsize:
    raise "binary value larger than the expected size"
  while len(binval) < bitsize:
    binval = "0"+binval #Add as many 0 as needed to get the wanted size
  return binval

def nsplit(s, n):
 return [s[k:k+n] for k in range(0, len(s), n)]

ENCRYPT=1
DECRYPT=0
class des():
  def __init__(self):
    self.password = None
    self.text = None
    self.padding = None
    self.keys = list()

  def run(self, key, text, padding, action=ENCRYPT):
    if len(key) < 16:
      raise "Key Should be 16 bytes long"
    elif len(key) > 16:
      key = key[:16] #If key size is above 8bytes, cut to be 8bytes long

    self.password = key
    self.text = text
    # print(text, len(text))
    if len(self.text) % 16 != 0:
      padding = True
    if padding and action==ENCRYPT:
      self.addPadding()

    self.generatekeys() #Generate all the keys
    text_blocks = nsplit(self.text, 16) #Split the text in blocks of 16 bytes so 64 bits
    print(text_blocks)
    result = list()
    count = 0

    for block in text_blocks:#Loop over all the blocks of data
      block = string_to_bit_array(block)#Convert the block in bit array
      block = self.permut(block,PI)#Apply the initial permutation
      LEFT_BLOCK, RIGHT_BLOCK = nsplit(block, 64) #g(LEFT), d(RIGHT)
      g, d = nsplit(LEFT_BLOCK, 32)
      g_dash, d_dash = nsplit(RIGHT_BLOCK, 32)
      tmp = None
      tmp_dash = None
      for i in range(16): #Do the 16 rounds
        d_e = self.expand(d, E) #Expand d to match Ki size (48bits)
        d_dash_e = self.expand(d_dash, E)
        if action == ENCRYPT:
          key, key_dash = nsplit(self.keys[i], 48)
          tmp = self.xor(key, d_e) #If encrypt use Ki
          tmp_dash = self.xor(key_dash, d_dash_e) #If encrypt use Ki
        else:
          key, key_dash = nsplit(self.keys[15-i], 48)
          tmp = self.xor(key, d_e) #If decrypt start by the last key
          tmp_dash = self.xor(key_dash, d_dash_e) #If decrypt start by the last key
        tmp = self.xor(g_dash, tmp)
        tmp_dash = self.xor(g, tmp_dash)
        if action == ENCRYPT:
          print(tmp)
          print('[+]' + '-'*140)
        else:
          print(tmp)
          print('[-]' + '-'*140)

        g = d_dash
        g_dash = d
        d = tmp
        d_dash = tmp_dash


      result += self.permut(d+g+d_dash+g_dash, PI_1) #Do the last permut and append the result to result
      count = count +1


    final_res = bit_array_to_string(result)
    if padding and action==DECRYPT:
      return self.removePadding(final_res) #Remove the padding if decrypt and padding is true
    else:
      return final_res #Return the final string of data ciphered/deciphered

  def substitute(self, d_e):#Substitute bytes using SBOX
    subblocks = nsplit(d_e, 6)#Split bit array into sublist of 6 bits
    result = list()
    for i in range(len(subblocks)): #For all the sublists
      block = subblocks[i]
      row = int(str(block[0])+str(block[5]),2)#Get the row with the first and last bit
      column = int(''.join([str(x) for x in block[1:][:-1]]),2) #Column is the 2,3,4,5th bits
      val = S_BOX[i][row][column] #Take the value in the SBOX appropriated for the round (i)
      bin = binvalue(val, 4)#Convert the value to binary
```

```
        result += [int(x) for x in bin]#And append it to the resulting list
        return result

    def permut(self, block, table):#Permut the given block using the given table (so generic method)
        return [block[x-1] for x in table]

    def expand(self, block, table):#Do the exact same thing than permut but for more clarity has been renamed
        return [block[x-1] for x in table]

    def xor(self, t1, t2):#Apply a xor and return the resulting list
        return [x^y for x,y in zip(t1,t2)]

    def generatekeys(self):#Algorithm that generates all the keys
        self.keys = []
        key = string_to_bit_array(self.password)
        key = self.permut(key, CP_1) #Apply the initial permut on the key
        g, d = nsplit(key, 56) #Split it in to (g->LEFT),(d->RIGHT)
        for i in range(16):#Apply the 16 rounds
            g, d = self.shift(g, d, SHIFT[i])
            tmp = g + d #Merge them
            self.keys.append(self.permut(tmp, CP_2)) #Apply the permut to get the Ki

    def shift(self, g, d, n):
        return g[n:] + g[:n], d[n:] + d[:n]

    def addPadding(self):
        pad_len = 16 - (len(self.text) % 16)
        print(pad_len)
        self.text += pad_len * chr(pad_len)

    def removePadding(self, data):
        pad_len = ord(data[-1])
        return data[:-pad_len]

    def encrypt(self, key, text, padding):
        return self.run(key, text, padding, ENCRYPT)

    def decrypt(self, key, text, padding):
        return self.run(key, text, padding, DECRYPT)

if __name__ == '__main__':
    key = "holaholaholahola"
    text= "Hello world!!!! "
    padding = False
    if len(text) % 16 != 0:
        padding = True
    d = des()
    t0=time.perf_counter()
    r = d.encrypt(key,text,padding)
    t1=time.perf_counter()
    print(t1-t0)
    t0= time.perf_counter()
    r2 = d.decrypt(key,r,padding)
    t1=time.perf_counter()
    print("Deciphered: %r"% r2)
    print(t1-t0)
```

X. Simulation Results

On applying the Our Algorithm and 2 DES cryptographic algorithm on the same, the following results are obtained:

2 DES

Plaintext = “Hello world!!!!!”

K_1 =”holaholaholahola”

K_2 = “ouiouiouiouiouio”

Encryption time: 0.010863126000003831s

Decryption time: 0.011737551000010171s

Our Algorithm

Plaintext = “Hello world!!!!!”

Key = “holaholaholahola”

Encryption time: 0.004856472000028589s

Decryption time: 0.006842922000032559s

Time taken by an arbitrary attacker (Brute force attack)

2 DES: 2^{57} * Decryption time = 1.69 * 10^{15} s (Meet in the middle attack)

Our Algorithm: 2^{112} * Decryption time = 3.55 * 10^{31} s

Our Algorithm is faster than 2 DES with less encryption-decryption time. The brute force time for Our Algorithm is much larger than that of 2 DES. Our Algorithm provides better security than 2 DES with lower encryption-decryption time.

XI. Comperative Study Between Our Algorithm And 2 DES

- Our Algorithm has a lower encryption- decryption time compared to 2 DES:

  In 2 DES two back-to-back Feistel ciphers are used while in Our Algorithm the whole encryption process comprises a single Feistel cipher (the modifications are made within the 16 round Feistel cipher).

- Our Algorithm provides better security over 2 DES:

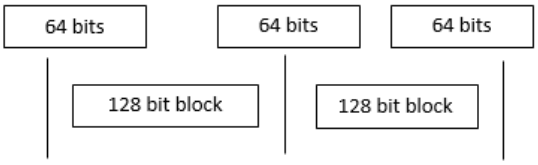
  Our Algorithm doesn’t use multiple encryptions and hence isn’t susceptible to Meet in the Middle attack. The number of encryption-decryption required for its brute force is of the order 2112. The worst-case time complexity is $O(2^{112})$, the average case being $O(2^{111})$.

  On the other hand, 2 DES is vulnerable to Meet in the Middle attack and can be effectively broken down by a mere 257 operations. Its time complexity is of the order $O(2^{57})$.

XII. CONCLUSION

This algorithm when compared to 2 DES proves to more efficient. The same algorithm with few modifications can prove to be a boon for medium sized data packets.

- A further modification to our algorithm can be made by taking overlapping 128 blocks of plaintext



The 64 bits in the middle is encrypted twice and hence provides a better security.

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Prediction of Student Success using Student Engagement with Learning Management System

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***Abstract*—There has been a surge in student failure rates in blended-learning courses in recent times, which has generated considerable research interests. Engagement is identified as one of the core metrics for measuring students' success or failure in any learning system. This study utilizes machine learning algorithms on students' log-file data collected from an LMS to predict student success and increase the students' throughput rates. The machine learning predictive models considered in this study are the Naïve Bayes Classifier, Decision Tree, Gradient Boosting Tree, Linear Logistic Regression, Random Forest, Multilayer Perceptron Neural Network, and Support Vector Machines. The results provide an automatic predictive model for early detection of students at risk of failing for timely instructor intervention. The result serves as a feedback tool on learning for an increase in student performance. The machine learning algorithms' performances were evaluated using accuracy, precision, recall, and ROC-AUC for the best performing predictive model.**

***Keywords*—Student success, At-risk student, Machine Learning, Predictive models, Student engagement, Educational Data Mining**

I. Introduction

Educational Data Mining (EDM) is an emerging research area, serving a variety of instructional goals within web-based educational systems. [1] provided instructional purposes of EDM as evaluation of learning and instructional design efficacy, designing adaptive environments for students based on their actual behavior, providing input to both students and teachers, and detecting abnormal learning habits in the system.

Academic success is a huge challenge for higher education institutions across the world. The authors in [2] and [3] identified data analytics for detecting students failing academically and increasing the throughput rate in universities across the globe. Student engagement is a core metric for measuring a student's success or failure in any learning system. Recently, the rate of failure in undergraduate blended-learning courses is increasing, especially in science courses [4]. The trend in blended-learning failure necessitated the investigation into the key engagement metrics that have a high correlation with a student's performance in a blended-learning environment. Blended-learning is the combination of conventional classroom learning, and technology-aided instructions [5]. However, there are many challenges associated with blended-learning systems. [6] in their study identified a lack of motivation of students in different courses and their respective course materials as major drawbacks in technology-aided learning.

Some of the earlier studies classified performances of students into outstanding, average, or below average [7]. The students in the bracket of below-average are eventually identified to fail the course. [6] also emphasized in their research that excellent learning can be achieved by tracking student engagement in an educational program through different practices, which ultimately helps minimize dropout rates. This study seeks to investigate the vital student engagement metrics that affect students' success in a course.

This study is motivated by the need to increase students' throughput rates in a blended-learning course [4]. The study also aims to reduce to the barest minimum the number of at-risk students in higher education through the predictive model.

This research would provide automated predictive models to the Learning Management System used by the institution to monitor at-risk students. The predictive models will also produce significant insight for the educational instructors to improve their teaching material and student performances.

Section II provides a comprehensive literature review of student success prediction, particularly in relation to student engagement in the learning management system. Section III outlines the research methodology, including data collection and pre-processing, machine learning models, and evaluation techniques. Section IV highlights the results and conclusion.

II. Literature Review

Investigating student success using student engagement in the Learning Management System (LMS) is vital in reducing the at-risk of failing students in higher institutions of learning and improving learning outcomes [8]. Researchers have made various attempts to study student success using engagement in blended-learning, and online learning environments [6]. The correlation between students' performance and engagement has also been extensively investigated using data mining, statistical analysis, and machine learning. Many studies revealed that students' performance has always been correlated with

different LMS engagement measures and strongly associated with their success in the course [4], [6], [9].

[6] studied student success using engagement in online learning using four variables: initial assessment scores, the highest level of education, final examination score, and the total number of clicks on Virtual Learning Environment (VLE). The authors' findings also showed that learners' clicks on "forumng and oucontent" are significant in predicting student success. The activities on the forum discussion and course content access positively impact student engagement and examination final grade [6]. The authors in [6] tested six predictive models in their study: Decision Tree, J48 Decision Tree, Classification and Regression Tree (CART), JRIP Decision Rules, Gradient Boosting Trees (GBT), and Naïve Bayes Classifier(NBC) on three extracted types of data (demography, performance, and learning behavior). The results of their study showed that J48, GBT, DT, and JRIP performed better than NBC and CART with accuracy values of 88.52%, 86.45%, 85.91%, 83.27%, 82.93%, and 82.25% respectively.

[10] studied the relationship between student engagement and performance in the e-learning environment by considering nine engagement metrics that are both frequency-related and time-related using association rule from learners' event logs. It was revealed in their study that student features such as the number of logins, the number of content read, and the number of forum read influenced the quiz performance, which later resulted in a higher final grade in the course. [10] proposed that student engagement can be a predictor of academic performance due to the positive correlation engagement has on performance.

The authors in [11] predicted student performance with ensemble methods on three models: Artificial Neural Network, Decision Tree, and Naïve Bayes. The study shows a direct correlation between the learner's interaction with LMS and academic performance. All the three models used in [11] study achieved over 80% accuracy.

In summary, past researches using statistical analysis, data mining, and machine learning techniques by researchers yielded various propositions in the study of student success. This paper focuses more on predictive models to monitor the students on the institution's LMS for a swift instructor or administrator's hypothetical intervention, especially for at-risk students.

III. Methodology

This research provides automated predictive models to the Learning Management System used by the institution to monitor at-risk students based on their engagement. The predictive models also produce significant insight for the educational instructors to improve their teaching material and student performances.

A. Data Collection

In this study, we used students' academic performance dataset that is freely available on Kaggle to investigate student success. The data were obtained from the Kalboard 360 Learning Management System using the xAPI learner activity tracker tool. The xAPI monitors learning and learner activity, such as login time or page read. The dataset consists of 480 student records and 16 attributes. The attributes are divided into three: (1) Demographic features such as gender and nationality. (2) Academic background features such as educational stage, Grade Level, and section. (3) Behavioral features such as raised hands-on class, opening resources, answering surveys by parents, and school satisfaction [11].

B. Pre-processing

- The target variable is classified into three classes based on student grades: Low, Medium, and High. A score between 0 to 69 indicates Low, scores between 70 to 89 indicates Medium, and 90 to 100 score is High. The attributes were classified into three categories : (1) Demographic attributes, (2) Academic attributes, and (3) Behavioral attributes [11]. The classification of the attributes is represented in tab:Attributes.
- Re-sampling strategies to obtain a more balanced data distribution were applied to the dataset's imbalance problem. A random under-sampling technique of the data to equal counts was employed to avoid bias and the predictive models' poor performance.
- Information gain attribute evaluation evaluates the attribute values by calculating the entropy in relation to the rank. Information Gain gives the importance of the attributes.

C. Predictive Models

In this paper, seven predictive models were used in the prediction of student success. The models are Gradient Boosting Tree, Multilayer Perceptron, Support Vector Machines, Naïve Bayes, Logistic Regression, Decision Tree, and Random Forest.

- Gradient Boosting Tree: Gradient boosting is a machine learning technique that draws recognition to its speed and accuracy of prediction, particularly with massive and complicated data. It reduces the risk of over-fitting. It works by combining a learning algorithm to achieve an efficient learner from several weak learners that are concurrently related [6].
- Multilayer Perceptron: Multilayer Perceptron is an artificial neural network feed-forward class. It uses the supervised learning concept called back-propagation for training and includes a minimum of three processing layers: input, hidden, and output layers [12].
- Support Vector Machines(SVMs): SVMs are supervised learning models with associated learning algorithms that analyze the data used to interpret classification problems. It is a commonly used Educational Data Mining because it has high accuracy in prediction [13]. SVMs can effectively perform a non-linear classification using the kernel trick, mapping their inputs into high-dimensional function spaces. The architecture of SVMs used in this study is from [14].

- Naïve Bayes Classifier (NBC): For most predictive problems, this algorithm is the most pragmatic and most straightforward learning approach. The Naïve Bayes Classifier (NBC) is based on Bayes' theorem with strong independence assumptions between the features using a probabilistic approach [6]. NBC is efficient because it takes less processing time and less training data compared to most machine learning models. The classifier estimates the parameters of the probability distribution P(A/B) on the training set of features B (16 features represented in table II) given class A (Low, Medium, or High), and then compute the posterior probability of the testing set. This leads to classifying the testing set based on the largest computed probability. The probability can be represented mathematically as:

$$P(A/B) = \frac{P(B/A) * P(A)}{P(B)} \quad (1)$$

- Logistic Regression: Logistic regression is one of the mostly used in Educational Data Mining analysis. It is used to model-dependent variables with the aid of independent variables. It is based on the calculation of the highest probability, and, according to this probability, the data observed should be the most probable.
- Decision Trees: A Decision Tree has a flowchart-like structure where each internal node tests an attribute. Each branch corresponds to the attribute value, and each leaf node assigns a classification(failed or passed). The tree is constructed from the dataset by deciding which attributes at the child nodes better divide input features. In this case, we are using the concept of information gain. If a node has minimal entropy (highest information gain), it is used as a split node. When a study seeks to determine which features are important in a student prediction model, a decision tree is important [6].
- Random Forest: The Random Forest is an associative learning algorithm. It consists of several randomly generated decision trees. These randomly generated decision trees are merged to achieve higher accuracy and reliable predictions. The performance of random forest is usually better than decision trees [13].

The seven predictive models will be assessed using a confusion matrix, and the accuracy of each model will be provided after a 10-fold cross-validation [13]

IV. Results and Discussion

The results of the accuracies of the seven predictive models after the 10-fold cross-validation is shown in table III. Random Forest has the best performance compared to the remaining six models with an accuracy value of 73.19%. The high accuracy of random forest is due to the model's ensembling of the decision trees characteristic it possesses [13]. The Naïve Bayes model follows the random forest directly with 72.44% accuracy. The other models' performances for the student success prediction are 72.42%, 72.29%, 70.31%, 66.36%, and 64.79% for Gradient Boosting, Logistic Regression, Decision Tree, Support Vector Machines and Multilayer Perceptron, respectively. The least performing model is Multilayer Perceptron, and this poor performance is due to the long learning time, and poor interpretability [13].

Table I: The students' attributes classification.

Attribute Classification	Attribute	Explanation
Demographic Attributes	Gender Nationality Place of Birth Relation	Statistical data such as age, gender
Academic Attributes	Stage ID Grade ID Section ID Topic Semester	Data related to student academic activities
Behavioral Attributes	Raise Hands Visited Resources Announcement Views Discussion Parent Answering Survey Parent School Satisfaction Student Absent Days	Student Engagement with LMS

The Information Gain in table II shows the ranking of the set of attributes in descending order. The top five attributes/features are the most contributing attributes to the model predictions. These five attributes fall under behavioral attributes of students on LMS as shown in table I and [11] also specified the categorization of these attributes. The top five features are:
(i) Visited Resources: the number of times students visited the resources,
(ii) Student Absence Days: the number of absent days on the LMS,
(iii) Raised Hands: the number of times the student raised hands to ask questions or make contributions on LMS,
(iv) Announcement Views: the number of times students viewed the announcement placed on LMS and
(v) Parent Answering Survey: The parent response to the surveys offered by the school.

The other attributes on levels 6 to 16 are categorized as demographic and academic attributes respectively. This is an indication that students' engagement has a direct correlation on students' academic performances [6].

Figures 1 to 7 are the Receiver Operating Characteristic (ROC) curves. ROC is probablity distribution of both the True Positive Rate(TPR) and True Negative Rate (TNR). The X-axis is a False Positive Rate (FPR) and the Y-axis is a True Positive Rate (TPR) [15]. The AUC scale is from 0 to 1. If the value is greater than 0.5, then the model is considered as a good model [15] The performances of the predictive models shows that AUC scores are above 0.5. Random Forest model has the highest AUC score of 0.9198. AUC curve is calculated by this formula :

$$AUC = \frac{1}{2}(TPR + TNR) \quad (2)$$

Table II: A ranking of the information gain (entropy) for a set of features to predict the students success.

Rank	Entropy	Attribute Name
1	0.45801	Visited Resources
2	0.39745	Student Absence Days
3	0.37337	Raised Hands
4	0.2578	Announcements View
5	0.1504	Parent Answering Survey
6	0.12773	Nationality
7	0.1261	Relation
8	0.12292	Place of Birth
9	0.11393	Discussion
10	0.10676	Parent School Satisfaction
11	0.07611	Topic
12	0.05178	Gender
13	0.04748	Grade ID
14	0.01182	Semester
15	0.01058	Stage ID
16	0.00703	Section ID

ht

Table III: Predictive model accuracies after 10-fold cross-validation

Predictive Model	Accuracy
Random Forest	73.19%
Naïve Bayes	72.44%
Gradient Boosting	72.42%
Logistic Regression	72.29%
Decision Tree	70.31%
Support Vector	66.39%
Multilayer Perceptron	64.79%

TPR and TNR are used in AUC and ROC curve as follows:

$$TPR = \frac{TP}{TP + FN} \tag{3}$$

$$TNR = \frac{TN}{TN + FP} \tag{4}$$

$$FPR = \frac{FP}{FP + TN} \tag{5}$$

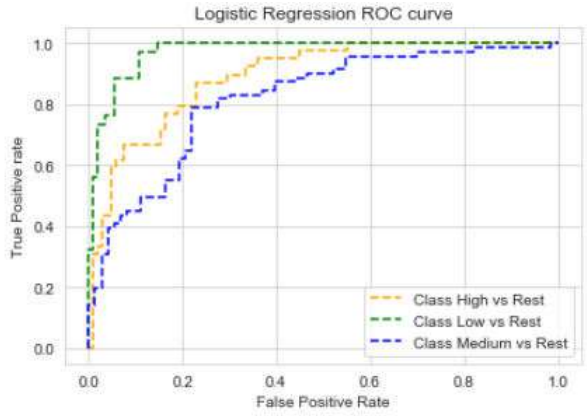

Figure 1: Logistic Regression Model ROC curve

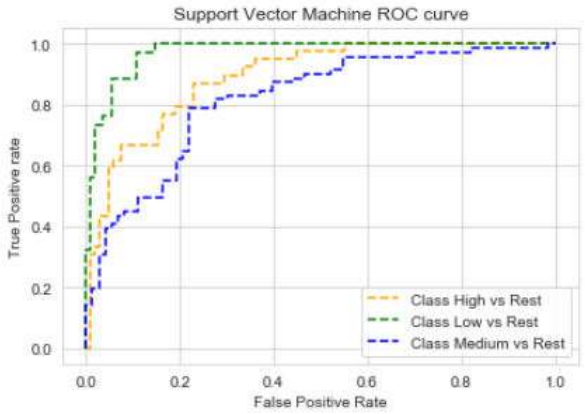

Figure 2: Support Vector Machines ROC curve

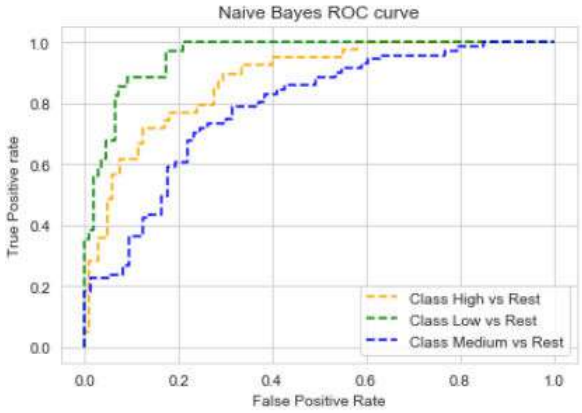

Figure 3: Naïve BayesROC curve

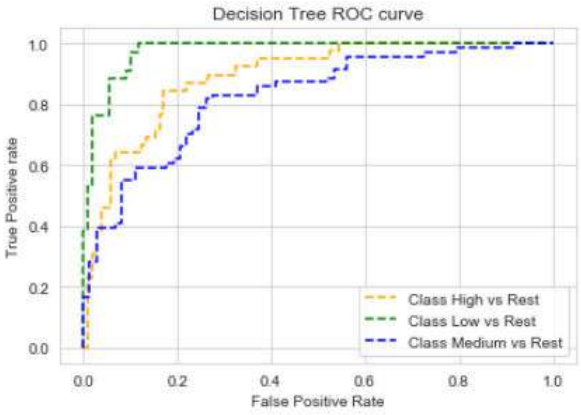

Figure 4: Decision Trees ROC curve

V. Conclusion

Predictive models offer substantial insight in education to the instructor, administrator, and institution for student performance improvement, increase in throughput rate, and reduction in the dropout rate. The implication of this study is

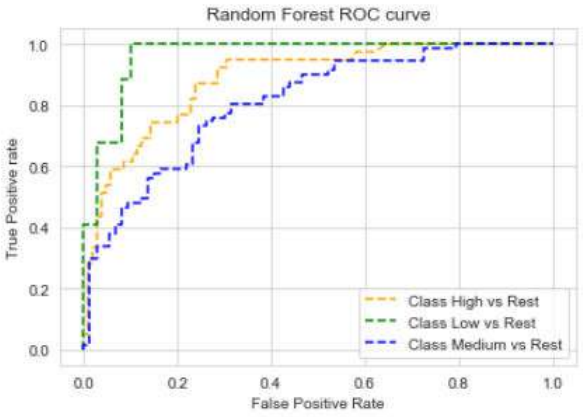

Figure 5: Random Forest ROC curve

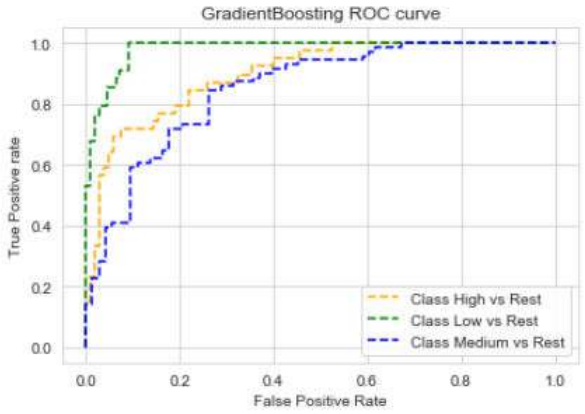

Figure 6: Gradient Boosting ROC curve

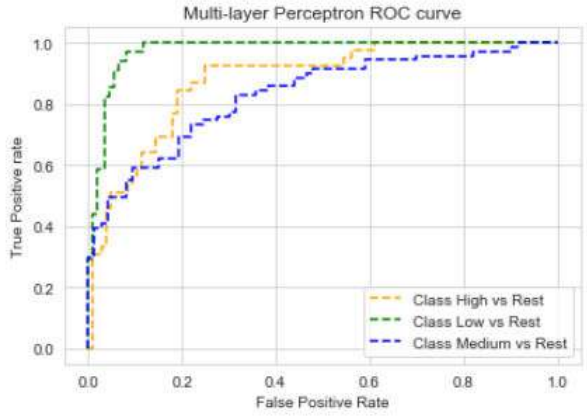

Figure 7: Multilayer Perceptron ROC curve

that the student will get the instructor or institution's timely intervention, thereby averting possible failure in their courses, increasing throughput rate, and other academic outcomes. The dataset used in this study is an LMS interaction of students on the Kalboard 360 Learning Management System. Seven

		Predicted		
		LOW	MED	HIGH
Actual	LOW	34	0	0
	MED	7	49	15
	HIGH	0	10	29

Figure 8: A Confusion Matrix describing the performance of the **Logistic Regression** predictive model

		Predicted		
		LOW	MED	HIGH
Actual	LOW	32	2	0
	MED	15	38	18
	HIGH	2	14	23

Figure 9: A Confusion Matrix describing the performance of the **Support Vector Machines** predictive model

		Predicted		
		LOW	MED	HIGH
Actual	LOW	31	3	0
	MED	11	39	21
	HIGH	0	7	32

Figure 10: A Confusion Matrix describing the performance of the **Naïve Bayes** predictive model.

		Predicted		
		LOW	MED	HIGH
Actual	LOW	34	0	0
	MED	1	60	10
	HIGH	0	2	37

Figure 11: A Confusion Matrix describing the performance of the **Decision Tree** predictive model.

		Predicted		
		LOW	MED	HIGH
Actual	LOW	34	0	0
	MED	0	64	7
	HIGH	0	2	37

Figure 12: A Confusion Matrix describing the performance of the **Random Forest** predictive model.

		Predicted		
		LOW	MED	HIGH
Actual	LOW	34	0	0
	MED	4	57	10
	HIGH	1	0	38

Figure 13: A confusion Matrix describing the performance of the **Gradient Boosting Tree** predictive model.

models: Logistic Regression, Support Vector Machines, Naïve

		Predicted		
		LOW	MED	HIGH
Actual	LOW	34	0	0
	MED	7	55	9
	HIGH	0	1	38

Figure 14: A confusion Matrix describing the performance of the **Multilayer Perceptron** predictive model.

Bayes, Decision Trees, Random Forest, Gradient Boosting Tree, and Multilayer Perceptron Network were trained and evaluated. Random Forest performed better than the other models with an accuracy value and AUC score of 73.19% and 0.9198, respectively.

Behavioral attributes of the students' interactions with LMS were also identified to have a strong influence on model predictions. The ranking of the features shows that student engagement is positively correlated to student success or performance.

The limitation of this study is the size of the dataset used. A larger dataset would have given a better insight into the other influencing factors on student success prediction. The outcomes of this paper are based entirely on the study obtained in the data used. The contributions of this paper are: the provision of the vital engagement metrics on student's performances, early detection technique for instructors or lecturers to identify a student at risk of failing during courses for possible intervention based on the behavioral attributes and the impacts of student engagement on the students' success or performance. Based on the predictive models used in this paper and their evaluation metrics, we proposed that student engagement can play a vital role in predicting student success.

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Impact of Customer Trust in Online Shopping amidst the COVID-19 Pandemic: A study on Dhaka, Bangladesh

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***Abstract*—This study aims to determine the impact of Customers' trust on online shopping amidst the COVID-19 pandemic in Dhaka, Bangladesh. Since the inception of the pandemic, a few industries have thrived and e-commerce is one of those industries. The research attempts to determine the factors which influence customer trust during the global pandemic and what kind of relationship customer trust has on online purchase intention. In order to attain these objectives, a sample of 171 respondents residing in Dhaka, Bangladesh were drawn. The sampling method adopted in this research was non-probability Convenience Sampling. To analyze the data, frequency analysis, multiple regression analysis and correlation analysis techniques have been used. The overall findings suggest that during the pandemic, recommendation and eWOM along with security and safety instills trust on the customers while website quality and size of the vendors are the least prioritized. This article also determines that there is a positive relationship between customer trust and online purchase intention. This study will provide an understanding for consumer behavior during the COVID-19 pandemic.**

Keywords—Customer Trust, COVID-19, Online Purchase intention, E-commerce, Bangladesh.

I. INTRODUCTION

The COVID-19 pandemic has led mankind into adapting to the "new normal". Terms like 'Social distancing', 'Lockdown', 'Work from home' and 'Quarantine' have become a part of our daily lives. The Asian Development Bank (ADB) estimates a downfall of USD 3.02 billion in the economy of Bangladesh due to this global pandemic whereas the United Nations Conference on Trade and Development (UNCTAD) forecasts a loss of USD 16 million in imports (Khatun, 2020). While most of the industries are suffering due to the COVID-19 crisis, a few industries are on the rise and constantly thriving to stay ahead of the curve. The E-commerce industry is one them. In US, Walmart observed a 20% increase in sales during the month of March since consumers are also changing their buying behavior (Wahba, 2020). Even the local markets saw an upsurge in sales by 50% in the supermarkets upon confirmation of the first case of COVID-19 (Parvez, 2020).

Online shopping is considered to have three fundamental dimensions, namely: B2B, B2C and B2G (Rahman, 2007). This paper has mainly focused on B2C dimension. In the beginning the industry focused only on Business to Business (B2B) but now it has transitioned on to Business to Consumer (B2C), Consumer to Consumer (C2C) and also Business to Employee (B2E) (Ramachandran, 2016). Due to the ease of access and high-speed internet facilities in Bangladesh, many entrepreneurs are entering the realm of E-commerce and F-commerce (The Business Standard, 2020). But the COVID-19 pandemic has changed the scenario as some research shows around 52% avoid going to stores for shopping and around 36% are awaiting the vaccine to be discovered before going out for shopping (Bhatti et al., 2020).

The abundance of online retailers is a good sign for the economy. But this also paves way for exploitation. Some vendors are taking advantage of customers and this is causing trust issues among both parties (The Business Standard, 2020). Trust is a very important factor in any business. There are various factors that can influence the trust of a customer.

This paper aims to determine the factors which affects customer trust for online shopping and how trust influences online purchase intention amidst the COVID-19 pandemic. The first part of this paper discusses about various literature regarding factors of customer trust, e-commerce and the online shopping trends during the pandemic. The following chapters focuses on the methodology of the research followed by the analysis and findings. Lastly, the significance of this study along with implications and future research directions are discussed.

II. LITERATURE REVIEW

A. 'Customer Trust'

As mentioned before, trust is necessary in any given business. The concept of 'trust' can be defined as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party" (Mayer et al., 1995, p.712). This is a very common definition used in studies related to trust. Nair (2016) stated that trust is a noticeable asset for the business which helps to increase the output and works as a catalyst in challenging times. Trust is also stated to reduce complexity in situations dealing with uncertainty (Grabner-Kraeuter, 2002). Customer trust in online can be stated as the willingness to be vulnerable to the vendor, expecting the best interest to be kept, irrespective of monitoring or control over the online transaction (Hidayat et al., 2016). Another widely recognized concept of trust can be stated as trusting the belief and intention during risky situations (McKnight et al., 1998). Another author on the other hand defined 'trust' as the psychological condition which includes the vulnerability based on positive expectation and intentions from the other party during situation consisting uncertainty (Rousseau et al., 1998). The trust factor is significant in any kind of

transaction and especially in the case of online shopping. Thus, emphasis is given in understanding the factors which entails customer trust, resulting in the development of the online shopping process (Grabner-Kraeuter, 2002).

B. Online shopping trends in the Covid-19 pandemic

The Coronavirus pandemic has brought in revolutionary changes in terms of retail. Retailers are struggling to survive due to low footfalls (Hasanat et al., 2020). Luxury goods are relatively low on the priority list compared to convenience goods. The initial stockpiling behavior of the consumers shifted to online shopping (Pantano et al., 2020). Companies like Foodpanda, HungryNaki and Bikroy.com have extended their portfolios to provide groceries and essential products (Zahir, 2020). Domino's pizza has adopted 'Zero Contact Delivery' in dealing with the COVID-19 pandemic (Dominos.com, 2020). Safety and security are considered to be a great concern among the consumers while ordering online (Meyer, 2020). On demand streaming or subscription services like Netflix, Hulu, Disney plus and HBO are on the rise as well (Bhatti et al., 2020).

C. Factors affecting Customer Trust in E-commerce

There are various factors which influences customer trust in online shopping. Size, Reputation, Perceived Service Quality and Perceived Website Quality influences customer's trust in China (Mao, 2010). In another research, the authors considered brand recognition, website look & feel, navigation, payment related issues, product description, order tracking, terms & conditions, money back guarantee, secure connection to be trust factors in online shopping (Kaur & Madan, 2013). A research shows security, reputation, third party certification, recommendation & testimonials, product information, order fulfillment, web site design, service quality design influence customer trust in online shopping (Chan & Huang, 2005). Another research entails usage of social media has a positive influence in customer trust and online purchase (Aref & Okasha, 2020). Jalilvand et al., (2011) emphasized on the impact of electronic word of mouth on customer trust and purchase decision making process. Pnatano et al., (2020) suggested a proper digital communication can instill trust among the consumers.

D. Customer Trust and Online Purchase Intention

Customer trust towards online vendors is a key to making purchase decision (McKnight et al., 2002). Another research by the same authors reveal how factors of trust influences the online purchase intention and how a website and exert the trust factors (McKnight et al., 2002).

E. E-commerce in Bangladesh

There have been many researches focusing on the status of e-commerce in Bangladesh. Bhowmik, R. (2012) in his article has given an overview of the present situation of B2C e-commerce in Bangladesh. Rahman, A. (2007) highlighted status, potential and constraints to e-commerce development in Bangladesh. Mohiuddin (2014) focused on the overall e-commerce websites and business to consumer category of Bangladesh (B2C). Neger & Uddin (2020) covered the factors affecting online shopping in Bangladesh during the COVID-19 Pandemic. Studies stated above focused on the status of e-commerce in Bangladesh but there has been limited research on customer trust.

The aforementioned studies discuss about customer trust or factors affecting customer trust but insignificant research has been done on Bangladeshi customers, especially focusing on the current global pandemic. This paper aims to determine the factors which affects customer trust for online shopping and how trust influences online purchase intention amidst the COVID-19 pandemic.

III. PROPOSED MODEL & HYPOTHESIS

Based on the aforementioned literature, a conceptual framework for this study has been developed.

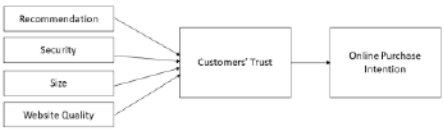

Fig. 1: Conceptual Framework

This framework represents the proposed model for this research. Here, the factors are Recommendation, Security, Size and Website Quality.

Factors influencing Customers' trust

A. Recommendation

In the era of internet, customer reviews and feedbacks have been very easy to find. In case of electronic word of mouth (eWOM), it has revolutionized the recommendation process for online shoppers, leading them to entrust the vendors and purchase online (Jalilvand et al., 2011).

B. Security

Safety and security have become a major concern amidst the COVID-19 pandemic. Consumers are concerned about virus spreading through the packages though authorities have assured this is unlikely due to the time and temperature (Meyer, 2020). The advent of online payment security will also play a major role in ensuring customer trust (Ramachandran, 2016).

C. Size of the company

A company which has a large state of operations may instill a sense of trust among the customers.

D. Website Quality

E-commerce is different from offline commerce as it lacks the physical evidence and ambience a store has. In order to compete with this issue, online retailers focus on sleek and convenient design of the website to encourage trust among the customers (Kaur & Madan, 2013).

E. Impact of trust on Purchase Intention

As McKnight et al., (2002) discussed, customer trust is a significant factor of influence in developing the online purchase intention. Thus, the researchers hypothesized,

H1: Recommendation positively influences Customers' trust in online shopping during COVID-19 pandemic.
H2: Security positively influences Customers' trust in online shopping during COVID-19 pandemic.
H3: Size of the company positively influences Customers' trust in online shopping during COVID-19 pandemic.
H4: Website quality positively influences Customers' trust in online shopping during COVID-19 pandemic.
H5: Customers' Trust and online purchase intention have a positive relationship.

IV. RESEARCH METHOD

The purpose of this research was to analyze the factors affecting customers' trust in e-commerce and how trust influences online purchase intention in Dhaka city. Thus, the target population were individuals from Dhaka having some knowledge of online shopping. There have been arguments about the optimal sample size being 100 or 150 depending on the number of variables (Aref & Okasha, 2020). For this study, a sample size of 200 has been targeted. Non probability sampling technique which is convenience sampling has been implemented. The questionnaire was designed in English and the survey was conducted online from August to September, 2020. A total of 171 responses were considered fit for use, thus the final sample size was 171. The items used to construct the factors were partially adopted from the studies of Aref & Okasha (2020), Doney & Cannon (1997), McKnight, Choudhury & Kacmar (2002), Mao (2010), Neger & Uddin (2020) and Ribbink, Riel, Liljander & Streukens (2004). All the items were scaled on the basis of a five-point Likert scale ranging from 1= Strongly Disagree to 5= Strongly Agree. The questionnaire also included some questions to extract the demographic variables. SPSS 20.0 was used to analyze and verify the data.

To test hypothesis 1, 2, 3 and 4, a multiple regression analysis was carried out. Here customer trust is the dependent variable and recommendation, security, size and website quality are the independent variables. The purpose of this analysis was to measure the relative influence of each independent variable on the dependent variable.

A correlation analysis has been conducted for hypothesis 5.

V. ANALYSIS & FINDINGS

A. Descriptive statistics

Among the respondents 43.3% were female and 56.7% were male. People within the age group of 23-26 are dominating in the sample size with a proportion of 66.7%. All 171 respondents visited an e-commerce website and purchased something within the past six months.

TABLE 1 DEMOGRAPHIC PROFILE

Demographic Characteristics	Total (171)	Percentage
Gender		
Male	97	56.7
Female	74	43.3
Age		
23-26	114	66.7
27-30	41	24
31-34	14	8.2
35-38	2	1.2
Occupation		
Business	4	2.3
Housewife	3	1.8
Service holder	51	29.8
Student	113	66.1
Income in BDT		
Below 10,000	112	65.5
10,000-29,999	5	2.9
30,000-49,999	50	29.2
50,000-69,999	3	1.8
70,000-89,999	1	0.6

Most of the respondents preferred Cash on delivery (71.9%) whereas only 21% preferred bkash or other mobile financial services and 5.8% opted for debit/credit cards.

B. Reliability Analysis

In order to determine the reliability of the constructs, Cronbach's alpha has been calculated. All the factors had a score of 0.8 to 0.9, which is considered a very good fit (Ursachi et al., 2015).

TABLE 2. RELIABILITY ANALYSIS

Variables	Number of items	Cronbach's alpha
Recommendation	5	.933
Security	7	.896
Size	3	.910
Website Quality	4	.926
Customers' Trust	6	.863
Online Purchase Intention	3	.908

C. Regression Analysis:

To test hypothesis 1, 2, 3 and 4 a multiple regression analysis was carried out. Here customer trust is the dependent variable and recommendation, security, size and website quality are the independent variables.

TABLE 3. MODEL SUMMARY

R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
				R Square Change	*F Change*	*df1*	*df2*	*Sig. F Change*
.846[a]	.716	.709	.51368	.716	104.434	4	166	.000

From the table we can assess that there is a strong correlation (R= 0.846 or 85%) between the predictor variables and Customers' Trust. The R Square = .716 entails that the predictors can explain 72% of the variation in customers' trust, which is a good fit for the model. The adjusted R2 is .709 which shows that adding each of the independent variable makes 71% contribution in explaining the variation of customers' trust in e-commerce. The significant F change (.000 < .05) meaning the regression model is significant in 95% confidence level.

TABLE 4. ANALYSIS OF VARIENCE

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	110.225	4	27.556	104.434	.000[b]
Residual	43.801	166	.264		
Total	154.026	170			
a. Dependent Variable: Customer Trust					
b. Predictors: (Constant), Website Quality, Recommendation, Size, Security					

In table 4, the analysis of variance has been conducted. It can be seen that the significance level of the F value is valid. Thus, (p= 0.000 < 0.05) the model is a good fit at 95% confidence level.

TABLE 5. COEFFICIENTS

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	*Std. Error*	*B*		
(Constant)	.776	.257		3.025	.003
Size	.080	.066	.0640	1.214	.226
Recommendation	.716	.045	.773	16.080	.000
Security	.171	.069	.150	2.472	.014
Website Quality	-.080	.079	-.065	-1.010	.314

The above table (Table 5) shows us that except for size and website quality, all other variables have a positive relation with customer trust. Since the value of p is less than the significance level of .05, the hypothesis 1 which is all these factors positively influence customer trust. Among the factors, recommendation has the most significant influence on customer trust followed by security. Recommendation has the highest standardized beta which means if recommendation increases by 1 unit, customer trust increases .773 unit. It is clear that recommendation and trust have a very strong positive relationship. Security also has a strong relationship. It can be assessed that, during the global pandemic, customers are more aware of the safety and security issue.

TABLE 6. COLLINEARITY STATISTICS

Model	Tolerance	VIF
(Constant)		
Size	.611	1.636
Recommendation	.741	1.349
Security	.465	2.150
Website Quality	.415	2.407

Table 6 represents the collinearity statistics which indicates that the model is free from multicollinearity as the tolerance is greater than 0.1 and VIF is less than 10 for all the independent variables.

D. Correlation Analysis

TABLE 7. CORRELATION ANALYSIS

		Customer Trust	Online Purchase Intention
Customer Trust	Pearson Correlation	1	.713**
	Sig. (2-tailed)		.000
	N	171	171
Online Purchase Intention	Pearson Correlation	.713**	1
	Sig. (2-tailed)	.000	
	N	171	171

**. Correlation is significant at the 0.01 level (2-tailed).

To define the relationship between customers' trust and online purchase intention, correlation analysis has been used. As we can see from the table, Customers' trust and Online purchase intention have a high degree of positive relationship where coefficient is r = 0.713. This entails that an increase of customer trust increases online purchase intention. Here, the value of p (p = 0.000) is less than the significance level of 0.05 which implies hypothesis 2 is accepted.

VI. DISCUSSION

From the above-mentioned analysis and findings, it can be observed that during the COVID-19 pandemic, customers' trust plays a significant role in online purchase intention. The factors differ from conventional approach as a strong focus on recommendation and security is observed, whereas size and website quality are considered less impactful among the respondents. This could be due to small scale entrepreneurs entering into the field with limited resources but major service quality. Also, in a very conventional approach, service quality is a vital factor which instills trust among the consumers. But in this paper, that factor was evidently missing but its impact can be observed in the larger emphasis on recommendation and electronic word of mouth (eWOM), which entails customer trust increases from good service quality, resulting in more people recommending the website or the vendor. Consumers are aware of the risks in general and amidst the pandemic they are more cautious. Thus, an emphasis on safety and security has been observed. Most of the respondents agreed in terms of security factors which reduces the risk of COVID-19 infection. A high propensity of ordering online during the past six months is proof of that.

VII. LIMITATIONS

This study has been conducted among the citizens of Dhaka, Bangladesh. A more holistic approach covering all the districts would have provided a more concrete result. Also, the sample size is relatively small, which also somewhat hinders in determining a proper output of the analysis. The study mainly focused on B2C (Business to Consumer). Lastly, the research has been conducted in a very challenging time, considering the trauma and mental health conditions of the respondents during the pandemic, the survey data may not convey their actual intention.

VIII. CONCLUSION & FUTURE RESEARCH DIRECTION

Online shopping has become the go to factor for a lot of people during the pandemic. With the easy access and government agenda of 'Digital Bangladesh' a lot of tech-savvy startups are coming into the market. E-commerce and F-commerce is booming and it is adding a separate source of

income to the people amidst the COVID-19 pandemic. Online shopping had been already popular in Bangladesh but during the pandemic, it has reached new heights. Considering the expansion and diversity of portfolio from the vendors, it is evident that the online shopping scenario is evolving due to the COVID-19 pandemic and with proper utilization of the resources, customers' trust can be attained, resulting in a higher online purchase intention and conversion.

To the author's knowledge, such study has not been conducted elsewhere, thus with a more robust questionnaire and a holistic sample size, it would provide a much better approach. Also, adaptation of TAM (technology acceptance model) (Aref & Okasha, 2020) and TPB (Theory of planned Behavior) can result in a more concrete and significant output.

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Dynamic-Balance Monitoring Scheme for Industrial Fans using Neural-Network based Machine Learning Approach

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Abstract—**Dynamic balancing is a very essential and commonly used technique for the rotating equipment, specially for induced draft (ID) fans of industries. Dynamic balancing is an offline condition monitoring technique which is done when there is unbalance in the rotating part of the equipment. The unbalance of a single impeller of ID fan will result in high vibration problem to the whole ID fan and also to the motors which are in physical contact with the vibrating ID fan. Due to high vibration, the rotating ID fan impeller may get damaged. Therefore, dynamic balancing is done in the ID fan impellers on maintenance schedule basis or when there is increased vibration observed on the online monitoring system. This process takes a long time to diagnose and locate the point of unbalance and it is very dangerous for the maintenance team to visit the restricted areas of the plants where these huge fans are placed for the plant process. To avoid these issues, this paper proposes a new dynamic-balance monitoring (DBM) scheme for getting useful information regarding dynamic balancing for industrial fans using convolution neural-network (CNN) based machine learning approach and Fast Fourier transform (FFT). The historical data is used to train the proposed algorithm. The technique is valid for DBM of all rotating industrial machinery and previously it was not done in any literature.**

Keywords—***Induced Draft Fan, Fan Impeller, Dynamic Balancing, Dynamic Unbalance, Neural Network, Machine Learning***

I. INTRODUCTION

This high vibration issue of ID Fan is generally reported by the maintenance team due to unbalance in the impeller. Due to the high vibration of the impeller, bearing and other rotatory parts also face high vibration and reduce the life of these parts of the equipment and needs to be changed frequently. The complete removal of the cause of vibration is practically not possible with the large-sized equipment but one can avoid main causes of high vibration like unbalance which can be avoided by balancing. By doing these in an interval of time, one can keep the vibration level within an acceptable level.

The unbalance occurs when the mass of the impeller is not distributed uniformly. This is reduced either by adding an extra mass in the impeller at appropriate angle and place or by removing an extra mass present in the impeller such that the effective mass center line coincides with its rotation axis. This is called a balancing of the impeller. The balancing of rotating equipment has lots of benefits: quality of operation is increased, vibration level is reduced to a large extent, minimizes the audible and signal noises, fatigue stresses, power loss and increases equipment life as explained in [1]. The ID Fan-2 of the stock house working in Tata Steel, Jamshedpur in I-Blast Furnace has been considered for this case study of dynamic balancing which has been performed recently. The figure 1 shows the ID Fan place where the operation has been performed. The unbalances are of three types: static, couple and dynamic unbalance. Static unbalance occurs when the center of gravity of the equipment is not in the axis of rotation of the equipment. This is avoided by static balancing in which the forces are balanced by the action of gravity. Couple unbalances occurs when two equal forces but of different planes are present in the rotor part. These two forces act in 180-degree phase shifting with each other. This unbalance is just like dynamic unbalance but the difference is that it occurs due to two equal and opposite forces of two different planes. Due to couple force produced during the rotation of the rotor, they cause vibration and since they are displaced axially so they cannot cancel each other. As static balancing is done due to the action of gravity, dynamic balancing is done due to the action of inertia forces. Once dynamic balancing is done, the static balancing is automatically done as in dynamic balancing, all the couples or moments which cause unbalance of different moving parts are made zero [2–4].

Fig. 1. Placement of ID fan in the blast furnace

There are various types of faults occur in the impeller including mass unbalancing, shifting and looseness. These are identified from the FFT of vibration signals measured from the horizontal, vertical and axial directions of the fan using the accelerometers mounted on the fan [5–7]. The deep learning-based monitoring techniques including deep belief network and one-dimensional convolution neural network (CNN) are proposed for monitoring the unbalance issue of the rotating equipment [8], [9]. The authors have taken simulation data for the analysis of the proposed technique [9] which does not give practical results. In practical, the mechanical systems involve various noise

factors caused due to the structure, stiffness, and connected systems. Therefore, the investigation of the proposed technique is very necessary with the data set collected from the practical equipment. The authors [10] have implemented the CNN technique for monitoring the vehicle wheel balancing which involves vibration of lesser magnitude. The industrial rotating equipment involve large magnitude of vibration. Therefore, CNN technique is used in this paper for checking the capability of the technique for large size equipment with larger magnitude of vibrations. In this paper, IBA analyzer and MATLAB software are used for implementing the proposed technique.

This paper deals with the convolution neural network (CNN) approach and FFT algorithm for the detection of need of dynamic balancing of the ID fan and also the location of unbalancing. The paper is organized as follows. The system under consideration for dynamic balancing is discussed in Section II. In Section III, the proposed methodology including CNN and FFT are discussed. For testing and validating the proposed technique, a case study is made using ID fan of Iblast furnace as discussed in II. The results obtained from the proposed techniques and offline measurements are discussed in Section IV. The work done in this paper and the findings are concluded in Section V with future scopes of the work.

II. Case Study

The proposed DBM is tested by implementing it using an ID fan running in the section I-blast furnace of the plant where it is placed as an exhaust fan. There are many other ID fans connected in the same section. This part of the plant is not safe for the people to visit. The high vibration is caused in the ID fan and connected induction motor (IM) due to mass unbalancing in the impeller of the fan. The mass unbalancing is caused due to the flow of dust particles outside the window through the fan. The maintenance team visit the site as the maintenance schedule. If any problem is detected like increased vibration then, the team does the maintenance which is unplanned and takes unwanted shutdown of the machines and the process. The vibration sensors are placed in the driving end (DE) and non-driving end (NDE) of the fan and also on the motor as shown in the figure 2. This figure shows the connection of motor and fan. The vibration sensors are placed at motor driving end (MDE), motor nondriving end (MNDE), fan driving end (FDE) and fan nondriving end (FNDE). The sensors are placed at each of these points for measuring vibration of three directions including vertical (V) axis, horizontal (H) axis and axial (A) axis. These sensors' data are monitored online through programmable logic controller (PLC). The vibrations of three-axes of both driving and non-driving end are monitored for detection of any fault by setting a particular threshold control limit. This way of monitoring the equipment is not reliable. The fault is detected after it has occurred and also the diagnosis is not possible until any diagnosis algorithm is implemented. For the diagnosis of the exact fault, the maintenance team visit the site with the accelerometer and other diagnosis machines. This type of maintenance is called reactive maintenance which is not reliable. For avoiding the sudden breakdown of the process and the machines, it is required to detect the fault at the initial stage and diagnose the same through a convenient method using the online raw data of real time and the historical data of the equipment whose vibration is increased. The technical data of the system under study is provided in the table I. The parameters given in the table I including suction gas pressure and total pressure increase have the unit of mmWC which is milimeter water column. The conversion of this unit to pascal is done taking 1mmWC to be equal to 9.80665 pascal or N/m2.

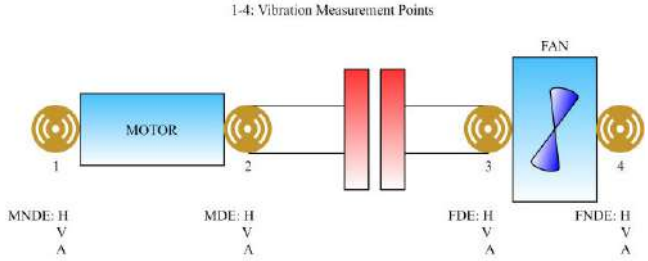

Fig. 2. ID fan-motor system with vibration sensors at DE and NDE

TABLE I. TECHNICAL DATA OF FAN-MOTOR SYSTEM UNDER STUDY

Parameter	Value	Unit
Suction volume rate	287000	m^3/h
Suction gas pressure	-1840	mmWC
Total pressure increase	+2340 (with gas recovery)	mmWC
Suction gas temperature	67	deg C
Maximum power at shaft	2265	kW
Motor power	2650	kW
Gas composition	CO-44.92	%
	CO2-10.54	%
	N2-9.39	%
	H2O-35.16	%

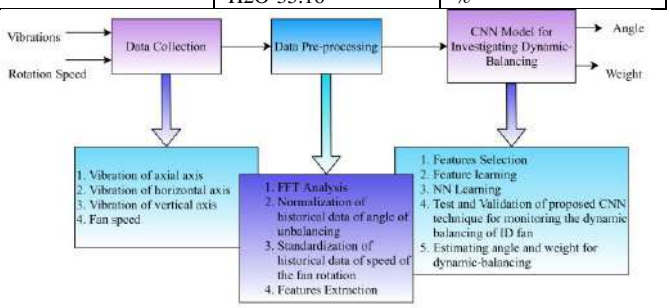

Fig. 3. Process flow of the proposed algorithm

III. Methodology Used

The proposed methodology involves the FFT method for the extraction of information of vibrating equipment and CNN model to fix the problem of visiting site for unnecessary maintenance and also for saving the maintenance cost and time. The steps involved in the proposed monitoring system are shown in figure 3. The first step of DBM is the data collection which involves the collection of vibration sensors' data and fan speed. The second stage is the pre-processing of the collected data which involves FFT analysis of the vibration signals, normalization of the historical data, standardization of historical data and extraction of features from the pre-processed data. The third and the last stage involves the monitoring of dynamic balancing of the fan under study. This is done by selecting the features found from the second stage and using these features for CNN model learning. After the model is trained, the model is validated for the new raw data of vibrations.

From the last stage, the angle of unbalance and weight required to balance the impeller are estimated.

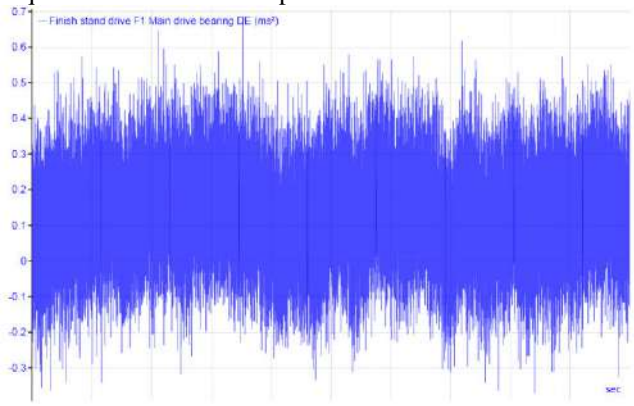

Fig. 4. Vibration raw data of DE of fan with time

A. *Data Collection*

The implementation of any analytical algorithm and machine learning based techniques for condition monitoring of industrial equipment is possible through the historical data of the equipment. The collection of data is crucial to understand the behaviour of the equipment. The health status of equipment is monitored with the help of parameters' values and characteristics. In this paper, the collected data are the vibration signals of three axes and the rotation speed of the fan. The raw vibration signal of driving end of the fan is shown in the figure 4. The vibration is plotted over the time and the unit of the vibration signal is m/s^2 i.e. acceleration unit. The rotation speed of fan along with vibration of DE is shown in figure 5. The speed is variable and changes according to the process requirement. The figure 5 is extracted from the IBA analyzer where all the raw data are analyzed. The motor vibration of DE and NDE are shown in figure 6. The raw data under unbalanced condition is also collected for learning the CNN model.

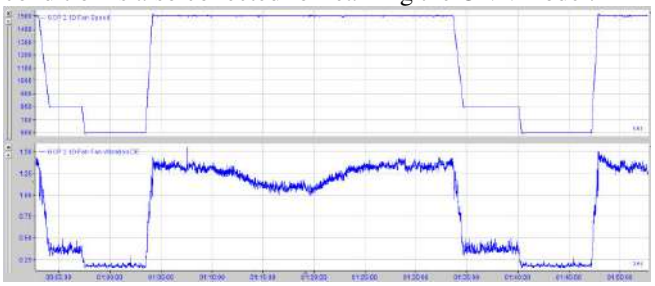

Fig. 5. Rotation speed of fan and DE vibration with time

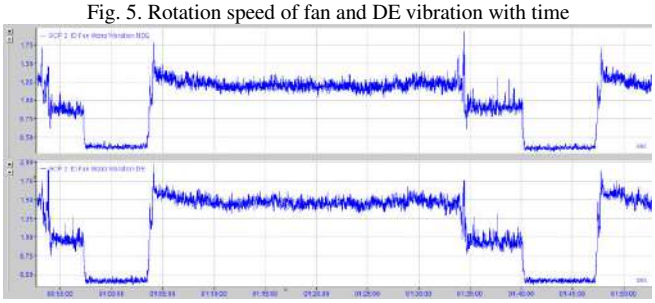

Fig. 6. Motor vibration of DE and NDE with time

The data sampling is done for discretization from which each s^{th} sample is collected represented by V_s which is one dimensional (1 x L) data array of discrete vibration data as given in equation 1. In equation 1, T is the sampling time period, t=1, 2, ..., T and l=1, 2, ..., L.

$$V_s[l]=V(t) \ldots. (1)$$

The raw data is passed through a rising pulse detector which detects the sample number and time at which the pulse rises. The mathematical equation of the detector is given in the equation 2. The $D_s[l]$ detects the s^{th} pulse rising time. This information is used to set a reference of starting the rotation which is given in equation 3. The R_s value is taken 1 from where the rotation starts and rest other will be 1.

$$D_s[l]=1 \text{ if rising pulse detected and 0 otherwise } \ldots (2)$$

$$R_s=l: D_s[l]=1 \ldots (3)$$

From the historical data available, the angle of unbalancing and weights values are taken. The corresponding vibration signals are used to learn the CNN model. Therefore, this information is collected. The vibration signals are used as indicators and the angle of unbalance and weight are taken as predictors as given in equation 4.

$$P_s= [A_s, W_s] \ldots (4)$$

B. *Data Processing*

Before making the CNN model learn with the historical data, it is needed to collect features from the historical data. The collected historical data includes vibrations of fan and motor, speed of fan, vibrations under unbalanced condition, weight and angle of unbalance under unbalanced condition. FFT analysis is used to extract the features from the vibration signals. Before implementing FFT analysis, the signal is segmented into N parts. The steps involved in pre-processing of data are shown in figure 7. The signal V_s is segmented into N parts. The n^{th} part f_s^N is taken as the individual sample. To synchronise the f_s^N with Vs, the equation 3 is used as given in equation 5.

$$f_s^N=V_s[R_s[(n-1)xR+1]]R_s[nxR] \ldots (5)$$

where, n=1, 2, ..., N and $R = R_s/N$ which evaluate how many rotations are there in one cycle of rotation.

In this paper, the features are extracted from the FFT analysis of the vibration signals. The vibration signal and its corresponding FFT spectrum is shown in figure 8. The historical data of unbalanced condition is standardized and normalized to get the faulty data of angle and weight which are used to learn the CNN model. For weight data, normal distribution method is used by z-score calculation and for angle it is normalized between 0 and 1 instead of 0 to 360 degree.

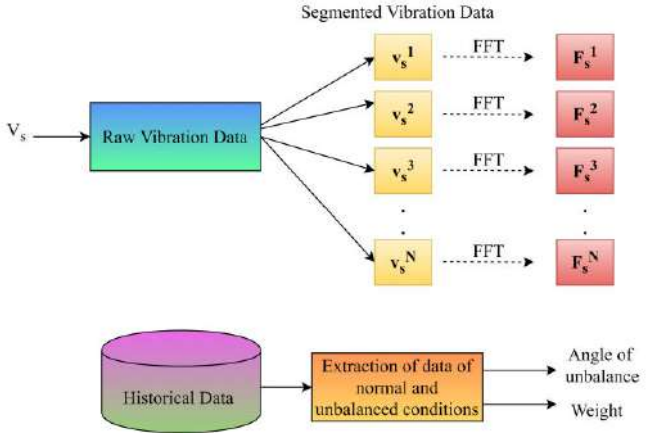

Fig. 7. Pre-processing of vibration data and historical data for features extraction

C. *Estimation of Angle and Weight using CNN Model*

The proposed DBM scheme, estimation of angle and weight using CNN model is shown in figure 9. After the pre-

processing of vibration data, each n^{th} segment of s^{th} sample F_s^N is passed through both angle estimator block and weight estimator block at the same time so that synchronism is maintained as shown in figure 9. The proposed scheme gives the predicted outputs of angle and weight. From the predicted values, average is taken from the N parts so that variance can be reduced. This way, bias is also reduced.

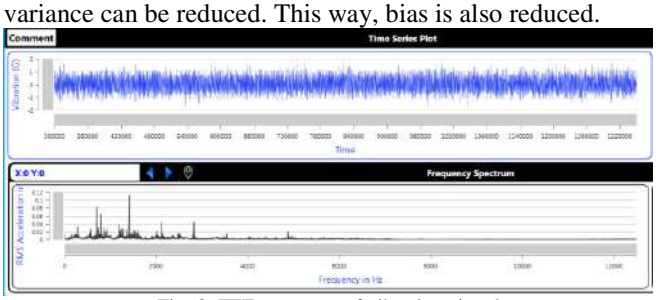

Fig. 8. FFT spectrum of vibration signal

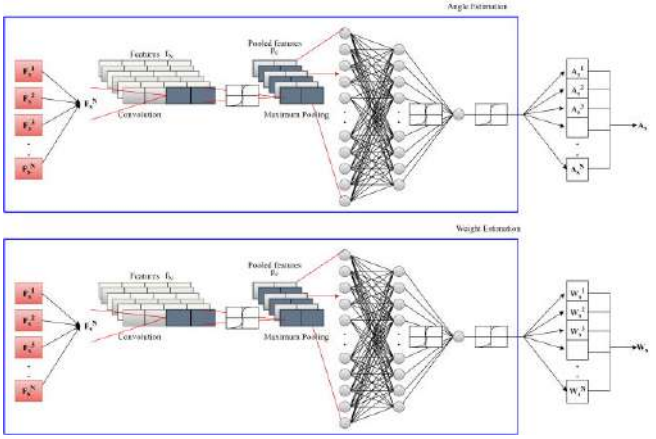

Fig. 9. Estimation of angle and weight using CNN model

In DBM scheme, the convolution is taken with K kernel filters to convolute the n^{th} part F_s^N from the input layer of CNN model through a fixed number of filter of weights W_k^c for generating features f_N as given in equation 6.

$$F_k = \tanh (F_s^n * W_k^c + b_k^c) \ldots (6)$$

where, * is representing the convolution, W_k^c is the weight matrix of k^{th} filter and b_k^c is the bias of k^{th} part when k=1, 2, ..., K. The activation function used here is the tanh which is hyperbolic tangent of the output layer of convolution. To make the model simple and fast, the number of parameters is reduced by using the concept of maximum pooling. This extracts the block of lower dimension with maximum value of feature from the output of equation 6 as given in equation 7. The features are flattened into one dimensional vector represented as pf as given in equation 8.

$$p_k = \max(f_k) \ldots (7)$$

$$p_f = [p_1, p_2, \ldots, p_k] \ldots (8)$$

The outputs of the DBM scheme are A_s and W_s which are angle of unbalance and weight respectively. The function including these two as predictors is given in equation 9 and the activation functions for A_s and W_s are given in equations 10 and 11.

$$P_s^n = [A_s^n, W_s^n] \ldots (9)$$

$$A_s^n = \text{hard\_sigmoid}(\sum=1^k \tanh(p^c * w^c + b^c)) \ldots (10)$$

$$W_s^n = \text{ReLu}(\sum=1^k \tanh(p^c * w^c + b^c)) \ldots (11)$$

The both the model of As and Ws are trained for predicting the output values by minimizing mean square error (MSE). The MSE is calculated using the loss functions given in equations 12 and 13 for A_s and W_s respectively. In equation 12, Θ_s is the trained angle value and in equation 13, the $W1_s$ is the trained weight value which are compared with the estimated values of equations 12 and 13. Finally, the ensemble average is taken for each of the equations 12 and 13 to find the net value of angle and weight with reduced bias and variance.

$$MSE_A = (1/S.N)\sum(s=1 \text{ to } S)\sum(n=1 \text{ to } N) [(\cos \Theta_s - \cos A_s)^2 + (\sin \Theta_s - \sin A_s)^2] \ldots (12)$$

$$MSE_w = (1/S.N)\sum s = 1^s \sum n = 1^N (W1_s - W_s)^2 \ldots (13)$$

IV. Results and Discussion

The proposed DBM scheme using CNN model and FFT analysis is found to be more accurate as compared to the existing methods including wavelet transform (WT) and features like mean, standard deviation, peak and trough values of signals, peak to peak, kurtosis, RMS, and skewness for dynamic balancing and features extraction as discussed in [11], [12]. The measurements and results of dynamic balancing done on particular days as shown in figure 10 are collected and compared with the proposed technique and existing techniques. The figure 10 shows the dynamic balancing information including location (angle) of unbalance and weight for ID fan impeller. The features including mean, standard deviation, peak and trough values of signals, peak to peak, kurtosis, RMS, and skewness are taken as characteristics of any signal and for comparison these are grouped in class c. The results obtained from the proposed scheme are shown in figures 11 and 12.

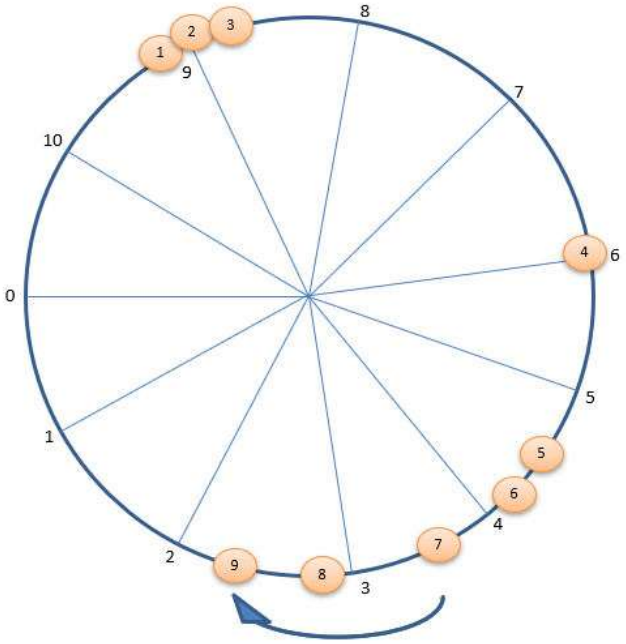

Fig. 10. Dynamic balancing on particular days for the impeller

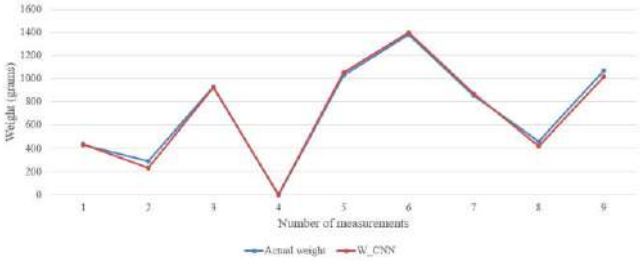

Fig. 11. Estimated weight with actual weight measured from device

The comparison of the proposed method with WT and characteristics of signal methods are shown in figure 13 and 14. From these figures, it is clear that the proposed DBM

scheme using CNN is better than the existing WT and characteristics-based techniques for dynamic balancing of industrial rotating equipment.

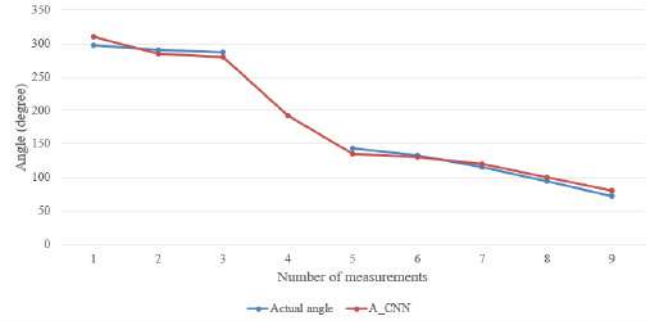

Fig. 12. Estimated angle with actual angle measured from device

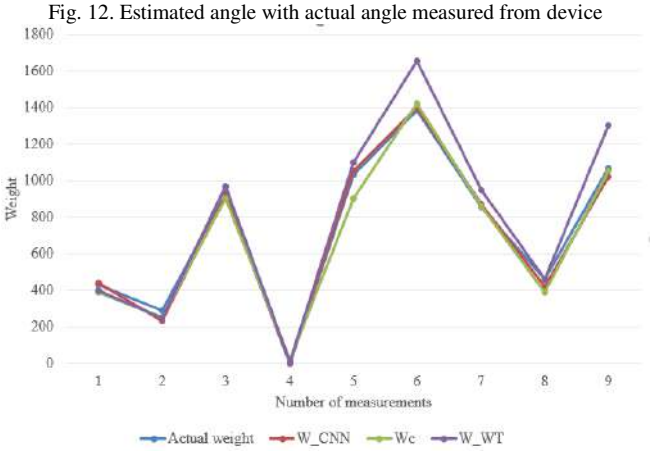

Fig. 13. Comparison of estimated weight with actual weight measured from device, WT method, and characteristics-based method

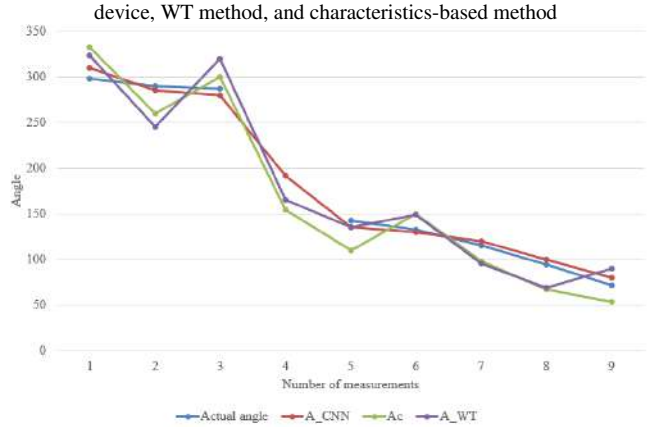

Fig. 14. Comparison of estimated angle with actual angle measured from device, WT method, and characteristics-based method

V. Conclusion and Scope for the Future Work

The high vibration issue in industrial rotating equipment decreases the life time of the equipment. Most of the time it is caused due to mass unbalancing. The dynamic balancing is very necessary on time for avoiding the sudden breakdown of the equipment and the process of the plant. Therefore, in this paper, a DBM scheme is proposed for industrial ID fan which faces lots of vibration issue due to mass unbalancing in the impellers. The proposed algorithm is compared with the existing methods in the literature and it is observed that the prediction of weight and angle of unbalance using the proposed method is more accurate as compared to the existing methods. The comparison of the proposed DBM scheme with other features extraction techniques and prediction models are the future scopes of this work.

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Deep Reinforcement Learning Approach with Adaptive Reward System for Robot Navigation in Dynamic Environments

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***Abstract*—Deep reinforcement learning (DRL) has the ability to learn and solve complex and challenging tasks when compared to traditional robot navigation methods. In this study, using DRL robot navigation developing with the ability to detect in a dynamic environment is researched. The robot has no prior knowledge of the environment in navigation tasks. In addition, the position of the random moving obstacle and target changes with each navigation task. Because of this, the navigation task has become more difficult, and the classic reward system has fallen behind. In this study, we propose a new adaptive reward system instead of the classic reward system used in Deep Q-Network (DQN) of DRL to increase efficiency of this algorithm. The results of the classical reward system and the new adaptive reward system were compared with other studies in the literature. As a result of these comparisons, we saw that the reward system we proposed was successful in the success rate and the number of reaching multiple targets.**

Keywords— deep reinforcement learning, deep q network, deep q learning, improved reward system, robot navigation

I. INTRODUCTION

Robots are assets that used in every field and they have an increasingly important role in our daily life. The autonomy of robots in an unknown dynamic environment has become a fundamental feature. With the increase in artificial intelligence (AI) and computing power in autonomous robots, great progress has been made. However, robot navigation is still a challenging problem. Traditional robot navigation consists of localization, mapping and route planning [1,2]. With the advent of deep reinforcement learning (DRL), it has become popular to try to solve the problem of navigation by trial and error without the need for them [3].

DRL algorithms are frequently used in researches on robotics [4]. In most studies, there is no dynamic obstacle, and in studies with dynamic obstacles, the dynamic obstacle moves according to the rule. In real life, these studies are not sufficient in practice, because the obstacles make completely random movements.

In this study, no information about the environment is provided to the robot. The location of the random moving obstacle and target changes with each navigation task. Under these conditions, we want the robot to reach the target by using the shortest path without any collision. Thus, using Deep Q-Network (DQN) algorithm, which combines q-learning and artificial neural networks, and which is one of the algorithms of DRL, success rate and the number of targets reached has been attempted to be increased to higher value by transforming the reward system of other studies with fixed rewards of an adaptive reward system. Using two reward systems with same hyper parameters for the robot navigation in dynamic environment, success rate of these reward systems and highest number of targets reached by these reward systems over trained models are compared.

In one of the studies in the literature, SAC (Soft Actor-Critic) algorithm, one of the policies and value-based algorithms of DRL is used [5]. However, the neural networks they have created are made with LSTM layers and are technically a study that should be completely dissociated. In their study, only the success rate of the single target reached is presented. Besides, a maze map is given instead of a dynamic or fixed obstacle and when the results are examined, success rate in our study is far above success rate of the study presented.

In another study, authors used the Deep Q-Network algorithm that we used in our study [6]. Unlike our study, they used only feed forward neural network instead of CNN in the artificial neural network in the Deep Q-Network they used in their study. Another difference is that they defined 4 different actions in the robot. In addition, both the success rate reached within a single target and the number of reaching within multiple targets are presented, in our study. Although the fixed obstacle is used instead of the dynamic obstacle in study, our study is more successful.

The organization of this study continues as follows: In the second part, the issue of DRL is handled together with its algorithms. In the third chapter, the algorithm used, the artificial neural network and the reward system are mentioned. In the fourth chapter, the simulation environment and its results are mentioned. In the fifth chapter, the results of the study are given.

II. DEEP REINFORCEMENT LEARNING (DRL)

Reinforcement learning is one of the three main sub-branches of machine learning. All the goal-oriented learning algorithms are called reinforcement learning. Reinforcement learning is a type of learning commonly used in real-time decisions, robot navigation, learning tasks, skill acquisition and game AI [7]. The basic idea of reinforcement learning is to enable the agent to learn by trying to maximize the total reward. There is an agent in reinforcement learning and this agent gets a numerical reward value as a feedback by choosing an action from the defined action set randomly or from previous experiences. This process is called the Markov Decision Process [7,8]. The Markov Decision progress is given in Fig.1.

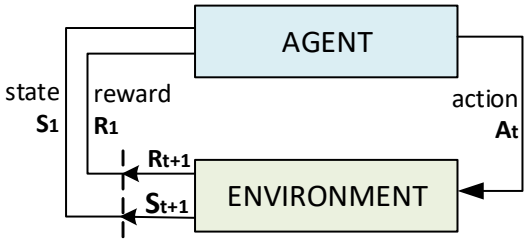

Fig. 1. Markov Decision Process

This way, the agent learns how to collect the highest reward during training. The formula for calculating the Q value in reinforcement learning is defined in (1).

$$Q(s,a) = R + \gamma * \max[Q(s',a')] \quad (1)$$

where s represents state, a represents action, R represents previous total reward, γ represents discount factor, $\max[Q(s',a')]$ represents highest Q value from the previous similar situation and action.

The discount factor takes a value in the range [0,1) [8], and the closer this value is to one, the longer the agent provides long-term returns and the more it considers future rewards. The closer this value is to zero, the more it takes into account the current reward and causes it not to look ahead. DRL is a combination of reinforcement learning and deep learning [8,9]. DRL is basically the same as Reinforcement learning but uses deep neural networks to predict reward values [10]. The success of DRL in [11] has made it one of the most interesting topics in artificial intelligence field.

A. *Deep Reinforcement Learning (DRL) Algorithms*

DRL algorithms are basically divided into two: Model-Based and Model-Free. These categories are divided into Model Learner, Model Given, Policy Based, Value Based. Information about these is given in the following subheadings.

1) Model-Based Algorithms

In model-based algorithms, the agent is either given a model and acts actions by creating a plan within framework of that model or it is expected to learn a model and acts actions by creating a plan according to it [12]. The most popular of the model-based algorithms is AlphaZero. The scheme of model-based RL algorithms is given in Fig. 2.

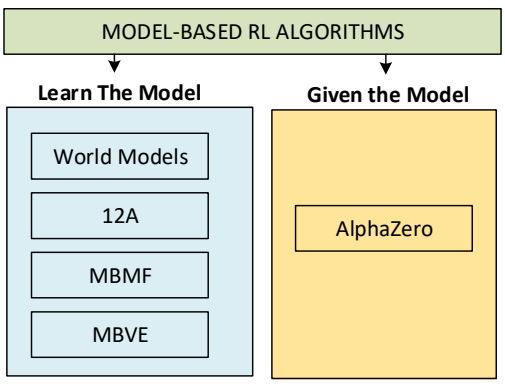

Fig. 2. Classification of Model-based RL Algorithms

2) Model-Free Algorithms

The feature that distinguishes model-free algorithms from model-based algorithms is that the agent does not know any model or need any model. Since the agent does not have a plan in any model framework, it acts on a trial and error method. Model-Free algorithms are basically divided into Policy-Based and Value-Based but there are algorithms that use a combination of the two. Policy-based algorithms are known as actor algorithms, value-based algorithms are known as critical algorithms, algorithms using both are also known as actor-critic algorithms. The scheme of model-free RL algorithms is given in Fig. 3.

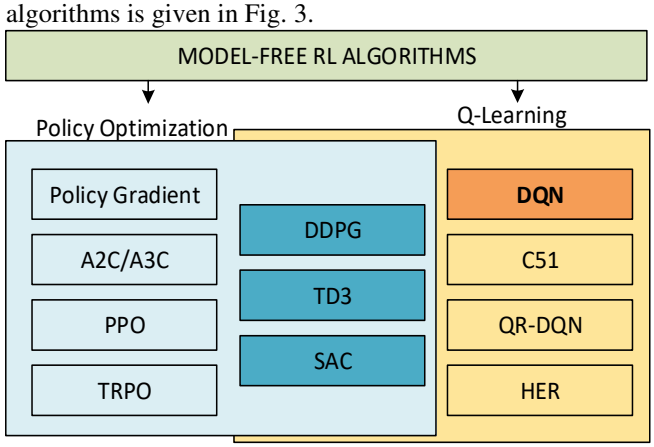

Fig. 3. Classification of Model-free RL Algorithms

III. THE PROPOSED METHOD

Model-free value based on Deep Q-Network algorithm of DRL is used. As the neural network to be used in this algorithm, convolutional neural networks [9,13], which have achieved great success in image processing, are used instead of feed-forward neural networks.

There are multiple challenges that the robot must overcome in the problem of robot navigation in a dynamic environment. These are not colliding the wall, not colliding any dynamic obstacles and reaching the target in the shortest path. In addition, the dynamic obstacles used increase the difficulty level for the agent because it moves randomly without being bound by any rules. Therefore, unlike other DRL applications, the reward system becomes important. The block diagram of the proposed method is given in Fig. 4.

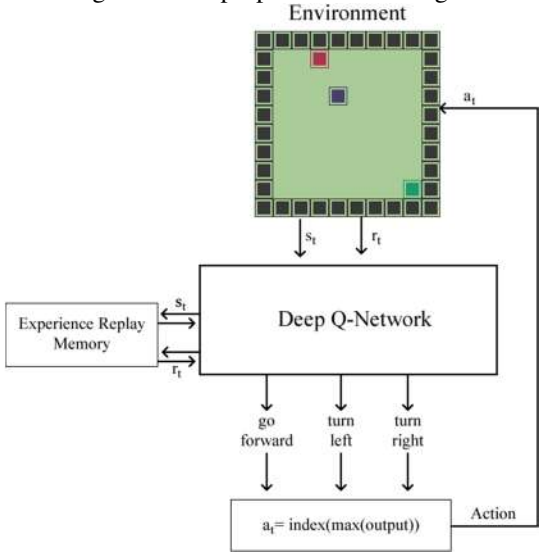

Fig. 4. Block diagram of the proposed method.

A. Deep Q-Network (DQN) Algorithm

Deep Q-Network is in the Model-Free category, one of the DRL algorithms, and is a value-based algorithm. This algorithm, first announced in [9], has achieved human-level success that a machine could not reach before [14]. This algorithm is shown in Table 1. Since this algorithm is a model-free algorithm, an explicit estimate of ε is not generated [11]. It must do the learning with a greedy strategy. For this, the ε-greedy strategy is used.

1) ε-greedy Strategy

This strategy is one of the techniques used to balance the rate of exploration-exploitation [15]. Instead of choosing learned actions as greedy, the rate of exploration between $0 \leq \varepsilon \leq 1$ is compared with a randomly generated number. If the randomly generated number is less than ε, it moves randomly. If randomly generated number is greater than ε, it moves the action that has the largest q of the learned state-actions [8]. This strategy is defined in (2).

$$a_t = \begin{cases} rand\ action\ from\ A(s)\ , if\ rand < \varepsilon \\ argmax_{a \epsilon A(s)} Q(s,a) \quad , otherwise \end{cases} \tag{2}$$

where, ε represents exploration ratio, a_t represents action at time t, A(s) represents action set, Q(s,a) represents set of learned actions.

2) Experience Replay

Used to solve the stability problem of the DQN algorithm [16,17]. In the form of mini-batches, the same situation and same rewards repeats the experience with data from the environment for performing weight updates in the neural network more stable.

TABLE I. PSEUDO CODE OF DQN ALGORITHM.

Algorithm 1: DQN
1. Initialize replay memory D with capacity N
2. Initialize Q network with random weights θ
3. Initialize target Q network with weights θ - = θ
4. repeat (for each episode):
5. Observe initial state s0
6. repeat (for each step of episode):
7. choose action a_t by $a_t = \begin{cases} rand\ action\ from\ A(s)\ , if\ rand < \varepsilon \\ argmax_{a \epsilon A(s)} Q(s,a) \quad , otherwise \end{cases}$
8. Execute action a_t
9. Observe reward r_t and new state s_{t+1}
10. Store transition (s_t, a_t, r_t, s_{t+1}) in D
11. Sample mini-batch of transitions from D
12. Calculate target for each transition: $y_j = \begin{cases} r_j & , is\ terminal \\ r_j + \gamma max Q(s_{j+1}, a')\ , is\ nonterminal \end{cases}$
13. Perform a descent step on $\left(y_j - Q(s_j, a_j; \theta)\right)^2$ with respect to the Q network parameters θ
14. until step
15. until episode

B. Deep Q-Network Architecture

The deep q-network (DQN), as an artificial neural network, is created according to the actions of the robot in previous situations and the awards that result from these situations. The robot uses this artificial neural network to choose its next actions. The neural network created consists of five layers, two convolutional layers [9] and three fully connected layers [9]. The input of this neural network is given a 10 * 10 sizes 2-dimensional matrix representing the simulation environment. As an output to the neural network, three neurons, the number of actions, the robot can make, are given. In this neural network, the function ReLU [18] as the activation function, RMSprop [18,19] as the optimization method and MSE [20] as the loss function are used. The architecture of this neural network is given in Table 2.

TABLE II. DQN ARCHITECTURE

	Layer Type	Input	Output
Input	Conv2D	(4,10,10)	(16,8,8)
Hidden	Conv2D	(16,8,8)	(32,6,6)
Hidden	Dense (FC)	(32,6,6)	(1,1152)
Hidden	Dense (FC)	(1,1152)	(1,256)
Output	Dense (FC)	(1,256)	(1,3)

C. Reward System

Value-based algorithms usually use reward system with fixed rewards. These reward systems are defined as positive reward when reaching the target, negative reward when undesirable situation (e.g. collision situation). Therefore, it takes a longer training episode for the agent to reach the desired state. The reward system we propose is based on adaptive rewards. With this reward system, it is purposed to increase efficiency by enabling the agent to reach the target in a shorter training duration.

The reward system based on the mentioned fixed rewards has a reward value of +1 upon reaching the target, -1 when colliding with the obstacle or wall, and 0 for other situations. This reward system is defined in (3).

$$reward = \begin{cases} 1, for\ reached\ target \\ -1, for\ collision \\ 0, for\ step \end{cases} \tag{3}$$

The reward system we propose is an adaptive reward system using parameters within the environment. The reward for reaching the target in this reward system: When the episode is started using a distance finding algorithm, the distance between the robot and the target points is found and the minimum number of steps to reach the target is found. And this value is divided by the number of steps the robot reaches the target, and the less steps it reaches, the more rewards it will get. In addition, after reaching a target, the number of targets reached multiplies reward, and a higher reward is given in order to go to other targets continuously. In short, the more targets the robot reaches in the number of short steps, the more rewards it will get. In the reward system we propose, it is given by subtracting the distance from the target before the robot takes a step and the distance after it takes. In the reward system we propose, it is given by subtracting the distance from the target before the robot takes a step and the distance after it takes. In this way, even if the robot does not reach the target at all, it will reach the target in a shorter training time as it receives reward when it approaches the target. This reward system is defined in (4).

$$reward = \begin{cases} rt_t * maxstep/stepcount, for\ reached\ target \\ -1 \qquad\qquad\qquad , for\ collision \\ dist_{t-1} - dist_t, for\ \ step \end{cases} \quad (4)$$

where, rt_t represents number of targets reached, maxstep represents the maximum number of steps the target can be reached, stepcount represents how many steps the target has been reached, $dist_{t-1}$ represents the distance between the robot and the target in time t-1, $dist_t$ represents the distance between the robot and target in time t.

IV. Experimental Results

Conducted training and testing of both reward systems to observe the performance of the reward system proposed for robot navigation in a dynamic environment using DRL. Detailed information about the simulation environment is given in the sub-heading "Training and test environment". The training and test results of the simulation are given under the sub-heading "Simulation Results".

A. *Training and Test Environment*

In this study, a 2-dimensional environment consisting of 10x10 matrix is created. The simulation environment has walls, dynamic obstacle, robot and target. The robot is located at the (2,2) position at the start of each episode. The target and dynamic obstacle are created in a random location at the start of each episode. When the robot reaches the target, the new target is randomly placed on the empty location and this cycle continues until the robot hits the walls or the dynamic obstacle. The actions made by the dynamic obstacle have absolutely no rules, it act completely randomly, and this makes the robot's job even more difficult. Five different actions are defined for the dynamic obstacle. These actions are go right, go left, go up, go down, and do not act. For the robot, three different actions are defined. These actions are turn right, turn left and go forward. The environment is shown in Fig. 5. The red square represents the robot, the green square the target, the purple square the dynamic obstacle, and the black squares the walls.

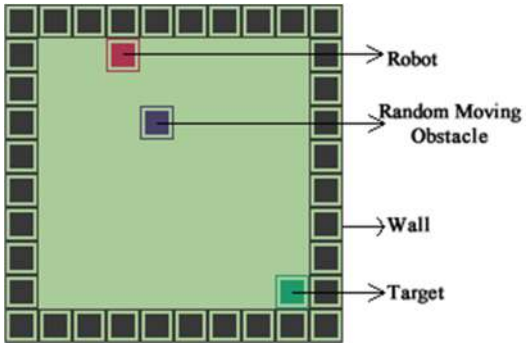

Fig. 5. Train and Test Environment.

TABLE III. DQN Hyperparameters.

Hyperparameters	
Inital $\boldsymbol{\varepsilon}$	1.0
Final $\boldsymbol{\varepsilon}$	0.1
mini-batch size	64
$\boldsymbol{\gamma}$:discount factor	0.95

B. *Simulation Results*

Two different reward systems, which described in the subtitle C of Chapter 3, have been trained with the same hyperparameters. In both trainings, the ε value started from 1 and decreased until the 30000th section reached 0.1 linearly. ε continued as 0.1 from episode 30000th to episode 45000th. As a result of the data obtained from these trainings, the "success rate", which we assume as failure of the robot to reach the target at all, is given Fig. 6.

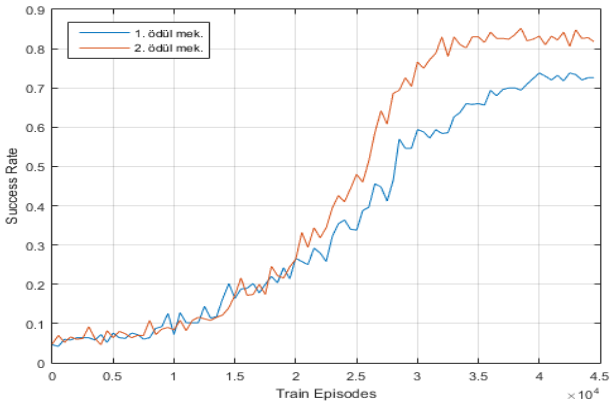

Fig. 6. Comparison of success rates of two reward systems.

As can be seen in Fig.6, the second reward system succeeded faster than the first reward system and at this rate, it has achieved a higher success rate at the same rate. The expectations from the reward system presented theoretically in (4), which the C subtitle of Chapter 3, have also been realized in the simulation environment. While this comparison is acceptable for reaching a single target, it cannot be used for comparison of reaching multiple targets. The number of targets they have achieved through the trained models has been graphed. This graph is shown in Fig. 7.

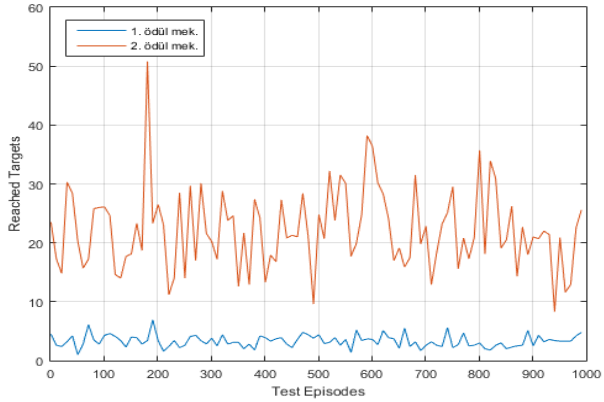

Fig. 7. The number of reached targets of two reward systems.

In the graph of the number of reaching multiple targets given in Fig. 8, the second reward system presented in (4) seems to be far ahead of the other reward system. With the increase in the number of reaching multiple targets, we have seen the success of using the number of reached targets as a coefficient to the value given when the target is reached in the reward system.

In order to see what kind of results, the developed reward system has against other studies in the literature, studies conducted with different reward systems or different algorithms in the robot navigation problem are examined. The studies [5,21-22] are examined for the success rate of

reaching the single target. The study in [6] is examined for reaching multiple targets. The graphics in this study are converted into numerical data through the program in [23]. Comparing the success rates in other studies with our own reward systems, our reward system, except for [21], has been more successful. This graphic is shown in Fig. 8.

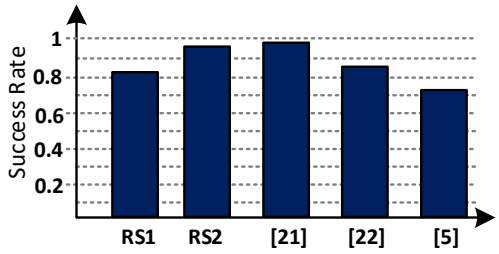

Fig. 8. - Comparison of success rates in reaching at least one target.
* RS: Reward System, [X]: Ref X.

TABLE IV. COMPARISION OF SUCCESS RATES.

Study	RS1	RS2	[21]	[22]	[5]
Success Rate (%)	81.7	97.1	98.95	85.93	71.44

The study in [6] is examined to compare how many targets the robot reached the most, and the second reward system we developed is compared with reward system of the study in [6]. It is seen in Fig. 9 that the reward system we developed has reached more targets.

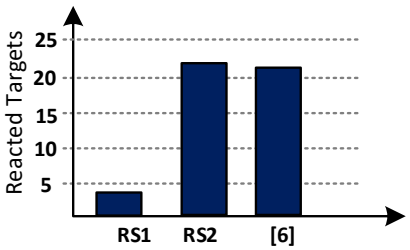

Fig. 9. Comparison of average of reached targets.
* RS: Reward System, [X]: Ref X.

TABLE V. COMPARISION OF AVERAGE OF REACHED TARGETS.

Study	RS1	RS2	[6]
Average Reached Targets	3.32	22.16	21.08

V. CONCLUSION

In this study, robot navigation problem in a dynamic environment with DRL tried solve. DQN algorithm is used for the navigation of the robot. An adaptive reward system is developed as an alternative to the reward system, in which it is given +1 when the target is reached and is given -1 for the collision. Among these reward systems, comparisons such as the success rate of reaching a single target and the number of multiple targets have been made. It has been observed that the developed adaptive reward system as a result of these comparisons is more successful in all respects, and the reward system generally used is insufficient.

When the reward system we developed is compared with other similar studies in the literature, it is seen that our success rate of reaching the single target is slightly below the study in [21]. However, our number of reaching multiple targets is at a higher level than the other study. The reward system we developed in reaching both single and multiple targets has been successful.

As a result, we seen in simulations that DQN agents trained with the adaptive reward system we propose will be more successful in dynamic environments without environmental information than DQN agents trained with the traditional reward system.

When the results of the training are examined, it is seen that while the ε value decreases, the performance values become close. The fact that ε decreases in 2/3 of the number of trainings and continues as 0.1 in the remaining 1/3 shows that a correct exploration-exploitation ratio has been chosen. Considering these data, it can be easily said that if the number of training is increased with the same exploration-exploitation ratio, the performance will increase even more.

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Smart Health Monitoring System Using IoT & Android

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Abstract- In the ongoing circumstances of the current scenario of medical situation and provision of treatment to individual personnel, addressing the expansion of online medical services is one of the prime solutions. With a view to accomplishing this objective, a patient monitoring system is proposed. In this model, diagnosis and enhancement of communication are the primary objectives kept in mind. With the maintenance of this flow, the work is implemented to measure the temperature, pulse rate, oxygen saturation, and ECG using IoT sensors and devices. In the post completion of these procedures, these measured data is relayed to the thingspeak server. After that using the string API key, the similar data passes to the android application where the patients and doctors are already registered. There is an alternative available for the storage of data as well. On the ground of data entry in the application, communication options like chat, calls are available for doctors and patients. This entire process will be helpful to create a ray of satisfaction in terms of gaining medical treatment by the individuals. The system has been implemented making simplicity, easy accessibility, and reliability the key factors.

Keywords: *Patient monitoring, IoT, Telemedicine, Communication, Application, Android*

I. INTRODUCTION

Health being a primary concern for every human being needs utmost attention by means of checkup and derivation of urgent treatment when necessary. In the present scenario, it is gradually becoming a tough call because of increasing global population and other minor reasons as well. Especially for the under developed countries, it is becoming a huge concern day by day. Hence, under this pretext, the most optimal solution is the expansion of medical treatment services over the internet so that the accessibility can remain unquestioned.

Incorporation of IoT in the sector of health and treatment has been prevalent for a long period of time. By the extension of margin from a patient to hospitals and diagnostic centers in a major parameter has made IoT an inseparable part in health sector. Usages of fitness bands, fitness-trackers, glucometers, blood pressure monitors and heart rate monitoring devices by peoples irrespective of ages and classes has made a stronger appeal for further extension of IoT as well. Moreover, ensuring proper and proactive connections between patients and medical personnel has never been underestimated at all.

Inclusion of experimentally proven sensors with reasonable price in the measuring devices has made the whole process of diagnosis easier and less problematic. Even the role of IoT in diagnosing and addressing special diseases like diabetes, heart issues and cancers is noteworthy. Besides, the impact created by IoT in management of lethal disease like cardio vascular disease and more is adding more inquisition of researchers and technical experts which will result in a wider expansion of IoT implementation in medical and health sector.

With the implementation we have tried a decent venture in order to contribute a little to this revolution and eradication of problems and hassles to some extent.

II. LITERATURE REVIEW

Due to the ease of usages and accessibility, IoT has certainly made a great appeal in the sector of telemedicine. Multi-dimensional research on different diseases and IOT sensors deployed in order to eradicate the problems has been noteworthy in this regard. In the cases of sensors and improvising the functionality, these researches have made some revolutionary changes. In[1],a portable ECG system is designed using AD8232 microchip and open source platform. Unification of both analog and digital platform is one of the key aspects in this regard. In [2], with usage of pulse and ECG, a system is proposed in order to measure a patient's condition. Use of raspberry PI and advanced technologies in order to ensure maximum services for patients is one of the noteworthy mentions in this case. In [3],a monitoring system including surveillance of room and patient along with the integration of hospitals and medical staffs is proposed. This system also emphasizes on environment condition surveillance which is a unique addition with the rest of the completed works. In [4], a comprehensive survey on IoT for health care is completed with detailed and meticulous analysis. The flaws and the problems of the implemented systems so far along with the optimal possible solutions are presented here. In [5], a patient monitoring system, using simple Wi-Fi technology is proposed. Simplicity of the procedures with maximum ease and accessibility have been tried to be ensured. .In [6], a wheelchair is implemented on the basis of head movement for patients. In [7], a review on IOT based

health monitoring system is accomplished with proper analysis. The detailed summary of the completed research on IOT based health monitoring system is also displayed here. In [8], a complete analysis of IoT based health monitoring system along with possible challenges is accomplished. An advanced cloud based approach is proposed as well. The possible challenges and hurdles along with advanced suggestions have made the proper impact on the subsequent research in the given field. In [9], another monitoring system integrating GSM module and RSA algorithm is proposed. Besides, an endeavor put in order to design a complete system with the simplest circuitry and sensors have made quite impact in this regard. In [10], effort has been made to implement measurement device that is capable of measuring oxygen saturation, heart rate and temperature of human body. Also, the transmission of data to android phone by the usage of Bluetooth technology is emphasized. Usage of Arduino NANO and LCD display is the prime aspect in this regard. In [11], an IoT based health monitoring system is proposed that will measure the temperature and pulse rate of a patient and relay the data to the base station and from there doctors will be notified as well. An effort to make a complete full package system using wireless technology is made.

On the basis of the existing researches we can come to the conclusion that wide and numerous efforts have been made to improvise and flourish this sector. Hence in that motive, we have made a small effort to combine both the diagnosis and communication dimension in order to make a full proof system.

III. Proposed System

The ultimate motive of this system is to analyze the condition of a human body by monitoring 4 major criterions. These are: Pulse rate, oxygen saturation and temperature. On the other hand, separately an ECG monitoring device is also implemented .The main reason of separate setup is the minimization of over-consciousness of peoples due to the ease of accessibility. The numerical values are directly passed through to the thingspeak server via Wi-Fi (ESP8266) which is an IoT analytics platform to visualize live IoT data streams. In the separate field marked numerically, the data can be viewed. From the server through string API key, the data is transferred to the android application.

From the thingspeak server, the obtained data is relayed to the android application via string API key. Then these data are available for the patients registered in the android application. For further usages of these data, useful alternatives like call, chat and storage is available. The doctor can view the patient data from the Chat option. The doctor can also view the patient's medical reports and past data measured by the IoT device from the report repository. By using these useful features, the necessary calls can be made in order to establish a proper communication between doctors and patients. The doctors have to approve the follow request from the patients. Otherwise, there can be no chat or communication between the doctor and patients.

The block diagram of our proposed system according to the aforesaid discussion is given below:

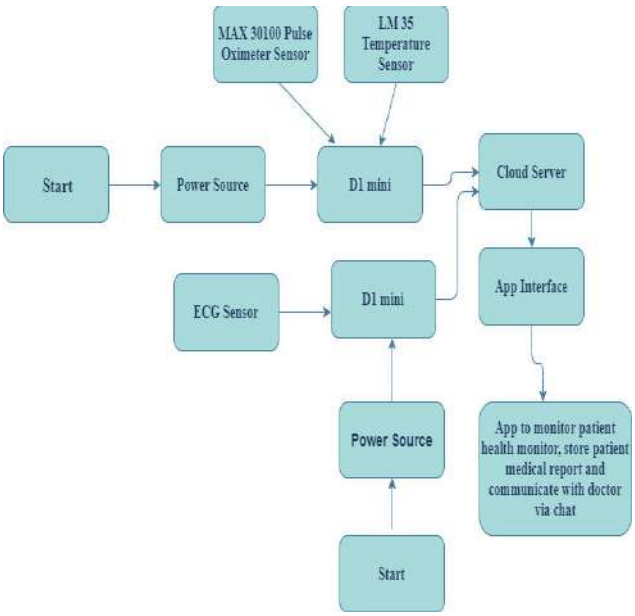


Figure 1: Block Diagram of the proposed system

The system architecture of our proposed system is given below:

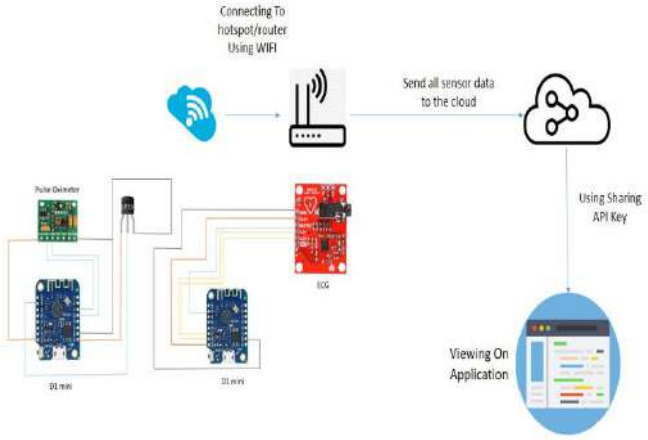


Figure 2: System Architecture of the system

IV. Measurement Procedures

For taking the desired data, the sensors have to be fitted to the body in the following ways.

In case of checking the pulse rate and oxygen saturation figure (4), the finger is placed on the sensor assigned. The sensor will fetch the required pulse rate and oxygen saturation which will eventually pass to the server.

In case of temperature figure (5), the sensor has to be bound to the finger along with remembering about the skin contact.

On the other side, in case of the checking of ECG figure (6), the three plugs have to be placed on the body to take the correct reading. The two plugs have to be connected on the upper left and right ribs respectively. While the other plug on the lower right rib.

Figure 3: Measuring Pulse rate and Oxygen saturation

Figure 4: Measuring Temperature

Figure 5: ECG

V. System Components

Sensors:

MAX 30100: MAX 30100 sensor is one of the most widely used and experimentally proven sensors for pulse rate and oxygen saturation. It is a sensor that gives much reliable performance with optimum input voltage.

LM 35: Maintaining similar indifference, LM 35 is also one of the most authentic sensors used for temperature which has a wide dimension of usages. It is also available at a very reasonable cost. The performance is very comprehensive with accuracy reading of approximately 0.5 degree Celsius.

AD8232 heart rate sensor: One of the most dependable sensors for ECG monitoring and used widely in fitness tracking devices. It acts almost like a portable ECG device. Simple implementation and easy pin configuration makes this sensor one of the most widely used one.

LOLIN D1 mini: A Wi-Fi flash board which is based on ESP8266 Wi-Fi module. This is generally used to integrate Wi-Fi routines with any device setup. The clock speed is excellent and authenticity and reliability of this flash board have made things much easier.

ThingSpeak server: The IoT analytics platform which allows to visualize the IoT data streams live and also stores them in the cloud.

VI. Flow Diagram of Device Measurements

For the device measuring pulse rate, oxygen saturation and temperature,
The following procedure is followed:

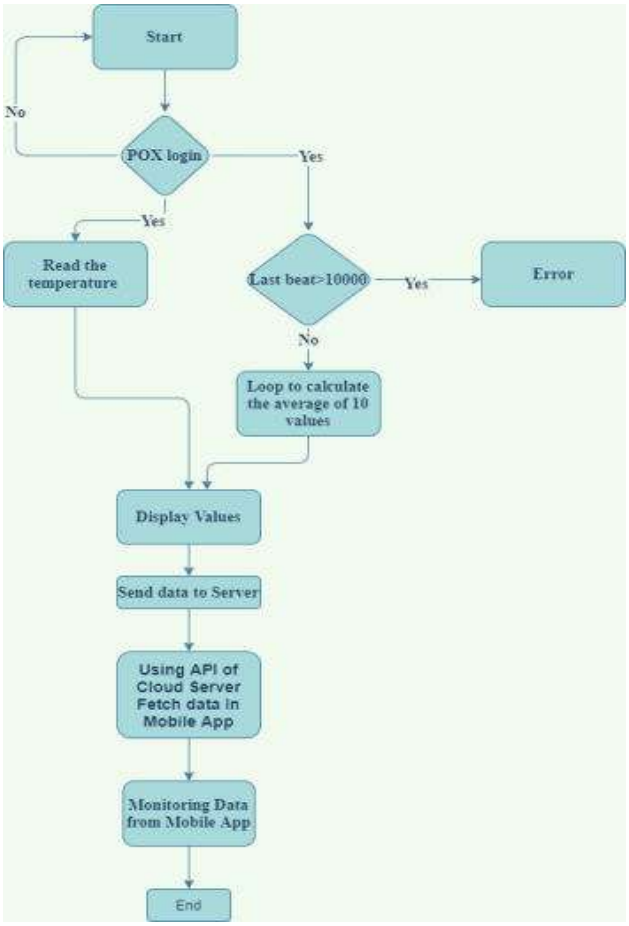


Figure 6: Flow chart for pulse rate, oxygen saturation and temperature measuring device

POX function is used for pulses rate and oxygen saturation. Initially, if pox is not initialized properly, then the whole procedure is null and void. In case pox is initialized properly, then the subsequent phases take place according to the given flow. After reading the data from server, the data is fetched by the android application.

For the device measuring ECG,
The following procedure is followed:

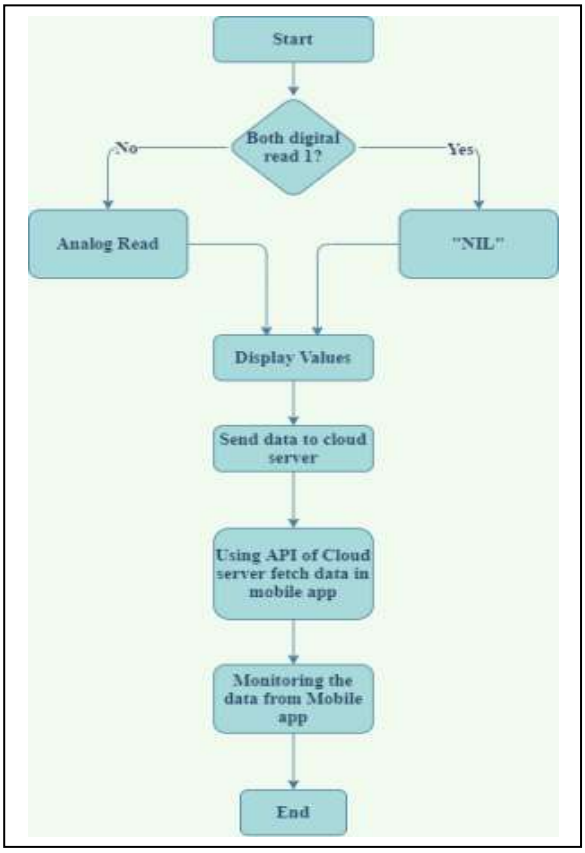


Figure 7: Flow chart for the device measuring ECG

VII. Mathematical Equation Analysis:

In case of calculation of temperature, the following algorithmic approach is followed:
Step 1: Raw voltage is read from output pin.
Step 2: The obtained voltage from 1 is converted to the mili volt unit by multiplying with 0.1007.
Step 3: Then, drop is calculated by subtracting the obtained value of 2 from 3600.
Step 4: The ceiling is calculated by division with 100.
Step 5: And finally applying the mathematical formula, (1.8 * cel+33), the desired temperature value is calculated.

In case of calculation of pulse rate and oxygen saturation, we have used these equations:
Average beat = filterweight*beat + (1 – filterweight) * average beat;
Average oxygen saturation = filterweight*beat + (1 – filterweight) * oxygen saturation.

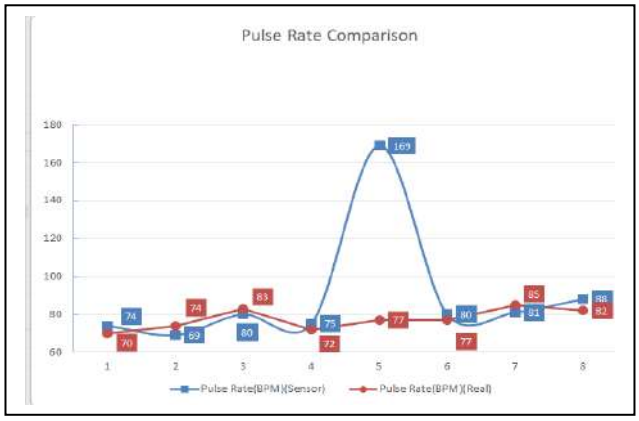
In case of ECG,
For two digital read being 1, the value is nil. Otherwise, obtained value is displayed as string.

VIII. Data analysis & Accuracy test

With the help of the implemented devices, we took real time data of some persons in order to determine the accuracy.

Pulse rate (MAX 30100) Data:

Patient Name	Pulse Rate (MAX 30100)	Pulse Rate(FO)	Percentage Error(Pulse Rate
Ishtiaque Ahmed	74	70	5.71%
Harun Rashid	69	74	6.76%
Dilruba Begum	80	83	3.61%
Rehnuma Ahmed	75	72	4.17%
Zahir Ahmed	169**	77	119.48%
Zahir Ahmed	80	77	3.90%
Rehnuma Akhter	81	85	4.71%
Shovan Kamal	88	82	7.32%



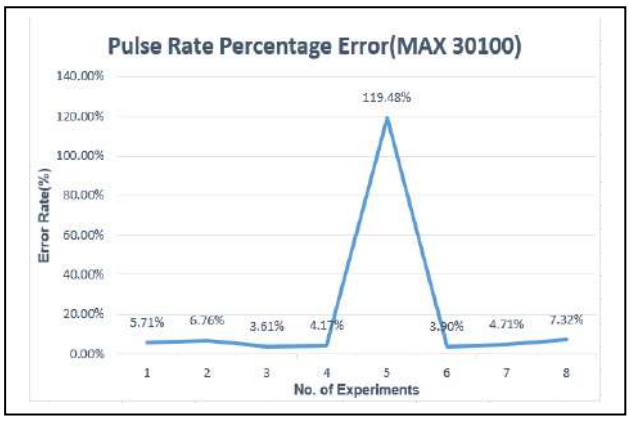
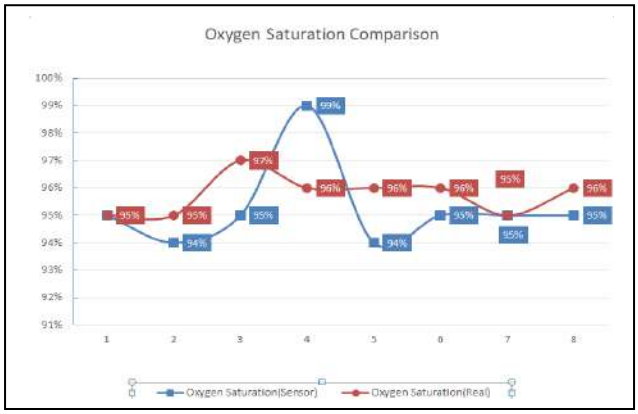


Figure 8: Test on accuracy of data detecting Pulse Rate (MAX 30100)

Oxygen Saturation (MAX 30100) Data:

Patient Name	O2 Saturation (MAX 30100)	O2 Saturation (FO)	Percentage Error(O2 Saturation)
Ishtiaque Ahmed	95%	95%	0.00%
Harun Rashid	94%	95%	1.05%
Dilruba Begum	95%	97%	2.06%
Rehnuma Ahmed	99%	96%	3.13%
Zahir Ahmed	94%	96%	2.08%
Zahir Ahmed	95%	96%	1.04%
Rehnuma Akhter	95%	95%	0.00%
Shovan Kamal	95%	96%	1.04%



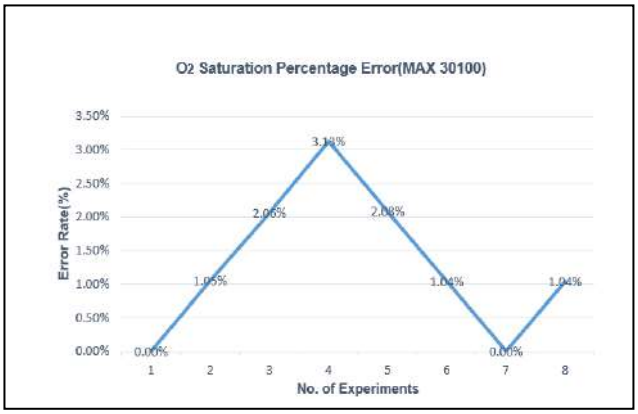
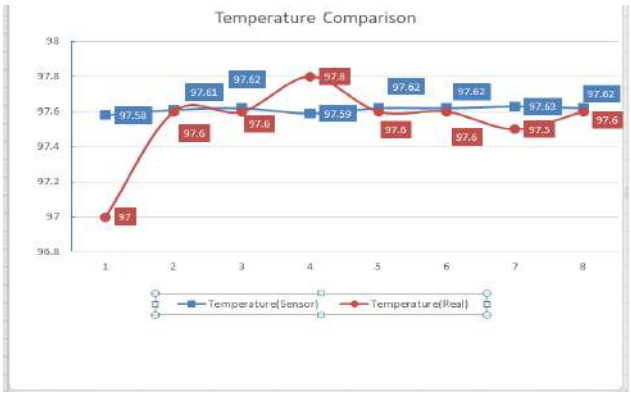


Figure 9: Tests on accuracy of data detecting Oxygen Saturation (MAX 30100)

Temperature (LM35) Data:

Patient Name	Temperature(LM35)	Temperature(Digital Thermometer)	Percentage Error (LM35)
Ishtiaque Ahmed	97.58	97	0.60%
Harun Rashid	97.61	97.6	0.01%
Dilruba Begum	97.62	97.6	0.02%
Rehnuma Ahmed	97.59	97.8	0.21%
Zahir Ahmed	97.62	97.6	0.02%
Zahir Ahmed	97.62	97.6	0.02%
Rehnuma Akhter	97.63	97.5	0.13%
Shovan Kamal	97.62	97.6	0.02%



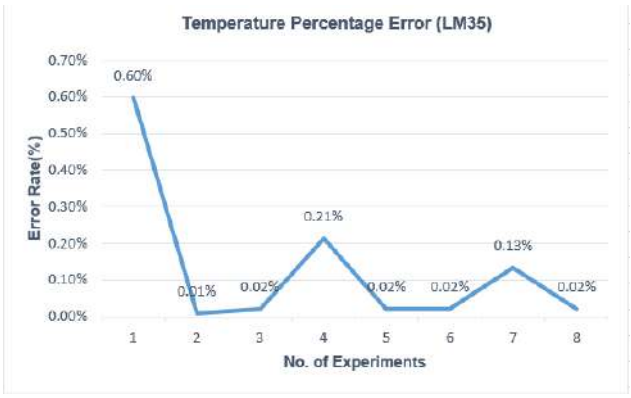


Figure 10: Tests on accuracy of data detecting Temperature (LM35)

Figure 11: Display of data in the thingspeak sever

We have carried out accuracy test on the devices against industrial standard measuring devices. We have carried out tests on 7 different patients.

In the case of MAX 30100:

From our tests, we can see that the highest error percentage for Pulse Rate is 7.32% & the highest error percentage for Oxygen saturation is 3.13% and lowest

error percentage is 3.61 % and 0.00% for Pulse rate and Oxygen saturation respectively.

In the case of LM35:

We can see that the highest error percentage of temperature sensor is 0.60% & lowest error percentage is 0.01%.

The error percentages that we found for each case is minimal and the differences between the data from the sensors we have used and the industrial standard sensor is very little.

The given index 169 in the pulse rate is a fault data due to the faulty connection of the sensor. Sometimes due to the malfunctioning of the USB cable or the other relevant and valid issues, some fault data like the aforesaid case can be seen.

But by proper connection being re-established, the proper reading can be obtained. In this case, re-connection of sensor to the body or the USB cable can be the possible optimal solution.

IX. Deployment of Data to Android Application

Figure 12: Display of ECG in the application

The obtained value of ECG is displayed in the application like this. Because of separate ECG setup, other respective values are nil. That is why the other readings are displayed as zero. This data can be viewed by the doctor from the chat option.

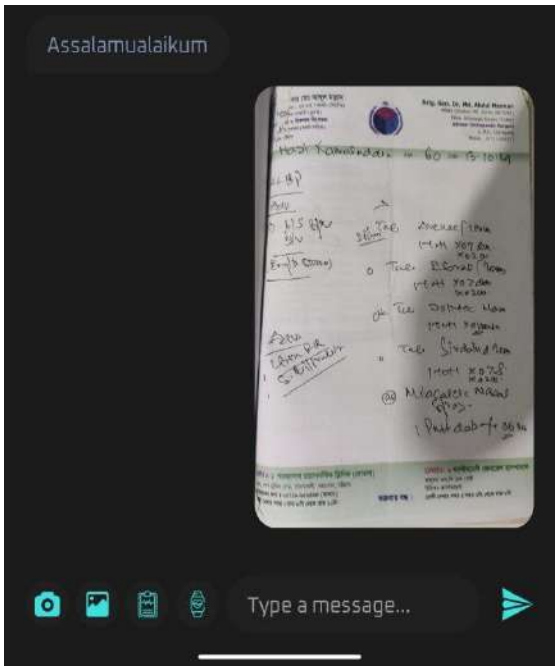


Figure 13: Chat Option

Chat appears like this in the android application. Via this, a doctor can view patient medical report and data from device.

Figure 14: Display of pulse rate, oxygen saturation and temperature

The above figure displays the pulse rate, oxygen saturation and temperature readings of the body. Because of being separate, the ECG reading is nil in this case.

Figure 15: Notification from application

X. Conclusion

The proposed system can be of massive use when it comes to the eradication of hassles and problems of peoples who are victimized of deprivation. Also, easy diagnosis of any problems and following up after that will help to increase the confidence of the patient. On the other side, minimum expense and very minimum time consumption makes the whole system quite advantageous.

Sometimes, for unexpected performance of the sensors and poor connection issues, some fault data is provided. In order to solve issue like this, improved variety of sensor can be used. Also, with the usage of improved sensor direct connection can be avoided with a view to averting the poor connection issues.

Efforts will be made in the future to make this proposed system a complete package. From improving the sensor interface to implementing in-app audio and video call in order to improvise user experience is our prime aim. Conversion to mini portable devices to ensure ease of users is also one of the huge priorities. Also, addition of necessary security features for the better acceptance of system will be incorporated as well. Implementation of blockchain for providing necessary security can also be a better alternative in this regard.

Adaptation of IOT in medical sectors is nothing less than a blessing at present. The contemporary tragic scenario can be brought under control to a great extent by the extension of IOT in this sector. Restoring confidence in people's mind by breaking the shackles of complexity and high expenses can be considered as a prime priority at this moment of time. IOT can surely play a magnanimous role at this point of time to accomplish all the aforesaid objectives.

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Conceptual Framework of Supply Chain Counter-Measures through Supplier against Disruption

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***Abstract*— Better in managing suppliers were found as an effective supply chain counter-measures in dealing with supply chain disruption, and such phenomenon was found even more obvious in coming three years comparing with the last three years, and probably owing to the sudden occurrence of pandemic and tighter control on supply chain becomes a new normal from now on.**

Keywords*— *supply chain management, procurement, risk management.

I. INTRODUCTION

Supply chain risk management has been one of the major research areas since 1970s, in which it originally focuses on the control of manufacturing process and then evolves to cover as well that of services process in the recent decades. Many researchers had actively analyzed supply chain network, its associated risk, and also tried various means to measure the performance. From risk management perspectives, four basic approaches have been defined to describe the treatment on any identified potential risks, namely avoidance, reduction, transfer, and retention. In reality, it would be always easier said than done, as actions largely depend on to the power balance with supply chain partners and relative importance of the products or services to the focal organization itself. Successful endorsement and monitoring on the execution of supply agreement shall be a simple, realistic and quantifiable measure on how good a strategy being implemented for an organization. Under COVID-19 pandemic circumstance for instance, many organizations has been indirectly examined for their vulnerability of supply chain management towards business continuity. This study aims to measure on how good an organization being immune from supply risk and how Kraljic matrix supports procurement professionals to strategically negotiate supply agreement and in turn contribute to the supply chain resilience.

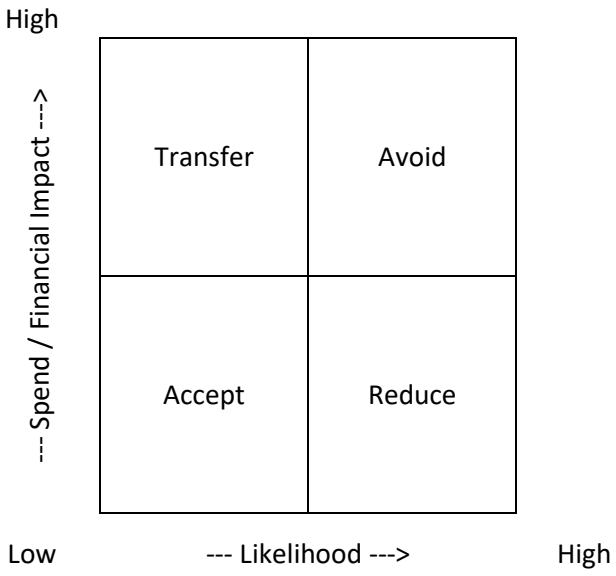
II. LITERATURE REVIEW

A. *Risk Categorization*

Trent and Roberts (2010) provide an example of risk matrix with risks under the broad categories of operational risks, natural disasters, terrorism/political instability, and financial risk. Upon the risks are identified and the sensitivity of the focal organization to those risks have been adequately quantified and evaluated, the next step is to select risk management strategies, i.e. risk avoidance, risk retention, risk reduction or risk transfer, by applying the results of the risk matrix.

Due to the nature of identified risks, different approaches shall apply in tackling those risk with primary goals of protecting the interest of the focal organization or resuming the normal process from the disruptions. Of course, for any risk that purely inherent and virtually not able to escape, it will be regarded as pure risks. Instead of putting effort to avoid or reduction, its impact is reduced by means of looking for financial corporation entering into an insurance coverage. Foreign currency exchanges are also one of the typical example and hedging as counter-measure has been widely deployed and accepted in the industry.

Plan-Do-Check-Act or PDCA procedures are common as tools for ongoing risk monitoring about the performance and suitability of any business process in place. As market keeps on changing depending on various factors under PESTAL model, thus political, economic, social, technological, environmental, or legal aspects. For instance about the sudden occurrence of COVID-19 pandemic during 2020, it has seriously affected the usual practices of business operations. Originally it thought to be able to manage it within few months, and afterwards re-anticipate of to manage it within half year, and later pragmatically re-examine its effect that could be lasted for few years until year 2022 or alike.



B. *Risk Management Measures and Implementation*

Risk management includes the processes of identifying the risk, quantifying the risk, assigning responsibility for management of the risk, and mitigating the risk. Mitigation actions can take many forms, including site protection, emergency response plans, and insurance. The development and implementation of a risk management program includes various types of risk such as geopolitical, environ-mental, public relations, financial, operational, brand/reputation, legal, technical, and data security risks. (ISM Glossary 6th edition).

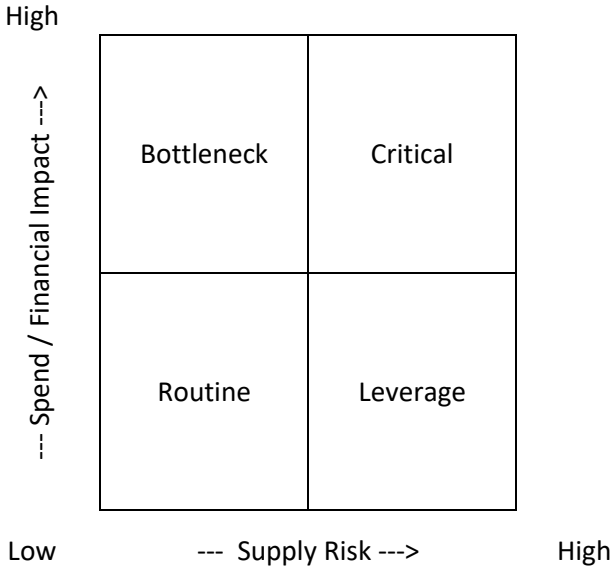
- Risk Avoidance – eliminate cause of risk such as by dropping out any particular of product, process or provision of services.
- Risk Mitigation – reduce the likelihood or impact of risk such as by expansion of source supply or buffering to reduce the impact upon adverse conditions come.
- Risk Transference – identify third party of taking up the risk such as by adopting an insurance policy with financial institution.
- Risk Acceptance – setup any contingency plan such as by putting hiring more front-line staff for handling customer goods return as far as both of likelihood and financial impact are at low level.

C. *Supplier Portfolio under Kraljic Model*

Implementation and execution of any business strategy or risk management plan requires organization resources which includes internal or external, given that resources is always limited and shall only be wisely deployed for the greatest cost and benefit ratio in return, as pointed out by Michael Porter {Porter, 1996 #2828}. He developed business strategy model to create and maintenance competitive advantages and made use of five-forces model as industry analysis to examine including the bargaining power of suppliers and buyers. While procurement belongs to supporting activities under the value chain model. Kraljic portfolio matrix provided corresponding tools in proper execution of any strategic plan. Kraljic {Van Weele, 2014 #94} examine supplier in two dimensions namely supply risk in terms of availability and associated financial impact from spend perspectives. Four quarters are so expanded in classifying the buying items into strategic, leverage, bottleneck and non-critical.

Kraljic's classification of items and management directives:

- Critical (high supply risk and high financial impact)– ensure long term availability through partnership development or supply agreement.
- Leverage (low supply risk and high financial impact)– – make good use of such purchasing power to optimize the benefit especially in terms of financial.
- Bottleneck (high supply risk and low financial impact)– – maintain good relationship with existing sources and explore for any new sources of supplies.
- Routine (low supply risk and low financial impact) – automate the process or decentralize its purchasing decision thus save the management effort in dealing with.



Procurement or supply chain management department is so collaborating internally with users' department and determine the relevant approaches for ensuring continuity of supplies. Of course, a spend and forecast analysis examining the historical purchasing patterns within the focal organization is the initial information to start with.

D. *Supply Chain Counter Measures for Supply Resilience*

Many people are aware that a strategy is only as good as its execution, so extra care must be taken in chooing the most appropriate way of ensuring any supply disruption. Key and common buying arrangements include (ISM Glossary 6th edition):

- Buying to requirement – advance purchases for use with reference to the ordering lead time to ensure stable supply while avoiding excess inventory on hand.
- Buffering, forward or speculative buying – conditions such as potential supply constrictions or inflationary markets cause procurement to hedge price or source of supply for buying more than required quantity.
- Volume purchase or supply agreement – establishment of contract in advance by the focal organization especially with those high bargaining power of suppliers, to secure its source of supplies. Depending on the contract

period or demand duration, such contract may be either short term, long terms or extensible subject to any prescribed conditions.

- Multiple and global sourcing – continuous exploration of new suppliers and expansion of source of supply thus in turn to lessen the bargaining power of a particular supplier, for benefit of stable supply at the lowest possible cost.

III. Methodology

It can be commonly image that numerous factors in practice may cause supply disruption, so six common factors are taken out without losing generality, namely supplier, transport storage, corruption, bureaucracy and labour ((ISM Glossary 6th edition). Online survey was conducted to procurement or supply chain professional asking about the most frequent causes of supply chain disruption happened in last and coming 3 years, and impact of each associated risk were then reviewed to conclude the risk profile.

To deal with assessed risks, survey respondents were invited to review the usual and effective way in industrial practice in tackling the identified risks in last and coming 3 years.

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IV. Result and Discussion

More than 50 survey respondents completed the online survey, in which

- 40% were with manager or above capacity
- 82% were with sourcing product or materials in a regional and global basis
- 35% focuses on supply chain management responsibilities
- 69% were from European countries and the rest were mainly from United States and Asia.
- 44% were with organizations' annual revenue over one millions US dollar

The survey indicated that the occurrence of supply chain disruption were majority originated from transportation, bureaucracy and labor related matters. While combining the financial consideration in terms of medium or high impact, the core concerns were confined to either bureaucracy and labour in the last three years.

Same analysis was conducted in examining the coming three years, significant difference came out that 'Supplier' related disruption jumped up. Probably it was affected by recent pandemic situation that most of supply chain, if not all, no matter physical goods or services had been seriously interrupted.

On the other hands, the survey respondents were rated the effectiveness of what supply chain counter-measure were the best in tackling those identified risks. It found that buffering redundancy and strategic intent were the most effective tools in handling supply chain disruptions, given that buffering was nearly always effective in tackling multiple identified risks.

V. Limitation and Future Research

Lots of limitation for the current analysis as it only confined to the reply from 50 survey respondents and largely were from European countries. And the supply chain counter-measures were relatively limited, so more detail guidance and choice would be beneficial to put into the survey for better resolution on research results.s

Factors Affecting of Employee Performance Appraisal System in the Pharmaceutical Industry: An Analytical Study

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***Abstract*— Performance appraisal refers to the assessment of employees' current performance, work activity, and their capacity for future performance. The research study is based upon the performance appraisal System in Meridian Medicare Limited. The present research was carried out to evaluate the determinants of employee performance, satisfaction level, and impact of employees' performance in the pharmaceutical industry. The sample size of the employees was 60 and the data were gathered through the questionnaire. The data were analyzed using a percentage, mean, standard deviation, and regression model. The results of the study found that the majority of respondents were pleased with the performance appraisal system. The study found the six factors which influence the employee performance appraisal system in Meridian Medicare Limited, Himachal Pradesh, India. The results of the study showed that all six factors working environment, compensation salary and supervision, work efficiency, training and work performance, achievements and improvements, performance through motivation, and job satisfaction had a strong positive relationship with the performance assessment system. The multiple linear regressions also found that 79.2 percent of the variation in the performance appraisal system was explained by selected explanatory variables. It shows that if these variables are taken into consideration by the company it may give the best results.**

Keywords*— *Performance Appraisal; Pharmaceutical Industry; Employees, Satisfaction level; Motivation; Job satisfaction; working environment

I. INTRODUCTION

Performance appraisal refers to the assessment of employees' current performance, work activity, and their capacity for future performance. The performance appraisal is the method of evaluating employee performance by contrasting present performance with existing expectations that have already been communicated to employees and then providing employees with input on their level of performance to enhance their performance as required by the company.As mentioned above, the goal of the performance rebellion is to know the performance of an employee, then to determine if a specific employee needs to obtain training or to offer promotion with additional pay hike Performance appraisal is the instrument to decide whether workers are to be promoted, demoted or fired (removed) in the event of extremely low results and without room for change. Every corporate sector uses performance appraisal as a method for knowing about the employee and making decisions about the employee. Human resource is the prime asset of an organization as well as the nation.The valueof the effective human resource is getting momentum nowa day dueto the awareness of the costs associated with poor human resource management (Wright and McMahan, [1]). Human resources are important means for improving productivity. Managersnow realize that the effectiveness of the human resource function has a considerable impact on the bottom-line performance of the firm (Griffin, [2]). But the frustrating point is that performance appraisals are often apprehended by both the employee and the employer (Scholtz, [3]). Many coetaneousorganizations are placing a greater accentuateon their performance management systems as a means of producing higher levels of job performance (Grumana and Saksb, [4]). The optimal development and utilization of individual characteristics and competencies are vitalto enhance efficiency in the workplace (Jonker andJoubert, [5]). The selection and application of performance appraisal systems are also difficult. The performance evaluation systems affect employee behavior (Robbins and Judge, [6]).

II. LITERATURE REVIEW

Jahan [7] found that the majority of the employees were satisfied with the organization's performance appraisal system and also they demanded a more systematic and informative performance appraisal system.Kumari et al. [8] found in their study the most of the software professionals were satisfied with welfare facilities appreciation and rewards, career prospects, physical working environment, communication, and fringe benefit. Cook and Crossman [9] analyzed in this study that evaluation disappointment is a major cause of the disparity between expectations and performance. According to them, fairness can only be based on the expectations of the worker, and the performances were contrasted with another similar employee in the company. This personnel claimed that the appraisal was insufficient due to the framework of fair performance assessment.Nurse [10] examined in this study the performance appraisal in such a way as to demonstrate that the process is politically motivated since the success of the individual employee is one of its main objectives. The study of the cross-section of the views of employees of the method was also driven by the need to decide whether they believed that the performance assessment had achieved fair outcomes and whether their use was seen to contribute to their career growth.Zaman [11] explored in this study that the performance assessment process is the increased efficiency of employees at the workplace.Monari [12]analyzed that the management position, employee ability, and financial capital play an important role in ensuring that performance evaluation method.Ochoti*et al.* [13] Investigated in their study that all five variables namely the implementation process, interpersonal rater and rate relationship, psychometric rater precision, knowledge factors, and employee attitudes give an effect on the performance

appraisal method. The factors under these variables have shown the impact of the performance assessment program implementation process and the quality of care the rate receives in the rater's hands. Elimination of rating errors has also been shown to improve machine performance. Virani [14]evaluated thatthe parameters considered for evaluation, standards communication process, input mechanism, and performance appraisal method, consistency of performance assessment process, and accountability of performance assessment process.Rana and Lokhande [15] explored that the company has developed a benchmark of performance for research and development activities, as Maruti Suzuki believes that this operation would allow the company to offer its customers superior and environmentally friendly products with complete satisfaction. Maruti Suzuki's environmental performance is quite negligible.

Renganayaki [16] found the performance assessment is very closely linked to the identification of training and development needs, which are not only of benefit to the organization but also to employees. The emphasis must therefore be on optimizing talent capabilities through and adequate training and development reward strategies.Singh *et al*. [17] examined in their study the relationship between the organizational assessment and employee productivity between staff members with the manufacturing sector in India. The results have shown that the periodic assessment of the workplace performance of organizations has become a fundamental requirement that will help minimize the difference between employee performance and the achievement of its objectives.

Suresh and Mohideen [18] examined the performance appraisal of automobile industries in Chennai. The study indicated that the degree of satisfaction did not reach higher levels with the current appraisal method being adopted by the industry. The introduction of an effective method of company performance evolution however has become crucial and has also helped to apply motivational strategies and pay attention to the level of motivation of employees, which could contribute to employees ' satisfaction with their evaluation. Yoganandan *et al*. (19) concluded that the performance assessment is a vital practice for companies in this ever-increasing competitive world searching for growth and benefit maximization. Their results unveiled that the essential elements of an excellent performance assessment system are the understanding of its foundations and the essential steps that lay the foundation.Agarwal [20]analyzed in this study to evaluate the impact of performance evaluation on employee behavior, and establish the connection between performance assessment and employee's performance.Todetermine the factors affecting job satisfaction and know the level of satisfaction, Kumari et al. [20]observed that in their study organizational culture, pay compensation, career growth, social security.Wararkar and Wararkar [21] The study showed that the demand for the cotton industry in today's world has increased significantly with inherited outcomes such as lower installation costs, minimum space usage, simple expansion, aesthetic benefits, and increased product choices. So, employee performance evaluation is important to recognize the abilities, competencies, and relative quality and importance of each employee for the company. A well-designed performance management program facilitates an integrated human resource plan that allows the achievement of organizational and company objectives.Maheswari [22] suggested in this study that performance evaluation is considered to be a common procedure, but that its significance should be recognized and conveyed to all employees. The results of the study showed that the performance appraisal program of the company needed to sustain and improve the quality of work for employees. Performance evaluation can also be used to help identify successful performers. Narayana and Reddy [23]analyzed in this study that the Bharat Sachar Nigam Limited (BSNL) assessment system is average. to be an effective tool, assessment in the organization has to be continuous. The comprehensive performance evaluation procedure allows managers to develop training strategies and policies. It helps to assess employee strengths and weaknesses so that new positions can be planned for productive employees. It also helps to frame future planning programs. An illustrative work had been performed by Kumari et al. 2017 [26] with the objective to determine job satisfaction level of software professionals. Three private software industries, namely HCL Technologies Ltd., IBM India Pvt. Ltd. and Wipro Ltd. had been selected. The respondents of HCL Technologies Limited, are found with higher mean value of 3.44 for working hours as compared to IBM India Pvt. Ltd. and Wipro Ltd. So the respondents of the Wipro Limited were found more satisfied in terms of working hours than other two companies. Secondly, employees of IBM India Pvt. Ltd. got more authority and responsibility than other two companies. HCL Technologies Ltd. and Wipro Ltd's employees same satisfaction level in terms of appreciation and rewards. The respondents of IBM India Pvt. Ltd, had mean value of 3.27 whereas for HCL Technologies Limited mean value was 3.3 and Wipro Limited mean value was 3.26. Thus employees of IBM India Pvt. Ltd. enjoy favorable job condition than other companies. Khanna et al. 2019) [27] studied the occupational health and safety of workers of pharmaceutical industries using suitable mathematical and statistical tools. Workers have the most contribution in success of an industry since they are the most significant resources. Hence the occupational safety and health of employees are an inevitable matters. Occupational health and safety are two localities involved with the security, health, and well-being of individual worker. Safety and health programs leads to secure and healthy work atmosphere. In the study, health risks for pharmaceutical workers are identified and measures to prevent impact of hazards on workers' health are outlined. As per their findings, the continuous training program on risk of health and safety of workers helps to keep workers happy and motivated. The results show that large number of workers supported the standard checklist for health and safety inspections

Bhatia and Patel [28] examined in this study that the employee's satisfaction with the performance appraisal method. The results showed that overall results indicate that both employee satisfaction and performance evaluation are interrelated. Performance evaluation should satisfy the employees and if the employees are not pleased with the performance appraisal then it should be clarified to them that why their performance is unacceptable, therapy is the

best way to solve this employee performance issue by making it transparent about the personal and organizational goals.

A. *Objective of the Study*

To identify the determinants of employee performance system in the pharmaceutical industry.

III. RESEARCH METHODOLOGY

The research methodologies have been explored in this study and it explains the suitable methodologies to achieve the specific goals and the purpose of the research work is to examine and deal with the performance appraisal system in India. The descriptive research design and convenience sampling technique were used to fulfill the research objective. The total sample size for the study was 60 employees in the Meridian Medicare Limited, Himachal Pradesh. 30 employees were from the production department,10 employees were from the marketing department,10 employees wherefrom the finance department, and 10 employees wherefrom the finished goods department out of these 60 employees 37 were male while the other 23 were there female. The primary data was collected on a well-designed structured questionnaire through the survey method. The secondary data were gathered from the research paper, articles, books, and magazines, etc the questionnaire was structured based on a five-point Likert scale from strongly disagree to strongly agreed where point-1 strongly disagreed, 2 disagreed, 3 neither agreed nor disagreed, 4 agreed and 5 strongly agreed on the performance appraisal system. Data entry and interpretation were performed in the SPSS 20 version. The demographic features of the sample were represented using descriptive and inferential statistics. The factor analysis was used for inference Factor analysis is a statistical technique used to identify a relatively small number of underlying factors. This can be used to represent relationships among interrelated independent variables. The factor analysis is the identification of underlying factors that might explain the dimensions associated with data variability. There are two primary applications of factor analysis. The first application is to reduce the number of variables and the second application is to detect structure in the relationships between variables that might explain the dimensions associated with large data variability.

IV. RESULTS AND DISCUSSION

The results are analyzed and discussed through the collected data. In the descriptive investigation, the demographic information is presented in the first section as based on the respondent's responses in the pharmaceutical industry Meridian Medicare Limited. There were the following steps involved toidentify the determinants of the performance appraisal system.

A. *Kaiser-Meyer-Olkin (KMO) and Bartlett's Test for Variables*

KMO measures the strength of relationships among different variables. It also determines the sampling adequacy that has to be greater than 0.5 for satisfactory factor analysis. If any pair of variables has a value less than this, it is considered to drop one of them from the analysis.

Table 1 KAISER-MEYER-OLKIN (KMO) AND BARTLETT'S TEST

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.734
Bartlett's Test of Sphericity	Approx. Chi-Square	614.406
	Degree of freedom	231
	Significance level	0.000

Source: As per the output of SPSS 20

The KMO test measures the sampling adequacy which falls in the acceptable range with a value of 0.734. Barlett's test of sphericityis significant, thus the hypothesis that the inter-correlation matrix involving these 22 variables is an identity matrix is rejected. Therefore, from the viewpoint of Bartlett's test, factor analysis is feasible.

B. *Communalities for Variables*

It shows how much of the variance in the variables have been accounted for by the extracted factor.

Extraction Method: Principal Component Analysis

Table 2 COMMUNALITIES

	Communalities		
Sr. No	**Variables**	**Initial**	**Extraction**
1	Do you satisfied with your salary?	1.000	0.550
2	In your opinion performance appraisal is?	1.000	0.832
3	Which method of performance appraisal is implemented in the organization?	1.000	0.643
4	Do you receive any increment in your salary after performance appraisal.?	1.000	0.645
5	Do you think that performance appraisal help to provide an atmosphere where all are encouraged to share one another burden.?	1.000	0.494
6	Do you think performance appraisal helps people set and achieve meaningful goals.?	1.000	0.776
7	Do you think performance appraisals give constructive criticism in a friendly and positive manner.?	1.000	0.652
8	Do you think that the performance of employees improves after the process of performance appraisal?	1.000	0.669
9	Do you think performance appraisal improves motivation and job Satisfaction?	1.000	0.865
10	Is the top-level management partial in performance appraisal?	1.000	0.659
11	After performance appraisal improvement in your performance.	1.000	0.506
12	Does the induction of training a well-planned exercise in the organization?	1.000	0.656
13	Does Training help to improve the employee-employer relationship?	1.000	0.655
14	Are you getting appreciation and rewards from management after the best performance?	1.000	0.756
15	Are you satisfied with the present method of selection of candidates of training?	1.000	0.706
16	Does the training course include special challenges by managers and or officers?	1.000	0.769
17	Training methods focus on developing teamwork and leadership skills.	1.000	0.678
18	Employees are given appraisals to motivate them to attend the training.	1.000	0.809
19	Do you feel the training session has helped you to improve your work efficiency?	1.000	0.688
20	Do you agree that the instructor responds to trainees' doubts?	1.000	0.488
21	Do you agree that Training has helped reducing absenteeism?	1.000	0.655

22	Do you agree that training helps to do the job with more commitment?	1.000	0.634
	Extraction Method: Principal Component Analysis.		

Source: As per the output of SPSS 20

Table 2 commonalities show 48.8 percent of the variance in the variables has been accounted for by the extracted factor.

C. Total Variance Explained: Performance Appraisal System

Total Variance: There were all the six factors extractable from the analysis along with their Eigenvalues, the percent of variance attributable to each other.

Table 3 THE TOTAL VARIANCE EXPLAINED

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Sr. No.	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.703	30.470	30.470	6.703	30.470	30.470	4.106	18.662	18.662
2	2.091	9.506	39.975	2.091	9.506	39.975	2.966	13.483	32.145
3	1.791	8.140	48.116	1.791	8.140	48.116	2.328	10.582	42.727
4	1.596	7.253	55.369	1.596	7.253	55.369	1.923	8.740	51.467
5	1.402	6.373	61.742	1.402	6.373	61.742	1.900	8.636	60.103
6	1.202	5.464	67.206	1.202	5.464	67.206	1.563	7.102	67.206
7	0.988	4.491	71.697						
8	0.889	4.042	75.738						
9	0.814	3.699	79.437						
10	0.791	3.594	83.031						
11	0.618	2.808	85.839						
12	0.523	2.376	88.216						
13	0.465	2.115	90.331						
14	0.392	1.782	92.113						
15	0.344	1.564	93.677						
16	0.321	1.459	95.136						
17	0.281	1.275	96.411						
18	0.210	0.952	97.364						
19	0.197	0.894	98.257						
20	0.156	0.711	98.968						
21	0.132	0.598	99.567						
22	0.095	0.433	100.000						
Extraction Method: Principal Component Analysis.									

Source: As per the output of SPSS 20

The first factor accounts for 30.470% of the variance, the second 9.506%, the third 8.140%, the fourth 7.253%, the fifth 6.373%, and the sixth 5.464 %. All the remaining factors are not significant.

D. Scree Plot of Variables

The scree plot is a graphic aid of the Eigenvalues against all the factors. It is proposed by Cattell. The graph is used to determine how many factors to retain. It is intended to help in deciding where the "trivial" dimension is begun. In the chart, the curve begins to flatten between 1 and 6. Only six factors have been retained.

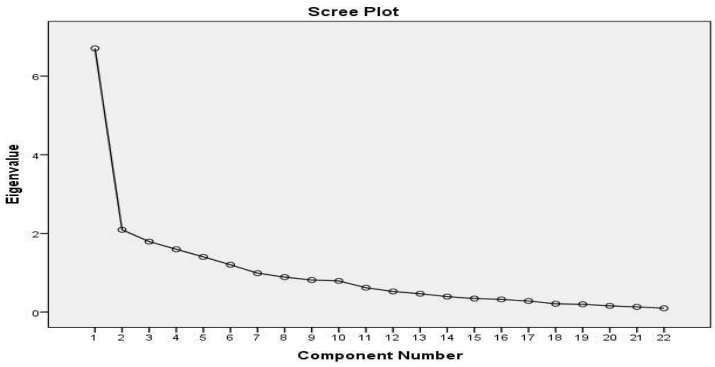

Figure 1 Scree Plot of Variables

E. Component (Factor) Matrix of Variables

This shows the loadings of the twenty-two variables on the six factors extracted. The factor contributes more to the variable when the absolute value of the loading factor is higher. In table 4.2.5, there are the results for the six factors that are extracted. The seventh column provides summary statistics detailing how well each variable is explained by the six components.

Table 4 COMPONENT MATRIX

Sr. No	Variables	Component					
		1	2	3	4	5	6
1	Do you satisfied with your salary?	0.447	0.273	0.211	-0.419	0.146	-0.186
2	In your opinion performance appraisal is?	-0.014	0.327	-0.311	0.499	0.607	-0.106
3	Which method of performance appraisal is implemented in the organization?	0.606	-0.145	0.062	0.078	-0.241	-0.432
4	Do you receive any increment in your salary after performance Appraisal?	0.503	0.195	0.041	-0.410	0.394	-0.167

5	Do you think that performance appraisal help to provide an atmosphere where all are encouraged to share one another burden?	0.401	0.249	-0.424	-0.198	0.110	0.201
6	Do you think performance appraisal helps people set and achieve meaningful goals.?	-0.160	0.050	0.723	0.139	0.437	0.120
7	Do you think performance appraisals give constructive criticism in a friendly and positive manner.?	0.649	-0.030	0.396	-0.235	-0.133	0.008
8	Do you think that the performance of employees improves after the process of performance appraisal?	0.364	0.595	0.015	0.347	-0.236	0.070
9	Do you think performance appraisal improves motivation and job Satisfaction?.	-0.420	0.492	0.314	0.159	0.226	-0.521
10	Is the top-level management partial in Performance appraisal?	-0.056	0.599	0.220	0.075	-0.224	0.440
11	After performance appraisal improvement in your performance.	-0.133	-0.179	0.578	-0.049	0.079	0.337
12	Does the induction of training a well-planned exercise in the organization?	0.574	0.426	-0.248	-0.063	-0.063	0.276
13	Does training help to improve the employee-employer relationship?	0.668	-0.439	-0.086	-0.034	0.079	0.018
14	Are you getting appreciation and rewards from management after the best performance?	0.747	0.060	-0.142	0.349	0.223	0.037
15	Are you getting appreciation and rewards from management after the best performance?	0.717	0.309	0.160	0.028	-0.196	-0.177
16	Does the training course include special challenges by managers and or officers?	0.859	0.080	0.006	-0.145	-0.027	0.054
`17	Training methods focus on developing teamwork and leadership skills.	0.730	-0.079	-0.007	-0.04	-0.161	-0.332
18	Employees are given appraisals to motivate them to attend the training.	0.800	-0.214	-0.066	0.297	0.154	0.090
19	Do you feel the training session have helped you to improve work efficiency	0.720	-0.228	0.041	0.267	0.063	0.200
20	Do you agree that the instructor responds to trainees' doubts?	0.360	0.175	0.330	0.292	-0.362	-0.049
21	Does training reduce constant supervision?	0.557	0.079	0.090	-0.426	0.347	0.169
22	Do you agree that training helps to do the job with more commitment?	0.476	-0.420	0.257	0.390	0.105	0.040
	Extraction Method: Principal Component Analysis.						
	a. 6 components extracted.						

Source: As per the output of SPSS 20

The first row of numbers at the bottom of each column is the Eigenvalues and indicates the relative importance of each factor in accounting for the variance associated with the set of variables being analyzed. The sums of squares are for the six factors are 6.703, 2.091, 1.791, 1.596, 1.402, and 1.202 respectively. Factor 1 and factor 6 is accounted for the most variance.

F. Rotated Component (Factor) Matrix of Variables

The VARIMAX rotated component analysis factor matrix is shown in table 4.2.6. The total amount of variance extracted is the same in the rotated solution as it was in the unrotated one, 67.206percent. Two differences are apparent in the following table. First, the variance has been reallocated so that the factors are different

TABLE 5 ROTATED COMPONENT MATRIX

Rotated Component Matrix							
Sr. No.	**Variables**	**Component**					
		1	2	3	4	5	6
1	Do you satisfied with your salary?	-0.040	0.685	0.271	0.059	0.038	-0.024
2	In your opinion performance appraisal is?	0.125	-0.009	-0.195	0.076	-0.078	0.876
3	Which method of performance appraisal is implemented in the organization?	0.329	0.139	0.687	-0.107	-0.170	-0.055
4	Do you receive any increment in your salary after performance	0.101	0.774	0.111	-0.072	-0.038	0.131

	appraisal.?						
5	Do you think that performance appraisal help to provide an atmosphere where all are encouraged to share one another burden.?	0.207	0.408	-0.176	0.233	-0.444	0.052
6	Do you think performance appraisal helps people set and achieve meaningful goals.?	-0.033	0.097	-0.073	0.033	0.849	0.195
7	Do you think performance appraisals give constructive criticism in a friendly and positive manner.?	0.316	0.467	0.420	0.132	0.174	-0.333
8	Do you think that the performance of employees improves after the process of performance appraisal?	0.093	0.032	0.319	0.701	-0.127	0.222
9	Do you think performance appraisal improves motivation and job Satisfaction?.	-0.624	-0.022	0.247	0.007	0.314	0.561
10	Is the top-level management partial in Performance appraisal?	-0.199	0.007	-0.098	0.762	0.160	-0.064
11	After performance appraisal improvement in your performance.	0.046	-0.011	-0.150	0.038	0.637	-0.270
12	es the induction of training a well-planned exercise in the organization?	0.277	0.400	0.018	0.540	-0.356	0.014
13	Does Training help to improve the employee-employer relationship?	0.682	0.260	0.173	-0.223	-0.130	-0.160
14	Are you getting appreciation and rewards from management after the best performance?	0.688	0.250	0.214	0.206	-0.149	0.331
15	Are you satisfied with the present method of selection of candidates for training?	0.257	0.385	0.595	0.357	-0.101	0.008
16	Does the training course include special challenges by managers and or officers?	0.514	0.550	0.324	0.224	-0.177	-0.126
17	Training methods focus on developing teamwork and leadership skills.	0.386	0.331	0.600	-0.046	-0.226	-0.077
18	Employees are given appraisals to motivate them to attend the training.	0.832	0.206	0.227	0.061	-0.080	0.117
19	Do you feel the training session has helped you to improve your work efficiency?	0.784	0.147	0.188	0.125	0.018	-0.018
20	Do you agree that the instructor responds to trainees' doubts?	0.177	-0.076	0.522	0.393	0.138	-0.068
21	Does Training reduce constant supervision?	0.286	0.747	-0.071	0.043	0.046	-0.083
22	Do you agree that training helps to do the job with more commitment?	0.687	-0.070	0.256	-0.105	0.283	0.027
	Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.						
	a. Rotation converged in 8 iterations.						

Source: AS per the output of SPSS 20

Especially, in the VARIMAX rotated factor solution, the first factor accounts for 18.662percentof the variance, compared to the 30.470percent in the unrotated solution. As the same second factor accounts for 13.483percent versus 9.506 percent, the Third factor accounts for 10.582percent versus 8.140percent, the Fourth factor accounts for 8.740percent versus 7.253percent the Fifth factor accounts for 8.636percent versus 6.373percent, and the sixth factor accounts for 7.102percent versus 5.464percent in the unrotated solution.In the rotated factor solution, variables 9,13,14,18,19, and 22 loads significantly on factor 1; variables 1,4,16 and 21 loads significantly on factor 2; variables 3,15,17 and 20 loads significantly factor on 3; variables 8,10 and 12 load significantly on factor 4 and variable 6, and 11 loads significantly load on factor 5. and variable 2 and 9 loads significantly load on factor 6.Factor 1 has six significant loadings, factor 2 has four significant loadings, factor 3 has four significant loadings, factor 4 has three significant loadings, factor 5 has two significant loadings and factor 6 has two significant loadings Finally, from the analysis five summarized factors are obtained, the data through Component Factor analysis and using VARIMAX method as six factors including their subprocess.

G. Factor loading of employee's performance

Table 6 FACTOR LOADING OF EMPLOYEE'S PERFORMANCE

Sr.No.	Factor Loading Component	Value	Extracted Factor
1	Motivation and Job Satisfaction	-0.624	Working Environment
	Employee-employer relationship	0.682	
	Appreciation and rewards	0.688	
	Employee motivation	0.832	
	Work efficiency	0.784	
	Job commitment	0.687	
2	Satisfied salary	0.685	Compensation Salary and Supervision
	Increment salary	0.774	
	Special challenges	0.550	
	Constant supervision	0.747	
3	Method implementation	0.687	Work Efficiency
	Selection of candidate	0.595	
	Leadership skills	0.600	
	Training doubts	0.522	
4	Performance of employees	0.701	Training and Work Performance
	Partiality by management	0.762	
	Induction training	0.540	
5	Achieve goals	0.849	Achievements and Improvements
	Appraisal improvement	0.637	
6	Opinion performance	0.876	Performance through Motivation and Job Satisfaction
	Motivation and job satisfaction	0.561	

Source: As per the output of SPSS 20

Finally, from the analysis, six summarized factors are obtained, the data through Component Factor Analysis and using VARIMAX method as Six factors including their subprocess. Linear regression and correlation applied for analyzing the data and results found that Working Environment, Compensation Salary, and Supervision, Work Efficiency, Training and Work Performance, Achievement and improvements, performance through motivation and job satisfaction are significantly related to employee performance. The results further indicate that all determinants of employee performance systems in the pharmaceutical industry.

V. CONCLUSIONS

The employees are the strongest assets in an organization if the employees get a favourable Performance appraisal system in the organization then employees will get motivated and give the best performance to the organization. From the findings it was found that there were six factors identified namely working environment, Salary and Supervision, Work Efficiency, Training and Work Performance, Achievements and Improvements, and Performance through Motivation and Job Satisfaction.As far as the performance appraisal system is mentioned, the selected pharmaceutical industries provide their employees with several facilities, as well as the level of employee gratification with these machines is strong, which is a good symbol of the harmonious relationship between management and the results. It can be said that the company has taken majors to create a better place to work and has made attempts to find out what the employees to keep fell less satisfaction level and more satisfying level to maintain healthy working environment and work-life balance based on the study some suggestions which emerged that may prove beneficial to the pharmaceutical industry. The working environment should be a healthy work climate in the workplace that encourages wellbeing, development, and accomplishment of goals for the employees. These conditions are more favourable to a healthy workforce, as they enable workers to succeed at the highest standard. By focusing on their organizational atmosphere, promoting employee development, and making workers feel healthand secure, businesses will create a productive work climate.The management should ensure that the system of compensation is structured after taking into account such considerations as education, expertise, mind-set, and prevailing market prices. Compensation is the compensation an individual gets for the job completed within a company. The supervisor ensures that all directives are transmitted to every employee. The supervisors enable the subordinates to work to their full ability when directing the employees

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A study to investigate the nature and consequences of brand love with special reference to Northeast India

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Abstract— **Today's marketing is focused on consumers and seeks to create consumer loyalty. Research shows that satisfaction is a source of loyalty to the brand. Yet, a satisfied consumer switch brand. Brand love comes in this attempt to create brand loyalty. The relationship between consumers and brands is similar to the relationship between people or the relationship between people and nature, the universe or religions and, as such, plays a crucial role in people's lives. The objectives of the study are (1) To identify the factors that form brand love (2) To find out the impact of these factors on brand love. From the study, the factors that form brand love are identified as Current self-identity, desired self-identity, life meaning and intrinsic rewards, attitude strength, willingness to invest resources, passionate desire to use, things are done in the past, intuitive fit, Emotional Attachment, Positive Affect, Long term relationship, Anticipation separation distress, Attitude Valence, Functional quality of brand and Loyalty, Word of Mouth, Resistance to negative information. Consumers have a feeling of love for a brand when they feel or observe all of these factors in a particular brand.**

Keywords— Current self-identity, desired self-identity, life meaning, intrinsic rewards, attitude strength, intuitive fit, Emotional Attachment, Positive Affect, Long term relationship, Anticipation separation distress, Attitude Valence, Functional quality of brand, Loyalty, Word of Mouth, Resistance to negative information.

I. INTRODUCTION

One of the most valuable intangible assets of a firm is its brands, and it is incumbent on marketing to properly manage its value. Brands are essential to consumers in their everyday lives. Moreover, relationships between consumers and brands are similar to relationships between people, or relationships between people and nature, universe or religions, and, as such, play a central part in people's lives, and therefore are indispensable (Luo, 2019)

Today's marketing focuses on consumers and tries to create consumer satisfaction. Research shows that satisfaction is a source of brand loyalty. Yet, it is seen satisfied consumers switch brands. Brand love comes in this aspect to create brand loyalty.

Companies have now recognized that a feeling of love for a brand is a crucial factor in maintaining a good relationship with a customer, and brands that can make consumers love their brands are more effective in gaining competitive advantage and beating their rivals (Roberts, 2006).

Brand love appears to be one among the foremost recent and popular marketing construct (Rajeev Batra, 2012), (Carroll, 2006). In today's Marketing context, the interest in brand love has been seen to be very important which can be observed from a growing relationship between consumers and brands. A company needs to know the consumers' love towards their brand. Love is the foundation of people's lives. This includes people's love of their close ones, their love for their job, their love of religions, their love of nature, and their love of brands which are all closely related to (Luo, 2019). We have studied that love towards a brand leads to brands loyal customers, word of mouth, etc, and these factors result in the brand's goodwill and a company can maximize their profit. This study measures the love feeling for brands concerning the consumer-brand relationship. This study also identifies the factors that form brand love and the impact of these factors on brand love.

Customer's self-identity and satisfaction play a very crucial role in building the customer's love towards the brand, which leads to forming his/her loyalty towards the brand and its company. Those customers who are loyal are less likely to switch competing brands (N, 2008) and; they also spread positive word of mouth (Shirsavar H, 2012); they are not affected by bad news or publicity about the brand they love (Zhaohua Deng, 2010); these customers also help in bringing new potential customers and always willing to pay higher prices (R, 2011)and they make frequent purchases than other non-loyal customers and; these customers helps in stabling revenue of the company (Kang MS, 2007)

The definition of love has progressed beyond the context of interpersonal relationships to understand how individuals relate to brands and consumer products (Cid Gon calves Filho, 2010).In a study, Carroll and Ahuvia defined brand love as "For a particular brand name, the degree of passionate emotional attachment a satisfied consumer seems to have." It involves a passion for the brand, attachment to the brand, positive brand assessment, positive feelings in response to the brand, and displays of affection for the brand (Carroll, 2006). The idea of brand love is at the heart of all-powerful brands and is described as an effective concept that recalls the interpersonal domain (Fournier, 1998). Brand love is derived from the psychological idea of interpersonal love (J.Madden, 1988). The love of a brand by consumers is a desire and an emotional desire for a special and unique brand relationship that can help consumers develop themselves by including their brands in themselves (Luo, 2019). Consumer Brand love is primarily divided into three segments:

affection, connection, and passion, (Reev Batra, 2012). Fournier said in 1998 that consumers can experience a sense of love for a brand when they have established that feeling, and also that consumers can develop a strong association with the brands. Consumers associate personality traits with a brand that forms the foundation for building relationships (Fournier, 1998).

Nothing is fixed or static in this world except "Change"; likewise, customer's loves for brands change from time to time. Thus, now a day it is very important for marketers to know consumers and the factors that lead to brand love and the outcomes of those factors on the brand. Although some studies had been done in this context by different researchers in places, not much research is found to be done in India let alone Northeast India on brand love. Hence, this research tries to fill this research gap especially in the context of Northeast India. Northeast India is a highly opportunistic region for business with it being the gateway of India to Southeast Asia as per the Act East Policy of the Government of India. If knowledge of brands and brand love concepts can be established, then marketers would have the scope for exploiting the market of Northeast India at best. This paper will help to identify the factors that measure brand love and the outcomes of those factors on brand love with special reference to the customer-brand relationship. This paper will help marketers to get knowledge and understanding about brand love. And also gives an understanding of the market situation and will provide a basis for formulating strategic decisions.

II. CONCEPTS AND DEFINITIONS

A. *Brand Love*

According to Fournier the concept of Brand love is the rich affective reminiscent concept inside the interpersonal domain towards brands and it is the core of successful brands (Fournier, 1998). Brand love can build consumer attachment to brands and consumers may sometimes forgive the brand loved brands for some mistakes (Kiuru, 2014).

B. *Word of Mouth (WOM):*

Word of mouth refers to terms used by consumers of the product to other people to explain the product (friends, family, etc.) and words may be positive or negative. Word-of-mouth (WOM) can be defined as any positive or negative comment made to a product or business by the present, future, or former customers (Thorsten Henning- Thurau, 2004). WOM is defined as the process that encourages customers to exchange knowledge and opinions that guide buyers toward and away from particular goods, brands, and services (Kenneth A. Coney Delbert, 2004). (Kenneth A. Coney Delbert, 2004). WOM was described as an informal contact between a perceived non-profit communicator and a recipient regarding a brand, product, organization, or service, by Harrison-Walker (2001) (-Walker, 2001). The literature focuses lately on WOM as a possible reaction, which can arise from efforts to form ties with customers (Peter C. Verhoef, 2002).

C. *Satisfaction:*

It's a pleasant feeling, according to the Cambridge dictionary, that you get when you get something you wanted, or when you do something you wanted to do. People are satisfied if they get what they anticipate. Others define customer satisfaction as the customer's feeling or attitude towards the product/service after it has been used (Hansemark, 2004). In 1965 Cardozo stated that the basic perception of marketing is that customer satisfaction with the product may lead to repeated purchases, approval of product line extensions, and favorable word of mouth advertising (Cardozo, 1965). Research has focused over the last two decades on customer loyalty and retention, branding, revenues, market share, and growth (Salwa Ammar, 2008). It is therefore not surprising that organizations spend substantial resources measuring and managing customer satisfaction (M.A.A Hasin, 2001).

D. *Brand Loyalty:*

Loyal customers are those who remain loyal to the brand, and even they will pay more for the brand, always endorsing the brand. Brand loyal customers are less willing to turn to other brands and less likely to react to price increases and actively promote the brand, since they know that their brand has a unique value not offered by other competing brands, meaning that a company with truly loyal customers can have higher revenue, lower marketing and publicity costs, and a better price Oliver defines brand loyalty as a strong commitment to consistently repurchase or reassign a preferred product/service in the future, which results in repeated purchases of the same brand or product line, although situational influences and marketing strategies can cause change (Oliver, 1999). The creation and improvement of brand loyalty is therefore a priority feature of any company that wants to retain a competitive marketplace and to increase its total brand equity and market value (Ovudiu, 2011).

E. *Brand Identification:*

Brand identification is characterized as 'the degree to which the customer sees his or her self-image as overlapping the brand's image (Sternberg, 1987). Consumers prefer goods and labels not just for their utilitarian values but also for their symbolic benefits. Brands have profound importance and construct customer self-conceptions or personalities (MacCraken 1989). Consumers use brands to create themselves, pose above others, or accomplish their identity objectives (Escalas, 2003). Brands have profound importance and are intended to construct the concept or identities of consumers (Noel Albert, 2013). (Sallam, 2015). Ahuvia said that in his study, informants use objects that they like to strengthen their identity and reconcile conflicting identities. While Ahuvia does not address causality or correlation directly, his research indicates that a person likes the brand, the stronger it associates with. Ahuvia notes, for example, that an informant insists that she "love a product with her desired identity as a culturally sophisticated bohemian" (Barbara A. Carroll, 2006).

III. SCOPE OF THE STUDY

The present study has been undertaken to identify the factor that forms brand love and the impact of those factors on brand. This study also helps in understanding the decision-making process of purchase. In today's competitive market acquiring knowledge about the factors that form love towards the brand is very important for the growth of the

company and to increase the revenue. Marketers can apply such considerations in their brand strategies.

IV. OBJECTIVES

In today's context, the phase of marketing strategies has varied. In this phase of the competition, the need for expensive marketing strategies is of utmost importance, with this the difficulty of decision making in the marketing strategies framing process is related. A sound decision making requires thorough knowledge and understanding of the consumer's needs and wants and a study of the consumer's attitude and behavior towards different products and brands. This study attempts to provide an understanding of the consumer behavior and consumer's choice for different brands, the reason for buying a specific brand, and lays down the way for carrying out further research in this area. The main objectives of the study are (1) To identify the factors that form brand love and (2) To find out the impact of these factors on brand love.

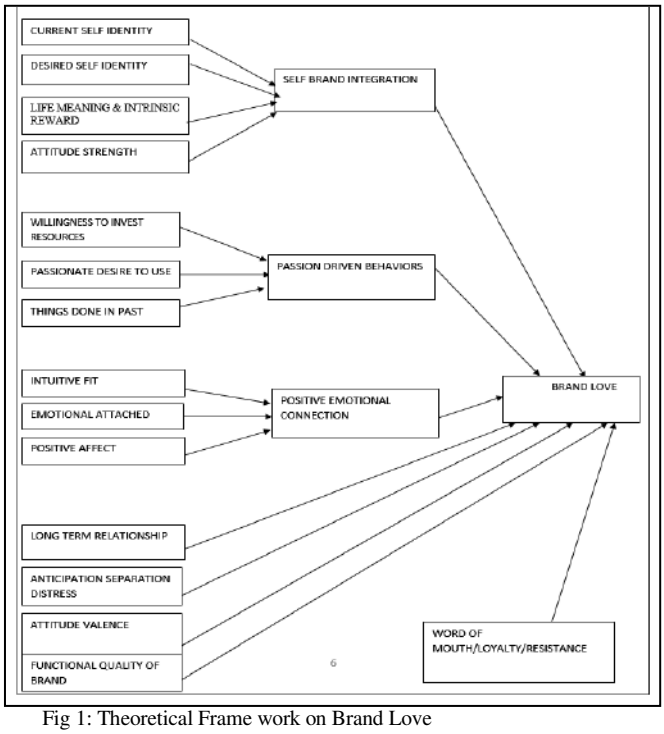

Fig 1: Theoretical Frame work on Brand Love

V. RESEARCH METHODOLOGY

Descriptive research design has been used to obtain information concerning the current status of the phenomena (Fig 1) and to describe "what exists" concerning variables or conditions in a situation whereas exploratory research design was used for gaining background information on a particular topic, a survey method using structure questionnaire is used for data collection. Data was collected through a survey of 320 millennial respondents using both online and printed form who were asked to rate the factors which show their love feeling for brands.

A. Research Instrument

A structured questionnaire consisting of fifteen items each of Current self-identity, Desired self –identity, Life meaning, and intrinsic rewards, Attitude strength, Willingness to invest resources, Passionate Desire to use, Things done in the past, Intuitive fit, Emotional Attached, Positive Affect, Long term relationship, Anticipate separation distress, Attitude Valence, Functional quality of brand and Word of mouth/ loyalty/ Resistance (Fig 1). The items were measured by using 7 points Likert scale to attain the degree of agreement or disagreement. The respondents were asked to rate each item on the Likert scale from 1= Not at all to 7= very much. A reliability test was conducted to ascertain the reliability and validity of the questionnaire.

VI. DATA ANALYSIS

Data were analyzed with SPSS Version 25.0. An analysis of descriptive statistics was conducted to illustrate the demographic and other selected characteristics of the respondents.

TABLE I. RELIABILITY STATISTICS OF THE VARIABLES:

Measures	Number of Items	Cronbach's Alpha
Current self- identity	2	.904
Desired self- identity	2	.914
Life meaning and intrinsic rewards	2	.924
Attitude strength	2	.836
Willingness to invest resources	2	.865
Passionate Desire to use	2	.859
Things done in the past	2	.750
Intuitive fit	2	.753
Emotional Attached	2	.687
Positive Affect	2	.774
Long- term relationship	2	.759
Anticipation separation distress	2	.799
Attitude Valence	2	.918
Functional quality of brand	3	.872
Loyalty/Word of mouth/Resistance	4	.794

To determine the reliability of the Questionnaire for this study Cronbach's Alpha Technique was utilized. These values support the internal reliability of the questionnaire because the calculated results for Cronbach's alpha are more than 0.7 hence the statistic of the respective emergent factors was found to be reliable. Hence the questionnaire i.e. being used for the survey is reliable (TABLE I).

The demographic and selected characteristics of the study population are shown in Table II. Among the sample of 320 respondents,60.9% of respondents were Graduates, 22.5% were 10+2 passed, 15% were post Graduates, .6% were 10th passed with the least percentage of the respondent and .9 % were from other categories. Out of 320 respondents, 72.2% of respondents were female and 27.8% were male respectively

TABLE II. DEMOGRAPHIC PROFILE

		Frequency	Percentage
Education Qualification	Class 10th	2	.6%
	10+2	72	22.5%
	Graduation	195	60.9%
	Post	48	15%

	Graduate		
	Others	3	.9%
Gender	Male	89	27.8%
	Female	231	72.2%

A. Measurement Model(Fig 2)

TABLE III. THE FIT VALUES BEFORE AND AFTER MODIFICATION

Goodness of fit index	Before modification	After modification	Acceptable fit
			Absolute fit
Chi-square ($X^{2)}$ = CMIN	174.669	170.268	
Degree of Freedom (df)	509	458	
Chi-square(X^2)/ DF	3.35	2.432	1-5
GFI	.717	.901	0.90= GFI=0.95
AGFI	.678	.872	0.85=AGFI=0.90
RMSR	.076	.082	0.05=RMSR=0.08
RMSEA	.072	.074	0.05=RMSEA=0.08
		INCREASING FIT VALUE	
CFI	1.000	0.96	0.95=CFI=0.97
NNFI=TLI	7.501	0.921	0.95=TLI=0.97
NFI	.707	0.956	0.95=NFI=0.97

Note: All these values are within the acceptable range of fit. NNFT and NFT values being between 0.95+ TLI+ 0.97 show a relatively good fit (Hu.L & Bentler, 1999)

(GFI= Goodness of Fit Index, AGFI= Adjusted Goodness of Fit Index, RMSR= Root Mean Square Residuals, RMSEA= Root Mean Square of Approximation, CFI= Comparative Fit Index, TLI =Tucker –Lewis Coefficient, NFI= Normal Fit Index)

Chi-square test, tests the difference between the observed data and the estimated data. This value is expected to be close to 0, However, in the case of large sample size, the degree of freedom is an important criterion. Chi- square (X2)/ DF ratio's being 5 0r less than 5 shows an acceptable fit between the model and sample data (L.Arbuckle, 2012). In this research, this ratio is found to be 2.432. This shows the existence of a very good fit between the datum and the model. T value, regression, and reliability coefficients of the variables are shown in TABLE III

TABLE IV. RESEARCH VARIABLE (FIG 2)

LATENT VARIABLE	OBSERVED VARIABLE	ESTIMATION	S.E	T.VALUE	S.R.C
Current self-identity (CSI)	To what extent do you feel that this brand says something true and deep about whom you are as a person	.830	.086	15.460	0.541
	To what extent do you feel that….This brand is an important part of how you see yourself?	.870			0.639
Desired self-identity (DSI)	To what extent is the brand can make you look like you want to look?	.980	.931	14.625	0.638
	To what extent is this brand can make you feel like you want to feel?	.880			.682
Life meaning and intrinsic rewards (LMI)	To what extent is this brand can do something that makes your life more meaningful?	.760	.765	14.352	.652
	To what extent this brand can contribute something towards making your life worth living?	.860			.571
Attitude strength (AS)	To what extent do you find yourself thinking about this brand?	.896	.84	16.41	.682
	To what extent do you find that the brand keeps popping into your head?	.92			.861
Willingness to invest resources (WIR)	To what extent are you willing to spend a lot of MONEY improving and fine-tuning a product from the brand after you buy it?	.830	.67	14.75	.781
	To what extent are you willing to spend a lot of TIME improving and fine-tuning a product from the brand after you buy it?	.740	.76	12.84	.72
Passionate Desire to use (PDU)	Using the products: to what extent do you feel yourself desiring to buy this brand?	.670	.82	14.64	.571
	Using the products: to what extent do you feel yourself longing to buy this brand?	.660			.452
Things done in the past (TDP)	To what extent have you interacted with this brand in the past?	.830	.79	15.82	.652
	To what extent have you been involved with this brand in the past?	.680			.632

Intuitive fit (IF)	To what extent do you feel there is a natural fit between you and your brand	.860	.78	15.365	.810
	To what extent do you feel your brand seems to fit your own tastes perfectly.	.680			.574
Emotional Attached (EA)	Please express the extent to which you feel emotionally connected to your brand?	.860	.685	13.121	.761
	Please express the extent to which you feel a bond with your brand.	.980			.863
Positive Affect (PA)	To what extent do you feel that your brand is fun?	.810	.683	11.621	.738
	To what extent do you feel that your brand is exciting?	.930			.853
Long-term relationship (LTR)	Please express the extent to which you, believe that you will be using your brand for a long time	.720	.82	13.521	.81
	Please express the extent to which you, expect that your brand will be part of your life for a long time to come.	.830			.793
Anticipation separation distress (ASD)	Suppose your brand were to go out of existence, to what extent would you feel…Anxiety (an uncomfortable feeling of nervousness or worry)	.840	.75	12.536	.766
	Suppose your brand were to go out of existence, to what extent would you feel…Apprehension(worry about the future, or a fear that something unpleasant is going to happen)	.690			.562
Attitude Valence (AV)	On the following scales, please express your overall feelings and evaluations towards your brand (Negative-Positive	.880			.862
	On the following scales, please express your overall feelings and evaluations towards your brand (Unfavorable – Favorable)	.980	.786	12.361	.862
Functional quality of brand (FQ)	I believe the products of my brand… have a functional quality	.860	.682	16.325	.876
	I believe the products of my brand… are practical	.840	.782	18.12	.763
	I believe the products of my brand…are well made.	.970			.881
Loyalty /Word of mouth/ Resistance (WLR)	How would you describe your loyalty towards your brand?	.870	.785	15.638	.782
	If you were shopping again for this kind of product/service, would you?	.790	.8742	16.106	.669
	If you heard something bad about your brand, to what extent would you question these statements, in your mind?	.870	.852	19.425	.748
	How often have you found yourself saying positive things about your brand, to other people?	.840			.724

B. Structural Equation Modelling

The measurement model links between latent variables to the manifest variables. In this model, there is a total of 9 latent variables with a total of 33 manifest variables (Fig 2).

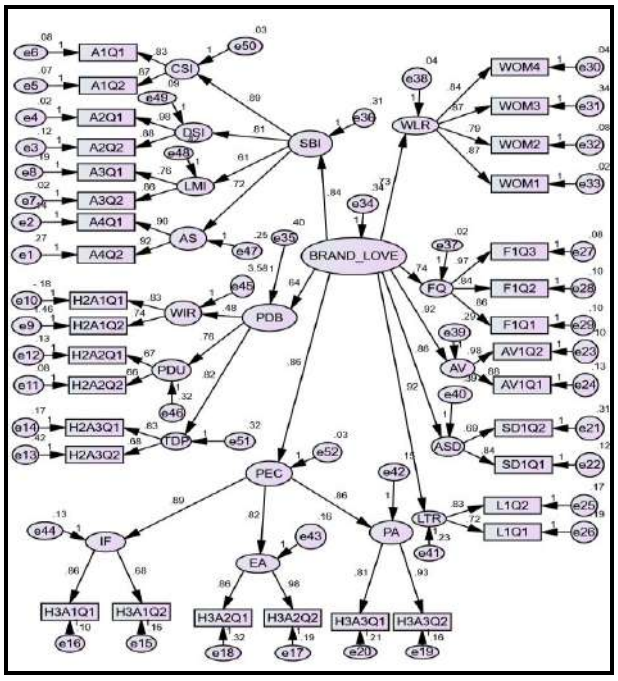

Fig 2: Structural Equation Modelling

VII. FINDINGS AND DISCUSSION:

From the research, factors that form the brand love is identified as Current self-identity, desired self-identity, life meaning and intrinsic rewards, attitude strength, willingness to invest resources, passionate desire to use, things done in the past, intuitive fit, Emotional Attachment, Positive Affect, Long term relationship, Anticipation separation distress, Attitude Valence, Functional quality of brand and Loyalty, Word of Mouth, Resistance to negative information (Fig 3). Consumers have a love feeling for a brand when he/she feels or observe all these factors on a particular brand. From the table, we can see that there is a positive impact of these factors on Brand Love. Brand love is dependent on all these factors. Brand love is formed when a customer feels all these factors regarding a brand (Fig 3).

When a brand says something true & deep about who you are as a person and plays an important role in how you see yourself (self-identity) it leads to Brand love i.e., when a brand can make you look and feel the way you want to look and feel then the desired self-identity factor is fulfilled (Fig 3). Life meaning & intrinsic rewards factor is established only when a brand can do something that makes customer life more meaningful and also the brand can contribute something towards making his/her life worth living.

It is now understood that when a brand can force you to think continuously about that brand then an attitude strength is developed. The construct "willingness to invest resources" calculated a low mean. The reason is that those customers who have brand love for mobile phones, two-wheelers and four-wheelers only responded positively to this factor. Those who have a love for clothes, shoes, cosmetics, etc. do not want to invest after buying the product. This is an important observation as this might imply that depending on the product category and buying behavior the factors affecting brand love might vary which warrants further research.

It has been found that when a customer feels himself desiring and longing to own a particular brand, the brand is placed in the mind of the customer which indicates love for the brand and that the customer is passionate to use the brand (Fig 3). Moreover, it can be seen that the customer has been involved and interacting with the brand in the past continuously because they feel love for the brand, and when a customer feels that the brand naturally fits with his image & tastes perfectly then brand love can be established automatically (Fig 3).

Creating strong emotional connections between consumers and brands can be seen as an important objective in the market today. (Thessaloniki, 2012). The study shows that the client has a very positive emotional attachment when he feels emotionally linked and has a positive link to a brand. When a brand has a 'positive effect on the brand,' customers have fun and excitement.

It has been found that when a customer utilizes a brand for quite a while and expects that the brand will be a part of his/her life i.e., the customer has a drawn-out relationship with the brand, he/she shows positive brand love. Besides, the finding demonstrates that when the customer feels awkward, stressed, and horrendous when the brand leaves presence shows good brand love.

It is interesting to note that a positive & favorable attitude leads to brand love. Furthermore, Brand love is also dependent on the quality (durability, comfort, practicality) of the brand (Fig 3).

If a customer is faithful to a company, positive words of mouth rise and negative opposition decline, with current loyal customers contributing to improved brand image (Fig 3). This finding confirms previous studies, which show that consumer confidence in a brand increases their resistance to negative brand information.

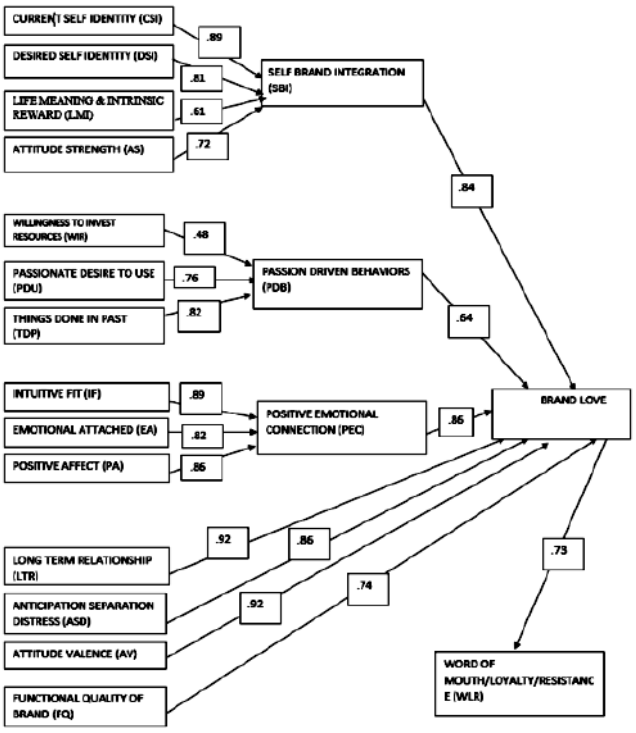

Fig 3: Brand Love Model

VIII. CONCLUSION

To maintain a good customer relationship, it is very necessary to feel love for a brand. Now a day, to create goodwill and maximize the sales of a particular product brand, it is important that you have a love for the client. A good relationship with a brand can only be established when customers have a love for a brand, and when customer expectations are satisfied with that brand, their love is formed. If a client is in love with a brand, he/she emotionally attaches him/her to this specific brand, which leads to a long-term relationship. This study identifies factors that shape brand love and tries to detect the impact of those factors. It confirms previous literature findings that consumer price premiums can be paid for some brands, and these brands continue to be preferred for a long time (Marc Fischer, 2010). A new customer is more expensive than keeping a current one. So companies rely on their brands to keep their consumers (Merve U Turgut, 2015)

Managers have to take into account a love relation with a brand. They should still strive to make a deep connection of love between their brand and consumers as much as possible. For instance, they might attempt to incorporate goods that are similar to customers or that are linked to their personality. Businesses can strive to improve their offerings to help consumers feel the way they want to feel.

If the consumer has a sense of affection for the brand, he or she is suggesting, appealing to, and behaving in favor of the brand to others (friends, families, relatives...). Therefore, the brand love factor can be concluded to yield positive results for the brand. Therefore, in today's market, it is very important to understand customers regarding their purchasing habits, decision, and perception of brand love.

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Influencer Marketing in Social Media context

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***Abstract*— The expansion of the use of social networks and surge in user-driven content has shifted the power and credibility of voice from organizations to individuals. Today's influencers broadcast their opinions and share their experiences via Instagram, Twitter, Facebook, YouTube and other social media services.**

Marketing professionals worldwide are looking for more effective forms of communication and are interested in understanding the new and evolving digital media landscape. They are trying to understand how this new marketing opportunity may align with their overall brand strategy. As per Forbes magazine, currently the leading trend in marketing is influencer marketing. The purpose of this paper is to examine the concept of influencer marketing in a social media context.

Keywords— marketing, influencer, social media, Instagram, YouTube, Facebook

Introduction

It is estimated that in 2020 there are around 3.6 billion people using social media around the world. The number of uses is expected to increase to 4.41 billion in 2025. The use of social media platforms and websites to promote a product or service and to establish a connection with its customers has increased due to the growing active user rates on social media sites.

The most popular social networking services based on the number of active users are Facebook, YouTube, WhatsApp and Instagram. Currently Facebook has 2.2 billion users, Instagram has 800 million users and Twitter has 330 million users. The use of social media put consumers on the position of spreading opinions, sharing experience, and has shifted power from organization to consumers, as it allows transparency and different opinions to be heard.

Social media personalities (or influencers) have been employed by marketers to promote products online. The purpose of this paper is to explain the concept of Influencer Marketing in a social media context by throwing light on the rise of this powerful marketing tool.

I. INFLUENCER MARKETING

A. What is Influencer Marketing

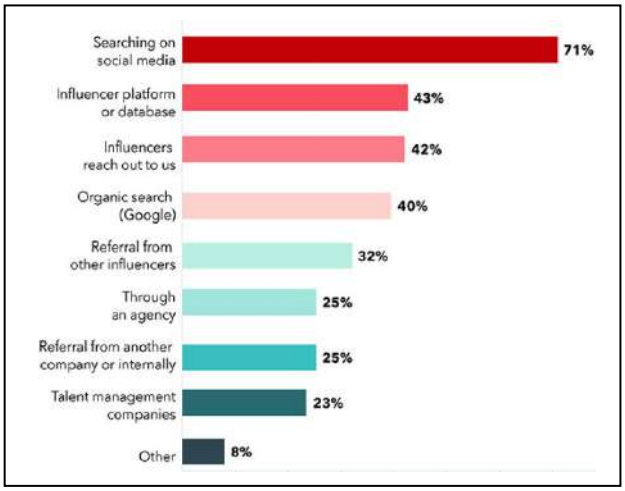
An 'influencer' is any person (personality, blogger, journalist, celebrity) who has the ability to affect the opinions, behaviors or purchases of others through the use of social media. The practice of employing social media personalities to market a product or service is referred to as Influencer Marketing.

Too much information on social media can quickly cross users' cognitive limits in processing news and can make them feel overwhelmed and overloaded. Hence consumers listen to the recommendation of someone they trust who is believed to be competent and reliable. Many corporates are working closely with the influencers to create brand awareness and adoption for their own brand.

Examples of influencer marketing include:

- Sponsored Instagram posts or stories.
- Sponsored blog posts.
- Sponsored offline event with an influencer appearance
- Other sponsored social media marketing posts

B. How do companies find influencers to partner with?



Source: www.mediakix.com (2019 Influencer Marketing Survey)

C. Categories of Influencer Marketing

Influencers may be categorized by the number of followers they have on social media.

a) Nano-influencers – with less than 10,000 followers. They may be ordinary people like our friends and family members.
b) Micro-influencers – with less than 100,000 followers. They may be known as industry expert or specialist in a niche market.
c) Macro-influencers – with 100,000 to 1 million followers. Few of them may be celebrities.
d) Mega-influencers – with more than 1 million followers. They are major public figures or celebrities.

II. EVOLUTION OF INFLUENCER MARKETING

Phase 1- The Pioneer

Marketers have leveraged the power of influential people since the 18th century. We can recall the example of Josiah Wedgwood, a potter who made a tea – set for Queen Charlotte, the wife of King George III. In that era the royalty was the ultimate influencer. Hence Wedgwood started marketing his products as 'Queensware' a luxury brand. This resulted in huge demand for his wares.

Phase 2 – Fictional Characters

There were only a few brands on the market in the early 20th Century. Hence, to trigger the purchase decisions of consumers emotionally, fictional 'personas' were created by the brands of this market. One of the most popular characters in the history of influencer marketing is Santa Claus. Santa was a creation of Coca-Cola company to promote their beverages. Tony the Tiger was another character created by Kellogg's to promote their cereals. They were not called 'influencers' but they had a similar impact on the consumers for Coca-Cola or Kellogg's brands.

Consumers had very few choices of brands in that era. Hence it was easy to make a buying decision. However, later the variety of products also increased.

Phase 3 – Celebrity Endorsement

Increase in choice of products meant that the buyer's decision making had also changed. The fictional characters were not sufficient any longer to convince a consumer during the decision-making process. A greater inducement was needed.

Compared to fictional characters, celebrities are real people who have real preferences and mass followings due to their fame. Hence, they have the ability to convince consumers to buy the products that they endorse. Due to these reasons, the major brands started using celebrities to promote their products.

The brands strategy used celebrities in the similar way like influencers do today. However, consumers couldn't always relate to their glamorous lifestyles. Hence the promotions by celebrities became less effective.

Phase 4 – Reality TV

The television genre of Reality shows emerged in the early 1990s. These shows involved unscripted real-life situations starring unknown individuals. This genre achieved considerable success in the early 2000s with series such as Survivor, Big Brother and American Idol. Many of us are drawn to the personalities on reality television. These stars are perceived as more relatable and authentic than traditional celebrities because these shows have the basis of portraying 'reality'.

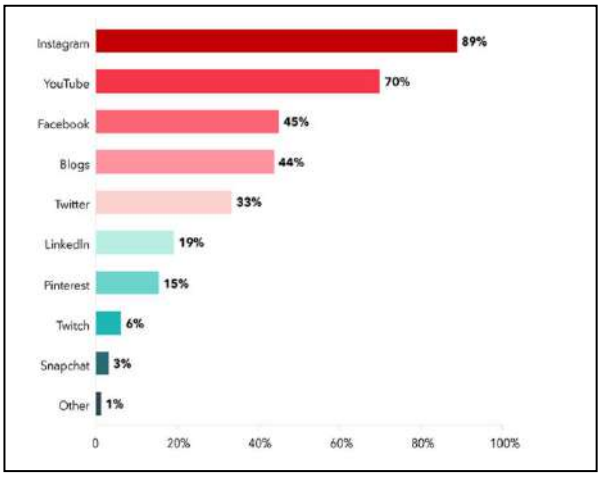
By 2006, reality shows were most popular among teen-age audiences. Due to their overnight fame and heightened engagement from viewers, reality TV personalities led the way for what was to come with social media.

Phase 5 – Development of Social Media

Social media are digital technologies that facilitate the creation or sharing of ideas, thoughts and information through the building of virtual networks and communities. Users access the social media services through apps on their mobile phones or computers. Let us take a look at the three most popular platforms.

a) In 2004, a Harvard student named Mark Zuckerberg launched Facebook, the social media and social networking service. Facebook had 500 million users by 2010 which rose to 70 billion monthly active users as of June 2020.
b) In 2005, the online video sharing platform YouTube was created. YouTube is used by major brands and also individuals to grow audiences. People share their talents and hobbies on the platform. There are currently around 2 billion YouTube users every month in 80 different languages as per YouTube CEO Susan Wojcicki.
c) In 2010, Instagram, the photo and video sharing social networking service was launched and rapidly gained popularity, with one million users in two months, 10 million in a year, and 1 billion as of June 2018.

These social media channels are most important for Influencer Marketing -



Source: www.mediakix.com (2019 Influencer Marketing Survey)

Due to their pre-existing popularity, many celebrities have huge followers on social media. However, many 'ordinary' people posted interesting content and started interacting with their followers. They also started attracting large number of followers. These 'ordinary' people were able to influence the brand preference and purchase decisions of their followers and were called 'influencers'.

Influencers are more similar to ordinary consumers as compared to the larger-than-life celebrities. They post

relatable content about the good, the bad, and the ugly in their lives. This has resulted in a high level of trust by their followers.

Marketers soon realised that they could increase sales by asking these influencers to post about their products. They started sending them free products and even paying for their influence. This tactic eventually became the influencer marketing industry we know today.

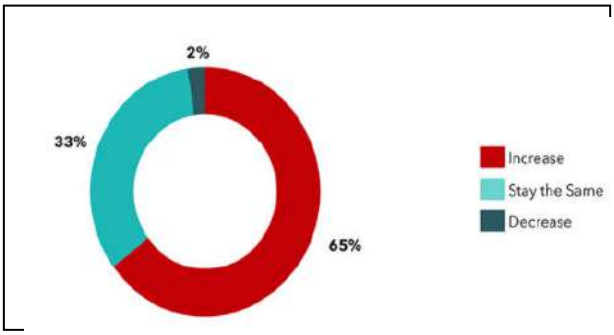
Phase 6 – Rise of Influencer Marketing

As anyone can now create online content via social media, this has led to information overload. As per the Global Web Index, 40% of internet users now use ad-blocking software also. This means a big chunk of consumers don't even see the ads brands pay for. These developments increasingly forced marketers to a value-centered marketing and change their strategy from push to pull. Hence, working with influencers provides an effective solution, as consumers learn about products through content that is native to where they already are — social media.

In 2019, we reached the peak of influencer marketing. As per a recent survey,

- 92% of consumers trust recommendations from friends, family, and influencers
- 70% of teens trust influencers more than traditional celebrities
- Influencer marketing earns 11 times the ROI of a standard digital campaign
- 74% of people use social media to discover products and make purchasing decisions
- 62% of marketers work with influencers to generate content.

Marketers planned to increase their budget for Influencer marketing in 2019 –



Source: www.mediakix.com (2019 Influencer Marketing Survey)

III. FUTURE DIRECTIONS

In 2020, due to lockdowns, social distancing and travel restrictions on travel imposed by the pandemic, television commercial shoots were also stopped. it was necessary for most businesses to move from physical realm to digital. The consumers were stuck in their homes and searched online for learning new skills, to manage their anxiety and self-care. This was a golden opportunity for brands to communicate to this audience via influencers.

Anuja Deora, CEO of the digital marketing agency Filter Coffee Co. has predicted the rise of Micro & Nano influencers due to their authenticity and low-costs, as many brands have slashed marketing budgets due to the pandemic. Influencers are able to display the usage and benefits of skincare and cosmetics brands via short video content. As per Anuja, these influencers engage more consumers who cannot visit stores and try the product.

Influencers can no longer promote a brand by clicking a selfie with the product, as per Neel Gogia, Founder, IPLIX Media. Hence both brands and influencers will create engaging content by exploring creative content together. Brands will use data analysis to get information about the consumers and this will allow influencers to create content with deeper impact.

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Leadership Style & Employee Engagement Dynamics in B-School

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Abstract— *A Leader can sometimes prove to be a Ladder for organization success. A Ladder which shows the path from bottom to top and be a support to cover the path efficiently .Looking at the modern Industry trend, Employee Engagement has become the urgent need for a successful organization which helps gain competitive advantage and increased productivity at work place. Leadership style is base for many research endeavors but with a combination of "Employee Engagement in Education Sector like Business School", the area still needs to be ploughed deeper. The Study asserts to explore the relationship between two variables namely; Leadership Styles of Leader's and Employee Engagement Levels of academicians' in B-Schools. As is rightly said, "employees leave the immediate supervisor and not the organization", indicates Implication of Leadership Style on Employee Engagement in Education Sector.*

Keywords— Leadership Style, Employee Engagement, B - Schools

I. CONCEPTUAL FRAMEWORK

Today's era is marked by the presence of leaders who have clarity of vision, consistent passion to make vision a reality, the persistence to plan and implement and inspire their team members. Leadership is said to be an Art, an art of influencing people, an art of inspiring members to achieve set goals, an art of developing skills in them, an art of making them face challenges & overcome obstacles, an art of making them realize not to resist change rather focus on surviving it.

Leader does not influence under any coercion but they have possessed authority to command their followers in right direction and channelize their energies to achieve organizations vision and goals. Being a Leader is not just an art but a skill to grow people's trust & commitment to pursue achievement of tasks at all levels.

A. Leadership Style

A Leader's Leadership style is the behavior felt and observed by their employees under different circumstances. A Leaders style reflects a lot about their personality like Attitude, Value system, skill set, perception, etc. A situation of crisis enables a manager to climb new heights of being a good leader. This refers to switching from current state of working to a future desired state.

B. Employee Engagement

Various research surveys had been conducted to know the rate of employee engagement in different company's and the result shows great variance in percentage of least and most engaged employees for different firms. Employee Engagement affects and is affected by the thought process of employee, their perception towards their leader and organization as a whole and their capability to achieve organizational goal effectively. Engaged employees feels an emotional connect with the organization that acts as a driving force to perform with more enthusiasm.

For achieving the organization's objective it's needed for the work force to contribute maximum towards goal fulfillment and to make employees' achieve the goal fully it is essential to make them aware about organization vision, mission and their contribution in converting vision to reality. This stage of making employees realize their worth for the organization and treating them to be valuable asset, calls for the presence of a Leader, who not only ensures work done with full efficiency and effort along with optimum resource utilization but also ensures timely completion of task, assuring the employees to be fully involved in work at work place. Different authors categorized Employee engagement levels in organizations. The most popular among them is Gallup who quoted Engagement levels as Engaged, Not Engaged and Actively Disengaged.

C. B -Schools

Education is a very important need that contributes in constructive learning in humans' life and is a basic right for every human being. An institution, whether private or public which trains and teaches art of working in a business administration and operate in commercial organization along with granting a formal Master's degree in any business related subject like management ,commerce, economics, etc., is said to be a Business School. The history of business education accounts to indefinable sense of balance between business and society.

In the beginning of fifties, business education was something similar to occupational training as compared to science. Some B-schools offered courses on basic bookkeeping and some others offered courses on baking practices in their syllabus. In 1959, some of the B School foundations criticized them on their lacking concern for scholars. So these foundations offered such schools certain grants to reinvent business education with greater obstinacy and academic depth. Carnegie-Mellon, Harvard, MIT and the University of Chicago were the centers of excellence those were initially funded with Economics highlighted as core scholarly discipline. Then the field of management education took flight by promoting its staff on academic front with scientific roots and developing analytical approaches, academic respectability along with practical exposure.

In the era of Digitalization where Google quotes its mission statement as "organizing the world's knowledge," and where Internet permits remote learning, a new era has emerged where learning seeks no school but only internet teaches them all.

Business schools are just one of the various knowledge hubs that are serving learners across the globe. B schools are thought of imparting skills to rationally deal in inconsiderate situations with a reductionist mindset and be able to survive in odds with an innovative approach, sometimes leading and at other time just following the planned way.

II. Literature Review

Leadership is defined as "elements present in group and comprising a personality" [1]. "Leadership involves, a Leader who acts as manager or supervisor by virtue of authority, being responsible for influencing people who are a part of his team"[2]. A Leader must maintain Cordial relationships with subordinates. Such relationships prove advantageous for Leader, followers and organization in long run" [3] [4].

"A leader may follow different styles of Leading with time, wherein a few styles prove to be successful while the rest like Laissez-Faire Leadership may prove to be negatively affecting the leaders because it does not even follow transactional approach or participative approach. Hence, decisions are not timely taken, rewards are not ensured & motivation and Satisfaction are unknown terms for such Leaders"[5]. Reference [6] supported Alderfer's Model to Transformational Leadership by stating, "Leader need not follow the Hierarchy of Needs" .They may change the order of Needs as and when the situation demands. Thus Such Leaders can bring about a change in group as well as organization at large scale. "A Leader with Transformational skills brings about high order changes like extensive shift in outlook, philosophy, ideals and needs. They motivate subordinates with great effort and communicate them vision and make subordinates connect to it" [7] [8].

Reference [9] asserted that a "Leader shall motivate and try building commitment in employees to successfully implement business strategies, gain edge over competitors, and fully utilize human capital in organizations". Reference [10] quotes "change to be a mediating variable that contributes in framing Leadership studies".

Literature supports the view that Leadership Style may differ across regions but the conception of Leaders affecting thoughts and senses of others is all-pervading"[11]. Reference [12] and [13] defined Engagement in job as opposite to burnout, because "Engagement is a state of mind which is constructive, rewarding and is characterized by 'Vigor', 'Dedication', and 'Absorption'. Reference [14] states Employee Engagement as: "Physical, cognitive, emotional and psychological association of employees to their job role and performance in organization. It assures physical and psychological well being at work place.". The organizations must focus on engaging employees so that the core values and vision of the organization can be realized, which requires a two way relationship between Leader and subordinate. People tend to prefer organization where engagement is a priority" [15] .Transformational leaders have direct impact on engagement levels of their employees and are efficient in meeting human needs in an empowering style" [16].Research studies conducted by reference [14], [17] revealed that "Initially there existed two dimensions of Engagement namely; Cognitive (here employees know his role and organization's mission) and Emotional commitment (here employees have a connection at work place and a sense of belongingness prevails)". "Employee Engagement is also associated with different HR aspects like customer contentment and faithfulness, employee efficiency, job security and employee turnover along with meeting profitability criteria"[18].

"Engagement promotes Psychological well being of employees which is significant driver of engagement and is in linear correlation with performance" [19] [20]. "Engagement crosses the hurdle of just being satisfied and committed. To be fully engaged is to be engrossed and be passionate about one's work" [21]. The belief that 'links superior performance with higher pay' is no more valid today until the engagement doesn't exist [22].

A business school evokes a magical atmosphere of magic which claims radical transformations in student's life. The business school seems glamorous in a developing economy like India where the media catches attention by showcasing salaries that business school graduates are offered after graduation. "A business school transforms student's capacity to contribute to big world and earn higher salaries without letting them face rejection which is more of an assumption than truth"[23] .

"There exist lot many Business Schools across nation and cross borders. Some tend to be autonomous; a few others to be universities, Government Colleges or University Teaching Departments and some are Standalone Institutes if one talks about Management Institutes. IIMs come at the top in terms of receiving management education and turning up to high placements . IIM's are regarded as institutions with excellence, in regards to higher education in India. Several components like fee structure, teaching pedagogy, course curriculum and programme outcomes, mirror the organizational forms of business"[24].

Reference [25] found that "In service organizations, leadership style directly affects employee engagement which lay an impact on service orientation of employees. Thus employers who assure transformational leadership style in their organization are more engaged and service oriented".

III. Methodological Approach

"Leadership Style & Employee Engagement Dynamics in B-School" asserts to understand the relationship between two variables namely; Leadership Styles of Leader's and Levels of Employee Engagement of academicians' in B-Schools. Data is collected from B-School Academicians with the help of Scales namely; MLQ and Gallup Q_{12}. Sample has been collected from B –Schools of Madhya Pradesh, India .

Madhya Pradesh is an emerging state in terms of higher education facilities. In a, tenure of 10 years the state witnessed outstanding growth in terms of growing market for various opportunities across nation. From getting a hat trick in being Smart city to being the only city that has an "Indian Institute of Technology (established in 2009) and Indian Institute of Management (established in 1996)" both, Indore

proves to be a populous education hub in central India. State has strong educational infrastructure including 218 Management Institutes of National Repute.

Using Stratified Random Sampling Method, data has been collected from 401 Academicians of B-Schools across Madhya Pradesh. Two popular measurement criteria namely Multifactor Leadership Questionnaire (MLQ) and Gallup Q_{12} Scale is used to measure Leadership Styles and Employee Engagement. The responses from academicians' were recorded and tabulated in a master sheet and statistical tool namely Correlation and Regression Analysis is applied to draw logical conclusion. Statistical Package of Social Sciences (SPSS) software has been used to analyze data and obtain test results.

IV. Hypothetical Framework

Ho1	There is no significant difference in between Levels of Employee Engagement with respect to academicians' of B –Schools.
Ho2	There is no significant relationship between Leadership Styles and Employee Engagement in B-Schools.

V. Analysis and Result

A. *Level of Employee Engagement with respect to Academicians' of B –Schools*

H_{o1}: There is no significant difference in between Levels of Employee Engagement with respect to academicians' of B –Schools.

H_{11}: There is significant difference in between Levels of Employee Engagement with respect to academicians' of B –Schools.

TABLE I. ANOVA Table

Table 1	**Analysis of Variance in between Levels of Employee Engagement with respect to academicians' of B –Schools**				
	ANOVA				
Employee Engagement Level	***Sum of Squares***	***df***	***Mean Square***	***F***	***Sig.***
Between Groups	3764.919	2	1882.46	39.56	0.00
Within Groups	18939.026	398	47.585		
Total	22703.945	400			

TABLE II. Descriptive Statistics

Table 2	**Descriptive**			
Employee Engagement Levels	***Frequency***	***Percent***	***Valid Percent***	***Cumulative Percent***
Engaged	78	19.5	19.5	19.5
Not Engaged	241	60.1	60.1	79.6
Actively Disengaged	82	20.4	20.4	100
Total	401	100	100	

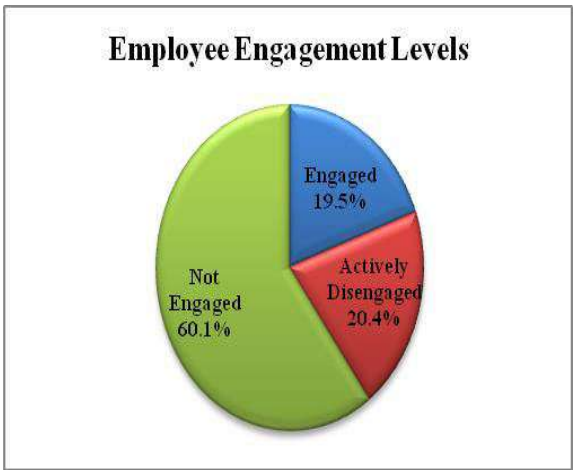

Fig1. Employee Engagement Levels

The data collected from 401 B-School Academicians was analysed via ANOVA test statistic to identify difference in Levels of Employee Engagement. The results shows the difference in Engagement at different levels (Fig.1) like 60.1 % of Academicians are Not Engaged in B-Schools, 20.4% are Actively Disengaged and only 19.5 % of total Academicians' in B –Schools are Engaged .The result shows incidence of difference in Employee Engagement at diverse levels. Thus, Alternate hypothesis stating "H_{11}: There is significant difference in between Levels of Employee Engagement with respect to academicians of B – Schools" gets accepted.

The result shows incidence of difference in Employee Engagement at diverse levels. Probable reasons can be difference in capabilities of individuals, unique working style and experience in dealing with variety of tasks that gives preference to a few and keeping other academicians on back foot of working.

Some authors conducted Employee Engagement study and revealed that "disengaged employees detach themselves from their job roles and withdraw cognitively and psychologically" [26]. Engagement level of employees can be predicted by understanding employee's emotions that are disclosed as "a feeling which attracts them to their work and make them inspired by their work such as "I want to do this", "I am dedicated to the truly engaged success of what I am doing" and "I love what I am doing". Employees use such statement expressing their feelings of commitment, contentment and fascination" [27].

B. *Relationship between Leadership Style and Employee Engagement in B- Schools*

H_{o2}: There is no significant relationship between Leadership Style and Employee Engagement in B-Schools.

H_{12}: There is significant relationship between Leadership Style and Employee Engagement in B-Schools.

TABLE III. CORRELATION ANALYSIS

Table 3	Correlation Analysis between Leadership Style and Employee Engagement	
	Correlation	
Leadership		*Employee Engagement*
Overall Leadership	*Pearson Correlation*	0.501
	Sig. (2-tailed)	0.00
	N	401
Transformational Leadership Style	*Pearson Correlation*	0.528
	Sig. (2-tailed)	0.00
	N	401
Transactional Leadership Style	*Pearson Correlation*	0.338
	Sig. (2-tailed)	0.00
	N	401
Non-Transactional Leadership Style	*Pearson Correlation*	-0.217
	Sig. (2-tailed)	0.00
	N	401

Correlation test statistic is applied to assess the relation between two key variables namely Leadership Style and Employee Engagement in B-Schools. Leadership Style is assessed primarily on Overall Leadership Score of a Leader and different Styles namely; Transformational Leadership Style, Transactional Leadership Style and Non-Transactional Leadership Style.

The table depicts p value to be 0.00 which is less than 0.05 which denotes Leadership Style and Employee Engagement has statistically significant linear relationship wherein both variables are positively correlated, which denotes that Leadership style affects Employee Engagement and both variable are allied positively.The magnitude of relation between Overall Leadership and Employee Engagement is 0.501.

Out of three Leadership Styles, Transformational Leadership Style is most significant with highest coefficient value of .528 whereas Non-transactional Leadership style follows negative relation with Employee Engagement denoting r value of -0.217.Thus, alternate Hypothesis is accepted "H12: There is significant relationship between Leadership Style and Employee Engagement in B-Schools".

A study on "The impact of leadership style on organisational productivity & employee's motivation in military setting" supports a positive correlation between, a Leaders Transformational Style and subordinates motivation. On contrary, there existed "Negative correlation between Transactional Style of leader and employees' commitment to output" [28].

C. *Contribution of Leadership Style on Employee Engagement in B-Schools*

Regression analysis determines extent of change in independent variables that brings about change in dependent variable. Leadership Style is an independent variable and Employee Engagement is a dependent variable in this study. The value of R square shows overall contribution of Leadership Style on Employee Engagement to be 28.2% with a standard error estimate of 6.40871.

TABLE IV. REGRESSION ANALYSIS

Table 4	Regression Analysis of Leadership Style on Employee Engagement				
	Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Model
1	.531a	0.282	0.276	6.40871	1

As per the Correlation test statistic result, there exists a correlation between Leadership Style and Employee Engagement. To further prove the extent of relationship, Regression Analysis is performed wherein value of Adjusted R^2 shows significant contribution of Leadership style on Employee Engagement in B-Schools. The overall contribution of Leadership Style on Employee Engagement is 28.2% solely, except the other external factors affecting employee engagement at work place.

Similar study was conducted by Reference [29] which established "a significant impact of transformational behaviors on work motivation and emotional obligation in comparison to transactional behaviors which were linked with subordinates' calculative dedication". Employee's actions affect overall productivity of firm. Reference [30] stated "A Transformational Leader with vision and inspiration, engage employees effectively by showcasing reliability, perseverance and strength towards their work, which prove to be dominant factors for Employee Engagement".

VI. CONCLUSION

Employee Engagement and Leadership styles plays a dynamic role in Organizational setting may it be manufacturing hub or a service oriented Industry like Education Sector.

The study successfully proves correlation between Leadership Style and Employee Engagement and also stressed upon the dynamics of both variables in B-School.

The output of study proved that Majority of Academicians that is 60.1% are Not Engaged and 20.4% are Actively Disengaged, in B-Schools. This is a challenging situation for a Leader. A Leader shall focus on keeping employees engaged by ensuring Reward Based Pay, conducting Training Need Assessment for each faculty, showcasing them growth opportunities and giving them a platform to freely express their issues with Leader, so as to bridge the understanding gap between employer and employee, if any.

Only 19.5% of total academicians in B –Schools are actively engaged. Leaders shall enhance Employee Engagement by making right use of Motivation techniques and Training Programmes such as Faculty Development

Programmes, Seminars, Sessions, workshops, etc to boost academicians' level of self achievement and enhance their commitment to imparting knowledge, as a disengaged workforce is a costly affair for an Institute.

Regression Analysis proved- overall contribution of Leadership to be 28.02% on Employee Engagement in B-Schools. Apart from Leadership Style certain other factors are also responsible for Employee Engagement at work place. A Leader shall also work upon identifying such factors and improving upon it to promote engagement at work place.

As Education Industry is a Service Based Industry; a Leader shall always ensure healthy employer-employee relationships so as to maintain satisfactory employee-customer (Teacher-student) relationship to sustain satisfaction at all levels.

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Impact of PMS effectiveness, Climate for creativity on Competitive Advantage in ITES sector

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***Abstract*— An Effective Performance Management system can foster the organisation to unimaginable levels of performance. It can also thrive innovative behaviour and build a Climate for creativity for the employees, thereby paving way for an organization's competitive advantage. Businesses grow under good leadership and a better climate for creativity in an organization leads to employee innovativeness and organizational performance as a whole. This study attempts to assess the impact of PMS and Climate for creativity on Innovative Behaviour and Competitive advantage among ITES companies in Tamilnadu. Although many studies exist on PMS, the linkage between PMS and the individual innovative behaviour that affects the organizational outcomes has not been very clear. Descriptive research has been carried out with mid-level execs and team leads in ITES sector who are expected to exhibit critical and creative thinking skills in their role, the sample size was 176.In the data collections, structured instruments were used to assess the constructs like Performance Management System Effectiveness (Sharma et al 2016), Climate for Creativity and Innovative Behaviour (Scott and Bruce, 1994), and Perceived Competitive advantage (Lai et al. 2006). the data was subject to Path Analysis using SMART PLS Path Modelling and the results indicate a model fit. It was identified that, the effect of PMS effectiveness and climate had a positive impact on employee behaviour. On similar lines Innovative Behaviour had a significant impact on Perceived Competitive Advantage.**

***Keywords*—** *Performance Management Effectiveness; Competitive Advantage; Climate for Creativity; Innovative Behaviour; ITES Sector*

I. INTRODUCTION

IT in India mainly involves four major categories, namely IT services, IT enabled services (ITES), software and finally e-business. NASSCOM in their report in 2016 observed that there is a visible growth in ITES sector such as Business Process Outsourcing widely known as BPO. Many Corporate leaders around the world has openly stated and appreciated the growth of Informational Technology sector in India. It is a success story that people like to quote in their business discussions. The IT services sector in India has largely contributed to growth in economy, and the availability of Human resources, with good English language skills has been a major reason for this growth. Since most of the graduates after their studies, choose the IT industry as a viable career opportunity, the industry keeps growing. Which also lead to developing of many startups across India, which made cities like Bangalore, Pune and Hyderabad as a hub for these activities. Many known Companies like Wipro, the Tata group has seized this opportunity and have taken the leadership roles in this sector across the globe.

A properly structured Performance Management System can play a vital role in rationalizing the activities of the employees in an organization and make them realize the ultimate corporate mission and vision. More than 4 million people work for IT service provider companies. And this the industry where a lot of layoffs happen, recently in a well-known international company in India, 10,000 employees were laid off. Even though sometimes the reason for these layoffs are lack of projects, sometimes companies also quote fourth rate performance or poor performance as a reason to sack these employees. So the purpose of the research is to understand the Effectiveness of PMS in some of these companies and understand their linkage with employees' innovative behaviour which on the whole contributes to the organizational outcomes.

II. REVIEW OF LITERATURE

A. Performance Management System Effectiveness(PMSE)

Lawler (2003) in his study describes that the PMS effectiveness leads to motivating employees bring some visible changes in their behaviour in an intended manner. They should be volunteering to bring in the change, the term voluntary is emphasized here, because the Performance Management System does not intent to control the behavior of the employee, its merely a medium through which we can develop an employee's skill and so on. (Bezerra George, 2016). Later DeNisi (2011) in his study noted that when an employee shows change in his behavior, it might be a reaction to the effectiveness of the Performance Management System of that organization. When employees start believing that the Performance Management System in their organization is helping them to achieve their goals and objectives effectively and encourage them to be more efficient in their tasks, they will start reacting in a positive manner towards the system. This means that the system has gained their trust. PMS can be called effective when the practices are discrete and is very consistent in such a way that the activities such as goal setting, appraisal, rewards and feedbacks comes together towards a significant completion (DeNisi, 2017).

B. Climate for Creativity (C)

Patterson (2004) and Ekvall (1991) defines climate as "the observed and recurring patterns of behavior, attitudes and feelings that characterize life in an organization". Patterson (2004) in his study has defined Climate as a set of shared views regarding individuals' perceptions of organizational policies, objectives and procedures. The different effects caused by the organizational climate and their impact on innovation and creativity in an organization

are identified in many studies in the past. (Abbey, 1983; Kanter, 1983; Siegel, 1978). Denison (1996), says that when compared with culture, climate is just a temporary factor of an organization, that involves controlling certain process but one would say that the impact of climate of an organization is limited. Innovation and Creativity are considered as the two most important pillars organizations that wish to establish a competitive advantage (Gisbert-López, 2014). Creativity of employees and motivation for the success of the organizations have been linked together in many research studies in the past (Rubra, 2012). This made organization realize that they need to encourage employees to be more creativity in the workspace. Mumford (2002) says that creativity involves the process of generating new and innovative ideas and the ability to translate those ideas into action in their system or workspace.

C. Competitive Advantage (CA)

Competitive Advantage is an element of competitiveness, and it was first described by Ansoff (1965) was the first to describe competitive advantage in his study, as the "properties of distinct products/markets which will give the firm a robust competitive position". Also, Uyterhoeven (1973) discusses that competitive advantage is a way in which a firm links its services and resources to obtain superior return on investment in a product market. Liu (2017) identified an indirect link or relationship of Innovative behavior of employee and Competitive advantage through his research study on the human capital model in various departments in organizations that are based in China.

From the above literature, it was clear that many researches have been done linking performance management systems with factors such as innovation behavior, competitive advantage and climate. PMS effectiveness can bring an effect not only on the task performance of an employee but to other significant results, such as Creativity, Organizational Innovation and Organization citizenship behaviors (Busaibe, 2017;Denisi, 2011; DeNisi, 2014). Even though here they are linking the effectiveness of PMS with organizational innovation, the effect or the linkage with individual innovative behavior wasn't studied. During literature collection, it was identified that there were not many researches that studied about the relationship between PMS effectiveness and innovative behavior. Thus the present study will try to establish the relationship between the identified constructs.

D. Innovative Behavior (IB)

According to West (1990) Individual Behavior can be defined as an individual's voluntary creation of new ideas and introducing the same to a group or another individual and applying those ideas in his/her work environment, to attain a better performance in their role as a group or an organization. Innovative Behavior was categorized into three behavioral tasks in a process by Scott (1994), namely Generation of Idea, promotion of the Idea and Idea realization. The idea generation phase is where an individual begins to anticipate inconsistencies and problems that could occur, an example would be a development of a performance gap in some of their day to day tasks. Individuals who have an alert mind analyze the information effectively, and access their work place and environment and learn to compare it with the previously acquired knowledge to select, organize and be able to proceed with the obtained new information. The Idea promotion phase involves the determinations to encourage and convince more people or groups who might become supporters of these new ideas and propose the ideas to them (Kanter, 1988). The more intriguing the new ideas are, the more knowledge, competency and roles of the allies are required to backup and to bring it to the implementation of the ideas (Damanpour, 2006). In the Implementation phase the individual tries to execute the proposed ideas and try to assess if it works in the system and decide in which level of the organization the idea can be used or put in action (Kanter, 1988).

E. Objectives and Hypothesis

A robust Performance management system, goes a long way in improving the individual 's creativity at work. Innovation and Creativity are considered as the two most important pillars organizations that wish to establish a competitive advantage (Gisbert-López, 2014).

- To study the impact of Performance Management System Effectiveness on Innovative Behaviour
- To Study the Climate of Creativity and its impact on Innovative Behaviour of Employees
- To Study the Impact of Innovative behaviour on Perceived Competitive Advantage among employees

Studies have shown that PMS effectiveness generally leads to maximization of individual performance and commitment, and also in the promotion of Innovative Behavior. (De Leede, 2005; Dorenbosch, 2005). In this study the impact of the employee's perception about the Performance Management System in an organization on the Innovative Behaviour of the same is studied. Hence the following hypothesis was formed.

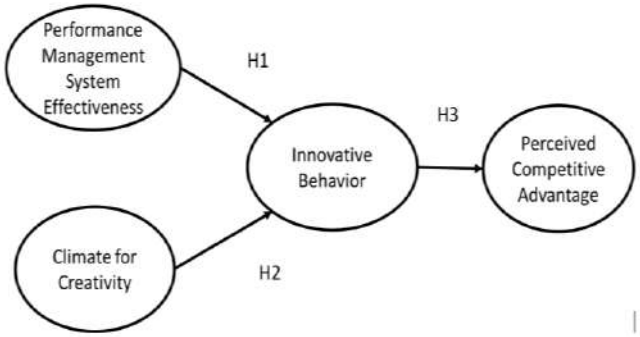

Fig. 1. Conceptual Model

H1: PMS effectiveness has a positive impact on the Innovative behavior of the employees

Innovation and Creativity are considered as the two most important pillars of organizations that wish to establish a competitive advantage (Gisbert-López, 2014). ITES employees work in teams and it was inevitable in this study to learn, if the climate for creativity had positive or negative impact on the innovative behavior of the employee.

H2: Climate for creativity has a positive impact on the Innovative Behavior of the employees

Liu (2017) identified an indirect link or relationship of Innovative behavior of employee and Competitive advantage through his research study on the human capital model in

various departments in an organization. In this study the impact of the Innovative Behavior of an employee on the perceived Competitive advantage, hence the below hypothesis was formed.

H3: Innovative behavior has a positive impact on the innovative Behavior of the employees

III. METHODOLOGY

In this research study, the focus is given to the ITES sector companies located in Coimbatore and Chennai, Tamil Nadu. So the study is mostly based in this particular regions. 175 valid responses were collected through a structured questionnaire via online. The data was collected from employees working in private BPO and information processing companies. There were 4 different sections in the questionnaire and it consisted of 33 questions in total. Responses were based on a Five-point Likert scale ranging from "1-Strongly Disagree" to "5-Strongly Agree". For the employee perception of PMS effectiveness, the 12-item scale from Sharma et al. (2016) was used. This scale mainly helps in understanding the perception of the employees of their Performance Management system in place and to what extent it helps them to achieve their daily objectives. The scale that measured individual Innovation Behavior had six items and was adapted from the work of Scott and Bruce (1994). It helps in accessing the innovativeness of their subordinates and the organization as a whole. For analysing climate for creativity, the scale from Scott and Bruce's (1994) was used it is called the Climate for Creativity scale. The study measured the competitive advantage variable using the nine items scale adopted from Lai et al. (2006). The advantage the company had in term of Cost advantage, service variety advantage and service quality advantage was explored.

IV. RESULTS AND DISCUSSIONS

To measure the impact of the constructs in the conceptual model, Path Analysis was performed by using the partial least squares (PLS) approach. A software that was used to carry out the same was SMART PLS version 2.0. The mean, standard deviation, reliability, and inter correlation were computed. Table 1 shows the mean, standard deviation, and reliability coefficients values for all the constructs. The reliability and validity tests were conducted for the collected responses and SMART PLS Software was used for the same the reliability of each construct in question is examined using Cronbach's alpha (Cronbach, 1951). It measures the interrelatedness of a set of items the alpha scores which greater than 0.7 is generally accepted as sufficient accuracy for a construct (Nunnally, 1978).

TABLE I. RELIABILITY AND VALIDITY OF CONSTRUCTS

Constructs	Mean	SD	CR	AVE	Cronbach Alpha
Performance Management System Effectiveness (PMSE)	3.56	0.46	0.71	0.40	0.55
Climate for Creativity (C)	3.61	0.67	0.76	0.46	0.62
Innovative behavior (IB)	3.60	0.69	0.86	0.51	0.81
Competitive Advantage (CA)	3.63	0.54	0.84	0.35	0.80

The composite reliability for internal consistency of the constructs was tested and was above 0.7. The value of Cronbach's Alpha for the whole items was found and represented in the below table which indicates that the instrument has a high level of consistency.

A. Model validation – Outer model

The relationship of sub constructs (Observed variables) and latent constructs are covered in the outer model. The measures like indicator and construct reliability, convergent and discriminant validity were examined. Outer Loadings of Indicators, CR, AVEs for the study construct

Survey Items	Factor Loading	Composite Reliability	AVE	VIF
C1	0.462	0.76	0.46	1.061
C3	0.704			
C4	0.608			
C5	0.869			
CA1	0.537	0.84	0.35	-
CA2	0.566			
CA3	0.569			
CA4	0.544			
CA5	0.604			
CA6	0.584			
CA7	0.605			
CA8	0.640			
CA9	0.663			
CA10	0.569			
IB1	0.709	0.86	0.51	0.071
IB2	0.796			
IB3	0.756			
IB4	0.756			
IB5	0.714			
IB6	0.516			
MSE1	0.489	0.71	0.40	1.034
PMSE2	0.492			
PMSE3	0.586			
PMSE4	0.870			

(C- Climate for Creativity, PMSE – Performance Management System Effectiveness, IB – Innovative Behaviour, CA- Competitive Advantage)

According to Hair, Black, Babin, Anderson &Tatham, (2006) if the indicator (factor) loading is greater than .50 and the Indicator reliability is acceptable and recognized in the model. The Construct validity is proven by composite reliability (CR) values of the construct. CR measures the sum of a latent variable's factor loadings relative to the sum of the factor loadings plus error variance. This value ranges from 0 to 1. This value should be greater than .60 for the validity of a construct. If CR values above the threshold of .70 indicate strong convergent validity (Kline, 2015; Nunn ally & Bernstein, 1994). The CR values is superior substitute than Cronbach's alpha, Chin (1998). From the table 1.its observed that the composite reliability of all latent constructs is 0.7 or above. CR and Cronbach value of all the latent construct are above 0.6 except for one. The convergent validity is measures through the value of outer loadings, According to Hair,et al., (2006) convergent validity exhibits if the outer loadings values were greater than cross loadings of the constructs, from the table its observed that all outer loading

were significant and greater than cross loading so higher convergent validity exhibits.

Correlation analysis was carried out to measure the direction and magnitude of relationship between climate for creativity, competitive advantage, Innovative behaviour and Performance Management System Effectiveness. Discriminant validity was measured by taking the square root of AVE and check whether its greater than its bi variate correlation of other latent constructs, Hulland (1999). The Table 3 shows the bivariate relationship between the latent constructs and AVE at diagonals. The values 0.678,0.591,0.714 and 0.632 are greater than the correlations in the row for the latent constructs, which shows that the discriminant validity is established.

TABLE II. CORRELATION OF LATENT VARIABLES WITH SQUARE ROOT OF AVE SHOWN IN DIAGONALS

Constructs	CC	CA	IB	PMSE
Climate for Creativity	0.678			
Competitive Advantage	0.325	0.591		
Innovative Behavior	0.282	0.396	0.714	
PMS Effect	0.174	0.198	0.303	0.632

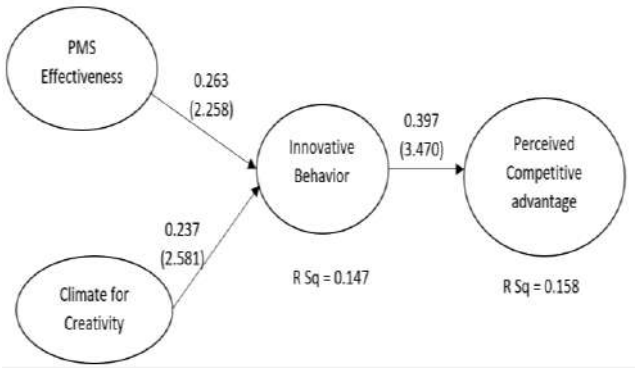

Fig. 2. Model showing the impact of PMS Effectiveness, climate of creativity and Innovative behavior on Perceived competitive advantage

B. Model validation – Inner model

The hypothetical model built in a recursive manner to avoid problems associated with statistical identification (Hair et al., 2006). Figure 1 shows the results of path model using SMART PLS intended at testing the proposed hypothesized model and effected among the latent constructs. The path coefficient for each hypothesis (Link) shown near the arrows and t values shown in the brackets and they referred as the statistically significant standardized regression path coefficient.

TABLE III. PATH COEFFICIENTS, T STATISTICS, AND SUMMARY OF HYPOTHESES VERIFICATION.

Hypothesis	Path	Path coefficient	T value	P value	Result
H1	PMS -→IB	0.263	2.258	0.000	Accepted
H2	CC -→IB	0.237	2.237	0.000	Accepted
H3	IB --→PCA	0.397	3.470	0.000	Accepted

According to Falk & Miller, (1992) the R2 coefficient of dependent variables should be greater than 0.1. Figure 2 indicates that the R2 value of Innovative Behaviour is 0.147 and that of competitive advantage is 0.158. , Form the table its observed that all the path coefficient values were above and are significant at P<0.05 level.

V. IMPLICATIONS

Creating a workplace environment that fosters creativity in individual thinking, and in organizational processes is a must for the changing times, when employees are given an opportunity to try newer experiences and are allowed to fail without the fear of being judged, managers are able to create a creative climate. Similarly, a performance management system that aligns the individual and organizational goals, that is robust and a system that builds trust has a higher influence on innovative behavior at the workplace. The results of the PLS analysis strongly indicate that Performance Management systems and a climate for creativity can boost individual creativity and thereby enhances competitive advantage of a firm.

VI. CONCLUSION

Employee recognition and employee development is a very essential part for the running a successful organization. And an effective PMS is required to do the same. Credibility of managers among the employees, the existence of transparent communication and feedback can help build better employees in an organization. The environment and climate of organization should be encouraging employees to be more innovative and creative in their work space, which then contributes to the overall organizational innovativeness. So generally, in BPO or IT service provider companies people tend to work in teams because of project requirements, hence having these factors in the right way can lead to a good working environment for the employees.

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Brief Study and analysis of promising animals' behavior to design new swarm intelligence based technique for solving optimization problems

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***Abstract*—Swarm intelligence is the area of problem-solving techniques which are inspired by the behavior of animals, natural or artificial. Some of the well-known swarm intelligence techniques are ant colony optimization, particle swarm optimization, fish schooling, bee's algorithm and so on. To design such techniques, one must thoroughly study the real-life behavior of such promising animals, based on which, new such techniques can be devised. This paper represents such study of promising animals like dog, eagle, snake, chameleon, and cat. For all these animals, their behavioral aspects are briefly discussed. This can be a base for the one who would like to devise a completely new swarm intelligence-based techniques for solving optimization problems.**

Keywords—animals' behavior, swarm intelligence, optimization, Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO)

I. INTRODUCTION

Swarm intelligence is a great field to work with as it takes the inspiration and motivation from the nature for the research. From nature only we can observe and grasp so many points on which we can think, and we can relate it with technical problem solutions. Metaheuristics are general algorithmicframeworkforsolvingoptimizationproblems.They workontheproblemswheretheexactalgorithmsfail.Metaheuristics always have problem specific implementation and parameter settings. Traveling salesman problem (TSP) is one of the standard optimization problems which is used for testing the performance of any new metaheuristic approach. The initial step in designing any new metaheuristic would be to find the promising behavior of the animal based on which, the technique can be formed.

An optimization problem, in simple words, is choosing the best solution out of all the feasible solutions. In computer science, some of the famous optimization problems are the traveling salesman problem[1],Map coloring problem[2-4],Assignment problem[5-7],Timetabling problem[8-9],sudoku[10-12],Airline scheduling[13-15] and vehicle routing problem[16-17].The different solution techniques can be Simulated annealing, Neural network, Fuzzy logic, integer programming, Tabu search etc. [2-17].

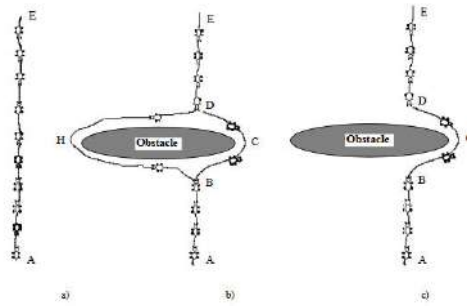
Here,anefforthasbeenmadetolisttheanimalswhosespecialcharacteristicscanbeusedtodesigna new swarm intelligence based technique.

II. RELATED WORK

A. Ant Colony Optimization

This is one of the quick explanations of how the real-world behavior of the ants can be formed in the form of a metaheuristic to form the optimization problem. Ants, while walking lays one chemical called pheromone on the path so that the other ants can sense that. The deposition of pheromone would be more on the path where the food source is nearer or rich. Other ants will detect the higher amount of pheromone on the path and can eventually follow that path to reach the food source. This is the main inspiration behind the ant colony optimization [1].

B. Ant Behaviour with Obstacle



a) SOME ANTS ARE WAKING ON A PATH BETWEEN POINTS A TO E

b) AN OBSTACLE SUDDENLY APPEARS AND THE ANTS MUST GET AROUND IT

c) AT STEADY-STATE THE ANTS CHOOSE THE SHORTER PATH

FIGUTE 1. ANT BEHAVIOUR WITH OBSTACLE [1]

III. ACO METAHEURISTIC

Now, let us discuss how this real-world behavior can be converted into a programming technique to solve the optimization problem. ACO [1] is basically a metaheuristic, means only the high-level description is given to solve the optimization problem. It does not give us the problem specific solution. The metaheuristic steps are to be implemented according to the problem to be solved.

ACO metaheuristic [1, 24]:

Set parameters, Initialize pheromone trails

While termination condition does not match,

Do {

1. *Construct the solution ();*
2. *Apply local search (); (Optional)*
3. *Update pheromone ();*

} End While

Here in the above method, (i) is the step where the problem specific implementation must be done. If the problem to be solved changes, this step implementation also changes. (ii) is an optional step which incorporates the use of local search procedure. By randomly changing the solution elements, if the solution is improved, then its changed. If the solution does not improve by doing so, then the actual solution only is considered. (iii) is the step when the pheromone values are updated for the best ant solution. By doing so, other ants would tend to choose this path with more probability [1], [24].

IV. MAPPING OF REAL ANT AND COMPUTATIONAL ANT

- Real ant – Ant (Structure in programming language)
- Pheromone (Chemical) – Pheromone (Numerical value)
- Path – Path (Two-dimensional matrix)
- Evaporation of pheromone – Evaporation (Decrease IN THE NUMERICAL VALUE)
- Path with more pheromone – Matrix value with the highest numeric pheromone value
- Memory of ant – Ant memory in form of matrix

So, from above co-relation, we can easily understand how the real-world behavior can be transformed into a program.

V. LIST OF PROMISING ANIMALS AND THEIR BEHAVIOR

The following are the list of animals which are found promising.

1. ***Eagle:*** The main characteristic of the eagle is that it has got the most powerful eyesight. While flying high in the sky, even from that distance, it can observe and locate the prey efficiently. Eagles have a keen vision. Their eyes are specially designed for long distance focus and clarity. They can spot another eagle soaring from 50 miles away [18] Eagles can fly up to an altitude of 10,000 feet, but they are able to swiftly land on the ground [18].
2. ***Red -wattled Lapwing:*** Lapwings are ground birds that are incapable of perching. Their characteristic loud alarm calls are indicators of human or animal movements. It has one unique habit. It lays the eggs which are like the ground pattern. The enemies are misguided by this as it becomes difficult to differentiate between the actual ground and the egg [19].
3. ***Snake:*** The old skin of the snake is discarded at regular intervals. snakes shed their skin because it does not fit anymore or because it is old or worn out. When snakes grow, their skin does not, so they outgrow it. When this happens, they shed their outer layer of skin. The process of shedding skin is called ecdysis, and many factors can affect how and when snakes shed, including species, age, weather and temperature, nutritional health and the presence of bacteria or parasites. Younger snakes typically shed more than adults because they are still growing. Another purpose of this is that It helps remove parasites that could harm the snake [20].
4. ***Chameleon:*** It can change the color to get itself adjusted to the environment. It is a common misperception that they do this to camouflage themselves against a background. In fact, chameleons mostly change color to regulate their temperatures or to signal their intentions to other chameleons. A cold chameleon may become dark to absorb more heat, whereas a hotter chameleon may turn pale to reflect the sun's heat [21]. It also has got very long and sticky tongue which can catch the prey easily. Chameleons have a distinctive visual system that enables them to see their environment in almost 360 degrees (180 degrees horizontally and +/-90 degrees vertically). They do this in two ways. The first is with anatomical specializations that enable the eyes to rotate with a high degree of freedom. The second is the chameleon's ability to transition between monocular and binocular vision, meaning they can view objects with either eye independently, or with both eyes together [22].
5. ***Cheetah:*** It is the fastest running land animal with speed being 69.5 miles/hour. It can accelerate from 0 to 103 km/h (64 mph) in three seconds, faster than most supercars [23].
6. ***Dog:*** The most powerful smelling capability they have. They can even track the smell for longer duration. They have tremendous amount of smell receptors in their nose compared to any other animal. Following is the table which shows the comparison of human and dog in terms of smelling capability.

TABLE 1 COMPARISON OF HUMAN AND DOG IN TERMS OF SMELLING CAPABILITY

Sr. No.	SMELLING CAPABILITY			
	Animal	*Brain Size*	*Portion Devoted to Smell*	*# Scent Receptor*
1	Human	Avg. 1.5 Kg in Adults	-	5 Millions
2	Dog	$(1/10)^{th}$ size of Human	40 times larger than Human	Avg. 220 Million

VI. CONCLUSION

Here in this paper, the promising animals' behavior are discussed and briefly represented with different parameters. This field of swarm intelligence is one of the most fascinating and outstanding fields to work upon. This paper will work as the fundamental inspirational point for those researchers who would like to design new swarm Intelligence based technique.

VII. FUTURE WORK

The future work would be to take one of the animals' behavior as a base to design a new swarm intelligence-based technique to solve optimization problem. Another ray of hope can be studying and identifying the other real-life behavior of animals which can be the base to design a new technique.

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Implementation of PSO Algorithm in Novel SEPIC Converter with PV fed Source

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***Abstract* - In this paper a novel SEPIC converter is designed for continuous input current operation. The SEPIC converter's voltage gain is greater than that of traditional converters. This converter works via a single switch and there is less voltage stress around the switch. The input side filter circuit is not needed because the proposed converter's input current is continuous. It is also suitable for applications involving renewable energy and fuel cells. The non-inverting output voltage is obtained in this converter. So, only by altering the duty cycle of the power switch pulse can it work at a wide output voltage range. This voltage regulation of the converter is regulated by the PI controller. Controller parameters are managed and varied by the PSO algorithm. This converter, due to the use of a single power switch, can easily control continuous conduction mode operation. Finally, the validity of the suggested dc-dc converter is checked by the simulation results and the output voltage control of the proposed converter is explained.**

Keywords — Novel SEPIC based DC-DC converter, Particle Swarm Optimization, Output Voltage Regulation, PV system, PI controller.

I. INTRODUCTION

Instead of using grid supply, it is possible to use solar powered light emitting diode bulbs in such places. There are several examples such as cinema halls, shopping malls, conference rooms which are illuminated in most part of the daytime. The rating of PV array can be computed based on number of LED bulbs and rating. The environment condition of the region over a year also needs to be considered for PV array design. In PV installation, due to moving clouds, shadows of trees, buildings and other neighboring objects, power generation from the PV panel is varying. In this paper, the design and development of PV powered isolated load scheme employing particle swarm optimization (PSO). The duty ratio of the dc-dc converter is dynamically changed with the sole objective of output power regulation through PSO. Computed and measured results are presented.

In N. Zhang, G. Zhang, K.W. See, and B. Zhang, (2018), a single-switch quadratic buck-boost converter with continuous input port current and continuous output port current has been defined, which can achieve a wider voltage conversion ratio range with the same duty cycle. E. Maali and B. Vahidi (2016) proposed Double-deck converter with soft switching action for buck-boost. Two identical buck-boost converters operating in parallel are designed from the suggested converter. As a bridge, the converter units are connected to each other by an inductor. However, some drawbacks of this converter are the use of two switches and discontinuous input current. M. R. Banaei, H. Ardi, and A. Farakhor, (2014), a transformer less buck-boost dc-dc converter with voltage
gain is 2D/1-D mentioned, which has a sufficient voltage gain, but this converter's input current is discontinuous. K. I. Hwu and W. Z. Jiang, (2014), a single-switch independent step-up converter was explained, which is derived from the conventional concept of the flyback converter and charge pump. The output current in this converter is non-pulsating. Due to the usage of the flyback structure in this converter, the output power is limited and the performance is poor over the entire load.

II. INTRODUCTION TO NOVEL SEPIC BASED DC-DC CONVERTER

A new non-isolated buck-boost dc-dc converter single-switch with high step-up voltage gain is proposed. This converter has a single power switch, so it will be easy to operate the converter. Less than the output voltage is the voltage stress through the diodes and power switch. It can also be used in renewable energy applications and can also be used in many applications, such as fuel cell systems, PV maximum power point tracking (mppt), and LED drivers. The input current of the proposed converter is continuous. The input power must be equal to the output power (assuming that there is no loss in the circuit) obtained by the law of energy conservation.

A. Description of PV Fed Isolated Load

The circuit diagram of PV fed isolated load is given in fig.1. Here, a Novel SEPIC based DC-DC converter is employed for output voltage regulation at the load side. Here the objective is to maintain the output voltage (vo) at the specified value (VO*). Towards this goal, the duty ratio of the DC-DC converter needs to be continuously changed so that vo →Vo* with good dynamic response. Particle swarm optimization is used for identifying the optimal duty ratio to give best dynamic response.

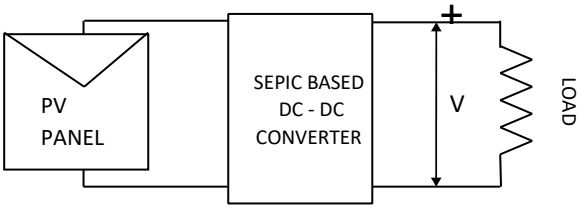

Fig .1. PV fed isolated load

B. PSO Based Voltage Regulation

Particle swarm optimization is focused on the movement of biological swarms such as birds, fish schooling, etc., where the individual moves independently at the beginning of the flight, but as the flight progresses, the swarm behavior determines the position and velocity of everyone. The full circuit diagram of the converter proposed is shown in Fig.2 A single-input single-output converter is this proposed converter. In order to provide a continuous input current and to obtain both buck and boost capabilities, it is derived from traditional SEPIC converters at input, and a mixture of inductors, capacitors, and diodes are often used to have a higher gain rather than conventional SEPIC and to have a high-gain buck-boost dc-dc converter. The voltage stress on the power switch for the proposed converter is lower. The proposed converter's voltage transfer gain is 3D/1 − D, which is greater than the typical buck-boost converter, etc.

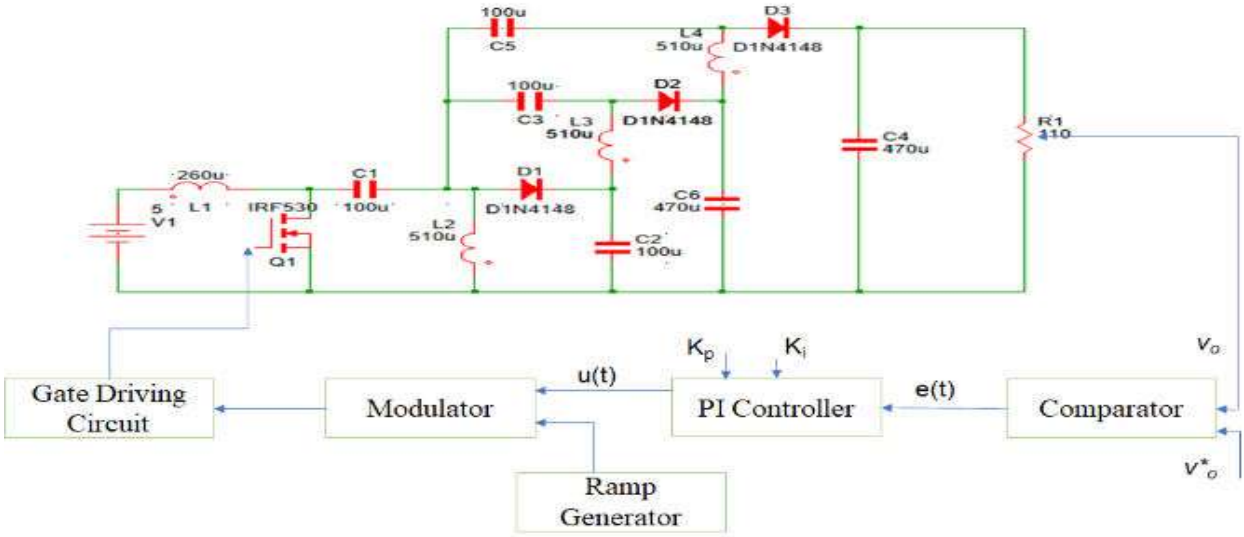

Fig.2. Circuit Diagram of proposed Converter

C. Steady State Analysis of the Proposed Converter

The proposed converter can be operated in continuous conduction mode (CCM). There are two main modes of operation concepts and analyses of the converter in CCM that are explained as follows.

(i)First mode [0 ≤ T ≤ DTs]: As shown in Fig.2, switch S is switched ON during this mode and diodes D1, D2, D3 are turned OFF. There is linear magnetisation of the inductors L1, L2, L3, and L4. The capacitor C1 is discharged, and the capacitors C2 and C6 are charged, respectively, to C3 and C5. The associated equations can, therefore, be written as follows:

$V_{L1} = Vi$ (1)

$V_{L2} = -Vc1 = -Vi = -Vc3 - V_{L3} + Vc2$
$= -Vc5 - V_{L4} + Vc6$ (2)

$V_{L3} = Vc1 - Vc3 + Vc2 = Vi$ (3)

$V_{L4} = Vc1 - Vc5 + Vc6 = Vi.$ (4)

(ii)Second mode [DTs ≤ T ≤ Ts]: The power switch S is switched OFF during this mode and the D1, D2, D3 diodes are turned ON. The L1, L2, L3, and L4 inductors are demagnetized linearly. The C1 capacitor is charged by the L1 inductor, the C2 and C6 capacitors are charged by the L2, L3 and the C3, C5 capacitors are discharged. The associated equations can, therefore, be written as follows:

$$V_{L1} = V_i - V_{C1} + V_{L2} = \frac{-D}{1-D} V_i \quad (5)$$

$$V_{L2} = -V_{C3} + V_{02} = -V_{C3} + V_o = V_{o1} = \frac{D}{1-D} V_i \quad (6)$$

$$V_{L3} = -V_{C2} = \frac{-D}{1-D} V_i \quad (7)$$

$$V_{L4} = V_{C2} - V_{C3} = \frac{-D}{1-D} V_i \quad (8)$$

D. Voltage Gain

By applying the voltage-second balance principle on the inductors L1, L2, L3, and L4 and using Eq. (1) – (8), it gives

$$\frac{1}{T_s}\left(\int_0^{DT_s} V_i\,dt + \int_{DTs}^{T_s}(V_i - V_{c1} - V_{L2})dt\right) = 0 \quad (9)$$

$$\frac{1}{T_s}\left(\int_0^{DT_s} -V_{c1}\,dt + \int_{DTs}^{T_s} V_{o1}\,dt\right) = 0 \quad (10)$$

$$\frac{1}{T_s}\left(\int_0^{DT_s}(V_{c1} - V_{c2} + V_{o1})dt + \int_{DTs}^{T_s} -V_{c2}\,dt\right) = 0 \quad (11)$$

$$\frac{1}{T_s}\left(\int_0^{DT_s}(V_{c1} - V_{c3} + V_{o2})dt + \int_{DTs}^{T_s}(V_{c2} - V_{c3})dt\right)$$

$= 0$ (12)

By using Eq. (6) in Eq. (9) and solving Eq. (9)– Eq. (10), we have

$$V_{C1} = V_i = \frac{1-D}{D} V_{o1} \quad (13)$$

And by using Eq. (13) in Eq. (11), one obtains

$$V_{c2} = V_{o1}. \quad (14)$$

By using $V_{o2} - V_{c2}$ instead of V_{o1} in Eq. (10), V_{o2} can be achieved as follows:

$$V_{o2} = 2V_{o1}.$$

By using the results of V_{c1} and V_{c2} in Eq. (12), we have $V_{c3} = 2V_{o1}$.

By using $V_{o2} - V_o$ instead of $V_{c2} - V_{c3}$ in Eq. (12) and using Eq. (13), V_o can be achieved as follows:

$$V_o = 3V_{o1} = \frac{3D}{1-D}$$

Hence, the voltage transfer gain (M_{CCM}) can be found as follows:

$$M_{CCM} = \frac{V_o}{V_i} = \frac{3D}{1-D} \quad (18)$$

Some of the main waveforms in the CCM mode of the proposed converter are shown in Fig.3

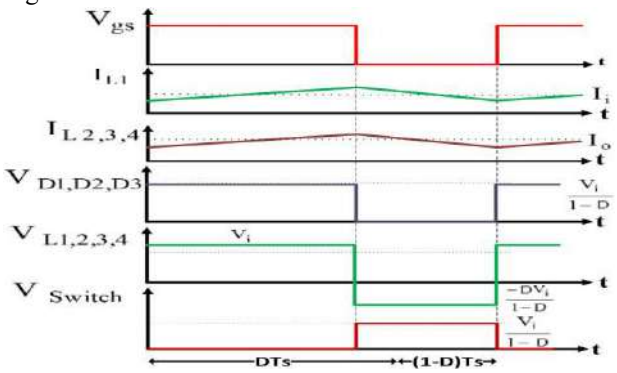

Fig.3 Waveforms of the Proposed Converter

E. Calculation of Currents

Average current equations for capacitors can be written as follows during the on-state switch:

$$i_{c1} = -i_{L2} - i_{c2} - i_{c3} = -3i_o \quad (19)$$

$$ic2 = -ico1 = iL3 = io \quad (20)$$

$$i_{c3} = -i_{co2} = i_{L4} = i_o \quad (21)$$

$$i_{co} = -i_o. \quad (22)$$

And during the off state of a switch, we have

$$i_{c1} = I_i = i_{L1} = -i_{L2} + i_{L3} + i_{Co1} - i_{C2} - i_{C3} = \frac{3D}{D-1} i_o \quad (23)$$

$$i_{C2} = i_{L3} - i_{L4} - i_{C02} = \frac{-1}{1-D} i_o \quad (24)$$

$$i_{C3} = i_{L4} - i_{C0} - i_o = \frac{-D}{1-D} i_o \quad (25)$$

By applying the current-second balance principle on capacitors $C_{1,2,3}$ and $C_{o1,o2,o}$ the following equation is derived as follows:

$$\frac{1}{T_s}\left(\int_0^{DT_s} I_{C1,2,3,o1,o2,o,On}\, dt + \int_{DT_s}^{T_s} I_{C1,2,3,o1,o2,o,off}\, dt\right) = 0 \quad (26)$$

By substituting Eq. (19)– Eq. (25) into Eq. (26), and considering $i_{L1} = I_i$, the average current through the inducors and capacitors can be described as follows:

$$i_{L1} = i_{in} = \frac{3D}{1-D} i_o \quad (27)$$

$$i_{L2} = i_{L3} = i_{L4} = \frac{-1}{3} i_{C1,on} = i_{C2,on} = i_{C3,on} = i_{C0,on} = i_0$$

$$i_{C01,on} = i_{C02,on} = -i_0 \quad (28)$$

According to Fig.1, for the average current that flows through the switch S (i_s), it can be written

$$i_{S,on} = i_{L1} - i_{C1} = i_{L1} + i_{L2} + i_{L3} + i_{L4} = \frac{3}{1-D} i_0 \quad (29)$$

For average currents of diodes, from Eq. (23) to Eq. (25) and Fig. 1 it can be obtained that

$$i_{D1} = I_i + i_{L2} + i_{C2,off} + i_{C3,off} = \frac{I_0}{1-D} \quad (30)$$

$$i_{D2} = i_{L3} - i_{C2,off} = \frac{I_0}{1-D} \quad (31)$$

$$i_{D3} = i_{L4} - i_{C3,off} = \frac{I_0}{1-D} \quad (32)$$

The current ripple of inductor $L1$ and current ripple of inductors $L2$, $L3$, and $L4$ can be calculated as follows:

$$\Delta I_{L1} = \frac{DV_i}{L_1 f_s} = \frac{(1-D)V_0}{3L_1 f_s} \quad (33)$$

$$\Delta I_{L2,3,4} = \frac{DV_i}{L_{2,3,4} f_s} = \frac{(1-D)V_0}{3L_{2,3,4} f_s} \quad (34)$$

the advantages of the proposed converter are low element voltage stress, continuous input current, high voltage gain, positive output, and the use of a single switch.

F. PSO Based Voltage Regulation

Particle swarm optimization is based on the movement of biological swarms such as birds, fish schooling etc, where at the start of flight individual move independently but as the flight continues, the position and the velocity of each individual is decided by the swarm behaviour.

The output voltage regulation of the scheme in the Fig.4 is formulated as an optimization problem and is given below:

Min e^2

Subject to $d_{min} \le d \le d_{max}$ where

$e = v_o - V_o^*$

and d_{min} and d_{max} are minimum and maximum values of duty ratio, d.

The procedural steps of particle Swarm Optimization best scheme are given below:

Step 1: Generate particles (i.e., to duty ratio) randomly subject to the constraints.

Step 2: Activate the dc-dc converter with each particle and corresponding to each particle computer e^2.

Step 3: Complete Pbest of each particle and Gbest of swarm.

Step 4: Adjust the position of each particle as per the following equation.

$$v^{t+1}_{ij} = v^t_{ij} + c_1 r^t_{1j} .[p^t_{best,i} - x^t_{ij}] + c_2 r^t_{2j} [G_{best} - x^t_{ij}]$$

Where,

v^{t+1}_{ij} is the velocity vector of particle in dimension at next time step t+1.

v^t_{ij} is the velocity vector of particle in dimension at time t.

x^t_{ij} is the position vector of particle in dimension at time t.

$p^t_{best,i}$ is the personal best position of particle in dimension found from initialization through time t.

G_{best} is the global best position of particle in dimension found from initialization through

time t.

c_1 and c_2 are positive acceleration constants which are used to level the contribution of the cognitive and social components respectively.

r^t_{1j} and r^t_{2j} are random numbers from uniform distribution at time t.

And the position of each particle is updated in the search space by the following equation.

$$x_i^{t+1} = x_i + v^{t+1}_{ij} \quad (35)$$

where, x_i^{t+1} is the positional vector of particle in dimension at next time step t+1.

x_i is the positional vector of particle in dimension at time t.

Step 5: Go to step if error square becomes 0.001; as go to step 2.

Step 6: Terminate the program and operator DC-DC Converter with Optimum duty ratio.

The general flow chart of PSO based direct controller design is discussed in Fig .4.

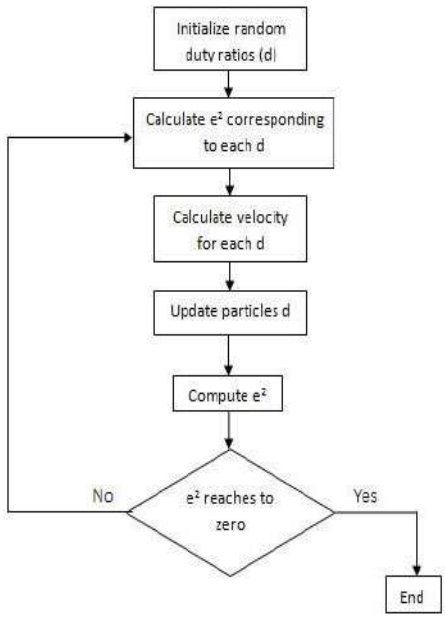

Fig.4. Flow chart of PSO Algorithm

The proposed methods are simulated for different level of voltages.

G. Simulation Data

The Solar PV Panel simulation data is tabulated in Table.1

TABLE. 1 SOLAR PV PANEL SPECIFICATIONS

S. No.	Parameters	Variable	Value
1.	Current at maximum power	I_m	8.2A
2.	Voltage at maximum power	V_m	19.7V
3.	Open circuit voltage	V_{oc}	24.8V
4.	Short circuit current	I_{sc}	8..7A
5.	Temperature coefficient of short circuit current	$\propto$	0.10199A/ °C
6.	Temperature coefficient of open circuit voltage	β	-0.36101V/ deg.C
7.	Internal series resistance	R_s	0.28Ω
8.	Reference solar radiation	S_{ref}	1000w/m^2
9.	Reference Temperature	T_c	30°C
10.	No. of series strings	N_s	1
11.	No. of parallel strings	N_p	1

In this paper, proposed converter is used to increase or decrease the voltage level up or down the input solar panel voltage. The DC-DC converter simulation data is given in Table. 2.The data which is mentioned here for one values and simulation has been made into two to three different values.

TABLE.2 PROPOSED CONVERTER SPECIFICATIONS

S. No.	PARAMETER	VARIABLE
1.	Output Voltage	112.5V
2.	Input Voltage	25V
3.	Input power	116.8W
4.	Output Power	115.056W
5.	Efficiency	98.50%
6.	Duty Cycle	0.6
7.	ΔI_{in}	1.588A
8.	Voltage stress across switch	62.5V

The PSO parameters are given in Table.3

TABLE. 3 PSO PARAMETERS

S. No.	Parameters	PSO
1.	Number of particles	4
2.	W	0.4

3.	C1	1
4.	C2	2
5.	r1,r2	0.8,0.75
6.	Iteration	48
7.	K_p limits	$1 \leq k_p \leq 10$
8	K_i limits	$10 \leq kI \leq 100$

III. Simulation Models and Results

The simulation circuit diagram of Proposed converter with PSO algorithm is shown in the Fig.5.

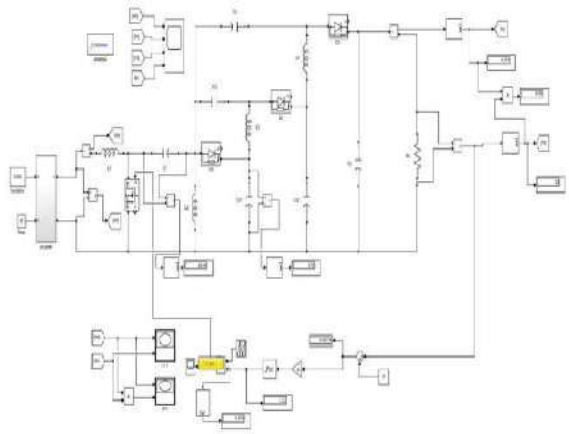

Fig .5. Novel SEPIC based DC-DC Converter Simulation Circuit Diagram

P-V Curve

The below fig.6. shows the P-V curve of solar panel under non -shading conditions. Under this conditions, global maxima occurs at 161.54 W at V_m = 19.7V and I_m = 8.2A.

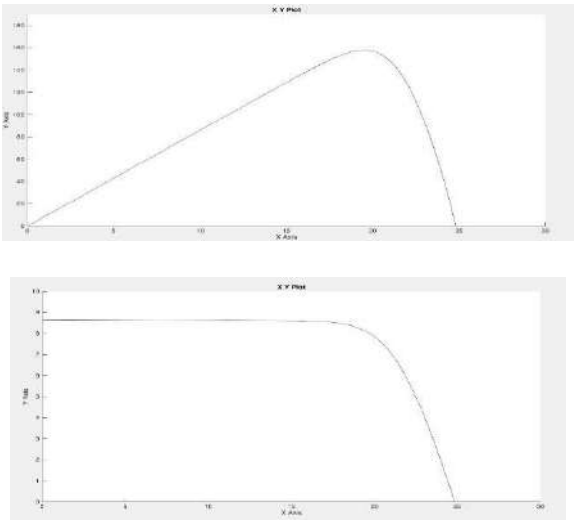

Fig .6. P-V and I-V Curve for non- shaded conditions

Here Proposed converter with and without closed results are discussed and compared. Fig.7. to Fig.8. shows the proposed converter with open loop mode. Fig.9. to Fig.10.shows the proposed converter with closed loop mode and constant input supply connected from input side. Fig.11. to Fig.12. shows the proposed converter with closed loop mode and PV panel from input side. The K_p and K_i are converged to 4.7858 and 48.5376 for output voltage 20V. The K_p and K_i are converged to 4.0736 and 90.738 for output voltage 112.5V. Proposed Converter with closed-loop mode [PV Panel Supply] –Irradiance = [1000,]w/m^2 T=30^o C Fig.13. to Fig.14.

Proposed Converter with open-loop mode

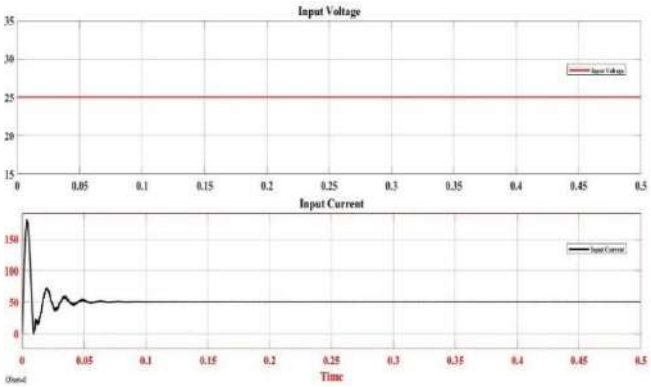

Fig.7. Input Voltage and Current Curve with open loop

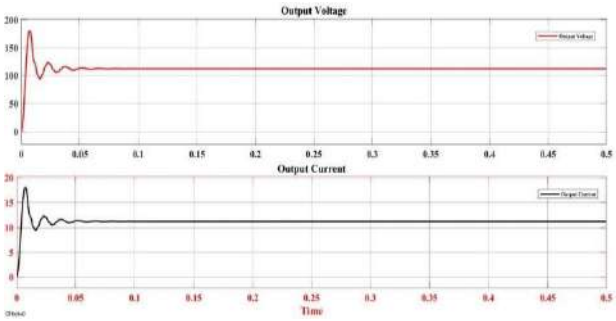

Fig.8. Output Voltage and Current Curve with open loop

Proposed Converter with closed-loop mode

[Constant input supply]

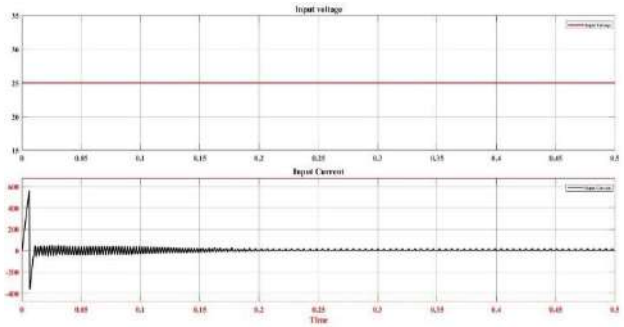

Fig.9. Input Voltage and Current Curve

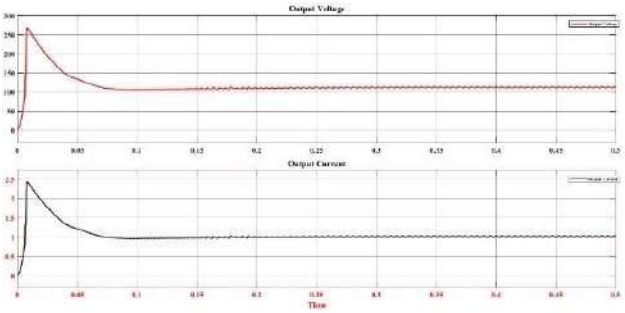

Fig.10. Output Voltage and Current Curve

Proposed Converter with closed-loop mode [Constant input supply and Different Output Voltage Condition]

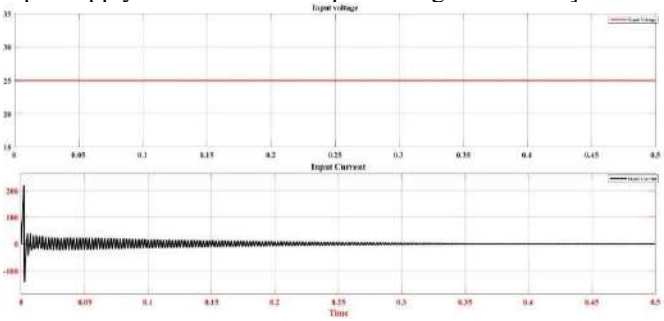

Fig .11. Input Voltage and Current Curve

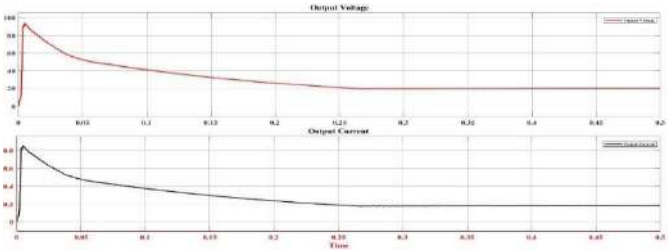

Fig.12 Output Voltage and Current Curve

Proposed Converter with closed-loop mode [PV Panel Supply] –Irradiance = [1000,]w/m^2 T=30^o C

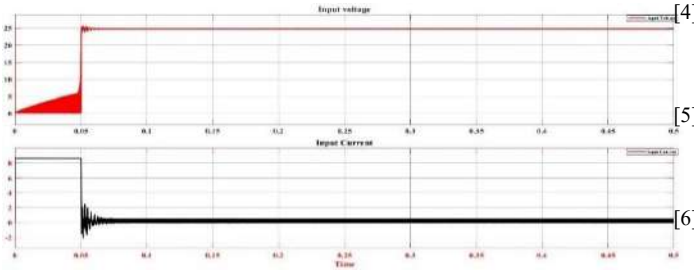

Fig .13. Input Voltage and Current Curve

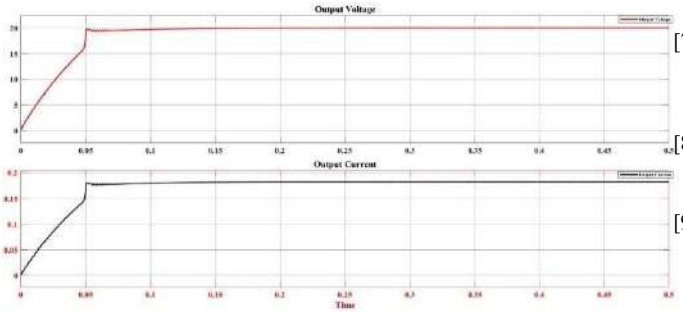

Fig.14. Output Voltage and Current Curve

The proposed converter without a closed loop has several oscillations above the simulated results and settling takes more time. While settling takes a little bit faster, the proposed converter with closed loop and constant supply shows has a significant overshoot during transient times. It clearly shows that overshoot has been minimized due to different voltages at different duty cycles when the proposed converter linked to the PV panel and PSO algorithm converges smoothly to the final value.

IV. CONCLUSION

This paper outlines the system converter with and without a closed loop. The parameters of the PI controller are managed by the PSO algorithm and optimization of the particle swarm is used to get the optimum solution. To demonstrate the efficacy of the new approach, computer simulation results are shown. SEPIC's latest converter with high voltage and continuous input current has been proposed in this article. Based on the particle swarm optimization methodology, the task ratio of the proposed converter interconnected between the PV and the load differs. The duty ratio is directly taken as constant without a closed loop in the first method, while an optimal PI controller is built via PSO in the second case.

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Control Strategies For Data-Driven Target Tracking Of Autonomous Unmanned Underwater Vehicle

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***Abstract*— This article includes new technological communication methods that allow us to make autonomous underwater vehicle (AUV) safer for projects such as research, investigation, identification and rescue operations on the sea floor. In addition, it was mentioned how to use more than one tool effectively. Autonomous underwater vehicles that have developed in recent years are faced with more complex situations such as water pressure, currents and different underwater environments compared to other land devices. It was mentioned that vehicles with different mechanical abilities were assigned to these situations.**

Keywords—AUV, Path Planning in AUV, Multiple Tasks in AUV, Autonomous Underwater Vehicle, Using AUVs in different tasks, Different hardware for AUV.

I. INTRODUCTION

Water has an important place in human history. It has been one of the most basic needs of living things for years. Today, water resources still maintain their importance. In this age of technology, unmanned underwater vehicles are now being used extensively for fast and safe research underwater. Demand for the use of this technology is increasing. Because these vehicles can safely make exploration searches in unknown regions or offer fast and effective solutions to an emergency in focused research areas [1]. In addition, having more than one vehicle will greatly affect the speed of research. It will have a major role in studies such as an unknown job security or the search for other valuable raw materials that can be obtained. It will benefit not only in research and development but also in the military field [2]. For example, in the military field, unmanned autonomous devices will be very useful for exploration. Therefore, it is a technology that its importance is increasing today [3]. Using more than one autonomous unmanned underwater vehicles simultaneously provides the shortest way to reach a solution in emergencies. For instance, thanks to the suggested approach, the security measures that may occur in the research area can be firstly made by these robots. Using more than one autonomous underwater vehicles to create a safety zone will increase the speed of the research to be carried out. Unmanned underwater vehicles use many path tracking algorithms and various field scanning technologies to safely move towards their targets on rugged terrain [4]. Some of the main methods used in autonomous systems are as follows [5];

A. Using Image Tracking Algorithms

Some of the path tracking algorithms are image-based algorithms For instance, it allows them to calculate depth of the field through the camera image and walk around them without hitting the objects. However, using such methods in an underwater vehicle can be a disadvantage in a way. Because the camera is not preferred as a very efficient system due to problems such as high pressure underwater, water pollution rate, late compilation of images or difficult to understand objects. This is one of the disadvantages in search and wayfinding tasks, as some objects are not recognized due to external factors.

B. Navigation with Path Planning Method

In submarine research, path planning of autonomous devices with navigation or seismic field scanning methods such as various sonar systems are used. Different area scanning systems have advantages and disadvantages according to their location [6]. For example, obstacles such as large boulders can be determined by scanning seismic areas; however, large pieces in motion may prevent the vehicle from reaching the desired target because it is not predicted instantly. In addition, it will be insufficient to use this method alone since it cannot react quickly in the event of emergency situations.

C. Routing with Instant Status Control

Thanks to the ultrasonic sensors mounted around the vehicle against all kinds of situations, the current position information of the vehicle, the distance and proximity of the objects that may damage the vehicle at that location will be instantly measured [7]. In addition, it will be effective against adverse conditions that may occur as it will act in a predictive way with the information received from the sonar system. In line with the data received from the sensors, the signal transfer system must be very fast in order to ensure the movement of the vehicle at certain time intervals so that the necessary actions are taken about the received data. However, if such high sampling systems are used, the negativities that may arise from the slightest wrong measurements will cause the vehicle to make a sudden wrong manoeuvre. Therefore, interfering signals in the field should be prevented [8]. Technology experts closely follow the latest researches and continue their research to adapt them to the devices in the best way [9] - [10].

II. AUTONOMOUS UNMANNED UNDERWATER VEHICLE

In order that the Autonomous Underwater vehicle to move more comfortably and quickly in the depths of the sea level, the surface area must be less [11]. In particular, the appearance of a submarine torpedo as in image 1 provides a great advantage for missions to be used in the military field.

Image 1. Torpedo Type Model [22].

The biggest advantage of a vehicle of this model is that it can go towards its target as fast as possible. However, this surface negatively affects the field movement manoeuvrability. Therefore, the model seen in image 2 is used in most of the research and exploration missions.

Image 2. Exploration Type Model [23].

In simulation we carried out, exploration type models were used. Their weight is 10 kilograms in the air and their total capacity is about 1 cubic meter. It is equipped with 2 T200 propulsion motors for forward and backward movement of the vehicles, 1 T200 for up and down manoeuvres and finally 2 T100 propulsion motors for right and left movement capabilities. Not only the external equipment of the vehicle but also it contains various sensors. Vehicles can be developed with different hardware to perform tasks such as exploration, research and attack. Before the autonomous unmanned water vehicles are launched, their targets are identified and positioned with the help of a sonar system [12]. These processes are configured by the computer and the force required by the motors in the 3 axes of the vehicle is calculated and the vehicle is set in motion towards its target. In the meantime, it operates X, Y, Z axis motors to reach target by using PID controllers towards the given reference values [13]. If the method used to define the axis in PID controllers will be used in continuous time, an expression as follows (1).

$$P + I\frac{1}{s} + D\frac{N}{1+N\frac{1}{s}} \quad (1)$$

However, the expression required to obtain the location information of the autonomous vehicle in discrete time should be as shown below (2).

$$P + I.T_s\frac{1}{z-1} + D\frac{N}{1+N.T_s\frac{1}{z-1}} \quad (2)$$

Variables used in given expression are Proportional (P), Integral (I), Derivative (D), Filter coefficient (N) which are calculated according to the actual and reference values of related axis of PID controller. In line with the values calculated with these expression, the vehicle tries to keep itself in balance according to the reference values sent to the motors of the relevant axes. After the impulse values are entered into the motors, it is decided that the system will ignore the interferences or take into account the interference from the "Sensor Data and Condition Prediction" section. If interferences are to be taken into account, the signals from the sensors are passed through a low-pass filter and the resulting signal is processed with a unit step signal to create a refining system. In order to do this process, the natural frequency and the damping ratio values from the accelerometer in the IMU Sensor and other values from the Gyroscope are compared with the instantaneous values (Figure 1).

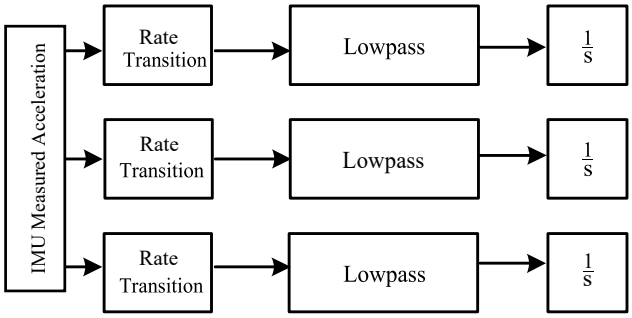


Fig. 1. Generation of anti-interference signals.

As a result, calculation errors are minimized in regions where AUV cannot receive signals underwater or where interruptions are experienced intensely [14].

III. SUGGESTED APPROACH

First of all, vehicles must be controlled with a dynamic programming. Using the possibilities of this created algorithm, statistics of multiple vehicle must be stored instantly. Then, an ID must be given to distinguish each of the vehicles. These vehicles, which are created by default algorithm, must be hardware upgraded to be used in various tasks.

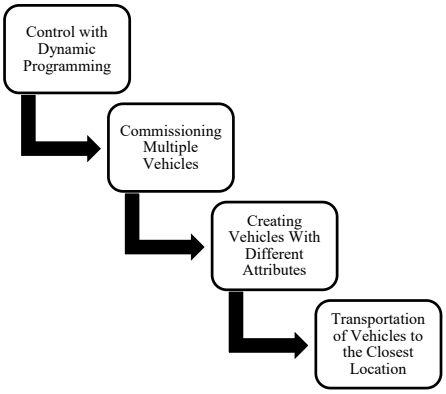


Fig. 2. Object Process Diagram.

A. *Instant State Control with Dynamic Programming*

In reconnaissance vehicles, after determining the target position, the conditions between the underwater vehicle and the target position should be evaluated with feedback after each process, while calculating this force that must go to the engines [15]. If we want to give examples of these possible situations; the program should work with the feedback to avoid problems such as the resistance of the density of the water to the motion motors, the target location following a different path, sudden maneuver scenarios and the vehicle accelerating continuously towards the wrong position. [16].

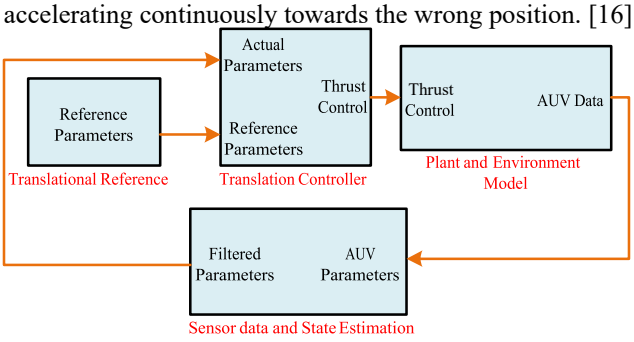


Fig.3. Dynamic Working Model.

Figure 3 can be seen above the block diagram of the Autonomous Underwater vehicle working with a dynamic structure. In this place, the reference parameters taken as the first entry are calculated, after the first step, the thrust forces to be applied to the engines compared to the current position of the vehicle. These thrust forces transmit the required power values to the propulsion engines by processing the effects of environmental factors such as water pressure, fluctuation direction in the Plant and Environment Model stage. Finally, in the sensor data and State Estimation section, these transmitted data are filtered and free from interference. Thus, the most up-to-date and accurate information can be observed in the system.

B. *Commissioning Multiple Autonomous Underwater Vehicles*

Instead of conducting research on a single vehicle in the specified locations, multiple different vehicles can be sent to the desired area, and these vehicles can be developed with different equipment, enabling them to perform the tasks that need to be performed faster and more effectively. For this method, firstly, different quality tools should be created. Then, it is necessary to decide which of the created vehicles will go to the desired location. After this process is completed, we need to ensure that the vehicle reaches the specified location safely from the shortest way along the way. Therefore, we can apply the method of "circumventing the obstacle", which is the simplest and most effective method among many path finding algorithms.

C. *Creating vehicles with different attributes*

Vehicle with different features have been developed to provide more effective solutions to different events that may occur underwater. In some vehicles, more agile and fast vehicle design has been adopted in order to perform primarily military tasks. More precisely controlled vehicles can also be used to perform exploration and all kinds of underwater repair and rescue missions. Vehicle designs produced for underwater emergency medical first aid can also be used. These vehicles must carry the necessary equipment as equipment according to their hardware engine power. The properties of these vehicles can be distinguished with the help of a matrix. The vehicles matrix was created as in Figure 4 to send the vehicles closest to the location and with the desired quality in response to three main aid signals such as first aid, attack, and repair.

1	2	3	4	5	6
1	1	0	0	0	0
0	0	1	1	0	0
0	0	0	0	1	1
34	30	24	30	37	20

Fig. 4. Array of Vehicles.

Vehicle IDs are kept in the first line of this series. In line 2, the status of the vehicles' ability to intervene in response to the First Aid signal is recorded as a binary number system. The 3rd line also determines which of the vehicles are equipped for the attack signal. Finally, the 4th line determines whether the vehicles are equipped to perform the repair task. The last line of the series records the current distances of the vehicles to the last location with the random help calls.

D. *Transportation of Vehicles to the Closest Location*

1) *Determination of the Closest Vehicle According to Emergency Coordinates.*

There should be and algorithm that can decide which vehicle will go to the closest location in case of any emergency signal that may arise while more than one vehicle is traveling autonomously under the water [18].

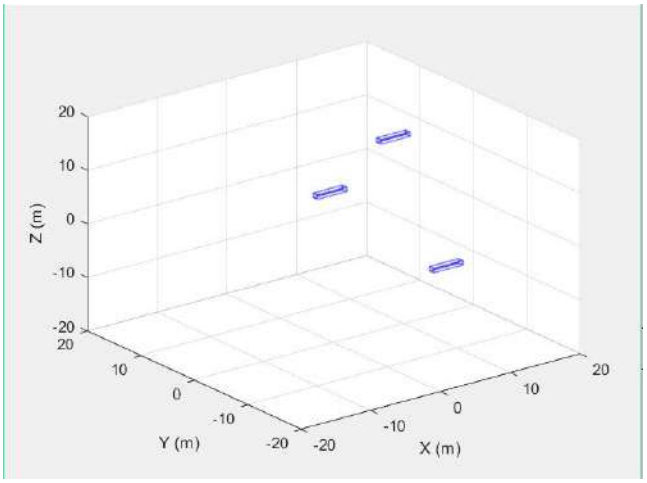


Fig. 5. Snapshot of Different AUV's [21].

Since the instantaneous positions of the vehicles are continuously recorded in the data center, the distance between two points formula in the analytical geometry can be used to measure the distances to the specified location (3). In order to find the distance between two locations in 3-dimensional space, the result of the operation we perform by placing the values x = latitude, y = longitude, z = depth according to the determined sea ground with the autonomous vehicle, will give us the distance between the two locations.

$$|AB| = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2} \qquad (3)$$

After finding the distance between the points, the vehicle with the shortest distance to the emergency position is determined and kept on standby to be assigned.

2) Determining the Nearest Vehicle According to the Requested Assistance Type

In order to find the closest vehicle, it is decided which type of aid the signal is according to the number 0, 1, 2 randomly chosen beforehand. According to this determined number, the vehicle ID returning from the relevant condition loop decides which vehicle can be sent against the randomly generated position and signal type. Thus, the most appropriate military, repair and reconnaissance vehicles for the emergency call are determined and directed towards the target. Detailed block diagram is as shown in Figure 6.

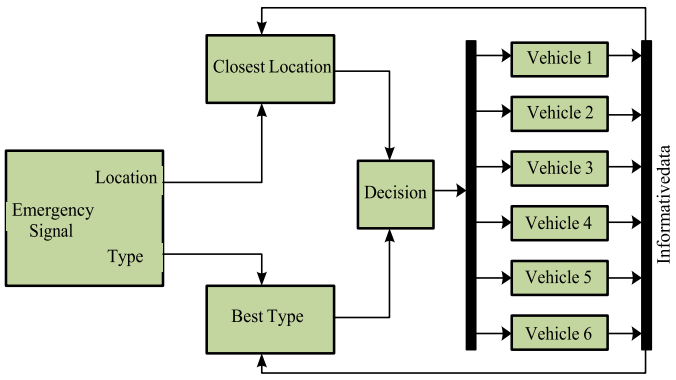


Fig. 6. Determining the Most Appropriate Tool.

This scheme is the stage where the incoming emergency signal and its coordinate are compared with the data received from existing vehicles, and the most suitable vehicle selected after a decision stage is re-sent as new reference values.

IV. Simulation Results

In the virtual submarine simulation, which is prepared using the Aerospace Toolbox over the Matlab Simulink program of the autonomous underwater vehicle, the result values were observed in line with the targets given to the vehicle. Target reference values are given to our vehicle from the Translational Reference section. Reference values can be entered in different types such as fixed or repetitive signals. As an example, a graphical drawing of the path followed by a simulation sent from the vehicle (0, 0, 0) point with reference to (15, 5, 22) points can be observed (Figure 7). This is a simulation example with a high output accuracy value.

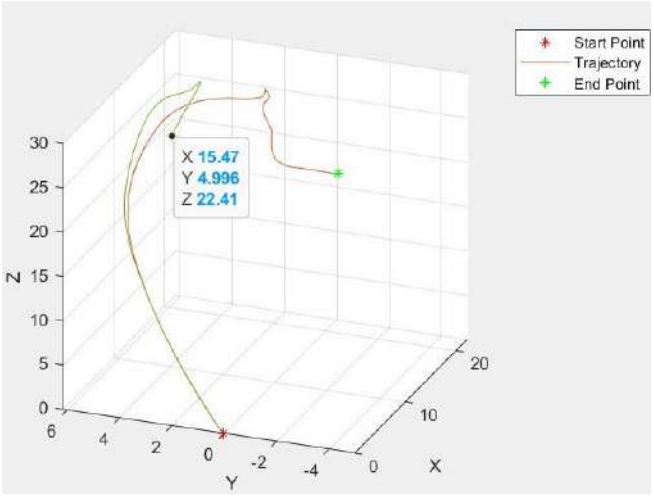


Fig. 7. Simulation with High Accuracy [21].

We know that there are more than one vehicle on the same simulation and if we test the program as we mentioned in the suggested approach steps, after leaving 6 vehicles with different reference values to the input information to operate autonomously, the system will give us an output as in Figure 8 in response to the help signal generated in a different position in a random help type. Consequently, according to this output, it is decided that the vehicle with the best equipment to perform the attack task is the 3rd vehicle. Later, the new reference positions of this vehicle are evaluated and it is determined that it will move towards the (17, 12, 19) axis.

Strike mission coordination;
X=17, Y=12, Z=19
1. Distance of The Vehicle = 7.8806
2. Distance of The Vehicle = 22.006
3. Distance of The Vehicle = 27.9876
4. Distance of The Vehicle = 33.6459
5. Distance of The Vehicle = 22.0191
6. Distance of The Vehicle = 28.5908
---3. Vehicle can be sent to help. ---

Fig. 8. Algorithm Output.

In addition to that, in Figure 9, we can see the instantaneous position of the vehicles on the coordinate system. The zone shown in green indicates the area where the emergency call is made. Among the underwater vehicles colored as Yellow, Blue, and Red, the yellow ones are classified as first aid signals, the blue ones are classified as repair and finally the vehicles shown in red as the vehicles that can perform their attack duties. Thus, one of the closest red vehicles to the specified attack mission, our number 3 vehicle has moved towards this attack position.

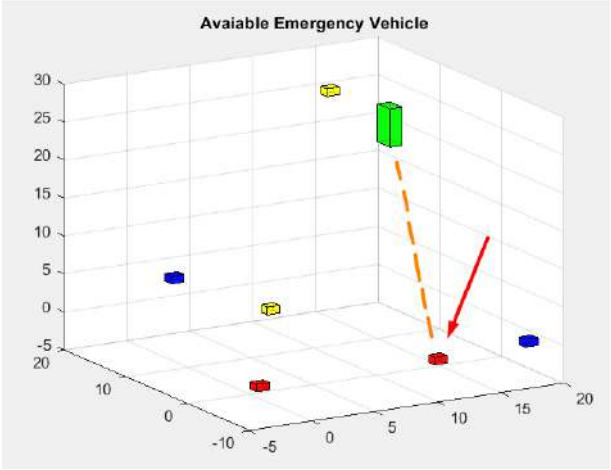
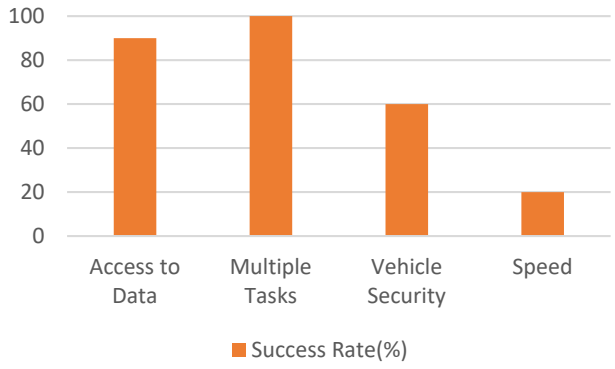


Fig. 9. Simulation Result.

Tests were carried out in many different scenarios similar to these simulation studies. For example, in order to test vehicle security, the success rates of attack missions were paid attention. Different missions were created at the same time in an environment with more than one vehicle and the time of vehicles to arrive the emergency position was recorded. As a result, a graphic as below was created based on the data obtained from performing all these tasks with different scenarios by repeating them.



Graph 1. Percent Success Rate of the System Used.

As seen in Graph 1, it is seen that the system we use is low compared to other criteria in terms of speed and vehicle safety. One of the main reasons for this is that our vehicle is constantly working with dynamic programming method, so it controls the environmental conditions in each sample and according to these data, it is inadequate in terms of reaching the target position since it gives the necessary power to the propulsion engines.

V. Conclusion and Discussion

In this article, it was discussed how to develop a remotely controlled vehicle and have a structure that can make its own decisions autonomously. As can be understood from the route search algorithms developed for the autonomous unmanned underwater vehicle to obtain more accurate results, there are many different methods. According to the results of the studies on these algorithms, the algorithm of each device should be designed based on the location and physical exterior model [20]. The designed working models must be tested many times. Moreover, situations where external factors may interfere should be considered. It was emphasized that probability-based algorithms that need to be controlled for each step should be used in order to ensure that AUV can reach the target in the safest way. Consequently, the damage to the physical vehicle created is minimized. Simulation of the system has helped us to observe the differences between the output values according to the input parameters and the results obtained against possible situations. We have tested how the vehicles with different qualities will react in which situations. It was intended to clearly express how the system will follow the path of the given inputs, using which methods it will move towards the target. Thus, in this article, we have talked about important details on the development of an autonomous underwater vehicle. It is predicted that the autonomous unmanned underwater vehicle, which is intended to be realized by taking these ideas into account, can yield more effective and positive results.

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Machine Learning Based Diagnosis System for Easy and Fast Heart Disease Prediction

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***Abstract*- The goal of the present research is the designing of Machine learning (ML) based system for heart disease (HD) prediction. In the study, different ML algorithms such as K-nearest neighbor, Decision Tree, Support Vector Machine, Logistic Regression, Random Forest, and Naïve Bayes have been used. Besides, some feature selecting methods such as Gain Ratio, Correlation-based feature selection, OneR attribute were applied to select the most influential features from Cleveland HD dataset. In addition, an extensive pre-processing measure such as normalization, integration, and discretization were applied to increase the predictive accuracy of the study. The study outperforms the state-of-art research once classified with different preprocessing and feature selection methods.**

Keywords—Features, Heart Disease, Prediction, classification

I. INTRODUCTION

Heart disease is the consequences of insufficient oxygen and blood supply to the heart. Identification of this disease at the early stage could save the people and improve standard way of life. Moreover, insufficiency of medical equipments or unavailability of skilled physicians affect the proper treatment and diagnosis of the HD patients [1]. A recent survey shows that it is increasing in an alarming rate[2]. In order to ensure prompt predicting and treatment of HD; two famous techniques such as invasive and non-invasive are used in the literature [3]. The invasive technique use the analysis result of medical expert, clinical history and physical test report of the patient to diagnosis the HD. This is time consuming, expensive and prone to error technique [4] and is resolved by non-invasive method, that is based on Machine Learning (ML) algorithms such as logistic regression (LR), k-nearest neighbor (KNN), Naïve Bayes (NB), decision tree (DT), AdaBoost (AB), support vector machine (SVM), neural network, and rough set [5, 6] etc. These algorithms are mostly used by the researcher for predicting and diagnosis of HD and reported to reduce the chances of death due to heart disease [7]. It is also found from the literature that, different feature selection methods play a vital role in accurate HD prediction [3, 8].

Therefore, the aim of the present research is the designing ML-based system for diagnosing HD to make prediction easier for the doctors and take necessary decisions depending on the prediction. In the study, different ML classification algorithms such as DT, SVM, LR, RF, KNN, and NB have been used for predicting a person with heart disease and those are not. Besides, some feature selecting methods such as Gain Ratio (GS), Correlation-based feature selection (CFS), OneR attribute (OA) were applied to select the most influential features that helps predicting the disease easily. In the study, an extensive pre-processing measure such as normalization, integration, discretization were applied on the dataset (i.e. Cleveland HD dataset) to improve the predictive accuracy of the study. In short, the key contributions of the present research are as follows:

i) Enhanced the predictive accuracy of heart disease.

ii) Nine most influential features are shortlisted from fourteen attributes.

iii) The performance of classification algorithms were tested on all and the selected features of the datasets and figure out the best among the algorithm for heart disease prediction.

The whole paper is structured as follows: related work is described in Section II; section III represents the problem statement and objectives; section IV contains the description of proposed methodology; section V is result and discussion; section VI represent the comparison; finally, section VII represents the conclusion of the study.

II. RELATED WORK

Many research attempts have been given to figure out the risk factor of heart disease (HD) due to the seriousness of this disease. They have applied different data mining (DM) and ML algorithms and methods for diagnosis & achieved different probabilities. Besides, there are some HD datasets freely available in UCI ML repository such as Cleveland and Long Beach VA etc. Among them, Cleveland is most widely used dataset by the researcher for diagnosis support of HD. El-Bialy et al. used both the datasets; where, they have adopted five variables in common and analyzed with two ML algorithms such as DT (C4.5) and Fast DT [9]. The fast DT and C4.5 was better with 60.5% and 78.54% accuracy for Long Beach VA and Cleveland data respectively. A hybrid DM model was designed by Verma et al. [10] for diagnosing the coronary artery disease. With a dataset of 335 records and 26 attributes, the authors selected the features using particle swarm optimization method and achieved 88.4% accuracy.

A smart heart disease predicting was proposed by Ali et al. [11] that has applied ensemble deep learning (DL) and feature fusion techniques and has evaluated using feature fusion, feature selection, and weighting techniques and achieved 98% accuracy. In another study, Li et al. [12] has applied different feature selection algorithms along with a novel (named as FCMIM) one to predict heart disease with ML and DL algorithms. The resultant system showed the optimal performance of 92.37% accuracy with FCMIM-SVM combination.. Fitriyani et al. [13] applied Density-Based Spatial Clustering, Synthetic Minority Over-

sampling Technique and XGBoost for eliminating outliers, balancing training data, and predicting heart disease respectively. With the application of different ML algorithms on Statlog and Cleveland datasets, the study claimed to achieve the accuracy of 95% and 98% respectively.

Babič et al. [14] conducted a predictive and descriptive analysis on three data sets such as HD Database, South African HD and Z-Alizadeh Sani Dataset using SVM, DT, NN, NB, association, decision rules and found 89.93% accuracy with NN. A ML-based HD prediction system was proposed by Haq et al. [3], where, they have applied LR. KNN, ANN, SVM (kernel-RBF), SVM (kernel- linear), NB, DT, RF classifiers on HD dataset and found LR as a best classifier with 89% accuracy. Kim et al. [15] used KNHANES-VI dataset to predict HD Risk using NN based on feature selection (NN-FS) and feature correlation analysis (NN-FCA) and said to achieve 82.51% accuracy with NN-FCA. Venkatesh et al. [16] has developed a big data (Hadoop-spark computing tool) predictive model for HD prediction using NB and achieved classification accuracy of 97.12%. Patra et al. [17] conducted a predictive analysis of HD with different classifiers such as J48 , KNN, RBF, NB, decision tree on Cleveland HD dataset and compare between weka and python anaconda evaluation. The evaluation results prevails that decision tree works better with 93.4% accuracy in python environment.

III. PROBLEM STATEMENT AND OBJECTIVES

The related work prevails that early prediction of heart disease is very important to prevent it. They worked with clusters and even with classification models on small dataset and ignored the application of widely used feature selection methods. Therefore, the objectives of this research are:

i) To find the influential features for heart disease with the use of widely used feature selection methods

ii) To enhance the predictive accuracy of heart disease with large dataset

IV. METHODOLOGY

To meet the above objectives, the present work followed the methodology as given in the figure 1. The description of each step of the methodology is given below:

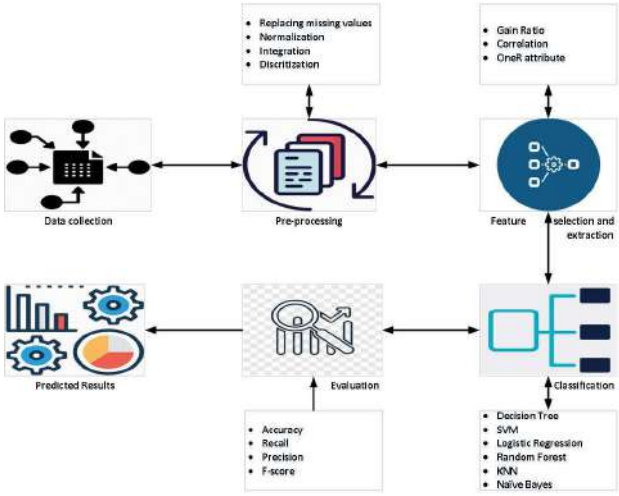

Fig.1: Methodology of the present work

A. Data Collection

The present work has collected the HD data from the UCI ML repository[1], known as Cleveland database. This database contains 76 attributes; however, most researches used only 14 of them. The current research considered the same with 920 instances. Table I represents the attributes and their corresponding descriptions. In the dataset, a heat map (i.e. color-coded graphical representations of data) is used to see which attributes are mainly responsible for the changes in the result.

TABLE I. ATTRIBUTE OF DATASET

No	Name	Description
1	Age	Years
2	Gender	1 = male , 0 = female
3	CP	1 = typical angina, 2 = atypical angina, 3 = non-anginal pain, 4 = asymptotic
4	Restbps	mmHg (on hospital admission)
5	Chol	Mg/dl
6	Fbs	1 = true, 0 = false
7	Restecg	0 = normal, 1 = having ST-T wave abnormality, 2 = left ventricular hypertrophy
8	Thalach	Maximum heart beat rate
9	Exang	0 = no, 1 = yes
10	Oldpeak	ST depression induced by exercise
11	Slope	1=upsloping, 2=flat, 3 = downsloping
12	Ca	Number of important vessels coloured by Fluroscopy
13	Thal	3 = normal, 6 = fixed defect, 7 = reversible defect
14	Class	0 = absence, 1,2,3,4 = presence

B. Preprocessing

Often, collected data is not understandable, inconsistent, and can contain various errors. Preprocessing makes data understandable. The following are the different preprocessing measure used in this research.

1) Normalization

Normalization is helpful for better classification. Here, the collected data are normalized into the scale, that is, from 0.0 to 1.0.

2) Integration

[1]"dataset", https://www.kaggle.com/ronitf/heart-disease-uci, accessed on June 25, 2019

There can be a conflict between data in different places of data set. The study resolves many such issues in the dataset and created a unified view of the data.

3) Discretization

The study applied the data discretization by replacing the unprocessed values of the numeric data by interval or conceptual levels.

C. Feature Selection

It is not very easy to run data mining algorithms in very high dimensional data. It makes training and tests of a model very complex[3]. To get rid of this, various feature selection methods are used such as gain ratio, correlation-based feature selection, and OneR. These methods and algorithms count the error rate for each attributes and take the attribute with the minimum error rate. Therefore, this research tried to find appropriate feature selection method. Details of these algorithms are given below:

1) Gain Ratio

Gain Ratio of attribute A $=\frac{Gain(C)}{Split\ (C)}$ ……(1)

Where,

Gain=(distribution entropy before split) – (distribution entropy after split)

Entropy(A_1,A_2,..,A_n)=−A_1log(A_1)−A_2log(A_2)−⋯−$A_n$log(A_n) = $-\sum_1^n A(n)\ logA(n)$

Split Info (C) = $f(x) = \sum_1^n \left(\frac{|Cn|}{|C|} \times log2\ \frac{|Cn|}{|C|}\right)$

Where C= Attribute; this study considered the splitting attribute only if it has the highest gain ratio.

2) Correlation-based feature selection(CFS)

CFS (heuristic evaluation function) is used that select the feature subset having high correlation.

3) OneR Attribute Evaluation

This algorithm evaluates the worthiness of an attribute and selects the one having smallest error. This is one of the most primitive schemes that being applied in this work

After applying feature selection algorithms, nine attributes with higher frequency is selected. All the methods have these nine attributes in common. So these are the most influential features that are used in the classification process. Table II shows the Feature selection by various methods. Top 9 attributes selected by three algorithms on frequency measures are shown in table III.

TABLE II. SELECTED FEATURES

Algorithm	Attribute No
Gain Ratio	3,13,9,12,11,10,8,1,2,5,4,7,6
Correlation	1,3,5,8,9,10,11,12,13
OneR	13,3,12,5,10,9,8,11,1,2,7,4,6

TABLE III. MOST INFLUENTIAL FEATURES

Selected Influential Features no	Features	Frequency
3	Chest Pain	3
13	Thal	3
9	Exercise induced angina	3
12	Number of major vessels	3
11	Slope	3
10	Old peak	3
8	Thalach	3
5	Cholestoral	3
1	Age	3

D. Classification

Six classification algorithms were used to predict the HD. The algorithms are LR, DT, NB, RF, SVM and KNN. The performance of the algorithms are measured and compared for finding the best among them in HD prediction.

E. Performance Evaluation

The performance of the models are evaluated by measuring accuracy, recall, precision, and F-measure. If the performance was not found satisfactory, then the method was repeated with different preprocessing and feature selection parameters to get the expected outcome.

V. RESULTS AND DISCUSSION

Table IV shows the average performance of the classifiers considering influential and all attributes in implementation. From the table, it is observed that the RF shows the highest accuracy of 98.9%. Besides, nearest classification accuracy of 90.9% and 94.7% are shown by DT and SVM respectively. A bit poor performance in the scale of accuracy are shown by NB (82.2%) and LR (83.3%). The least accurate measure is given by KNN, which is 77.4%. In the case of precision, the value for the RF is the highest again. Likewise accuracy, DT shows the second and SVM shows the third largest value with 95% and 91% respectively..

Performance with respect to recall shows, RF gives higher value of 98%. Besides, RF gives higher true positive rate in the confusion matrix. The performances of remaining classifiers are very similar to that of accuracy and precision. According to the result of F-measure, RF is best among the all the algorithms. The F-measure value of DT, SVM, NB, LR, KNN are 95%, 91% 82%, 83%, and 77% respectively. Overall, RF is found best because it can produce a better result without hyper tuning. Another reason is, it is best with high dimensional and subset of data.

TABLE IV. RESULT OF DIFFERENT CLASSIFIER

Algorithm	Accuracy	Precision	Recall	F-measure
KNN	0.774	0.777	0.774	0.774
DT	0.947	0.947	0.947	0.947
SVM	0.909	0.910	0.909	0.909
RF	0.989	0.989	0.982	0.982
NB	0.822	0.822	0.822	0.822
LR	0.833	0.834	0.833	0.832

VI. COMPARISON WITH PREVIOUS WORK ON THE SAME DATASET

A comparison between existing work and proposed work has been shown in Table V and figure 2. From the table, it is seen that with the same dataset and with the minimum feature and all feature average, present work got a better result in the Random Forest algorithm. The result is also better than all the results of the compared work [17, 18]. From the result, it can be concluded that the proposed work has enhanced the predictive accuracy of HD once applied feature selection methods and algorithms.

TABLE V. COMPARISON WITH PREVIOUS WORK ON THE SAME DATASET

Author	Techniques Used	Accuracy
	Decision Tree	0.83

Suvhodra et al., 2019[18]	Logistic Regression	0.85
	Naïve Bayes	0.90
	SVM	0.76
Patra et al. 2019 **[17]**	Decision Tree	0.94
	KNN	0.76
	SVM	0.63
Proposed Work	Decision Tree	0.94
	SVM	0.90
	Logistic Regression	0.83
	Random Forest	0.98
	KNN	0.77
	Naïve Bayes	0.82

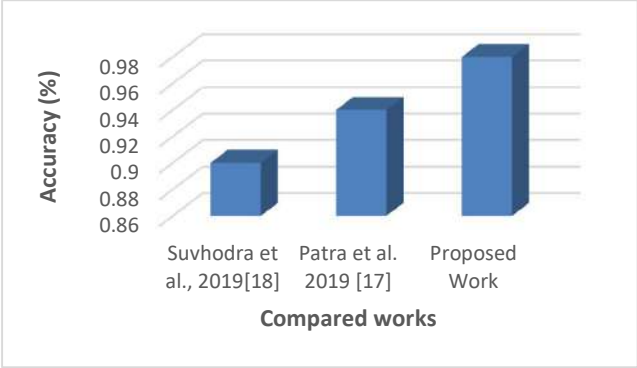

Fig.2: Comparison with state-of art-research

VII. CONCLUSION AND FUTURE WORK

In this study, a ML-based diagnosis system was designed for heart disease prediction. Six classification algorithms such as DT, SVM, LR, RF, NB, and KNN have been used and found RF as a best classifying algorithm. It is found from the study that, some features in the dataset reduced the performance of the classifiers; thereby three feature selecting methods such as GS, CFS, and OA were applied to select the most influential features and found the improved performance. Besides, the performance is improved once different pre-processing measures such as normalization, integration, and discretization were applied on the dataset. The overall performance is seemed to be satisfactory as compared to state-of-art research. In the future, this research design may be used to predict the HD from multiple datasets and different.

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Impact of Covid-19 on the rise of OTT platforms in India

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Abstract- With the growth of technology and the rise of digital age, the digital om-demand video streaming services are on a rapid rise in the recent years. With the Covid-19 pandemic and the subsequent lockdown, there has been an increase in the usage of OTT platforms among the Indian consumers. The study aimed to examine how the consumers are shifting from traditional television to OTT platforms and also to understand the various factors which is influencing the consumers to shift traditional TV to on-demand media platforms during the Covid-19 pandemic. The results showed the convenience, accessibility, price are some of the major cause of the shift from traditional television to OTT platforms. There has been a sharp rise in the usage of OTT platforms during the Covid-19 pandemic. Even when the lockdown was lifted, a new trend of work-from-home (WFH) was adopted by almost every companies and as the employees were working from home, this also contributed towards the rise of OTT platforms in India.

Keywords- OTT platforms, Work from Home (WFH), Covid-19, on-demand video content.

I. INTRODUCTION

The pace at which online video steaming is evolving is nothing less than revolutionary. Traditionally, the consumption of movies and other audio and video content was limited to only movie theatres and television. But with the advent of technology, everything is available and easily accessible at home whenever required through online video streaming or on-demand video services, typically referred to as OTT services. Within a very short time span of around a decade, OTT industry has become a serious threat to the long-established cable TV industry. In recent time, OTT service is altogether changing the experience of watching TV. Viewers can access the on-demand video content through their smartphones, smart TV, tablets, desktops, laptops, etc. at their own convenience at any time at any place. Once considered luxury, the OTT platforms has become a necessity for many people in recent times due to the Covid-19 pandemic. When the entire country was under strict lockdown and people were unable to step out their homes, they chose OTT platforms as one of the entertainments during that time. Many people who did not have subscription in any kind of OTT platform has subscribed during lockdown to several OTT platforms as the traditional linear television channel had no new content to stream and was repeating the old content. The KPMG report titled "Media and Entertainment post COVID-19" states that pandemic is entirely changing the way people consume media and entertainment (M&E). With people confined to their homes, their social lives have moved online and entertainment consumption has risen notably within the at-home segments of television, online gaming and over-the-top (OTT). On the other hand, movie theatres, theme parks, museums, and other external consumption models are suffering, as physical distancing norms and lockdowns are enforced. (KPMG,2020). Due to Work from Home (WFH) people had more leisure between work hours and spent most of their leisure time by watching series in different OTT platforms. As per reports of Statista, Netflix and Amazon Prime holds 20% each of the market share of OTT platforms in India for the period of April- June, 2020, which was the total lockdown period. This abrupt rise in the OTT platforms in the Indian market is due to the Covid-19 pandemic and the subsequent lockdown. The streaming market will collectively account for 46% of the overall growth in the Indian entertainment and media industry from 2017 to 2022, as per PwC reports. As per the latest report "Entertainment Goes Online," by The Boston Consulting Group, revenues from OTT platforms have seen a CAGR of over 40% for the period 2005–2017 and are expected to grow by 20% in the period 2017–2023. The Indian OTT market size is expected to grow to $5bn by 2023, as per BCG reports.

II. LITERATURE REVIEW

Jose (2020) concludes that user friendliness and content richness are most important factors that influence the shift of consumers from Television to

OTT platforms in India. It is found that the shift is largely dominated by the youth, the middle class and upper class of the society. **Kwon *et al.* (2020)** clarifies subscribers' continuous subscription behaviour in OTT services in terms of the recommendation agent values and search experience perspective. **Dasgupta and Grover (2019)** studies that with growing digitization, the challenge for marketers is to understand how consumers consuming Over-The-Top (OTT) content and adopting it effectively. The qualitative method adopted for the study, brought out four themes enabling the success of the OTT platform: Convenience, mobility, content and subscription strategies, which will ensure higher engagement levels of the consumers for the OTT content. **Farooq and Raju (2019)** studied that how the telecom companies are facing revenue losses due to digitisation. The study also mentioned that digitisation is bringing new opportunities to the telecom companies which makes a way for the telecom companies to also provide internet and digital value-added products and services parallel to traditional services. **Herbert *et al.* (2019)** explores the consistencies and divergences of streaming among consumer experience, business practices, and textual implications to compare how established uses, production practices, and media content have been affected by internet distribution. **Hutchins *et al.* (2019)** identifies and analyzes six defining characteristics of OTT live sport streaming, and outlines three services (Tencent Video, DAZN and Amazon Prime Video). It also proposed that OTT services are establishing new norms concerning how media sport is accessed and curated and, causing a historic shift in the global marketplace for sport coverage rights and the media systems through which live content circulates. **Katherine (2019)** focuses on how OTT TV and cable TV compete in Taiwan market. The findings indicate that OTT scores higher than the traditional TV in terms of convenience, ease of use. Overall, OTT TV's competitive superiority surpasses that of traditional TV in all dimensions. **Wayne (2018)** finds that the brand identities for Amazon are some television networks act as an attraction which draws customers attention into the Prime membership program. On the contrary, for Netflix, linear television networks are competitors whose brand identities reduce Netflix's own brand equity. **Kim *et al.* (2016)** used conjoint analysis to investigate the key attributes and examine the consumer's marginal willingness to pay for OTT services. It has been identified that recommendation systems, resolution, and viewing options as important product attributes of OTT services that influence the willingness to pay of Chinese and Korean consumers. **Jose Ganuza and Fernanda Viecens (2014)** argues that the technology that enabled the entry door of telecom operators to the content market and that, nowadays, online TV may be their exit door if they do not display innovative strategies to remain in this market.

III. OBJECTIVES

- To understand the shift from traditional television viewing to the OTT platforms among the Indian consumers due to Covid-19 pandemic.
- To study the consumer perception towards the viewership of OTT platforms.
- To identify the different factors which influence the viewership of OTT platforms in India.

IV. RESEARCH METHODOLOGY

The study is designed to analyze different factors which impacted on the surge of the viewership of OTT platforms during Covid-19 outbreak and also to understand the shift from traditional television viewing to the OTT platforms among the Indian consumers due to Covid-19 pandemic. The paper has followed a primary survey method to collect the responses through the use of structured questionnaire which was distributed to 250 respondents in different metropolitan cities of India. Out of those 250 respondents, 221 respondents were selected as the rest of the respondents were not aware about the OTT services available in India. Among those 221 respondents only 166 respondents were considered for further analysis, and the rest of the responses were eliminated due to incomplete responses. The survey was conducted among the people of similar background and experience which mostly comprises of students and employed personnel across different cities. The survey conducted was online and was spread through social media such as WhatsApp, e-mail and LinkedIn to gather maximum responses. The sample was collected with the use of Judgemental and Snowball sampling technique. Further, an analysis has been done using the collected responses.

V. ANALYSIS AND FINDINGS

It was found that the respondents preferred to spend most of their afternoon and late night by using several OTT platforms. There is a sharp rise in the use of OTT platforms among the young Indian consumers due to the lockdown, when the educational institutes and offices were not at all operational. Slowly, with the unlock phase, Work from Home (WFH) culture was introduced which sometimes were frustrating, as a result most of the employees chose OTT platforms as an entertainment during their leisure hours. When the participants were asked about their average hours spent on watching traditional television and OTT

platforms, the majority of the respondents had higher average hour of watching OTT platforms as compared to traditional television. Also, many participants of the survey, never used OTT platforms at all before Covid-19 lockdown, and have subscribed to different OTT platforms because of the free time and quality content available in the OTT platforms. It was also pointed out that the television was streaming the repeated content which also forced the respondents to switch to OTT platforms. The study aimed to investigate the various factors that impacted in increasing the viewership of OTT services and also to understand the shift from traditional television viewing to OTT platforms.

Demographic profile: Respondents were asked about their age, occupation, gender, annual income:

Table 1: Depicting the Demographic profile of the respondents

Frequency		(%)
Gender		
Male	45	27%
Female	121	73%
Age		
Below 18	3	1.8%
18 – 30	151	91%
30 – 40	11	6.6%
Above 40	1	0.6%
Occupation		
Student	126	76%
Employed	26	16%
Self Employed	11	6.6%
Housewife	3	1.8%
Annual Family Income (in ₹)		
Below 7,50,000	45	27%
7,50,000 – 10,00,000	45	27%
10,00,000 – 12,50,000	19	11.4%
12,50,000 – 15,00,000	20	12%
Above 15,00,000	37	22.2%

The majority of the respondents for this research belongs to the age group of 18 -30 years belonging to major cities, who belongs to the generation which is known as millennials. The respondents are frequent users of OTT platforms for watching video content online. The study showed that 86% of the respondents have traditional cable/DTH services at their home. And even if they have traditional cable/DTH service 90% of the respondents also using the OTT platforms in major cities of India.

Correlation: To understand the shift from traditional television viewing to the OTT platforms

Table 2: Depicting the correlation to see the shift from traditional television viewing to OTT platforms

Correlations

		Do you have DTH/cable services currently	Are you ready to subscribe for streaming services even if you have DTH/cable services to watch television?
Do you have DTH/cable services currently	Pearson Correlation	1	.234
	Sig. (2-tailed)		.002
	N	166	166
Are you ready to subscribe for streaming services even if you have DTH/cable services to watch television?	Pearson Correlation	.234	1
	Sig. (2-tailed)	.002	
	N	166	166

The study also found that the adoption process towards OTT platforms is taking place at a faster rate. 92% of the participants preferred using OTT platforms over traditional television. The sudden spike in the OTT platforms took place due to the covid-19 pandemic when the entire nation was under lockdown and people did not have any alternative form of entertainment. The respondents also pointed out that due to the lockdown situation and WFH culture, they are unable to step out of the house, so they adopted this new service at a very faster rate. It was also pointed out that the traditional television and no new content to entertain them so they were forced to switch to OTT platforms which provide quality content and latest movies and TV series. In the above Table 2, we can see that there is a positive relationship and a mild correlation between the respondents have DTH/cable services and their readiness to subscribe different OTT platforms. The test shows a significant result at 1% level.

In order to understand the consumer perception towards the viewership of OTT platforms, several questions were asked. It has been found out that 73.4% of the respondents are using OTT platforms to enjoy both movies and TV series. Due to the lockdown, people are stuck at their home and are unable to go out for movies at a movie theatre, and the traditional television is also broadcasting the repeated content and no new tv show or movie is being streamed in the traditional television. Thus, 86% of the respondents are of the view that OTT platforms streams new and innovative content and keeps the audiences entertained at their home without even have to step out during this pandemic. The culture of work from home (WFH) has also contributed a lot towards the growth of OTT platforms. The respondents are of the view that due to work from home (WFH) culture they get more time to spend with family and can enjoy new movies and tv series in different OTT platforms during their leisure. It was also pointed out by the 87.3% of the respondents that the OTT platforms have its own original content (movies, series, etc.) which is not available elsewhere. 96% of the respondents were also in the view that latest movies are streamed in OTT platforms much ahead of the traditional tv channels. This is also a reason for preferring OTT platforms over the traditional television. 72% of the respondents also pointed out that they think OTT platforms are better than traditional television services because of the poor quality of the content of the television and high monthly subscription charges of the DTH/cable network.

Factor Analysis: To identify the different factors which influence the viewership of OTT platforms in India.

Kaiser-Meyer-Olkin (**KMO**) Test is a measure of how suited the data is for Factor Analysis. The test measures sampling adequacy for each variable in the model and for the complete model. The statistic is a measure of the proportion of variance among variables that might be common variance.

Table 3: Calculation of Kaiser- Mayer- Olkin (KMO) and Bartlett's test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.858
Bartlett's Test of Sphericity	Approx. Chi-Square	1023.190
	Degree of Freedom	66
	Sig.	.000

The above table shows two tests that indicate the suitability of the data for structure detection. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy is a statistic that indicates the proportion of variance in the variables that might be caused by underlying factors. The above table shows high values i.e., 0.858 which indicate that a factor analysis is useful with the data. Approx. Chi-Square value is 1023.190 which implies that there is a strong association among the variables.

Bartlett's test of sphericity tests the hypothesis that the correlation matrix is an identity matrix, which indicates that the variables are unrelated and therefore unsuitable for structure detection. The above chart shows the sig. 0.00 which is less than 0.05 of the significance level, thus it indicates that a factor analysis will yield useful results.

For the purpose of identification of the different factors contributing towards choosing of OTT platforms over traditional television services during the Covid-19 pandemic, factor analysis has been conducted using the Principal Component Analysis in SPSS software.

Table 4: The total variance explained

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	5.715	47.623	47.623
2	1.297	10.806	58.429
3	1.029	8.577	67.005
4	.820	6.830	73.835
5	.689	5.740	79.576
6	.527	4.388	83.963
7	.468	3.898	87.861
8	.403	3.362	91.223
9	.352	2.930	94.153
10	.268	2.230	96.382
11	.228	1.904	98.286
12	.206	1.714	100.000

In the above table the Eigen Value reflects the number of extracted factors whose sum should be equal to number of items which are subjected to factor analysis. The next item shows all the factors extractable from the analysis along with the Eigen Value. The Eigen Value table has been divided into two sub-sections, i.e., Initial Eigen Value and Extracted Sums of Squared Loadings. For analysis and interpretation purpose only Extracted Sums of Squared Loadings are being considered.

A positive figure denotes a positive correlation between the sub-factor and the respective component. The researcher shall only consider sub-

factors with correlation value more than 0.05 for each respective component.

The factors whose Eigen value > 1 will be considered.

The factors which have the most significant effect on choosing the OTT platforms over traditional television due to the Covid-19 pandemic are:

- Viewership and Payment: The analysis suggests that viewership and payment plays a vital role on choosing OTT platforms over traditional television service. High Resolution picture quality, secured payment, ease of payment, variety of languages available with subtitles and personalised content as per viewer's choice are the certain factors which plays a great role in choosing OTT platforms. The most dominant factors are the secured payment and availability of various languages with subtitles, and personalised content, which affect the respondents to choose OTT platforms.
- Convenience and Accessibility: Only through one subscription, many people can share the screen, also they can watch at their convenient time and place and wide range of content is easily accessible, are the certain factors which affect the consumers to choose OTT platforms.
- Price: This analysis suggests that price is the factor which influence the respondents to choose OTT platforms over traditional television service. Annual subscription charge of the OTT platforms is lower as compared to the annual subscription charges of the traditional television service.

VI. CONCLUSION

More and more media consumption is happening on digital media, and people are spending more time on digital media as compared to traditional media. This increase can be credited to the improvement in technology and internet connectivity, which has provided the viewers with the option of accessing digital media content on the go. This has given rise to the demand for on-demand digital media platforms. The results of the study indicate that there has been an increase in the usage of OTT platforms during the lockdown. The quality of the content, with convenience, and no advertisement has increased the usage of OTT platforms among the Indian consumers. People working from home has more leisure time and they spend most of it by watching video content in different OTT platforms. The respondents equally enjoy watching both movies and TV series in different OTT platforms. The most used streaming applications are Netflix, Amazon Prime and Hotstar among the Indian consumers. The results show that there is an increase in the viewership of OTT platforms due to the covid-19 outbreak and the subsequent lockdown. Despite having DTH/cable connections, the respondents are opting for OTT platforms which signifies a sharp rise in the on-demand video streaming industry. The study also identified the various factors which influenced the growth of OTT platforms were majorly due to the viewership and payment, convenience and accessibility and price.

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E Commerce – Stitching the gap between weavers and Consumers

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1.ABSTRACT

The handloom sector is the sustainable, timeless, eco-friendly facet of the rich art and cultural heritage of India. Whereas with the technological evaluation, the handloom industry has dawdled due to lack of marketing and product modernization. From the last decade, the eCommerce industry is growing like a bush-fire and with the availability of the internet, people are preferring online shopping. The study is to understand and analyze the role of eCommerce on handloom weavers for selling products directly without the middlemen. The study provides primary level input for developing the bases for taking the decisions and has shown handloom weaver's economic condition and their interest in selling products through the online platform.

A standard questionnaire has been used for surveying five major clusters of India and the conclusion is drawn based on the findings.

Keywords: Handloom, Weaver, Social Media, Digital Media, E-Commerce, Economy

2.INTRODUCTION

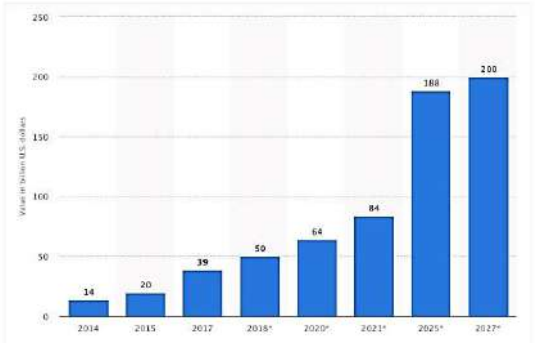
The term handloom is defined as "any loom other than power loom" (The Reservation of Article for Production Act, 1985)

Handloom sector in India is an important un-organized, huge employment provider, eco-friendly, family-driven, artistic heritage. Whole world is enticed by the craftsmanship and intricacy of Indian handloom.

The "Khat-Khat" sound of looms filled the narrow by-lane are no more heard and drowned in the buzz of the power loom as many weavers had switched their profession. Almost every states of India have its own traditional handloom legacy that represents their uniqueness and traditions.

2.1 Handloom Marketing: With the advancement of technology the idea of buying and selling and the marketing trends are changing along with the consumers choice and preferences.

Chart 1: India eCommerce Industry Market Size in Billion US Dollar from 2014 to 2027



Source: Statista

Above chart shows that e-commerce market in India is growing rapidly, a weaver can instantly start selling directly to a population of a billion people.

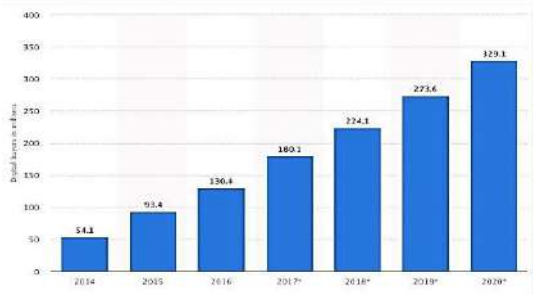
2.2 Weavers, being over-shadowed by the middlemen (Mahajan):

In the handloom sector the weavers are shading their blood and sweat, but the actual profit gainers are the middlemen (Gaddidar), the entrepreneurial class of the supply chain. Most of the weavers are leaving the industry because of low profit, irregular wage system, inconsiderate behavior of the middleman.
Citing a case study of "Unfair trade practices" by (PACS India). According to this case study, Vakar Ansari (Master Weaver, Varanasi) said that the sarees sold by him for (Rs 9500) are actually retail for double the price, once the middle men have added their mark ups. They still cannot avoid these middlemen as they provide them business and as they don't know how to get the customers without them.

2.3 E-Business model and methodology:

E-Business model is an approach which uses advanced technologies and internet for exchanging information with which a company can sustain and generate profitable revenue growth. (Statista 2016) There exist 3 types B2C, B2B and C2C basically in which B2C (Business to Consumer) is much newer area based on electronic retailing over the internet. ECommerce industry is based on B2C model.

Chart 2: Number of digital buyers in India from 2014 to 2020 (in millions)



Source: Statista

According to the above chart, digital buyers are increasing rapidly that's why almost every firms are going digital for coming close to the targeted customers.

3. LITERATURE REVIEW

In the interest of the study, following literatures were reviewed.

Ashish Kumar, Simran Kaur. (2018), analyzed different attributes and several government schemes for boosting handloom industry. They have also identified the different pain points of the handloom sector and suggested numerous strategies for the good-will of handloom sector.

Dr. Sabiha Khatoon (2016), recommended that the "Make in India" program can be a great success by strengthening products and showcasing it in global market through several online platforms which can boost the import and export trade of Indian handloom sectors. Further, recommendations include the conduction of skill development programs, cost control, technology up-gradation and providing market avenues.

Shaw Tanusree (2015), examined that the division of weavers, capitalism and the production process is totally controlled by the "gaddidars" (mahajan), the entrepreneurial class, and they were possessing capitals and power in order to control the entire production process and labor in Varanasi. Due to which there exist stagnancy in the weavers personal and financials. As a result, the Banarasi sari markets are now flooded with the **"Duplicate Saree"** instead of the authentic one, which is degrading the age-old legacy of Indian handloom.

Dr. Esha Jain, Ashank Yadav (2017), illustrated about the developments of modern technology and its impact on marketing as it is the faster and easier way to reach out to a large number of target audience by conducting surveys and campaigns as compared to non-digital and traditional way of marketing.

Shilpi Jain, Sripurna Basu, Bishka Majumdar, (2018), analyzed the problem in the adoption of information technology in the handloom sector of rural India. Creating small entrepreneurship, spreading education and social empowerment can solve the major problem of rural poverty and can boost the Indian economy.

Anam Bhatti, Hamza Akram, Hafiz Md. Basit, Md. Bilal (2020), analyzed how coronavirus has transformed the global and eCommerce trends as well as impending progress in eCommerce that might affect consumer behavior in future. They had reviewed how it could provide alternate way to people to meet their demands and future trends.

4. RESEARCH GAP

The literature review makes it evident that there are many detailed studies on the prospect of handloom industry, unfair trade practice, inequal wage system, socio-economic problems, government schemes and subsidies, importance and adoption of technology, entrepreneurship development. But hardly anyone has bridged the gap between all these sectors with subsequent evidence of conducting a study or survey. This gap will be cemented by showing how the weavers can market their own product using eCommerce model and how to make revenue out of it which can make their purchasing power better.

5. OBJECTIVES

- To highlight the pain points of weaver's economic condition.
- To examine, whether eCommerce business tools can bring betterment to the weaver's income level.
- To demonstrate the importance of eCommerce in order to reach out to the customers.
- Post COVID-19 whether online training could improve their economic condition and purchasing power.

6. RESEARCH METHODOLOGY

Need of the study: From last few decades, economical condition of the handloom weavers is deteriorating, whereas the middlemen are the most benefitted person. During Covid-19, handloom sector faced the worst-hit but E-commerce was a massive-hit. People's dependency on the online services boomed the E-Commerce business.

Scope of the study: The study broadly examines the weaver's opinion on eCommerce, perilous economic condition due to unfair trade practice in the selected areas of **West Bengal** (Murshidabad, Nadia district), **Madhya Pradesh** (Chanderi district), **Uttar Pradesh** (Varanasi), **Telangana** (Pochampally district).

Source of data: The above objectives can be accomplished by using (i) primary data and (ii) secondary data.

Primary Data: A standard structured questionnaire (Moc.gov.kh. 2013) has been issued to collect the primary data through survey process and sample method. The survey was conducted mostly through physical visits and interviews were taken by telephonic and google survey form. We have done descriptive study and used categorical values for frequency distribution(demography) and crosstab(relationship).

Secondary data: Data collected through published and unpublished reports by the government, published research paper, books, thesis and popular websites related to the Handlooms.

Sample size: Sampling unit consists of 70 respondents (handloom weavers) from different weaver's guilds to know their understanding on digital media

Statistical analysis: Percentages, Crosstabulation and Chi-Square test, frequency distribution is applied to analyze the data and to drive the valued interpretations.

Area of Study: The study was confirmed only to the Handloom Weavers in the selected states.

7. ANALYSIS

Handloom weavers were hamstrung by the pandemic. As per the survey, it is quite evident that most of the weavers are employed by the middleman, company and associations. The weavers don't have sufficient knowledge and scope of selling products online and through offline medium in the study area.

7.1 Demographics:

From **chart 3** we have found most of the weavers belong to age group of 31 to 40 years. Least are above 60 years.

Chart 3: Age

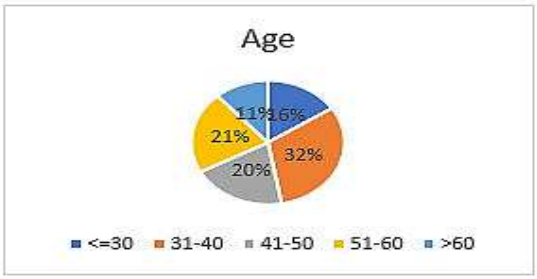


Chart 4: Qualification

From **chart 4** We found **(11.4%)** weavers are uneducated, whereas **(15.7%)** are graduated.

Chart 5: Internet-accessibility

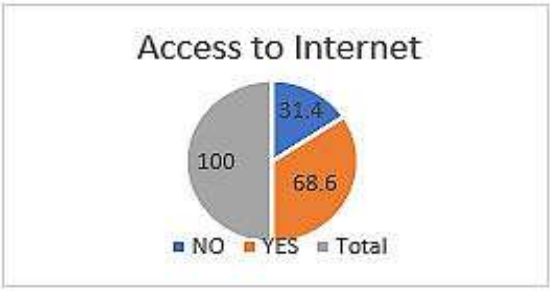
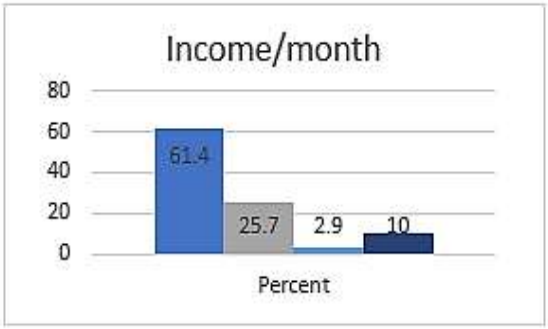


Chart 6: Income per month



From **Chart 5 and 6** it's clear that (61.4%) weaver's monthly income is below 10000rs only (10%) weaver's monthly income is above 30000rs. (68.6%) weavers have access to internet and 31.4 % don't have accessibility

7.2 Associations:

From the entire sample we have done the demographic in the earlier section. We have tried to establish relationship between variables with these three questions

- Are you interested in attending training workshops?
- Do you have any idea about digital marketing?
- (Post COVID-19) Are you willing to develop/ expand your business over online if trained?

We have taken above three parameters as **Independent** and others as **Dependent** Variables

7.2.1: Association between weaver's interest in attending training workshops and other variables:

From Table-1, it is observed that P value=0.031 i.e., P<=0.05 this means age is statistically significant, which shows that there is a significant difference in age group on their interest in attending training workshop.

It is observed, that the maximum weavers(<=30years) have opined that they strongly agree **(90.0%)** to attend training workshop.

It is further seen that weavers from Nadia district given positive response **(76.9%)** and **(81.8%)** of graduated weavers are interested in attending training workshop. This means educational qualification is statistically significant which shows that there is an association between educational qualification and their interest in attending training workshops. From the table below it is found that the weavers, selling their product directly opined that they strongly agree **(83.3%)** to attend the training workshops.

It is further observed that there is a significant association between weavers' interest and internet accessibility as they have strongly opined **(70.8%)** in attending training workshops.

It is observed that **(71.4%)** weavers agreed upon importance of social media and weavers who wanted to expand their business over online have shown strong **(61.9%)** interest in attending training workshops. This is also statistically significant.

TABLE 1: Association between weaver's interest in attending training workshops and other variables

Sr No	Groups	Response		P value	Significance
		Category	***positive %***		
1	Age	<=30 years	90.9	0.024	Significant
2	Location	Nadia	76.9	0.027	Significant
3	Educational Qualification	Graduation	81.8	0.000	Significant
4	Who is employing you	Company, self	83.3	0.026	Significant
5	Do you sell your products directly to sellers	Direct to market	100	0.016	Significant
6	Do you have access to internet?	yes	70.8	0.000	Significant
7	Do you think social media is necessary for business growth?	yes	71.4	0.018	Significant
8	How likely you want expanding your business over online platform?	yes	61.9	0.000	Significant

Significance @ P<0.05

7.2.2 FROM TABLE 2 it is observed that weavers age group (<=30 years) have given positive response (63.6%) about having an idea about digital media marketing. This is statistically substantiated that weavers feel positively on this point and there is statistically significant difference in age group on their knowledge/idea about digital marketing.

It is further noticeable that 22.2% of male weavers have opined that they have heard about digital media, and 40.9% of 12th passed weavers have idea of digital marketing this means educational qualification is statistically significant.

It is further observed from the table that weavers, whose monthly income is above 30000rs shown strong agreement (42.9%) of having idea about digital media. It is also statistically significant. It is further noticeable that weavers with internet accessibility and have marketed their products through online have opined that they have heard the term digital marketing and they have shown interest in expanding business over online. From the above table it is further observed that weavers who have received technical assistance to improve weaving skills and techniques have opined that they have (38.1%) knowledge about digital marketing.

TABLE 2-: ASSOCIATION BETWEEN WEAVER'S IDEA ABOUT DIGITAL MARKETING AND THE OTHER VARIABLES:

Sr No	Groups	Response		P value	Significance
		Category	***Positive %***		
1	Age	<=30	63.6	0.031	Significant
2	Gender	Male	22.2	0.018	Significant
3	Educational Qualification	High School	40.9	0.003	Significant
4	Overall Monthly Income	Above 30,000rs	42.9	0.018	Significant
5	Do you sell your products directly to sellers	yes	38.9	0.002	Significant
6	How do you sell your products?	Online and others	100	0.014	Significant
7	Do you have access to internet?	yes	27.1	0.000	Significant
8	Have you marketed your product through social media?	yes	44.4	0.030	Significant
9	How likely you want expanding your business over online platform?	Highly	29.2	0.003	Significant
10	Have you ever received any technical assistance to improve weaving skills and techniques?	Yes	38.1	0.030	Significant

SIGNIFICANCE @ P<0.05

7.2.3 FROM TABLE 3: It is observed that 69 out of 70 weavers who are employed by third party or have their own company have given positive response (98.6%) about their willingness to develop business over online (post Covid-19) if trained. This means the relationship is statistically significant company have given positive response (98.6%) about their willingness to develop business over online (post Covid-19) if trained. This means the relationship is statistically significant.

It is further observed that all weavers agreed upon handloom market getting affected during COVID-19 and post COVID-19 their willingness for selling product online if trained.
After hardships faced during covid-19 weavers have realized the importance of marketing products and selling directly to the consumers using online platforms

TABLE 3-: ASSOCIATION BETWEEN WEAVERS WILLINGNESS TO DEVELOP/EXPAND THEIR BUSINESS OVER ONLINE IF TRAINED AND OTHER VARIABLES (POST COVID-19)

Sr No	Groups	Response		P value	Significance
		category	***positive %***		
1	Who is employing you?	yes	100	0.043	Significant
2	Did the handloom market get affected during COVID-19 pandemic?	yes	100	0.014	Significant

8. INFERENCE:

The following results are drawn from the study

- Weavers who were graduated and below 30 years are technical enough and have shown enthusiasm in attending training workshops on e-commerce and digital marketing.
- Weavers with internet accessibility tend to attend the training workshop and grow their business online.
- Weavers who have sold their products online have an idea about digital marketing and know the importance of eCommerce.
- Most of the weavers have shown interest in growing their business online post-covid-19 if trained properly.

9. CONCLUSION:

we may conclude that most of the weavers have basic education, that means they are literate enough to understand and attain training workshops, 60% weavers have internet accessibility and 98.9% weavers are thinking of switching over online platform for boosting their income. So, we can infer that if weavers receive proper training on eCommerce marketing and process of selling products directly to the consumers (B2C) they can enhance their business

This may be exemplified from an article of **(The Economic Times 2015)** that many weaves would now be available on platforms like Flipkart, Amazon, eBay, and others. To get a broad consumer base globally many handloom bodies are opting for established eCommerce platforms.

Tata Trusts' initiative **'Antaran'** and Microsoft's project **'Reweave'** collaborated to skill the weavers technically.

Honorable Prime Minister Mr. Narendra Modi's **"Digital India Initiative"** has transcended the gap between consumers and handloom weavers by collaborating with tech giants like Amazon & Facebook.

Amazon's initiative of Amazon **Karigar** and Handicrafts Mela are supporting weavers to sell their products locally and globally. Facebook's initiative of **'Six Yards and 365 Days'**, Instagram's hashtag 'Vocal for local', Government of India's **E-Dhaga** app launched along with several schemes for weavers triggered the marketing of authentic handloom products direct from the weavers.

10. SUGGESTION & WAY FORWARD:

The study has shown handloom weaver's economic condition and their interest in selling products through the online portal. There exist many initiatives taken by govt and several tech firms to market handloom products. This study is just a pioneer work and can be further taken up for future research for robust reverse policy prescription.

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Generic visualization scheme for monitoring and strategic control of industrial systems

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***Abstract*— Control system for Industrial application often monitors and controls thousands of sensors and actuators in a single area of an industrial batch processing or continuous processing plant e.g. Steel Plant, Cement Plant or Paper Plant. There are normally alarms set to monitor parameters to check if the situation is going out of control. In many situations there is too much data to be monitored. A common saying is that there is too much data in the system and too little information. The operator is lost in the plethora of data and unable to get an overview of the system performance as a whole. The present paper addresses this issue with a generic visualization of the plant parameters to enable the operator to perform effective and strategic control, keeping the key performance Indices within an acceptable envelope.**

Keywords*— *Human-Machine interface, Human supervisory control, Alarm, Human technology integration, Performance visualization in Control System, Plant performance optimization, Artificial Intelligence.

I. INTRODUCTION

Process industry heavily relies on automated processes. They help to produce products with higher quality in less time, using less energy and raw materials. The degree of complexity and automation is still on the rise. Today, process control systems have graphical interfaces that display an enormous amount of data to be monitored by fewer and fewer operators. [2]

It seems that there would be no need for human operators if plant is fully automated. However, when more automation is installed in a plant, the operators have less training in controlling the process manually. This can be crucial when exceptional process states occur.

In such situations it is important for the operator to make correct decisions to bring the process immediately back to a stable state. With high degree of automation, the operators do not acquire the skills of controlling the process manually. In addition, long observation periods reduce level of vigilance, thereby, reducing the possibility of detecting important abnormal conditions.

From the operator's point of view, the complexity has increased because of use of different automation equipment and software products for process monitoring and control. Use of intuitive visualization bridges the gap between operator and production process. A graphical user interface provides situational awareness, enable immediate detection of exceptional process states and target-oriented information.

Typical information available in the control room includes:

-DCS Overview displays: Direct measurement of process variables critical to control
- PI Trends displays: Historic performance of process variables critical to control
- CCTV: Direct observation of online production status
- On stream analysis or MSA (multiple stream analysis) displays: Usually in table and trend format providing direct measurements of assays in flotation streams.
- Camera image analysis display: to assist operators for online diagnosis or status.
- (Visual or auditory) alarms: Alarm summary window or the latest alarm popping up at the bottom or top of each screen to indicate a deviation on an instrument reading of a process variable.
- Communications with people around the control room

It is easy to see that an operator can get overwhelmed with data, particularly at the time of crisis and may not be in thebest position to take appropriate decision.

There has been a lot of work going on Man-Machine interface with displays in plant control systems to make displays meaningful and operator friendly. An operator typically needs to be trained specifically on the system operating in a specific plant area to be able to understand and operate the controls when manual intervention is needed. A typical display from a process plant is shown below:

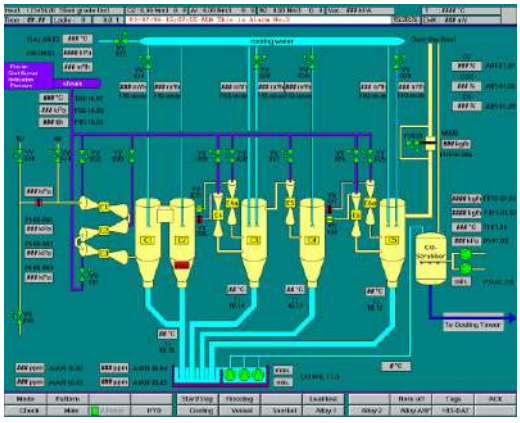

Figure 1 : A typical Process Plant mimic diagram

A typical plant operation is depicted with several such displays mimicking the Process and Instrumentation Diagram of the various liquid or gas flow e.g. water, fuel, steam as well as output of the process plant. On top of the screen, typically the alarms are shown in a streaming display. Many times the operator fails to get an overall grasp of the system performance from several such displays.

Unless there is very high level control system with systems models or artificial intelligence in place, which are not at all commonplace in industrial scenario, it is difficult for the operator to figure out and pursue a strategic control under a given circumstances. It is with this issue in mind the present paper is presented which will guide the operator to choose a correct strategy keeping considerations like Throughput, Costs, Safety and Ease of Control (conversely, avoiding severe control strategies), which are important for any plant. None of the available approaches [8][9][10] address visualization of complete industrial process in a comprehensive way as outlined in the present paper.

II. Objective

The objective of this paper is to design a man machine interface which gives a clear visual idea of Throughput, Costs, Safety and Ease of Control, in any instant. It will encourage the operator to choose a strategy manually, if needed or monitor whether these parameters (Throughput, Costs, Safety and Ease of Control) are well within limits set up by plant designers. If they cannot be contained within the stated limits the problem may be escalated by the operator. The purpose is to avoid unnecessary operator panic, at the same time, enabling the operator to maintain overall system performance.

III. Methodology

The method for providing a generic status display depicting overall performance of the control system is to quantify key performance indices (KPI) e.g. Cost, Throughput, Safety and Ease of control. Mathematical expressions have to be developed for the automated process in question for each of the key performance indices.

Throughput KPI is certainly an important element in any process plant. Let us say, there are two outputs from a plant, e.g. Propane and Butane in liquid form. How much of those liquids are produced in a given time would determine Throughput KPI. Suitable scaling, normalization and weightage applied to the actual production figures will be employed to yield a composite figure which has an acceptable range within 100 to 150. Given other KPIs of Safety, Ease of Control and Cost are within acceptable range, higher Throughput KPI would be more desirable.

$$\text{Cost} = f_1(\text{Cost of Raw Material}) + f_2(\text{Cost of consumables})$$

These relationships may be quite complex but once they are formulated and entered into an equation after scaling, weighting and normalization of the actual values, to a figure below 150, the operator need not worry about the calculations as long as the parameter is within specified limits. Let us say that for all the axes of the spider graph the limits are 100 to 150 for desired range of operation. This would mean that as long as this KPI is within 100 to 150 the operation is under control. For Cost KPI, lower figure would be more desirable.

In a similar way, each of the other key performance parameters may be evaluated. It must be noted that evaluating key indicator like Safety, we may take Pressure and Temperature of critical sensors and evaluate them. If the critical temperature and Pressure parameters are on the higher side, Safety KPI would yield a lower calculated value, indicating lower safety of the operation. It may be of highly non-linear nature, in the sense, that even when all other sensors are behaving well one particular sensor, say Steam pressure may have exceeded critical value which may result in completely unsafe operation calling for a system shut down. The system would automatically shut-down without operator intervention but the display envisaged would serve as an early warning system. Arriving at a composite Safety KPI figure, will require expert knowledge of the process but once this calculation method is formulated for a process, the operator need not worry about it every time.

Ease of Control KPI is to get an idea about how easy it is control the process at the present moment. The process may be yielding acceptable values of output parameters currently but some control valve positions may be at their limit, thereby leaving no head-room for manipulation if the uncontrolled variables so demand. In such situation, Ease of Control KPI would go down indicating process would be difficult to control. It is desirable to have the KPI as high as possible.

The system will also allow storage of past performance allowing operator to compare past performance with present situation. Benchmarking with a past good performance would provide guidance to the current operator of the plant.

To summarize, we define two associated parameters for each KPI. The associated parameters shown below are themselves composite values derived from underlying measured parameter values in the Process control system or measured values from laboratory.

- Throughput KPI derived from Production output 1 and 2 (for multiple outputs suitable formula to be worked out), to be maximized.
- Cost KPI derived from Raw material cost and consumable cost, to be minimized.
- Safety KPI derived from Critical Pressures and Temperatures, to be maximized
- Ease of Control KPI, derived from Control valve position and uncontrolled variable values, to be maximized

For visualization, the KPIs along with their associated variables are traced over time and displayed on a spider diagram shown in Figure 2. At any given instant the process is at a point on the graph and the historical trace may also be displayed for better insight into the process. [5][6][7]

IV. Components

Primarily the hardware and software components in the system are as follows:

- A standard Distributed Control System operating the process plant with its firmware in place

- Software modification to include calculation of key performance parameters.
- Development of additional display to display the Spider Graph as shown in Result Analysis section below

V. Result Analysis

In the illustrative figure 2 below, Key Performance Indicators are shown in the main four axes. Each main Key Parameter is calculated based on the adjacent axes shown. The figures are scaled/normalized in a way such that figure of 100 to 150 means that it is within acceptable range. Operator may choose to trade off, say Safety with Throughput, within limits, and get higher throughput with slightly reduced Safety with a clear idea of what is being done.

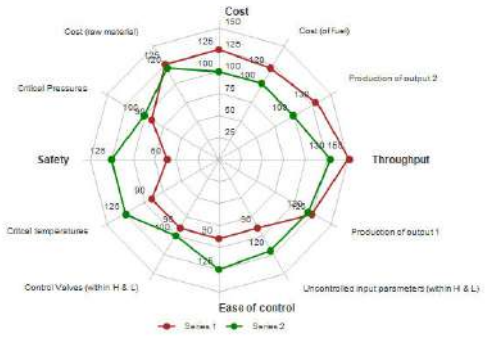

Figure 2 : Generic Spider diagram

For the purpose of analysis, two situations are depicted in the figure above, one shown in Red and the other in Green line. It can be visually ascertained that the graph in Red goes out of limit when Key Performance Indicator Ease of Control and Safety are evaluated, although the Throughput is higher than the one in Green.

In such situations the operator may be encouraged to choose the operation depicted by the Green pattern. The value to the operator of such simple visual aid is immense while controlling a complex process plant.

It would be possible to drill down to conventional trend or alarm displays wherever necessary. Let take the situation of Red line, Safety KPI. When it is seen that the Safety is low, one can drill down to see which critical pressure or temperature parameter is causing the Safety KPI to go low and then take appropriate action. The Spider Diagram helps in looking at the Big-picture, an insight that is missing in conventional data driven displays.

VI. Conclusion

Development and implementation of this Graphic User Interface will be of help to an operator of the plant. More importantly, it is generic in nature enabling interchangeability of operators from one process area to another. The visualization gives more insight into the process and makes the results of the interventions more interpretable.

VII. Future Scope

It is envisaged that many of the process plants will employ artificial intelligence or higher level control to lessen dependence on expert operators. The common activity during supervision of a control system is acting on a set of controllers, to see that the process objectives are met. This is normally known as local supervision. Supervision may also be done by using sources of information or data beyond the scope of the control currently under supervision; this is known as Global Supervision. [11][12][13]

The proposed system may be enhanced in scope to check that the trajectories of certain key process variables are close to their specified thresholds. If that is not the case, the system must investigate further for the reasons and causes for the discrepancy in order to advice or warn the operator. Historical data with Artificial Intelligence may be used, even if actuator control may not be given to the AI system. Most of the time, supervisory systems built under this type of concept is not able to modify its surroundings except through a corresponding control layer. The development of such software to assist the operator at the control room is advantageous from the following points of view: [2]

- Guarantee safe operation
- Assure efficiency
- Assure throughput
- Global Supervision ensures
    - Monitoring system attention to the process does not vary
    - More uniformity in the process, without usual shift to shift differences in quality
    - Much less operator stress
    - Planned objectives can be met

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Identification of an Input Attribute bases for Reactive Services in ERP : after Product Recall

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Abstract **- This paper means to inspect the determinants of the inclinations by customers after Product Recall and future buying intentions. All the more explicitly, this exploration means to explain the sorts of review procedures that organizations set forward, just as their effect on customer's practices and impression of the producer's picture. The objective behind this examination is to look at how Product Recall influence on repetitive buying intentions and what bases can be taken into consideration for developing effective actions for reactive services after product recall in the existing ERP. Based on the proven research results and role of the consumer during product recall, the information gathered, analyzed and investigated utilizing qualitative and quantitative mix model. As the consumers' perception is in center of the process of handing the product recall, the categories developed in previous research had tested in Indian context. Based on the study the efforts have been put down to identify the influence on the consumers for buying again the product of the brands or the same product after product recall. Results show differing impacts of voluntary / non-voluntary recall on the influence to the consumers for the given case studies of M models of BMW India in 2020. The categories developed in previous research have been tested in Indian context reveals that the behavior of the consumer group depends on many unexpected variables: many known and unknown, based on this the research opens the doors to help brand administrators in creating post-recall consumer management strategies applicable to Indian automobile consumers. In addition, the creativity of this exploration comes from the way that the producer's brand image is considered as a feature of the inconsistent tradition of the organization that it could be influenced by the "emergency circumstance," not a steady resource.**

Keywords— Affective commitment, Product recalls, Purchase Intention, Consumer Behavior, Brand Image, Risk Management, Crisis Management

I. INTRODUCTION

As far as effect on a business, a review is considered as a response to an emergency circumstance. As per the previous research [19], an emergency includes an occasion or arrangement of occasions that influence the exercises of an organization and damages its partners. An emergency carries unfriendly ramifications to tasks, funds and the standing of an organization. It has been observed that there are distinctive emergency modalities as indicated by the harm they can cause as far as benefit and notoriety with partners. In outrageous cases, the emergency may even compromise the endurance and the standing of the organization. Review is a route for organizations to manage emergency that carry danger to purchasers. An organization's choice not to direct a review, given its information on an item that could represent a peril to the wellbeing of its shoppers, frustrates its standing, deals and expands costs with instalments of reimbursements for hurt buyers.

Previous research focuses on the impacts of product recalls on brand commitment and further implications to the part of brand responsibility on purchase intention of the consumer group. Buyer brand commitment is characterized as enthusiastic or mental connection to a brand. It is viewed as a faith in a continuous relationship that is deserving of contributing most extreme exertion to keep up. Such significance makes responsibility not just the critical component to foresee brand–shopper relationship security yet additionally a driver of buyer reliability and rehashed buys. Commitment additionally assumes a significant part during negative exposure.

The Recall of the Product happens when items contain dangerous materials, can cause genuine injury or demise whenever utilized inappropriately, and disregards security norms. The expanding unpredictability of items and markets (related, among the others, to the augmentation of creation and appropriation affixes and to the developing utilization of redistributing concurrences with organizations situated in nations where item security guidelines are less rigid), the exercises of relationship for purchaser assurance, the more severe item wellbeing enactment and the intercession of administrative affiliations, for example, the U.S. Purchaser Product Safety Commission or the EU Rapid Alert System for all Nonfood Dangerous Consumer Products (RAPEX) have made item hurt emergencies repeating occasions indicated that the development of this wonder is inferable to some extent to an overall good debasement and a decrease of authoritative controls.

II. LITRATURE REVIEW

Regardless of the developing number of item emergencies, organizations are still regularly ill equipped to oversee them deliberately furthermore, the quantity of studies exploring this issue is still scant. When all process is done, an organization could respond to the item emergency in a few elective manners going from refusal to the acceptance of accountability and unqualified Product Recall what's more, super exertion. Accessible examinations reflects that product recall of hazardous items from customers are the measures most oftentimes embraced by organizations engaged with likely emergencies. Furthermore, it should be commented that at times Product Recalls are not coming about because of an unconstrained exertion of the organization, however from a commitment to mediate by public specialists. Truly, the review starts with the revelation of an imperfection either by either stakeholder of the channel. Various pas studies proposes that the result of the item emergency is impacted fundamentally by three factors:

the outside impacts (for example the dispersal of information by the media) and accompanying to the emergency. As respects the third factor, accessible investigations on these issues frequently contain the recommendation of key rules for dealing with the Product Recall and lessening its negative impacts.

Product recall can prompt negative ramifications for the organization, one being the effect on the trust that customers have in a specific brand. As indicated by the previous researcher, the public's trust in associations is basic to guarantee its authenticity and endurance. [8]

Various studies have characterizes trust as the eagerness of involved with be helpless against the activities of another gathering dependent on the desire that the other will play out a specific activity critical to the trustor, without the requirement for observing or control. An individual or substance is considered dependable when it is seen as having skill, kindness and honesty. Subsequent to allowing a chance to the organization, the customer assesses the outcomes accomplished, which can fortify or debilitate their certainty. At the point when view of ability, humbleness and honesty of an accomplice are high, this accomplice will be considered as entirely solid. The writing on the builds considered in this investigation demonstrates that capability and generosity related with uprightness add to the improvement of trust. [8]

Previous studies propose a calculated model of trust that incorporates capacity, consideration and trustworthiness. As indicated by the creators, capacity is the degree to which the gathering is regarded to have abilities and skills in the area of interest. In this article, capacity will be treated as skill.

For the creators, trust originates from consideration, ability and uprightness, yet these develops, are free and don't generally differ a similar way. That is, there are connections in which there is consideration, yet no ability, there are others in which there is fitness and kindheartedness, however no trustworthiness. Ability, comprises in the desire for a reliably qualified exhibition of an accomplice, a condition for the advancement of trust in a relationship setting.

Previous studies recommend that kindness compares to a view of a positive direction in which one of the gatherings – individual or association – wishes to do well to the next without the interest in its own bit of leeway. In a circumstance where there is altruism, there should be no falsehoods. The creators stress that consideration isn't adequate for there to be trust. It should be joined with skill and trustworthiness.

Previous research characterized that respectability is a goodness of every expert relationship, and has two implications. The principal importance is identified with the adherence to an ethical code, and the second, to culmination/respectability. The trustworthiness has become a resource for organizations, and its reality is joined by the craving to act with care and alert. The committed efforts from the organization for effectively handling the recall reflects the pessimism from influencing the favored brand. Subsequently, the ramifications of commitment on shopper maintenance is critical, particularly under negative exposure, for example, a product recall. Commitment is arranged into two kinds, in particular, emotional and Logical responsibility.[9]

III. THE MAJOR CAUSES AND PROCESS OF HANDLING PRODUCT RECALL

Product recall are a converse dispersion movement that pulls out products from clients or from selling areas. An item review tries to pull out the item from the market. The items are either risky or blemished, are definitely not as per determination, or don't follow government compliances. The review cycle commonly involves an official declaration sketching out the explanation behind the review and a cure offered to the client [6]. Purposes behind reviews incorporate issues, for example, non-conformance to quality, not keeping up some particular standard or particular, or absence of wellbeing [4]. Willful wellbeing related reviews are the obligation of the provider. In the event that item related issues are experienced by clients, clients advise the retailer or nearby provider, or the producer.

When numerous clients experience a similar issue, the maker (or now and then an administration authority) researches the issue, settles on a review choice and illuminates particular clients and partners. On the off chance that makers do not remember or don't react to client grievances, at that point the government authority may examine further. In the event that administration specialists discover a wellbeing standard disregarded, they contact the producer, who starts the reviews cycle.

Once in a while, in the event that item determinations don't coordinate with government security guidelines, government start producers to review the item from the market. Government started reviews follow a progression of examination stages, anyway at any point in the examination cycle the producer can select to lead a review [20]. On uncommon events, producers disagree with the choice of the government and carry the issue to court. When reviews are declared, producers send notice letters to clients what's more, declare the review through the media so that the item can be acquired and the issue settled.

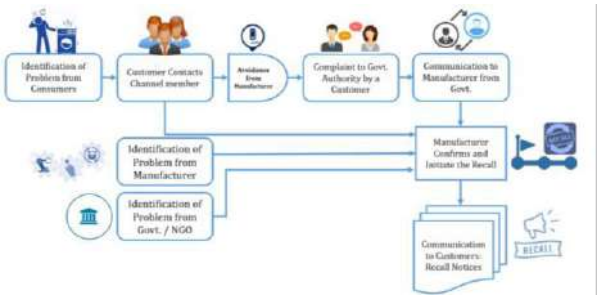

Fig. 1. The Common Process of Product Recall

The entire cycle of review is extensive. There are numerous means before a last review choice is made. Once in a while producers set aside some effort to react to client objections and a few cases end up in court and the particular government authority manages the maker to go to a settlement pay for clients. A genuine illustration of protracted review measure incorporates the Ford Motor and Firestone Tire review 2000. The NHTSA got letters from Ford Explorer proprietors in the USA from the mid 1990s. In July 1998, the NHTSA got information from insurance agencies with respect to 21 instances of Firestone tires for Ford Explorer mishaps. Subsequent to accepting more grievances the NHTSA reported a conventional imperfection examination concerning 47 million TAX, ATXII and Wilderness tires fabricated by Firestone. The Firestone tire

review that influenced Ford vehicles took over a long time from the primary report until an official choice was reached. The ongoing expansion in item reviews has moved consideration from why items are reviewed to why it takes such a long time to review faulty item that present wellbeing perils [6].

IV. THE PRODUCT RECALL CASE OF M MODELS OF BMW INDIA IN 2020

During this lockdown, BMW India dispatched three new vehicles. These incorporate the 8 Series Coupe and Gran Coupe models. Nonetheless, the 840i model is being reviewed now. Alongside it, the M6, X3M, X4 and X6 too are being reviewed. The explanation is distinctive for each model. The BMW 840i was fabricated between February 10 – March 2, 2020 and just five units including M6 were sold here. The explanation given is that the corridor sensor may pass over. This will occur because of mistaken wiring. This demonstrates a wellbeing danger as the airbag module for the driver or traveler probably will not work in such cases.

Eight units of the BMW X3M and X4 models are being reviewed to fix a downstream exhaust system oxygen sensor warming up. For this situation, the OBD too has been debilitated and henceforth it is hard for the proprietor to recognize this also. These units were fabricated between June 7, 2018 – March 10, 2020. With respect to the X6, just two units are influenced. These were made between January 16, 2020 – January 22, 2020.

The back spoiler of the X6 is fixed on the upper side of the rooftop. BMW says that the holding may be poor, consequently making it tumble off. For the BMW M6, the organization says that 16 units are influenced. These were made between Oct 4, 2013 – March 31, 2016. The models are being reviewed because their high-mounted brake light lays on six screws. Because of warmth and different components, these screws are being pushed out of their place, making the stoplight clatter when going quick or over broken joints. There is no time span given for the fixes however, we comprehend that the oxygen sensor issue may take at some point at the administration place contrasted with the others. Every one of these fixes will be liberated from cost to the client and the organization expects to begin requesting that clients visit administration focus once the lockdown is lifted.

V. THE RESEARCH APPROACH

Based on the proven research results and role of the consumer during product recall, the information gathered, analysed and investigated utilizing qualitative and quantitative mix model. Accordingly, the examination addresses explored during this study are:

- How does a product recall affect these two unique kinds of responsibility?
- Does it have similar impact on the two sorts of commitment? If not, what drives the distinctions among them?

The study presents 04 categories of the consumers groups, suggested by the previous studies on logical grounds.

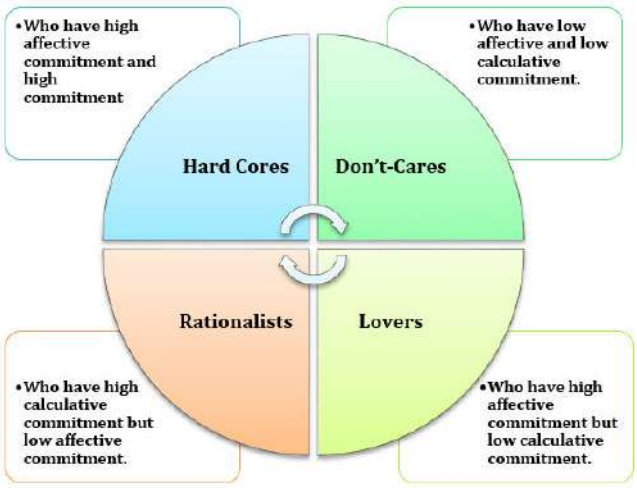

Fig. 2. These Four Categories of the Consumer Groups

Previous examination suggests that these four purchaser gatherings will react diversely to an item relied upon interior and outside attributions, including inner shopper qualities (for example brand trust, hazard recognition and thinking style) and outside review factors (for example review commitment , earnestness of the review and center of handling process of withdrawal of a product). The outcomes demonstrate changing examples of review consequences for responsibility over the four client gatherings, with a solid part of emotional commitment on buyers' post-review buy expectation. The commitment of the paper is as per the following: this investigation progresses the writing on the recall consequences. Second, the study likewise present another methodology, for example a limited combination model, to examine test information to the advertising writing, which is equipped for controlling for arbitrary and deliberate mistakes during gathering of the details.

VI. THE HYPOTHESIS

To explore this further, the examination classifies shoppers into four gatherings dependent on their degrees of these two responsibilities, specifically, Hard Cores, Don't-Cares, Lovers and Rationalists Hard Cores Hard Cores is characterized as buyers who show a serious level of both emotional and Logical duty for the brand. They are normally brand faithful and offer basic qualities with the brand they like, while their decisions are impacted by objective conduct, for example, exchanging costs, monetary advantage and the quantity of accessible decisions.[6] An item review may make a fear of significant worth sneak past, and thusly may incite buyers' sound decision of isolating from the thing. Thusly, Following are the speculation produced for improving bits of knowledge in understanding the review measures with shopper bunch outlook. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

VII. METHODOLOGY

This examination canters around content investigation technique as an exploration apparatus. Our unit of examination is chronicled item review notice. Content examination is an exploration method that empowers

surmising to be made dependent on a content considering the setting in which it was composed. On the selected cases of Toyota and Skoda, before and after recall details of product recall was collected from the customers located in Gujarat State. The interview of the existing customers, included with various other objectives were framed and conducted. The event that comprises the gathering of all relevant customer also asked the questions and noted down the responses.

Subjective substance investigation requests carefully perusing each archive and comprehension and deciphering the content in its significant setting. Then again, quantitative substance investigation sums up the surmising and bits of knowledge got from the subjective stage as mathematical assessments of the deciphered content units and the connected sorted codes. The investigation uses subjective and quantitative procedures in an incorporated way.

We utilize the following substance investigation steps:

(1) Find wellspring of authentic review information
(2) Gather review notice,
(3) Search review notice component data,
(4) Search the information recurrence of pertinent subjective information.

VIII. THE RESULT ANALYSIS

In this study, basically, 4 Clusters of Consumers have been identified with stand point of brimming with Emotional Commitment (EC) and Logical Commitment (LC). Next, the changes in the two sorts of responsibility were taken a gander at after an item used coordinated.

TABLE I. HYPOTHESIS TESTING RESULTS

Sl. No.	*Description*	*Result*
$H_{1a.}$	***Emotional commitment of Hard Cores will not change after a product recall***	🔴
H_{1b}	***Logical commitment of Hard Cores will decrease after a product recall***	🔴
H_{2a}	***Emotional commitment of Don't-Cares will decrease after a product recall***	🟢
H_{2b}	***Logical commitment of Don't-Cares will decrease after a product recall***	🟢
H_{3a}	***Emotional commitment of Lovers will not change after a product recall***	🟢
H_{3b}	***Logical commitment of Lovers will decrease after a product recall***	🟢
H_{4a}	***Emotional commitment of Rationalists will decrease after a product recall***	🟢
H_{4b}	***Logical commitment of Rationalists will decrease after a product recall***	🔴
H_5	***Brand trust will negatively influence***	
	a) Emotional commitment,	🟠
	b) Logical commitment, and	🟢
	c) Intention for Repetitive Buying	🟠
H_6	***Risk aversion will positively influence***	
	a) Emotional commitment,	🟠
	b) Logical commitment, and	🟠
	c) Intention for Repetitive Buying	🔴
H_7	***Holistic thinking will positively influence***	
	a) Emotional commitment,	🔴
	b) Logical commitment, and	🟠
	c) Intention for Repetitive Buying	🟠
H_8	***The origin of responsibility on a favoured brand will negatively influence***	
	a) Emotional commitment,	🟠
	b) Logical commitment, and	🟠
	c) Intention for Repetitive Buying	🔴
H_9	***Seriousness of a product recall will negatively influence***	
	a) Emotional commitment,	🔴
	b) Logical commitment, and	🔴
	c) Intention for Repetitive Buying	🟢
H_{10}	***Product recalls of core products will negatively influence***	
	a) Emotional commitment,	🟠
	b) Logical commitment, and	🟠
	c) Intention for Repetitive Buying	🔴

Indicators:

Not Supported	🔴
Partially Supported	🟠
Supported	🟢

The above findings mentioned on the Table-1, the study recommend that a review causes inverse impacts on full of emotional and Logical responsibility. Along these lines, if the two kinds of brand responsibilities are not viewed as appropriately in a review study (as most surviving investigations do not), the noticed impacts of might be a disparage as the impacts counteract in within. Thusly, forthcoming examinations upon function of responsibility expected from the brand after product harm crisis may think about utilizing the two kinds of brand responsibility rather than its total worth.

The outcomes further show that full of emotional responsibility tends to be free, as it is affected simply by its pre-review emotional commitment level. Specifically, the emotional commitment is seen to have a more grounded antagonism obstruction than Logical commitment, as appeared among Sweethearts. This recommends that building solid brand connections with purchasers help shield brands from the negative impacts of product recalls. In contrast to full of Emotional Commitment, results show that impacts of review on Logical commitment rely upon the pre-review levels of emotional responsibility and buy goal alongside Logical responsibility. Accordingly, Logical commitment of buyers might be shielded from the negative impacts of a product recall, as long as either pre-review buy expectation or full of emotional responsibility is high before the occasion.

At last, the negative impacts on brand responsibility differ over the four customer bunches relying upon the

inward what is more, outer attributions. As for inner attributions, Hard Cores are impacted by trust and comprehensive reasoning styles.

As their responsibility, levels are high in the two sorts of responsibility, their inclination to take a gander at an occasion overall as opposed to examining it in detail adds to expanded Logical responsibility dependent on the sign of decision erasure by a product recall. Realists are inclined to trust their encounters and item information, which sort them as judicious chiefs. Hazard avoidance is likewise discovered to be a significant factor for Lovers. As they will in general maintain a strategic distance from buy hazard, they depend vigorously on the brand, in this way expanding their full of Emotional Commitment. Concerning outer attributions, Darlings and Rationalists are more impacted by these attributions than different gatherings. The negative impacts are critical particularly when a product recall happens to a center result of the brand they like.

Curiously, reality of a product recall diminishes the buy aim of Hard Cores clients as opposed to their dedication levels. At last, not one or the other the inward nor the outside attributions impacts responsibility levels of Don't-Cares, as they do not pay regard for a product recall in the brand. Notwithstanding, their buy goal significantly diminishes contrasted with different gatherings, basically in light of the fact that they are unapproachable from the brand, and in this way simple to switch brands.

With the growing number of product recalls, understanding how such events affect consumer behavior has become a vital issue for both academics and managers. This paper investigates how a recall event changes consumers' commitment toward the affected brand. The related hypotheses were presented and analyzed using an experiment. The results were further validated using a second study.

IX. DISCUSSION

Product Recall factors (time, capable review the executives, crafty review the board, fault ascribed to the organization) were discovered to be critical. Even more curiously three of such factors (time, capable review the executives and entrepreneurial review the board) are straightforwardly identified with the way the organization chooses to deal with the review. Subsequently the aftereffects of this examination give valuable experiences to the organizations to characterize precise techniques to limit the negative impacts of a review and even to fortify the enthusiastic and trust bond with their clients. Such outcomes are additionally especially significant because the investigation depends on an improvement (for example a genuine letter of review by a PC maker) identified with a genuine and late review scene, while past examinations were generally founded on fake boosts.

A few constraints of this investigation should be referenced. Most importantly, the utilization of a trial setting was essential to confine the impacts of every one of the recommended factors; however contemplating items review in reality would help to improve our insight on this issue and to assess the effect of a few different elements excluded from the investigation.

In addition, the examination dissected the momentary response after the review message, yet an assessment of the impacts in the medium term could be helpful, too. At last, it should be commented that examination about product recall is scant as contrasted with the emotional increment of such marvel. Subsequently new examinations are expected to reveal new insight into this issue furthermore, to help organizations in characterizing effective response plans.

It has been experimentally shown that the effects of product recalls vary across the four groups. Lovers are the consumers who can endure negativity more strongly than any other groups. Second, this study identifies the effects of internal and external attributions on Commitment and purchase intention for each group. Third, this study emphasizes that weighted commitment (i.e. Lovers and Rationalists) rather than balanced commitment (i.e. Hard Cores or Don't-Cares) can be directly hurt by the external attributions of product recalls, even when their purchase intention is detained. Thus, if the negative publicity continues, even the bumper effect of affective commitment in Lovers will be depleted in the end.

Likewise, this study proposes that the four commitment groups will have a different propensity to resist against a negative event such as a product recall. For example, Don't-Cares who have little commitment to a brand have a decrease of purchase intention right after a product recall. Meanwhile, Lovers tend to maintain purchase intention after a product recall, although their commitment levels are affected by a product recall.

The results suggest that mangers should have different communication strategies for the four groups after a recall event. For example, delivering a variety of substitutes under the recalled brand helps Hard Cores and Rationalists to maintain Logical commitment after a product recall. On the other hand, Lovers will pay attention to a message that emphasizes the psychological attachment to the brand (e.g. repeated brand advertisements), or nostalgic bonding with the brand.

X. ACTION INPUTS TO BE ADDED IN ERP

Product recalls may result in a massive influx of customers calling customer support. It is essential that the business do everything in its power to meet the customer service and needs of the clients and this means to inculcate following features in the ERP of the organisation:

- Reassure customers
- Give customers the information and service they need
- Retain customer loyalty based on the inputs from the study as shown above
- Swiftly deliver parts or replacement items
- Process, handle, forward or dispose of returns

Customers will be contacting your business directly, and if you're keeping them on hold or they receive a busy signal, you're not enhancing your customer experience.

XI. FUTURE DIRECTIONS

The Brand responsibilities are vital because of high inconstancy in brand duty levels among the respondents. Despite the fact that the outcomes acquired from the two examinations were comparable, future examinations ought to research whether there is a collaboration between

classification and brand responsibility. On comparable lines, we recommend that future examinations consider various sorts of item classes, for example, medication, youngsters' toys, vehicles, etc., and inspect whether our discoveries hold across them. In this investigation, brand responsibility was estimated rather than controlled and the connections are viewed as direct. Future investigations may consider controlling responsibility and approve whether the connections are without a doubt direct.

The current study is restricted to analyzing the adjustments in responsibility and buy expectation levels after an item review. It is conceivable that customers will recover their pre-review responsibility levels after the reviewed brand is once again introduced into the market. Notwithstanding, the inquiry stays regarding whether item reviews cause lasting harm to the buy conduct of purchasers. Future examination ought to think about utilizing longitudinal information to look at these significant issues. With expanding mechanical progressions, there is huge improvement in item security and guideline measures. Nevertheless, item review occasions are as regular today as previously. This paper inspects an imperative issue – the impacts of an item review on brand duty – and presents some significant discoveries. Ideally, this examination will urge different specialists to develop these discoveries and take this exploration territory to the following level.

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A Five-Attribute Complex Adaptive Systems Framework for Reinvigorating Organizations

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***Abstract*— Complex Adaptive Systems (CAS) are considered to be amongst the most resilient of systems, and reveal themselves in the successful functioning of corporations, economies, societies, ecosystems, and civilizations, amongst a host of other organizational realities. This article will consider key attributes of CAS that will form part of a five-attribute CAS framework to reinvigorate organizations. In the experience of the authors, all experts in the implementation of CAS, these five attributes of self-organization, distributed control, authenticity, emergence, and interconnectivity, can function to reinvigorate an organization regardless of how it is structured. That is, an organization can be hierarchical or flat, or any hybrid of the two. Application of the five-attribute CAS framework often results in an increased sense of ownership, the ability for an organization to increase variety without increasing complexity, improvement in customer satisfaction, becoming responsive rather than reactive, the ability to finish projects successfully, continuous improvement, and increased efficiencies, and an increase in competitive advantage.**

Keywords—Complex Adaptive Systems, Self-Organization, Distributed Control, Authenticity, Emergence, Interconnectivity

I. Introduction

Regardless of where our vision settles, what we see around us in small or larger spaces is usually the result of a host of complex [1] interactions [2], often involving overlapping physical, chemical, biological, psychological, social, and technological realities. The simplest phenomenon has tremendous complexity informing it [3]. When we try to solve a problem in any space, be it personal, interpersonal, organizational, economic, environmental, or societal, again we are confronted with profound complexity.

If we take a deeper look at any of these spaces, we see what appears to be randomness and chaos. Yet looking at such situations through the lens of complexity theory, one can perceive that in fact there is profound order in the chaos, and further, that all outcomes when traced deeply enough are the result of a more precise interplay of patterns [4]. And looking yet further, we may observe that regardless of the space being considered, some outcomes that may be counter-intuitive in the short-term lead to greater order and a positive complexity in the longer-term. Where such dynamics have come to the forefront, it can perhaps be said that the foundation of complexity has in fact yielded to a subtle yet greater order and even a framework of change that suggests that that space has in fact been operating as a Complex Adaptive System (CAS) [5].

CAS are in fact the most resilient of systems, and reveal themselves in the successful functioning of corporations, economies, societies, ecosystems, and civilizations, amongst a host of other organizational realities [6]. That there can be such commonality across seemingly different systems is in fact astounding. Proust's advice that real discovery is not in seeking new landscapes, but in having new eyes to see, is prescient. An understanding of CAS in fact does precisely that, it gives us new eyes. We do not have to seek new landscapes in order to reinvigorate organizations, regardless of what kind they are, but have more so, to learn to see them differently.

To understand what makes a CAS a CAS can therefore be highly beneficial. In fact, given natural vicissitudes in environments, it becomes a necessity. To be able to re-see the same apparent situation differently is empowering because it can offer a new lease on something that often has been consigned as decaying or even dead. Fortunately, there are common principles and distinguishing characteristics that underlie all CAS and, in this article, we will focus on an important subset of these, and learn how to apply them in such a way so as to reinvigorate many situations and spaces.

This article hopes to provide a high-level overview of some aspects of CAS for business audiences. Section 2 will

review attributes of CAS that contribute to the five-attribute framework. Section 3 will discuss the relevancy of CAS in business. Section 4 will offer guidance on implementing CAS based on the five-attribute framework. Section 5 will consider the properties of CAS in context of Zappos and Nucor. Section 6 will suggest further work and some concluding comments.

II. THE FIVE-ATTRIBUTE CAS FRAMEWORK

The attributes we will consider include self-organization, distributed control, interconnectivity, authenticity, and emergence.

Self-organization

CAS are characterized by the ability of elements in a system to organize themselves, instead of being organized. This attribute is a bottom-up process that can create new groups from unplanned, nonlinear interactions of people [7]. Self-organization is not just limited to creation of groups. Self-organized teams are able to optimize, configure, heal, protect and manage by themselves, without the need of external forces.

Distributed control

Organizations can operate with little or no central control. *Distributed control* is not equivalent to *no control*. It is distribution of decision making and taking action to groups and individuals in the organization [8]. Control still exists, just on a localized basis. In reality, there can be many variations between central control and distributed control. Distributed control requires clear knowledge of roles, responsibilities, and expectations of each role/group within an organization.

Interconnectivity

Complexity is the result of interconnectivity between elements that create a system [9]. In organizations those elements can be people, processes, technologies, and management tools including policies, standards, and best practices, amongst others. Every organization is based on interconnectivity between these elements [10].

In considering the dimension of people, typically during the organization's lifespan, the number of average connections each person has either increases or decreases. Further, the amount of dynamic connectivity between people and groups within the organization, like neurons in our brain that are dynamically interlinked and then disconnect, can also dynamically interlink and disconnect. As dynamic connections within an organization increase, the conditions become favorable for complexity to grow. Therefore, interconnectivity creates complexity, but it is also one of the best tools to deal with complexity.

Authenticity

Authenticity is not a common attribute, but the most significant one for organizations. There are two types of CAS systems. One is based on finite simple rules that agents are following. Agents won't create new rules, since they are missing the capability of creativity and self-expression. With the given set of rules those system will adapt to new changes [11]. The other type of CAS is distinguished by agent self-expression and creativity. Those agents are creating new rules that help to not only adjust the system, but also to improve the system. This type of CAS is the recommended one for organizations.

Emergence

You might be familiar with the saying that the whole is greater than the sum of its parts. This is a good way to describe the result of emergence. An example of emergence is when, due to spontaneous interaction, new skills, competencies, and behaviors surface that did not previously exist at the individual level [12].

This attribute enables the “adaptive” portion of CAS. Emergence will also often create a new set of rules that will be followed by agents in the organizations. Those new set of rules enable organizations to adapt to external and internal changes [13]. A good example is creativity. An individual may have some level of creativity, but a group of people would collectively have a much higher level.

Emergence is not the result of any planned or controlled effort. It is a bottom-up activity that might be initiated in different ways. Emergence is a conducive condition for complexity.

III. RELEVANCY TO BUSINESS

This is typically the point where CAS easily loses its significance. A paradox emerges that widens the chasm between theory and practice. On one side is theory. This is where the deeply insightful and comprehensive nature of the subject is revealed but rambling esoteric CAS terms distract the practitioner from seeing their critical path to application. On the other side is practice. This is where the tangible and inherent benefits of the subject are manifested, but superficial insight, coming from shallow understanding, plagues the realization of CAS’ true potential. It is unfortunate that this subject would be misunderstood as one or the other. Bridging this metaphorical chasm becomes the effort, and the completion of this task provides the answer to CAS’ relevancy to business.

Like CAS, strategy and tactics exist as both deeply theoretical and profoundly practical. The subjects of strategy and tactics are foundational elements of effective business management. Collectively, they are present across the life cycle of an organization and are synonymous with organizational effectiveness. Whether it be strategy applied to thinking and planning, or tactics applied to coordination

and execution, they are deeply rooted concepts that are practiced broadly. Beyond mere familiar terms in the business lexicon, elements and variations of strategy and tactics are attempted constantly in mainstream organizations. One can hardly deny their relevancy to business [14].

Both CAS, and strategy and tactics, find themselves largely relegated to polarizing ends of the spectrum: CAS perceived as deeply theoretical, strategy and tactics perceived as profoundly practical. However, they are two fields of study plagued by the disease of ineffectiveness. CAS has been rendered less effective by its lack of transition from theory to practice causing a shortfall in application. Strategy and tactics are rendered less effective by their lack of transition from practice to theory causing a shortfall in insight. Paradoxically, the cure for both fields of study emerges as they are implemented collectively: "Complexity makes the strategic challenge more understandable and the task of strategic renewal more accessible" [15].

The traditional strategic and tactical business approaches to thinking, planning, coordination and execution are largely ineffective in dealing with the speed, scope and scale of change we see in today's business environment: "According to the premises of strategic planning, the world is supposed to hold still while a plan is being developed and then stay on the predicted course while that plan is being implemented" [16]. They are tools of a bygone era. However, the effective application of approaches that are specifically developed to leverage the speed, scope, and scale of change can generate results that seem improbable. They are tools of an era yet to be recognized.

When the elements of CAS are incorporated to the areas of thinking, planning, coordination and execution, we develop novel ways to utilize conventional tools and concepts:

- SWOT Analysis transitions to Fishbone Diagrams
- Five Forces Frameworks transitions to Eco-System Models
- Process Mapping transitions to Causal Diagrams
- Scenario Planning transitions to Game Theory and Systems Dynamics
- Strategic Initiatives transition to Collective Vision
- Committees transition to Emergent Teams
- Compliance transitions to Employee Ownership

Businesses are able to harness the collective wisdom of connections and provide an avenue to fluidly adapt based on dynamic opportunities. Employees of businesses have more latitude to organize in an effort to explore possibilities, and the authority to act on these possibilities, with deeper insights coming from more diverse perspectives. Forbes contributors Karl Moore and Phil Lenir describe this new approach in an opinion piece: "Emergent Strategy is therefore much more exploratory, dynamic, and organically home grown… The way we need to interpret this today is that organizations need lots of sharp minds—and not just at the C-suite level. Middle managers—the people who command the front lines of the workforce and have their feet on the ground where the action happens—have to be leaders who are constantly talking, learning, and innovating." [17]

IV. GUIDANCE ON IMPLEMENTING CAS

After understanding what CAS is and why it is relevant for you, it is time to explore why and how CAS is practical for any business that needs to survive and thrive in the ever-growing complex business world. This part is focused on explaining how the main attributes of CAS can be integrated into any type of organization as the guiding principles for running teams in organizations.

To make this part practical for different organizations, we'll distinguish between two types of organizations: hierarchal and flat [18]. Most organizations are of the hierarchical type. Any organization that defines a structure starting from the top of the organization down, is part of this group. The flat group contains a lot of other structures. Flat organizations are more categorized by a bottom-up approach to organize people. We'll use both these types to help with the practical implementation of CAS. In our experience both types of organizations generate similar results following the integration of CAS principles.

Self-Organization

We already discussed the concept of self-organization. Now it's time to understand how this concept can be implemented in hierarchical and flat organizations. In reality, self-organization is a more evolutionary as opposed to an organized and planned approach. Instead of planning organizational changes, the organization is going through many small changes or mutations on different levels. Those mutations typically are initiated by individuals and groups, not by managers and leaders. While the approach to reach a goal is different, both organized and evolving approaches are trying to reach a business goal. Self-organization is not just limited to creating new groups, it also applies to operating as individuals and groups.

Implementing self-organization is the same for both hierarchical and flat organizations. Both give groups the ability to create changes from the bottom-up [18]. The difference is more about how. In a hierarchical organization, the leader/manager defines a goal and expects the team to reach it using self-organization. The leader should govern and steer the group/individuals. Flat organizations expect the group to define the goal, govern, and steer the direction.

The first element that needs to be in place to implement self-organization is a clear and common goal [19]. Without a common and clear goal, every individual and group will strive to reach different goals. Such an approach usually proves to be catastrophic for organizations. On top of a common and clear goal, implementing self-organization requires clear and near real-time feedback.

Both common and clear goals, and near real-time feedback, gives an organization the ability to find out which mutations are a fit and should be adopted by other groups.

Distributed Control

Organizations are built from people and resources. Resources need to be managed and controlled and the second attribute of CAS suggests that control should be distributed across the organization and not centralized in one place [20]. We don't say that there is no need to control resources; we say that this control needs to be distributed. Practically, control of resources needs to be distributed to teams/people that are using those resources. Management needs to serve them by providing coordination.

The distribution of control requires clear definitions of what each group/person is responsible for, and what they are expected to do. This data should be available to anyone in the company to make sure that everyone knows who is controlling what, and whom they may need to connect to if they need assistance with certain managed assets. Distributed control also raises a potential problem with prioritizing. In hierarchical organizations, prioritization can be resolved within the hierarchy. Flat organizations require a fast and efficient process to resolve disputes around prioritizations.

A higher level of distributed control enables management of the same resources by several groups depending on the usage, certain type, or stage in the product life cycle. Implementing distributed control enforces a distinction between managing and coordinating. Managing or controlling an asset should be distributed between parts of the organization. Coordination of assets should be the responsibility of fewer parts of the organization. As mentioned above, it is key to have clarity across the organization about who is managing what.

Authenticity

Previously we defined two types of complex adaptive systems. One that is based on its agents to leverage simple rules to adapt to reality. Another, where the agents are also changing the rules to adapt. Authenticity is what enables the second type, which is the preferred type to be implemented in organizations. It is not enough to use certain capabilities based on existing rules for organizations to see benefits from CAS. Organizations need to enable and encourage the authenticity of people. Authenticity brings creativity that enables people to invent new capabilities and rules.

Authenticity is all about enabling people to be themselves, and to bring who they are to work [21]. Creativity is a skill set that each one of us has. Often, we are not invited to bring this to work. It is important to enable people to express and use all of their abilities even if these are not defined in their job description. Authenticity can be enabled both in hierarchical and flat organizations. In both scenarios, this is a different approach from the professionalism that most companies expect from people.

One of the preconditions for authenticity is self-awareness. Without being aware of your advantages and disadvantages, one can't even know what one is capable of and what one can do to continuously improve oneself.

Interconnectivity

Implementing interconnectivity is all about increasing random and defined interaction between people within an organization and, even more crucial, with people and organizations outside of an organization. “Defined interactions” end up with long-term interaction, while random interaction is usually ad hoc short interaction. Any interaction between people increases the sharing of knowledge, and this tends to add more perspective and variety to any decisions and actions [24].

Some attention should be given to "defined interactions". Too many "defined interactions" can be a toll on people's ability to perform their tasks. The random interaction, by definition, should have no planning. Most of the value is usually an outcome of the random interaction [25]. Some organizations rotate or move people between groups as a way to increase interaction between people.

Interconnectivity is equivalent to the neuroplasticity of our brain. As in the case on increasing the number of neurons connected, the ability to connect more people enables organizations to think and react faster, based on a larger set of experience and knowledge.

Emergence

The ability of a group to create skill sets and competencies that its members are missing (emergent properties) is a unique feature of complex adaptive systems, powered by authenticity and the other attributes we discussed. In a nutshell, to create emergent properties, organizations need to give groups the ability to do their work and to address their challenges by themselves. Getting instructions or suggestions on how to reach a goal or a given target will tend to stifle emergent properties.

When a group of people needs to define how to reach a goal, and then to follow their plan, this will often set into

motion learning how to create new skills and competencies. That is the first step of a journey that ends up with the team's ability to change how they are operating and therefore adapt to the challenges that the environment keeps on throwing at them.

Creating emergent properties means that the organization needs to understand the importance of letting people learn from mistakes. Without an atmosphere like that, no one will take any risk. Direct feedback loops are important as well. A direct line between teams and their customers ensures faster and clearer feedback about the last changes they adopted.

Flat organizations force teams to create emergent properties due to their structure and lack of people management [22]. Hierarchical organizations need to motivate and incentivize leaders to enable the right culture [23] that can create emergence in organizations.

V. CASE STUDIES

The following case studies considers the part that each of the attributes of CAS played at Zappos and Nucor. We intentionally select both a flat and hierarchical companies, to prove that CAS can be implemented and used successfully in any type of organization.

The Zappos case study is based on the experience of one of the authors who was the former Head of Organizational Sciences at Zappos. The comments are relevant to the time he worked there from 2015 – 2020. The Nucor case study is based on the experience of one of the authors who is the General Manager of the Grapeland Plant, and filled the operation manager role before (2016 – 2020).

Self-Organization:

Zappos	**Nucor**
The heart of work at Zappos was driven by self-organization. Layers of management were done away with, and every person in the organization was considered an equal. Therefore, every person was driven to make decisions for themselves and prioritize their own work. At the same time there was a system of roles that was critical to the successful execution of self-management. Certain decision-rights can be attached to a role. Not every role has decision-rights. So, in situations where there may be different points of view, or even if it was felt that someone was not pulling their weight, the role that had decision-rights to do with those kinds of situations could enforce a structural change to add someone to a role or remove someone from a role.	One of the most critical success factors for operational facilities in Nucor is the ability to self-organize at any level. Although flatter than most manufacturing companies, Nucor has an established hierarchy in place. The leaders use this lean hierarchy to establish a rough playing field for the team. Leaders enable and encourage employees to continuously find better ways to improve safety, quality, cost, and production efficiency. Every employee is expected to take the initiative of identifying opportunities, identifying solutions, involving the right people, and holding themselves and others accountable for successful implementation. All decisions are expected to be coordinated and communicated across the facility. Nucor doesn't have rigid job descriptions. Each employee has a direct responsibility but is expected to be a capable generalist. Each leader has 3 simple expectations: Serve the team, take care of their direct responsibility, take on more responsibility. In this way, leaders model the expected behavior. Employees, leaders and teams self-organize to take care of the most pressing needs of the operation at any given moment.

Distributed Control:

Zappos	**Nucor**
Distributed control took place through a system of "circles". Each circle is responsible for some focused work and may have some decision-rights attached to it. The overseeing circle was the governing council circle (GCC). This circle was responsible for the overall financial performance of the company, amongst other key responsibilities. This circle can spawn other circles, and each of the spawned circles can in turn spawn other circles. In such a manner many circles come into being, many of which are given budget and	Distributed control is the driving principle behind Nucor's ownership-based culture. Every business unit in Nucor is expected to balance the autonomy and independence with a spirit of teamwork and collaboration. The principle applied to the Grapeland facility means each team has responsibility for defining performance improvements and delivering results. Front-line employees have direct influence in many aspects of the operation: staffing decisions, work schedules, capital improvements, etc. These decisions are expected to be coordinated across the facility to ensure appropriate resource management and overall facility alignment. With higher level of control, comes a higher level of responsibility. Employees hold themselves and others accountable for effective decision making. This approach is incredibly effective and building ownership at all levels, however

decision-rights over certain "domains".	it develops higher levels of variety that must be appropriately monitored.

Authenticity:

Zappos	**Nucor**
Authenticity was ensured by following core values. Core values were fundamental to the way Zappos operated. One of the core values, for instance, had to do with authenticity, and was within the Zappos terminology expressed as allowing individual "weirdness" to exist. Therefore, it was expected that every person would bring all of themselves to work, including their "weird" parts, and there would be no judgment about that. As a result, people could more easily be themselves without any judgment, and this in turn fostered an environment of authenticity.	Alignment is the key to organizational effectiveness when operating based on the principles of CAS. Many times, the high degree of alignment required can come at the cost of healthy divergent thinking. Nucor's Grapeland facility recognized the cost of losing diversity of thought in the system and focused on creating a safe space for individual authenticity. Utilizing industrial psychologists and professional coaches, all leaders were trained on emotional intelligence, personality traits, composite profiles and team dynamics with the intent of fostering candor, challenge, empathy and awareness. Along with formal training and coaching activities, the Grapeland facility developed a feedback-rich environment where it is expected that everyone coaches everyone. Real-time feedback operationalizes the mantra of "never miss an opportunity to coach". In this way, each employee is able to share their unique perspective while being openly supportive of others.

Emergence:

Zappos	**Nucor**
Emergence was the result of the deliberate design of Zappos and built on other CAS features such as self-organization, distributed control, authenticity, and interconnectivity. Every employee, regardless of who they were, was required to spend a certain number of hours on the phone serving customers every year. This allowed a grounded-ness in the fundamentals of Zappos business, and allowed everyone to be connected by common experience. This was fundamental in allowing relevant ideas that people intuitively grasped, because there was this shared narrative, that then allowed emergence to take place more "relevantly".	Fire Teams - Nucor believes that emergence brings better results than the traditional command and control management structure. From their point of view, the previous CAS properties are a way to reach high levels of emergence. They seem to provide the conditions for effective emergence to take place. Nucor intentionally creates the space for brainstorming and idea generation with a bottom-up approach which is derived from the concept of bounded instability. Leaders are expected to facilitate individual and team development with resources and a supportive environment. In this way, leaders are able to serve the team with limited influence.

VI. FURTHER WORK & CONCLUSIONS

CAS' significance would lead one to believe there is a common and thorough understanding of the subject. Unfortunately, this is not the case. Complexity Theory, still in relative infancy, lacks clarity, coherence, and relevance. CAS is one of the many derivatives that are more broadly known as Systems Sciences. Although concerted effort has been made exploring elements of the Systems field, an accepted taxonomy has yet to be defined. As such, it is hard to delineate the many interrelated fields of study. For the purposes of this paper *Systems is the Family, Complexity is the Genus, and CAS is the Species*. The issue is further confused by the inconsistent and autological definitions applied. There is a high degree of variability in the definitions with only the commonality of certain express characteristics to tie the subject together. This is not intended as an admonishment as much as an identification of the work yet to be done. This work is a high endeavor, necessary to prevent the resultant confusion that stymies the democratization of the subject.

That said, as we indicated at the beginning of this article, complexity is one of the key challenges for organizations today and the five-attribute framework of CAS presented in this paper can help to understand the attributes that enable systems (including organizations) to survive and even thrive in complexity. As its name implies, CAS creates a high level of adaptability and resilience that is key for dealing with complexity. Different levels of CAS are not just the base for agile frameworks like SCRUM [26], it is the cornerstone for successful companies like Haeir, Zappos, Gore-Tex, Morning Star, Patagonia, amongst others.

To conclude we summarize additional areas that will benefit from the five-attribute framework presented in this paper:

1. A primary impact that implementing CAS on business can have is one that we also believe is the most important one. CAS significantly increases the *sense of ownership* and belonging amongst employees. Implementing CAS enables people to make decisions and execute them. When people execute what they plan, they will do a lot to prove that their plan is sound. This creates a level of commitment, accountability, and execution, that far exceeds results with current managerial approaches.
2. Understanding and implementing CAS helps with the common problem of not having enough resources to deal with complexity. To compete, companies often need to reach a higher level of variety. Increasing variety is coupled with an increase in complexity. Eventually, companies don't have enough resources to manage complexity, which impacts the companies' sustainability. *CAS enables companies to increase variety without increasing complexity*. Self-organization enables creating more variety of teams and capabilities with the same number of resources. Distributed control enables increase in the number of business capabilities with no change to the number of resources or interlinks. The same applies to emergence. Authenticity enables people to fill many roles within the company. This is yet another way to increase variety without increasing resources.
3. One of the major benefits of implementing CAS is in its positive impact on customers. When CAS is implemented into the fabric of supporting customers, the result is a *huge improvement in customer satisfaction* and brand recognition. This commonly occurs because customer service representatives are empowered to make decisions that will delight a customer. Two of the most known examples of this are Zappos and Southwest Airlines.
4. *CAS turns organizations from being reactive to being responsive*. Implementing CAS necessitates teaching people how to deal with unpredictability and uncertainty. It teaches them how to respond to the unknown instead of reacting to it. When a business needs to deal with the unknown, people practice what they've learned and respond effectively to the event. A good example of this involves a Toyota private distributor in the USA that over the course of two years, prepared their IT staff to respond to unplanned events by adopting CAS-based operating principles [27]. When they lost their datacenter and business facilities due to a hurricane, the trained teams executed all the five CAS attributes and returned the business back to business as usual in 3 days, without any impact on the business. This agility prevented the loss of tens of millions of US$.
5. *Finishing projects successfully - on time and in budget* - is one of the main challenges for every organization. Some projects can get very complex, and CAS attributes can be instrumental in allowing these to be successful.
6. *Continuous improvement and increasing efficiencies* are essential to increase net profit. Most organizations feel capped in their ability to increase efficiencies, mainly because they exhaust the common approaches to find and implement efficiencies. Such an approach is usually focused on the parts of a company only, and further, looks at organizations from a linear point of view. CAS provides a new way to look at systems. CAS focuses on connections and looks at organizations in a non-linear way. This approach reveals a lot of new opportunities for efficiencies.
7. Last but not least, is the area of competitive advantage. Knowing how to deal with internal complexity *increases competitive advantage* due to the creation of better and cheaper goods or services. Complexity is not just a phenomenon that companies experience, it's also a driver of the business world. CAS helps companies to use complexity as a competitive advantage in business as well.

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Why *Citizen's Resist Contact Tracing Apps: Factors affecting Adoption of Aarogya Setu*

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***Abstract*—The COVID-19 forced governments worldwide to deploy contact-tracing apps as an integral part of their lockdown exit strategies. The challenge was mass users' adoption of tracing apps deployed. One such app was Aarogya Setu deployed by Indian Government. The initiative did not see an exciting response from majority of population in initial phase and government had to change the approach after a while. The current study attempts to propose a conceptual model establishing the theoretical connect among four critical factors: Innovation Resistance, Perceive Security, Perceived Risk, Privacy and Co-production.**

Keywords—Contact tracing, Adoption, innovation resistance, co-production, privacy, perceived security and risk.

I. INTRODUCTION

Covid-19 has turned to be the most significant bio-medical emergency of the 21st century, which has engulfed more than 19 lakhs of lives, affected more than 9.2 crore lives globally. World Health Organisation termed it a global pandemic in March 2020 and supported three ways to keep a check. First, Active detection of cases and contact tracing. Second, functional testing of symptoms. And lastly, practicing social distancing. To check the virus's spread and find infection clusters, governments worldwide have used various methods for contact tracing.

In India, the National Informatics Centre, under the Government of India, released the Aarogya-Setu app. It is an open source "Contact tracing, Syndromic mapping, and Self-assessment" digital service in April 2020. The mobile application aims to leverage citizens and the government's partnership to actively detect citizens with COVID-19 symptoms and trace their travel history.

The successful deployment of the Aarogya Setu App, its adoption, and data analysis are of fundamental importance to India's government to control the spread of COVID-19. Creating an environment of trust addressing risk threats and privacy concerns is a bridge to the active adoption of Aarogya Setu application by citizens. In the absence of these fundamental variables, it would be highly possible that the application had to face innovation resistance from the citizens, leading to the initiative's failure.

This paper focuses on Innovation resistance and Co-production, the two crucial aspects of the Indian Covid19 Contact Tracing mobile application – Aarogya Setu. Initially, the growing concerns with Aarogya Setu led to innovation resistance (Andrew, 2020). But with govt's active intervention to mold good citizen behavior, Aarogya Setu was instrumental in leading to value co-creation (Srikanth, 2020).

II. CONTACT TRACING THROUGH AAROGYA SETU

First, confirm that you Contact tracing refers to the system of identifying, assessing, and managing people who might have met an infected person to contain the spread of a virus or infection. It requires active vigilance and monitoring to check and control an infected person's movement to limit the spread of infection/ virus.

Primitive forms of contact tracing are found in 16th and 19th Century when French Physicians used contact tracing to locate case zero of Yellow fever and later in Europe to control bubonic plague, which led to million deaths in the Mediterranean subcontinent (Cohn, 2020). Further, contact tracing in the Covid19 pandemic has been instrumental in protecting citizens from the Covid19 virus in East Asian emerging economies (Huang, 2020).

Modern-day contact tracing through digital means uses technology such as RFID or Bluetooth as an identifier to work efficiently. They also require access to a person's location information. It leads to privacy concerns among users. Even tech giants such as apple and google face severe allegations for their contact tracing applications with alleged privacy risks (Doffman, 2020).

Aarogya Setu -The official application of the Indian government required location information and the Bluetooth permit of the mobile user. The application was mired in controversy due to speculations of data sharing & security concerns; state enabled vigilance, and lack of privacy for the infected people (Jain, 2020). Thus, there was minuscule adoption of the Aarogya Setu app by Indian citizens.

Observing a lack of articles to understand the factors governing the adoption of vital contact tracing apps such as Aarogya Setu, this study identified three critical factors: innovation resistance, perceived security, privacy, perceived risk, and a moderating factor co-production, and proposed a further study model. In subsequent sections, the study justifies the importance of these factors in the proposed model and establishes various propositions.

III. INNOVATION RESISTANCE

Innovations in digital technology during the first decade of the 21st century paved the way for sustainable solutions to complex problems. Software as a service (SaaS) product made business processes and functions easier. However, there has been a constant resistance to innovations seen over a more extensive period. Innovation resistance is a by-product of attitude, social influence, loyalty to a company/product, and individual pursuit (Bagozzi & Lee, 1999).

The majority of the time, consumers resist innovation passively. Consumers always resist innovation without seeing these types of the invention for adoption (Management, 2015). However, a new set of researchers found innovation resistance to be the result of the impact of innovators and aggregators of a new technology/ product (HIETSCHOLD et al., 2020). Theories also suggest that innovation resistance might arise because the innovation conflicts with the consumer's ingrained structure, required acceptance of unfamiliar routines, or necessitated abandoning traditions (Garcia, Bardhi, and Friedrich, 2007).

Lately, resistance has been correlated with consumption value theory also. (Dhir et al., 2020) took into account the social values and functional values that influence an individual's innovation adoption behavior. Consumers' inability to make proper and effective technology usage makes them resistant to new technology such as mobile wallets (Leong et al., 2020). (Rodríguez Sánchez et al., 2020) attributed consumers' lack of understanding to comprehend innovation's value as the primary reason for resistance to innovation. The credibility of the source of innovation plays a primary role in the adoption of the innovation too. It has also been found that in many cases, the trust in the source of innovation plays a crucial role in resistance against Innovation (Ju & Lee, 2020). The following propositions is formulated based on this construct-

P1: Innovation Resistance will have a significant impact on the adoption of Aarogya setu.

IV. Perceived Security

Perceived security reflects a consumers' perception that a specific system is secure to conduct transactions (Shin, 2010). It is the degree to which people believe in a particular technological system's security. The perception of security may vary from user to user. For some, it is the users' feelings of control for the system in use. In contrast, for others, it could refer to technical security measures. In most of the research such as related to mobile payment adoption, it is seen that the lack of subjective security surfaces as the most persistent reason for a refusal to use.

In contact tracing applications, significant concerns stem from the information sharing with API clauses and the central servers' penetrability where the data is secured. Concerns have also grown on the use of data collected by firms or by governments for ulterior motives. Thus, these concerns become the breeding ground for perceived security concerns in the mind of consumers/users. The concerns of perceived security could only be serviced by providing more details about servers' localization, encryption of data stored, and privacy clauses making governments and firms liable to ensure data and user information security. The following propositions is formulated based on this construct-

P2: Perceived Security will have a significant impact on the adoption of the Aarogya setu app.

P3: Perceived Security will have a significant impact on innovation resistance towards the Aarogya setu app.

V. Privacy

Privacy is defined as individuals, groups, or institutions' assertion to determine when and to what extent information about them is communicated to others. Privacy concerns arise when individuals have concerns regarding information shared about their private lives in the public domain. Within the context of Digital information systems, these concerns can take the form of system-specific privacy concerns (Joinson and Paine, 2007). Precisely, the consumer's perceptions of privacy associated with a particular technology are conceptualized as system-specific privacy concerns (Kim, Brewer, and Bernhard, 2008).

In the case of contact tracing, users tend to develop system-related privacy concerns. They believe that the given application is not appropriate to safeguard their privacy (Kim et al., 2008). In case of data leak of infected people, users fear:

1. Cornering, discrimination, and marginalization by society.

2. Creation of unnecessary social stigma.

3. Tracking of a user's movement for surveillance beyond state power.

4. Availability of user information in the public domain, which could harm the user's integrity.

India's E-governance initiatives had already been marred with privacy concerns given the leak of Aadhar data on the dark web in the past. The interconnectedness of Aadhar with other identity proofs further aggravated the worries of its citizens. Given a history of a data breach, apprehension related to Aarogya Setu was bound to arise.

Users comprehend a massive gap in the privacy policy. It does not tell what is being done with the data collected every 15 minutes. It is only talking about data that is being uploaded on the servers. Aarogya Setu can become a perfect tool for monitoring and surveillance in the absence of checks and balances(Ahaskar, 2020). The state's compulsion to use Aarogya setu for intercity traveling further increased the privacy concerns in citizens' minds. The following propositions is formulated based on this construct-

P4: Privacy will have a significant impact on adoption of Aarogya setu app.

P5: Privacy will have a significant impact on innovation resistance towards Aarogya setu app.

VI. Perceived Risk

Risk has been interchangeably compared with uncertainty caused due to sound decisions having negative implications. Perceived risk impacts the prospects of adoption/ usage of a product or service. It affects consumer perception of a product. A consumer tends to weigh a product negatively if the risk perception of the product is high. A user is generally conceived to have risk-taking behaviour. However, if the assessment of benefits tends to be negative, the users tend to shy away. Thus, it is said that risk is a mixture of unpredictability and reality of conclusions. indicated that rejection of innovation due to perceived risk happens when the current belief structure of consumer clash with the innovation and a negative image of innovation is developed in consumers' minds, resulting in rejection of innovation. Perceived risk is a fundamental portion of consumer behaviour (Taylor, 1974).

Regarding adoption and non-adoption behaviour of consumers, particularly resistance towards innovations is a

multifaceted phenomenon that is also influenced by consumers' awareness of the perceived risk of adopting an innovation (Dunphy & Herbig, 1995). Perceived risks could be formalized in four ways: 1. Economical; 2. Social; 3. Functional; 4. Physical. In contact tracing applications like Aarogya Setu, most risk is weighted to be physical and social. Lack of transparency further made the app look dubious and less reliable for user adoption. The Aarogya Setu app was not open source, which meant there was no information on the app working. Surveillance or no surveillance, there was no idea on it unless the app went open source, thus generated concerns that negatively impacted the adoption. The following proposition is formulated based on this construct-

P6: Perceived risk will have a significant impact on adoption of Aarogya setu app.

P7: Perceived risk will have a significant impact on innovation resistance towards Aarogya setu app.

VII. CO-PRODUCTION

Co-production, as a method, has become popular over the last three decades. Popular technology companies such as Unilever, IKEA, BMW, and DHL have adopted a co-production concept to derive more excellent value from their products and services. Co-Production concept involves bringing in all the stakeholders of an organization, the product service's design, and being transparent about its manufacturing and execution. In this way, the end users constitute a natural part of the production process. Organizations do not include all inputs by citizens that affect the overall planning, design, and delivery of service but focus on citizens' direct information during the production phase—thus involving a collaboration of professionalized services of public agencies and private citizens.

Co-production in the domain of E-governance innovation is an inalienable element. It imbibes a sense of trust, transparency, and confidence in the citizens' minds, thus accelerating the adoption of e-governance applications. The Indian government organized hackathons to address several public issues by leveraging general professional expertise over digital mediums. It helped to make the system much more robust, citizen-friendly, and transparent. Taking cognizance of innovation resistance in the case of Aarogya setu, the government brought in the Co-production approach to make the product much more transparent and accelerate the initiative's adoption. These initiatives came in the form of:

1. Bug Bounty Program – It was organized to partner with security researchers and the Indian developer community to test the security effectiveness of Aarogya setu and improve or enhance its security and build user's trust. The program aimed to identify all the Aarogya setu application vulnerabilities, its API, data encryption, and servers. It also invited codes to improve the functionalities of the application. Cash prizes worth INR 3 lakhs were given to the program's winners.

2. Data Sharing a knowledge access protocol – A protocol for the same was brought in to make the application open-source.

3. The privacy policy was laid out in the public domain with a grievance redressal cell to reduce the citizens' perceived risk perception.

The following proposition is formulated based on this construct-

P8: Co-production will have a moderating effect on innovation resistance towards Aarogya setu.

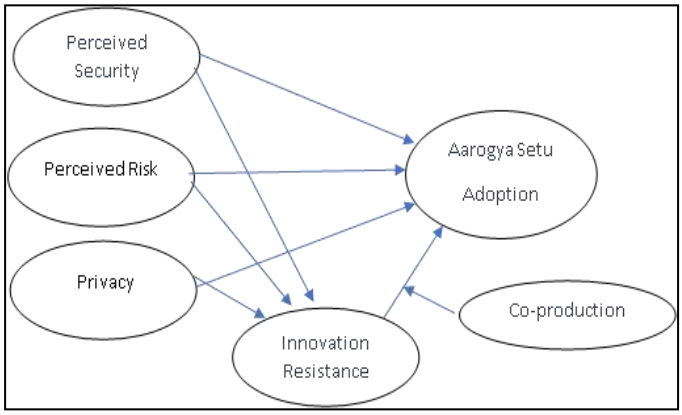

Figure 1: Conceptual Model

VIII. FUTURE RESEARCH DIRECTIONS

Contact tracing applications are in their emerging stage. With the evolution of pandemic and epidemic situations, new layers to the existing innovation will unfold. Further theoretical and empirical development is required to understand the adoption intentions of citizens. Searching for additional variables is also important because they may have an impact on citizens' usage intentions. Future research can also investigate the characteristics of Customer trust in E-governance initiatives and Value co-creation as result of citizen-enabled co-production. Further studies are also required to understand the barriers that prevent customers from using mobile tracing applications.

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Factors influencing customers' attitude and purchase intention of private label brands and national brands of men's apparel: A structural equation modeling approach

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***Abstract*— Customers' preferences are crucial and a matter of concern in the context of competitive branding for apparel, where brand switching is highly relevant. The study aims to propose a conceptual model portraying purchase intention as a function of customers' attitude and to examine the effect of relevance factors, value generating factors and perception factors on customers' attitude and purchase intention towards private label brands and national brands of men's apparel. Data were collected from 257 respondents and confirmatory factor analysis was used to test the reliability, convergent and discriminant validity of the items of interest. For testing the conceptual model, structural equation modeling was used. The results indicate that the relevance factors had a partial positive significant influence, value generating factors had a strong positive significant influence and perception factors had a negative significant influence on customers' attitude, of both private label brands and national brands. It is also observed that the customers' attitude led to purchase intention for private label brands and national brands.**

Keywords*— *private label brands, national brands, relevance factors, value generating factors, perception factors, confirmatory factor analysis, structural equation modeling

I. INTRODUCTION

Private label brands (PLBs) are rarely promoted and positioned as cheaper alternatives to national brands (NBs) [21]. Instead of always emphasizing that PLBs are good quality products at cheap price, retailers can adopt a marketing strategy which will make customers believe that they are certainly at a loss, if they do not buy PLBs [12]. Stores must ensure that the marketing strategies adopted by them for their PLBs, result to favorable customer attitude and to also be prepared to develop or implement customer attitude modification strategy if they experience unfavorable customers' attitude [9]. Men's apparel consumption behavior is comparatively a lesser explored topic of research and has a more scope of study in the competitive scenario of PLBs and NBs. The present study aimed to explore the customers' attitude and purchase intention variables that may influence the purchase behaviour of PLBs and NBs of men's apparel, as done in prior research in different contexts [2, 20]. A conceptual model was empirically tested with structural equation modeling (SEM) based approach.

II. LITERATURE REVIEW

Customer loyalties to PLBs have enhanced influence on their purchase behavior than NBs and their attitude towards PLBs directly influences one's inclination to switch to PLBs [4, 17]. Purchase intention of PLBs is influenced by, social value and perceptions of risk, value for money, social value and brand awareness [15]. Customers' fashion conscious attitude, store image and loyalty, price, and quality of PLBs influences the purchase intention and preference of customers towards PLBs of apparel [16]. With the growing acceptance of PLBs in the country, the study was an attempt to further understand the customers' attitude and purchase intention towards the PLBs and NBs of men's apparel. The study was conducted in the city of Kolkata.

III. THEORY OF REASONED ACTION (TRA)

The underpinning theory of the current study is the attitude theory, for which, the three components of emotion, behavior, and cognition work together. Customers' behavior has been explained in the retail sector with the application of the Theory of Reasoned Action (TRA) in previous research for apparel by [3].

IV. CONCEPTUAL MODEL

The above-mentioned concern can be addressed with a

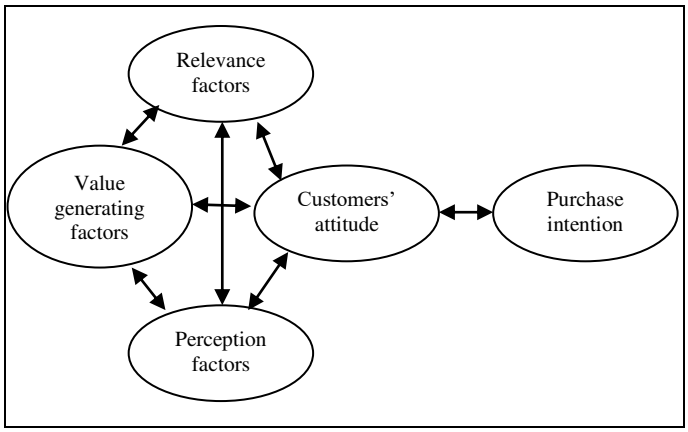

Fig. 1. ***Proposed model for customers' attitude and purchase intention for men's apparel brands***

conceptual model, provided by the study in Fig.1. Relevant brands are the successful brands that can cater to the needs of the customers and also continue to evolve in the dynamic market environment. Value is the perceived contentment, the customer experiences in lieu of the price compensated for the brand. Customers' confidence/pessimism concerning their economic situation and their trust in retail brands are influencing their perceived behavior and indirectly their attitudes [18]. Customers' attitude plays a crucial role in the behaviour of the customers and developing a marketing strategy [16]. An attitude refers to the consistent tendency of the customers to behave favorably or unfavorably towards a specific product or brand [26]. The 'way of thinking' of an audience influences their purchase intention [5]. The conceptual model hypothesized that relevance factors, perception factors and value generating factors had direct impact on the customers' attitude and purchase intention for PLBs and NBs of men's apparel.

V. Research Methodology

A structured questionnaire was developed using a 5-point Likert-type scale. Table I presents the pre-existing scales in the literature that were used for measuring variables. The judgmental sampling technique was applied to choose the pilot sample of 20 respondents. The final study was conducted with 257 respondents in Kolkata. The study was conducted in different parts of Kolkata who belonged to various socio-economic strata to get a generalized response. Forty eight respondents from East, Kolkata, forty six respondents from West Kolkata, fifty five respondents from North Kolkata, sixty eight respondents from South Kolkata and forty respondents from Central Kolkata.

VI. Findings

A. Respondent profile

The respondents were categorized based on age, education and income. The categories of age were 20-25 years, 25-35 35-45, 45-55 and 55-65 years and the majority were 25-35 years. The qualification choices were undergraduate, graduate, postgraduate and PhD degrees and majority qualified as a postgraduate. The income ranges were <US$ 500, US$ 500–US$ 1000, US$ 1000–US$ 2000 and >US$ 2000 with the majority earning US$ 500-US$ 1000.

B. Measurement model

The data were analyzed using factor analysis, correlation and SEM. The reliability, validity and overall fit of the measurement model were checked. Confirmatory factor analysis (CFA) was used to assess the theoretical structure of the measurement model. The reliability, validity and overall fit of the measurement model were checked. Convergent validity was checked through standardized factor loadings (SFL or λ), composite reliability (CR) and the average variance extracted (AVE). Latent constructs were tested for the composite reliability, which was found under the established criteria, i.e., CR > 0.70 and ideally, AVE > 0.50 [13]. The findings revealed that the most of the items were very close to the required reliability [13]. The thumb rule is followed that the square root of the inter-construct correlation (SIC) should be less than the AVE values in the model [10]. The values established the discriminant validity among the latent variables, as they did not statistically overlap each other and were free from the problem of multi-collinearity [28].

TABLE I. SOURCES

Latent variable		Items	Sources
Relevance factors	R_1	I buy trusted brands	[27]
	R_2	The brand name is important in my purchase decision	Own elaboration
	R_3	I become loyal to a particular brand and repeatedly buy it	[25]

	R_4	I buy brands which gives me mental satisfaction	[6]
	R_5	I always gift people brands of their choice	[22]
Value generating factors	V_1	I can buy any brand, if I like the color	[24]
	V_2	I can buy any brand, if I like the design	[7]
	V_3	I buy the brand which is giving the best offer or discount	Own elaboration
	V_4	I buy a brand if it is comfortable for my age	[7]
	V_5	If I get the same quality at a lower price I will certainly buy the cheaper brand	[11]
Perception factors	P_1	I never feel like buying private label brands	Own elaboration
	P_2	Owing to its' low cost, the durability of private label brands is less	[8]
	P_3	Unlike national brands, there is always an adequate stock/ shelf space of private label brands	[14]
	P_4	I never take the risk of gifting private label brands	[29]
Customers' attitude	CA_2	I think private label brands are worth buying	[22]
	CA_4	I buy both private label brands and national brands	Own elaboration
Purchase intention	PI_1	I will buy private label brands next time	[29]
	PI_2	I would definitely consider buying private label brands	[23]
	PI_3	I would buy private label brands for casual wear	[22]
	PI_4	I would buy private label brands to save money	Own elaboration
	PI_5	I buy private label brands for promotional coupons	Own elaboration

C. Structural model

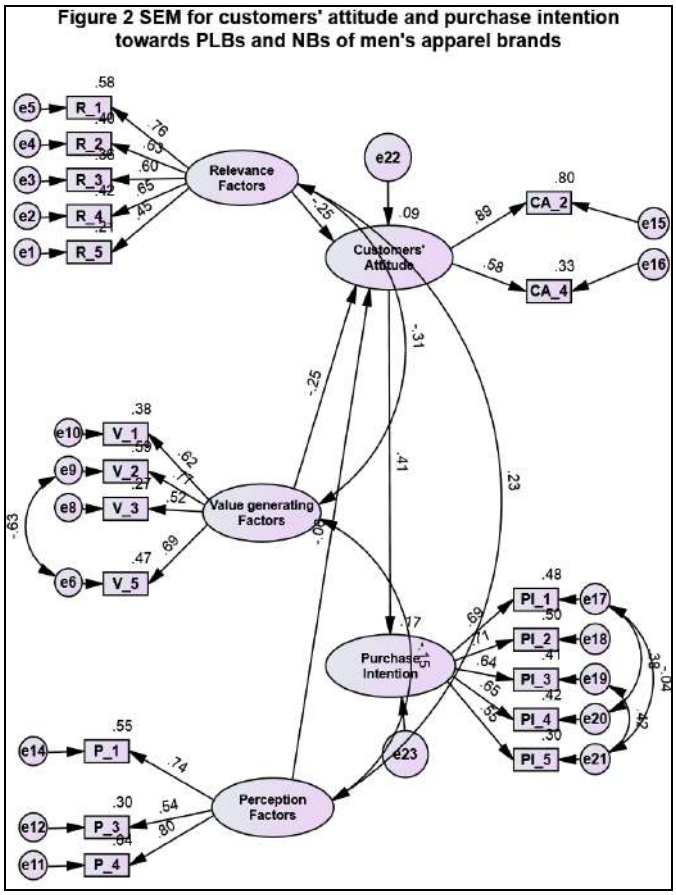

Fig. 2: ***SEM for customers' attitude and purchase intention towards PLBs and NBs of men's apparel brands***

Fig. 2 depicts the SEM model for the customers' attitude and intention to buy PLBs and NBs. SEM was used as it is an integrated approach to accommodate relationships between multiple variables at once with substantial accuracy [13]. AMOS 26.0 software tool had been used to analyze the SEM model. Accordingly, all the values of the three fit measures, namely absolute, incremental and parsimony were close to the prescribed norms of the goodness of fit. The results indicated in Table II, depicted that the model exhibited a good fit. Statistical evidence, provided in Table III concludes that the relevance factors would convert into customers' attitudes towards PLBs and NBs of men's apparel brands as the *p*-value was greater than the significance level of 0.05. As the *p*-value is accepted at the 10% level, it could be concluded that relevance factors had a partial positive and significant relationship with the customers' attitude (C.R.= 3.679, $p < 0.10$). Similarly, it was observed that the value generating factors had a positive significant relationship with the customers' attitude towards

PLBs and NBs of men's apparel brands as the *p*-value was lesser than the significance level of 0.05 (C.R.= 7.235, $p< 0.05$). The perception factors had a negative significant relationship with the customers' attitude as the *p*-value was greater than the acceptable level of 10% (C.R. = 1.734, $p> 0.10$). Finally, it was observed that there was a positive and significant relationship between purchase intention and customers' attitude as the *p*-value was lesser than the significance alpha level of 0.05. Therefore, there was a significant influence of customers' attitude on purchase intention (C.R. = 12.456, $p< 0.05$).

TABLE II. GOODNESS OF FIT AND INCREMENTAL INDICES OF A MEASUREMENT MODEL

Fit Indices	Accepted value	Model value
Absolute Fit Measures		
Chi-square ($\chi 2$)		443.156
Degrees of Freedom (DF)		141
$\chi 2$/ DF		3.143
GFI (Goodness of Fit Index)	>0.90	0.899
RMSEA (Root Mean Square Error of Approximation)	<0.10	0.091
Incremental Fit Measures		
AGFI (Adjusted Goodness of Fit Index)	>0.80	0.868
NFI (Normed Fit Index)	>0.90	0.904
CFI (Comparative Fit Index)	>0.90	0.976
IFI (Incremental Fit Index)	>0.90	0.945
RFI (Relative Fit Index)	>0.90	0.906
Parsimony Fit Measures		
PCFI (Parsimony Comparative of Fit Index)	>0.60	0.659
PNFI (Parsimony Normed Fit Index)	>0.50	0.606

TABLE III: DIRECT EFFECTS OF RESEARCH MODEL: STANDARDIZED REGRESSION WEIGHTS OF COMPONENTS – CUSTOMERS' ATTITUDE AND PURCHASE INTENTION TOWARDS PLBs AND NBs OF MEN'S APPAREL BRANDS

Relationship between exogenous and endogenous	C.R.	*p*-value
Customers' attitude <--- Relevance factors	3.679	.006
Customers' attitude <--- Value generating factors	7.235	.003
Customers' attitude <--- Perception factors	1.734	.488
Purchase intention <--- Customers' attitude	12.456	0.000

VII. Conclusion

The results reveal that the relevance factors have a partial positive significant influence, value generating factors have a positive significant influence and perception factors have a negative significant influence on the customers' attitude. The results also determine that the customers' attitude shows a positive significant influence and also leads to the purchase intention towards PLBs and NBs of men's apparel brands, which is similar to previous studies done in different context [19, 22].

VIII. Implications

The study highlights the role of value generating factors in developing a positive customers' attitude towards the brands and enhancing the purchase intention. It also sheds light that the perception of the customers can change if they get the desired value from a lesser relevant brand, as relevance has a partial significant influence on the customers' attitude. The results provide useful insights to marketing managers to advance the understandings of the competitive environment of PLBs and NBs of men's apparel who could consider how to spur relevance factors, value generating factors and perception factors when designing branding strategies. Managers also need to expand their focus from existing brand customers to non-customers, as value generating factors predominate and they may develop the intention to purchase, if they find value.

IX. Limitations and Future Study

The study can be extended on to another level with the consideration of an external or moderating factor that could

affect customers' attitude and purchase intention towards PLBs and NBs of men's apparel brands with other statistical applications. The current study and similar studies in the future are an initial step that will help the need to expand marketers' customer learning efforts, and create a source of competitive advantage.

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Measuring Financial Inclusion in India- An Index considering Banking and Insurance Indicators

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Abstract*— The gravity of an inclusive economic system has been extensively recognized in recent years and financial inclusion is seen to be a priority for policy makers in various countries. Financial inclusion is the ease of access, availability and usage of the formal financial system by all the people of the economy. The growing literature on financial inclusion has provided plenty of evidences on the merits of an inclusive financial system. This paper is an attempt to propose an index of financial inclusion for India for a period of 13 years from 2005 to 2017. A comprehensive measure of financial inclusion is important to keep a track of the progress of the initiatives taken by policymakers to boost financial inclusion. This paper aims to analyze various dimensions of financial inclusion and enumerate an index which can extensively apprehend the impact of multi dimensional variables. Earlier studies have attempted to measure financial inclusion taking banking indicators alone. This paper incorporates the insurance sector indicators as well. So the paper induces an index that allows for an overview of India in terms of financial inclusion. The results show a general increase in the level of financial inclusion over the span of 13 years.

Keywords*— Dimensions, Financial inclusion, Index, Multi-dimensional variables, Indicators

I. INTRODUCTION

Financial inclusion is a global topic for sustainable economic growth. The growth of an economy is determined by its inclusiveness. Financial inclusion can facilitate fuller participation of the weaker sections and low income groups. According to the World Bank, financial inclusion has been recognized as an enabler to reduce extreme poverty and can be used as a benchmark for measuring the growth of an economy. In the current era, the policymakers are thus giving priority in framing various policies to build a more financially inclusive system. However, India has low financial inclusion and has the second largest unbanked population in the world after China. According to Global Findex data of World Bank, 11 per cent of the world's unbanked adults are in India with 190 million people still not having a bank account whereas the global figure of unbanked stands at 1.7 billion.

'Financial exclusion' is a term that comes before financial inclusion. In this context, we also need to understand the nature of financial exclusion classified as 'voluntary' or 'involuntary'. Voluntary exclusion refers to the condition where an individual or firm does not feel the need to have any access to formal finance owing to cultural or religious reasons; while involuntary exclusion is the unavailability and inaccessibility of formal financial services due to the presence of barriers like income insufficiency, high risk profile or market imperfections [10]. The classification of financial exclusion into voluntary and involuntary clearly explains that voluntary exclusion is not a direct consequence of market failure hence little can be done to address it. The matter of concern lies with the involuntary financial exclusion. A study mentioned insufficient income, excessive lending risk profile and government failures to be the causes of involuntary financial exclusion [4]. Overall, there are several barriers to financial inclusion identified in different literatures. Among them a few include lack of supportive financial infrastructure, low level of financial literacy, high costs, lack of governance etc. Individual and societal factors like age, gender, culture and religion also impede financial inclusion [1]. Thus, the importance of addressing these barriers and trying to achieve an inclusive financial development cannot be denied.

Against this backdrop, it is essential to have a measure of financial inclusion over time using different indicators to explain the dimensions of financial inclusion and to look at the progress of financial inclusion over the years. A number of literatures have proposed indices for measuring financial inclusion considering banking indicators. The committee on Financial Sector Reforms, chaired by Dr. Raghuram Rajan has broadly defined financial inclusion referring to the universal access to a wide range of financial services at a reasonable cost. They posited that the financial services not only include banking products but also other financial services such as insurance and equity products. This paper has attempted to include different dimensions essential to calculate financial inclusion index. The paper not only considers banking indicators but also adds insurance indicators while measuring the financial inclusion dimensions to have a more comprehensive study.

The paper is divided into five sections. A brief review of literature is presented in section II. Methodology applied to calculate the financial inclusion index is discussed in section III. Section IV presents empirical results and discussion and the last section V concludes the study.

II. LITERATURE REVIEW

Financial development is an essential ingredient for the overall progress of the economy and inclusive financial growth is the key to effective financial development. Many authors have established the nexus of financial inclusion with growth and development and its impact on reducing poverty and inequality [2, 3, 11, 19, 23, 25].

There are empirical analysis of determinants of financial inclusion in India indicating that branch networks corresponding to the supply side of inclusive endeavors has a beneficial impact on improving financial inclusion [9,16]. Another study [6] examined financial exclusion in Italy and found that despite a large bank penetration a high rate of

financial exclusion is observed. This suggests that demand driven factors hamper access to formal financial services.

While the importance of financial inclusion is well established by various researchers, it is also important to have a comprehensive measure to know the extent of financial inclusion in a country or for the comparison of countries across the globe. Different approaches have been proposed in the literature that includes variety of financial inclusion dimensions. [14] estimated the proportion of households having accessibility of formal financial services for about 160 countries. However his study has been criticized for not being useful for understanding the changes across different countries or over time. [20, 22] proposed a multidimensional index of financial inclusion following which several researchers have calculated the index of FI [12, 15, 17, 18, 24, 26, 27].

A study developed an index of financial inclusion using factor analysis for identification of financial inclusion dimensions [4]. Yet another study incorporated the index using principal component analysis [7]. [13] reckoned index of financial inclusion with special reference to India using geometric mean. A different study demonstrated an axiomatic approach for the measurement of financial inclusion by developing a conceptual frame and aggregating data on various dimensions of financial services [8]. [5] in her paper has measured financial inclusion index including more variables like ease and cost of transactions which have not been included in earlier studies. So, various literatures have posited financial inclusion measurements by considering different dimensions and methodologies.

A. *Contribution of this study*

As observed in earlier studies, attempts have been made to construct an index of financial inclusion by using select dimensions. For instance [20] does not include geographical penetration in outreach dimension while [5] has not considered usage dimension. However, almost all of the studies are done using banking sector indicators. None of the studies have considered dimensions from sectors like insurance or equity. This study has attempted to construct an index of financial inclusion following the method of Euclidean Distance as proposed by [21] by incorporating two additional indicators from the insurance sector, apart from the banking sector indicators. Moreover, earlier studies are either cross country study or study on a particular country like India but only for a limited time period. The present study is a construction of financial inclusion index in the Indian context for a period of thirteen years, i.e., from 2005 to 2017. The study intends to know the progress of financial inclusion since its formal initiation in 2005 till 2017 which is the most recent available data. This makes the study more current than earlier studies and enables to compare the extent of financial inclusion over the years that might be reflective of the initiatives that have been adopted by the government throughout these years.

III. METHODOLOGY

The paper followed the below mentioned methodology:

- Firstly, the identification of the dimensions of financial inclusion and their indicators to measure the country's attainment in those dimensions are taken into consideration.
- Secondly, the dimension indicator indices are calculated.
- Finally, the index of financial inclusion (I_F) based on Euclidean distance method is calculated and analyzed for the period of study.

A. *Dimensions and Indicators to measure financial inclusion:*

The present study considers five dimensions for measuring financial inclusion- three dimensions from banking sector and two insurance sector dimensions. To measure these five dimensions, nine indicators have been considered.

Dimension 1: Banking penetration dimension (D_1): A financial system that is inclusive should penetrate widely among its users. Thus an inclusive financial system should have as many users as possible. The size of banked population is a measure for this dimension. Thus, the indicator to measure this dimension includes:

- Number of deposit accounts with commercial banks per 1000 adult population (d_1).

Dimension 2: Banking Services Availability dimension (D_2): In a financially inclusive system, the services of banking should be easily available to its users. Four indicators have been considered to measure this dimension:

- Demographical branch outreach (d_2) defined by the number of commercial bank branches per 100000 adult population.
- Demographical ATM outreach (d_3) defined by number of ATMs per 100000 adult population
- Geographical branch outreach (d_4) defined by number of commercial bank branches per 1000 km^2.
- Geographical ATM outreach (d_5) defined by number of ATMs per 1000 km^2.

Dimension 3: Banking usage dimension (D_3): This dimension is measured by the following two indicators:

- Outstanding deposits with commercial banks as a percent of GDP (d_6).
- Outstanding loans (credit) from commercial banks as a percent of GDP (d_7).

Dimension 4: Access to Insurance (D_4): The indicator to measure this dimension includes:

- Number of life insurance offices per 1000000 adults (d_8)

Dimension 5: Insurance penetration (D_5): This dimension is a measure of the contribution of insurance premium to GDP of a country. Thus it is measured by:

- The ratio of premiums underwritten to GDP (d_9).

B. *The Method used:*

Calculation of Financial Inclusion Index:

The present study computes the index of financial inclusion (I_F) for India following the method used by [20,21] which is an approach similar to that used by UNDP for the computation of some well known developmental indices like HDI,GDI and so on. The study incorporates various banking and insurance sector dimensions as

explained in section III *A*. Since the calculation of I_F depends upon various dimensions which are divided into different indicators, thus in this study the dimension index for each dimension has been calculated first. Each dimension has n number of variables:

For each indicator of the dimensions, we compute d_i as:

$$d_i = A_i - m_i / M_i - m_i \quad (1)$$

Here, A_i is the actual value of the indicator; M_i is the maximum value while m_i is the minimum value of the indicator. This ensures that d_i lies between 0 and 1. Now each dimension D_i is a simple average of all d_is for that dimension. The maximum and minimum values are set to the actual observed maximum and minimum values of the indicators for the period under study, i.e., from 2005 to 2017.

Now, if n dimensions are considered, the achievement of a country in these dimensions can be represented by a point $X = (D_1, D_2, D_3 \ldots, D_n)$ on the n dimensional space. Also we can consider $O=(0,0,0,\ldots,0)$ representing the worst situation i.e., no achievement in the dimensions and $I(1,1,1\ldots,1)$ representing the ideal situation implying the highest achievement in all the dimensions. The location of the achievement point X with respect to the worst point O and ideal point I is what is important in measuring a country's level of financial inclusion. So, a larger distance between X and O would indicate higher financial inclusion while a smaller distance between X and I would indicate higher financial inclusion. In the given n-dimensional space, there is a possibility of having two points which have the same distance from I but different distance from O and vice versa. So the achievement point can be at the same distance from one of these points but having different distances from the other point. Hence, if the achievement point is at the same distance from I but different distance from O, then the point with higher distance from O should be considered more financially inclusive. Similarly, if both points have same distance from O but different distance from I then the point with less distance from I should be considered more financially inclusive. Thus, both these distances are significant and taken into account while calculating the index.

In this proposed index, a simple average of Euclidean distance between X and O and inverse Euclidean distance between X and I have been used. Both these distances are normalized by the distance between O and I to make them lie between 0 and 1. So, for calculating I_F, the following distances are calculated:

$$X_1 = \text{distance between X and O/ distance between I and O} = \sqrt{(D_1^2 + D_2^2 + D_3^2 + \ldots + D_n^2)} / \sqrt{n} \quad (2)$$

$$X_2 = 1 - (\text{distance between I and X/ distance between I and O}) = 1 - [\sqrt{\{(1-D_1)^2 + (1-D_2)^2 + \ldots + (1-D_n)^2\}} / \sqrt{n}] \quad (3)$$

$$I_F = \tfrac{1}{2} [X_1 + X_2] \quad (4)$$

Formula (2) indicates the Euclidean distance of X from the worst point O, which has been normalized by the distance between the worst point O and the ideal point I. Formula (3) presents the inverse normalized Euclidean distance of X from the ideal point I. The numerator is the Euclidean distance of X from the ideal point I and the denominator is normalization by the same procedure as done in (2). Subtracting this from 1 gives the inverse normalized distance.

The normalization is done to make the value of X lie between 0 and 1. The inverse distance is considered so that the higher value of X corresponds to higher financial inclusion.

Formula (4) is the simple average of X_1 and X_2 thus incorporating distances from both worst and the ideal point.

The index so defined can be used to measure financial inclusion at different points in time and different levels of economic aggregation. It can also be used to compare different countries in terms of achievement of financial inclusion.

C. Data:

To construct financial inclusion index for India, the required data has been extracted for 13 years from 2005 to 2017. The data for the banking dimensions have been extracted from International Monetary Fund Financial Access Survey (IMF FAS) database while the insurance dimensions data are taken from the website of Insurance Regulatory and Development Authority of India (IRDA). The data on access to insurance was not readily available. The data on number of life insurance offices is taken from IRDA and the data on adult population of India for the 13 years period under study is taken from World Bank's World Development Indicators (WDI) database. Thus the dimension has been calculated by dividing the number of life insurance offices by the total adult population and multiplied by 1000000 for each year thus obtaining the required values for the dimension.

D. Calculation:

The values of nine indicators (for five dimensions) of financial inclusion are presented in Table I for the period 2005 to 2017. The value of each dimension is then calculated by averaging the indicators' value under each dimension (Table II). Finally, the financial inclusion index (I_F) is calculated for the 13 year period (Table III) as per the method discussed in the previous section III *B*.

IV. RESULTS

With the given data on all the five dimensions for the time period of thirteen years (2005-2017), the financial inclusion index values (I_F) have been calculated as presented in Table III. Depending on the values of I_F, the time line of India has been grouped into three categories viz., high, medium and low financial inclusion. The categorization is mentioned as follows:

$0 \leq I_F \leq 0.4$- low financial inclusion

$0.4 < I_F \leq 0.6$- medium financial inclusion

$0.6 < I_F \leq 1$- high financial inclusion

These three categories of financial inclusion for the 13 years period are presented in Table IV.

According to the results, low financial inclusion existed from the year 2005 to 2007, which pertains to the initial years when financial inclusion was taken into serious policy considerations.

TABLE I. VALUES OF THE INDICATORS

Year	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	d_9
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2006	0.00	0.00	0.02	0.01	0.02	0.09	0.22	0.09	0.81
2007	0.03	0.01	0.05	0.04	0.04	0.30	0.44	0.27	0.76
2008	0.08	0.07	0.10	0.10	0.08	0.67	0.66	0.68	0.71
2009	0.14	0.12	0.15	0.15	0.13	0.85	0.72	1.00	1.00
2010	0.20	0.19	0.25	0.22	0.22	0.72	0.66	0.99	0.95
2011	0.25	0.27	0.33	0.30	0.30	0.80	0.79	0.92	0.47
2012	0.32	0.39	0.44	0.40	0.40	0.77	0.88	0.85	0.42
2013	0.43	0.50	0.53	0.51	0.50	0.85	0.93	0.73	0.38
2014	0.57	0.68	0.7	0.67	0.74	0.93	1.00	0.79	0.09
2015	0.72	0.80	0.88	0.78	0.85	1.00	0.97	0.78	0.14
2016	0.87	0.88	0.95	0.88	0.94	0.88	0.94	0.76	0.18
2017	1.00	1.00	1.00	1.00	1.00	0.95	0.82	0.73	0.28

Source: Author's Calculations

TABLE II. VALUES OF DIMENSIONS

Year	D_1	D_2	D_3	D_4	D_5
2005	0.000	0.001	0.000	0.000	0.000
2006	0.008	0.015	0.159	0.099	0.810
2007	0.032	0.042	0.376	0.273	0.762
2008	0.081	0.091	0.374	0.682	0.714
2009	0.146	0.141	0.414	1.000	1.000
2010	0.200	0.225	0.388	0.997	0.952
2011	0.255	0.304	0.414	0.920	0.476
2012	0.324	0.412	0.420	0.855	0.429
2013	0.432	0.515	0.433	0.738	0.381
2014	0.570	0.720	0.447	0.799	0.095
2015	0.729	0.830	0.450	0.780	0.143
2016	0.877	0.917	0.438	0.767	0.186
2017	1.000	1.000	0.435	0.739	0.281

Source: Author's Calculations

TABLE III. INDEX OF FINANCIAL INCLUSION (I_F)

Year	X_1	X_2	I_F
2005	0.00045	0.0002	0.0003
2006	0.37187	0.1622	0.2670
2007	0.39983	0.2477	0.3238
2008	0.47532	0.3298	0.4026
2009	0.66522	0.3982	0.5317
2010	0.65444	0.4312	0.5428
2011	0.52949	0.4231	0.4763
2012	0.52272	0.4548	0.4888
2013	0.51558	0.484	0.4998
2014	0.58147	0.4655	0.5235
2015	0.64058	0.5126	0.5766
2016	0.78179	0.5407	0.6612
2017	0.75024	0.5747	0.6625

Source: Author's Calculations

TABLE IV. INDEX OF FINANCIAL INCLUSION (I_F) AND CLASSIFICATION INTO CATEGORIES

Year	I_F	I_F Range	Category
2005	0.0003	$0 \le I_F \le 0.4$	Low financial Inclusion
2006	0.2670		
2007	0.3238		
2008	0.4026	$0.4 < I_F \le 0.6$	Medium Financial Inclusion
2009	0.5317		
2010	0.5428		
2011	0.4763		
2012	0.4888		
2013	0.4998		
2014	0.5235		
2015	0.5766		
2016	0.6612	$0.6 < I_F \le 1$	High Financial Inclusion
2017	0.6625		

Source: Author's Calculations

The value of financial inclusion index has increased overall from 2005 to 2017 showing achievement of the country's financial inclusion initiatives reaching from a low value from 2007 to somewhat moderate value since 2007 giving us a medium financial inclusion up to the year 2015 after which the country experiences a relatively high financial inclusion from 2015 to 2017.

Thus, from 2008 to 2015 we observe medium financial inclusion. During these years, a notable observation is the value of financial inclusion being more in the years 2009 and 2010, eventually falling the next year and then again rising from 2012. The fall in the value might be attributed to reduced achievement in the dimension of insurance indicators in those years. Earlier studies like [12] did not reflect this pattern and showed a gradual increase in the index value with increase in time. However the introduction of insurance sector indicators has reflected a slight change in the pattern. Though the insurance indicator d_9 is having decreasing trend from 2010 till 2014, yet the financial index value has only decreased for the year 2011 and has been showing an upward trend thereafter. One possible interpretation might be the country's achievement in the banking sector indicators which has risen with every year and has outweighed the fall in the country's achievement in insurance sector indicators.

The year 2016 and 2017 has shown a high financial inclusion in this study. This might be attributed to the success of different policy initiatives taken by the government, mainly the success of Pradhan Mantri Jan Dhan Yojana initiated after 2014 which has resulted in significant reduction of unbanked population in the country. This is also reflected in the value of the dimension index D_1 which has risen from 0.570 in 2014 to 0.877 in 2016. Thus the study shows that financial inclusion has improved over the years and is a positive sign for the economic growth of India.

V. CONCLUSION

Financial inclusion is one of the fundamental pillars for the inclusive growth of any country. The financial inclusion index proposed in this paper is likely to monitor the progress of the Indian economy over time. The analysis however needs to be done cautiously which can provide proper direction and feedback to the policy makers. Further research could focus on construction of an index including more dimensions outside the domain of banking sector to have a constructive study of other financial services as well. Inter-state analysis may even be done to compare the progress of financial inclusion in various states of the country over a time period. This might have a policy implication in shifting focus to few states where financial inclusion is low.

The present study is an overall view of the state of financial inclusion in India and shows a general improvement in the level of financial inclusion over the given time period. However other studies like that of [21] shows that India still falls in the category of low financial inclusion when compared with other countries. This implies that there is a need of deepening of the financial institutions. The social implication of this would be a developed economic system which would be both inclusive as well as sustainable. There is also a

requirement of moving a step further by starting to focus on improving access to other financial services apart from banking and try on bringing more people into the spectrum of capital markets. Of course this needs a great deal of financial literacy that is one of the main obstructions in achieving financial inclusion of the masses. Thus policymakers need to find out ways to remove the obstructions in gaining access to and use of affordable financial services.

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APPLICATION OF NEUROSCIENCE IN PREDICTING CONSUMER BEHAVIOUR

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ABSTRACT IDEA: Neuromarketing is currently one of the most emerging fields of study of behavioral psychology and the application of connecting consumers' behavior with neuroscience [1](Staton, 2017). It is also termed as Consumer Neuroscience: Unlocking Answers without Asking. It is basically revealing the subconscious processing of the consumers mind of decision making towards purchasing which they don't articulate rationally or consciously. Currently, it is acting as the groundbreaking principle for most marketers [2](Laybourne P, 2005). 'Nature Neuroscience' has stated that "Neuromarketing is little more than a new fad exploited by scientists and marketing consultants to bind corporate clients with science." Therefore, this article attempts to highlight the upthrust of this rising field. It also highlights the prevalent cutting edge techniques and tools for directly probing the minds without requiring conscious participation of the consumers [3](Berns, 2012).

KEYWORDS- Behavioral Psychology, Consumer Behavior, Consumer Neuroscience, Unlocking Answers without Asking, Subconscious, Decision making, New fad, Nature Neuroscience, Conscious Participation

I. WHAT IS NEUROMARKETING

Neuromarketing as a marketing tool has been introduced by Gerry Zaltman in 1999 [4](Krajinović & D., 2012). Nowadays, concepts like behavioral psychology, human emotions, economic development, and consumer neuroscience form as a part of neuromarketing. Consumer neuroscience studies the cognitive and affective sides of human behavior [5](Ramsøy, T.Z, n.d.).It uses a variety of brain scan techniques (such as Electroencephalography(EEG)), eye tracking and physiological measurements (heart rate and galvanic skin reaction (GSR)) to understand the unconscious drivers of choice and preference [5](Ramsøy, T.Z, n.d.). The sole reason for this is consumers are oblivious of these influencers, which are not detected by conventional techniques such as focus groups, interviews, and questionnaires. However, this doesn't bring an end to the usage of traditional techniques but highlights a merger with advanced methods for "up-gradation" [5](Ramsøy, T.Z, n.d.).

In the remaining study I have presented a typical survey about what is the take of consumers over the objective of neuromarketing by using the Kano Model. However, before moving into the survey report I have provided an overview of the different neuromarketing techniques and how they help the researchers to gain insights.

II. NEUROMARKETING TECHNIQUES

To measure and study brain and biometric responses, as well as behavior, to understand and shape how consumers feel, think and act are by the following techniques [6](Harrell, 2019)

A. Electroencephalography(EEG)- measures neurons' electrical activity. It is the most preferred neuromarketing tool due to its low price and small size. It is effective for measuring approach-avoidance motivational reactions or cognitive workload [5](Ramsøy, T.Z, n.d.).
B. Functional magnetic resonance (fMRI) is used to measure oxygen-rich blood influx of an active part of the brain indirectly. It uses magnetic and radio waves to create brain images

[4](Krajinović & D., 2012). It is the only technology that can pinpoint activity at any location within the brain and measure the blood oxygenation level [7](NMSBA, n.d.) [8](Poldrack, 2008).

C. Positron emission tomography (PET) scanner is a method that uses radioactive drugs to study the tissue activities of the brain. This method is used to understand how substances that affect human behavior (i.e. dopamine) are distributed in the brain [5](Ramsøy, T.Z, n.d.).
D. Eye Tracking is used for measuring visual attention, cognitive "load," consistency of goal pursuit, and implicit preferences. Pupil dilation can be caused by changes in brightness, emotional response, and task difficulty. [5](Ramsøy, T.Z, n.d.).
E. GSR/EDA (Skin Conductance) is an excellent measure of emotional arousal or stimulation, both consciously and non-consciously experienced [9] (ESOMAR, 2013).
F. Facial Coding Analysis is a tool that answers questions about the response rates of expression and the type of positive and negative emotions expressed [7](NMSBA,n.d.).

III. PURPOSE

A. What was the aim of the Study?

The goal of the study is to understand how to design the products and services more effectively and evaluate the ground on which compulsive buying grows its roots.

B. What did you want to learn?

The intent was to learn how to solve and find the solution to the following [10](Neuromarketing Science & Business Association, n.d.):

i. How much desirable is the product
ii. Which emotion is triggered by the promotion
iii. Which ad is effective
iv. Which price acts as the customer pain
v. How colors and brightness have an impact on the consumers

So, the element aimed to learn is growing interest in understanding and focus on how brain responses reflect the decision-making process of consumers.

IV. BACKGROUND/SIGNIFICANCE

A. What was the problem faced and why was it important?

With emerging trends, the companies following traditional marketing were not able to capture greater market share and neither customers' attention towards their products or services [6](Harrell, 2019). For marketers there existed uncertainty and conjecture that traditionally hampered the efforts to understand consumer behavior. This led to the rise of NEUROMARKETING.

Importance of neuromarketing [11](Chartrand,2005):

i. Filling in the gaps by collaboration
ii. Linking of physiological reactions to content
iii. Improved reliability of results
iv. Value for money
v. Influence of website atmospheric cues by using a stimulus organism response [12](Lingling Gao, July 2014).

B. What Knowledge Are You Building On?

Neuromarketing provides key insights into matters relating to business sustainability, business ethology, and its relationships with other business environment elements. It provides information about consumer behavior which helps to develop products and services for customer delight by product scanning and the color of the advert as it has great impacts on the neurals to determine the level of preferences.

V. WHAT INSTRUMENTS WERE USED FOR THE STUDY?

The following instruments that have been used, based on the index of how significantly

an advertisement or product impacts a consumer's mind like [13](Farnsworth, 2017) [14](Farnsworth, 2020)

- Whether it has a high impact, or
- Whether it has a medium impact, or
- Whether it has a low impact

TABLE 1

PHYSIO - LOGICAL OBSERVATION	EYE TRACKING	GSR/EDA (SKIN CONDUC-TANCE)	FACIAL CODING ANALYSIS	HAND GESTURES **	VOICE PITCH ANLYSIS (VPA)**	SURV-EY**
EASE OF USE	High	High	High	High	Medium	High
TIME REQUIRED FOR STUDY	Relatively low	Relatively low	Relatively low	Minimum of 1 minute	Relatively low	Dependent on the type of survey
PORTABLE	Yes	Yes	Possible but technically difficult	Yes	Possible but difficult	Yes
MEASURES	Eye movement, pupilometry	Physiological arousal	Externally displayed emotions	Cognitive or unspoken thoughts	Attitude towards the stimulation	Opinions, conscious emotions
AVERAGE COST	Medium	Low	Low	Low	Medium	Low

FIGURE 1: DIFFERENT INSTRUMENTS USED FOR ANALYSIS

**In Figure 1 the eye-tracking, GSR, and facial expression analysis are being extensively used by the researchers and are well established. However, after conducting a random survey the importance of the instruments Hand Gestures and VPA have been observed which are not that prevalent.

VI. METHODOLOGY FOR THE STUDY

The purpose of the survey was to understand the pattern for buy-oly and concept over neuromarketing. I have conducted a random sample survey of around 20 customers each for 4 weekends for a month. The survey was carried out in 4 different consumer decks especially shopping malls. It was being conducted during the peak period of the day that is around 4 p.m. to 6 p.m.

The survey questionnaire was based on the Kano model which aims to find out the customer perception towards the offering of marketers [15](Lee YC, 2009). The questions for the survey are as follows:

(A) Neuromarketing is an emerging field where with the application of Biological techniques marketers can better understand the Buy-ology of customer, how do you feel?

- I like it that way.
- It must be that way.
- I am neutral.
- I can live with it that way.
- I dislike it that way.

(B) Neuromarketing is an emerging field where with the application of Biological techniques marketers cannot better understand the Buy-ology of customer, how do you feel?

- I like it that way.
- It must be that way.
- I am neutral.
- I can live with it that way.
- I dislike it that way.

However, the answers by the customers were not the only concern. The physiological response of the customers to the questions was equally important and have been noted.

VII. FINDINGS

In this survey, I have extended the aspect of my study and introduced 3 more instruments apart from the most prevalent instruments like eye tracking and so on. I have studied and observed how vocal cord vibrations provide adequate signals to judge the customer's mindset. It was also observed that customer's hand movements while filling the questionnaire represent body language which is derived from the brain.

VIII. ANALYSIS

For the survey, 80 prospects were approached amongst which clean observations have been noted from 36 respondents. Here out of the total, 60% were females under the age group of 25-45 years

and were more expressive and interested whereas the rest 40% were males whose age group was 30-50 years. Among the 80 respondents, the chosen 36 observations have mostly completed their graduation and above.

From the above the response on the instruments have been analyzed as follows:

TABLE 2

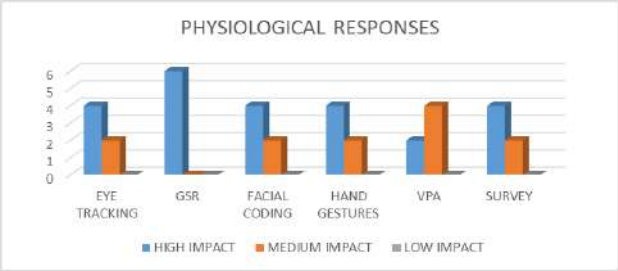
PHYSIOLOGI-CAL MEASURES	EYE TRAC KING	GSR	FACIAL CODIN G	HAND GEST URES	VPA	SURV EY
EASE OF USE						
TIME REQUIRED FOR STUDY						
PORTABLE						
AVERAGE COST						

FIGURE 2: INTENSITY OF PHYSIOLOGICAL MEASURES

TABLE 3

	EYE TRACK ING	GSR	FACIAL CODING	HAND GESTU RES	VPA	SURVEY
HIGH IMPACT	4	6	4	4	2	4
MEDIUM IMPACT	2	-	2	2	4	2
LOW IMPACT	-	-	-	-	-	-

FIGURE 3: FREQUENCY TABLE OF PHYSIOLOGICAL MEASURE



It is evident from the above analysis that:

Under physiological measures, GSR or Skin conductance has the highest impact on the part of the marketers as it is very easy to be used, it is affordable, portable as well as requires very little time for study.

Now, if we compare the instruments' table and the above graph, we can deduce that:

The facial coding, eye tracking, and hand gestures have weightage in understanding consumer's perception. However, I found that the facial expressions and hand gestures go hand in hand and were more evident and successful in expressing their unexpressed logical emotions.

VPA or Voice Pitch Analysis has a medium impact or is less preferred by the marketers. However, the vibration frequency of the human voice is also an effective way of measuring unexpressed emotions. Thus the VPA has the potential to reflect the actual emotions appropriately. So, there remains a loophole in predicting answers to the unsolicited questions.

Therefore, VPA and Hand Gestures like eye-tracking or GSR should also form an integral part of consumer neuroscience as well as neuromarketing by adopting telemarketing techniques or one on one interviews as one of its technique which has not been rapidly explored.

IX. SUGGESTION AND CONCLUSION

Every human is a consumer. However, the nature and habits differ from person to person which is a determining factor of consumer choice. A consumer is highly influenced by brands, social connections, context, price etc. either on a conscious or a subconscious level. [16](Foley, 2010).

Modern advertisements have a powerful influence on consumers' minds. The objective of marketing today should be to read their customers so that the product can be personalized.

Thus from above, we conclude that consumer behavior can be predicted from the following:

1. The importance of eye gazing

2. Ad efficiency
3. Product reviewing by scanning different social media networks.
4. Identifying hidden agenda
5. Brightness and color of the advert
6. The satisfactory level evaluation
7. Importance of right price and memorable prototype

Thus, neuromarketing indeed is a need of the hour, with its limitless scope and applicability.

I have presented neuromarketing and its techniques with its impact on the consumer's perception through a literature survey. Along with the analysis of each technique, I have also suggested that there is a need for an improvement over the Voice Pitch Analysis and hand gestures

X. LIMITATIONS AND WAY FORWARD OF THE STUDY

One of the limitations of the study is that due to time constraint sample testing over how consumers are responsive to the brightness and color of the advert and the pricing of the product has not been analyzed.
This discipline has got a large scope and lots are still yet to be explored. I look forward to carrying out a more intense research to explore the unexplored area in this field.

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Games Based Learning: Method and Integrity

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***Abstract*— recently, the world is living in an era of technology, where everything is developing and spreading rapidly around us. An increase in new technologies in education has recently observed to develop and improve students' performance in every area of their program. However, game-based learning is still not at a reliable level. This study aims to create a literature review on different learning methods that help students improve their educational studies—the research's idea based on the reference to the basic types adopted in learning using games. The survey results to evaluate the impact of using game-based learning distributed among undergraduates of Oman universities show a significant acceptance and full participation with using this learning in higher educational institutions. The paper's outcome demonstrates the need to use game-based learning to share their information, knowledge, and comments about the educational process.**

Keywords— Game-Based Learning; Academic Performance; Student motivation.

I. INTRODUCTION

An application game defined as an electronic game where all joined participants follow specific policies and transparent rules. [8] Discusses educational games that use games to support education and learning. The game is a support tool that complements traditional teaching methods to enhance the student skills and experience as an assistance tool work in parallel with everyday teaching to improve critical thinking and student creativity [6]. Learning should not consider boring and does not mean that students learn concepts through repetition or padding and memorize them with understanding. Some teachers have started using online platforms to help with education [20][33][19][21][37][9] therefore, learners or students can participate as online with a lot of offered activities and use the peer-to-peer interaction with students. This type of learning can improve a student's educational performance, but it cannot increase academic motivation [31]. Therefore, how students are interested in the course and their willingness to develop their knowledge has become a new important field for the researchers and programmers.

II. GAME-BASED LEARNING

In the traditional university courses at designed, still follow the policy to constant memorization and recitation when learning the course material for most students, especially course programming that is a bottleneck for students doing homework [6]. Therefore, students lost faith in the curriculum, and as a result, learning incentives diminished, giving up [8]. To overcome this collapse, will investigate among studies that give attention to using games to help students understand and motivate them to keep online learning [25]. Also, it allows students to self-learn their course-related knowledge to win the next game and improve their learning effectiveness. Game-Based Learning Many educational strategies studies use this facility in learning especially with challenging courses [6] Of these, and education stimulus often used as an educational strategy to improve learning outcomes [1][2].

Game-based learning aims to develop enthusiastic learners, motivate and engage students, reduce monotonous learning methods, and help students focus, self-esteem, and memory. Various types of educational games are applied and used in educational institutions, schools, and homes [3] [4][6]. The use of games in education primarily focused on improving critical thinking skills while teaching specific topics by allowing students to think outside the box while adhering to the rules. Other games can use to limit the improvement of knowledge on a particular topic, and the most popular are math games [5][11][34][18].

The European Commission has published a communication to boost digital skills in training in September 2013 [35]. The correspondence referenced insights uncovering that somewhere in the range of half and 80% of understudies in EU nations never utilized computerized course readings, practice programming, communicates/web recordings, simulations or learning games [4]. It also identified the problem not considering themselves sufficiently carefully confident, and the requirement for even more preparing in utilizing it. Among the presented measures for improving the circumstance with animating high-calibre, inventive instructing and learning, the Commission likewise highlighted Open Educational Resources (OERs). It recommended that they delivered, gathered and utilized at an expanded level [4].

The main idea of game-based learning in the education field is to teach as more prevalent in these recent years, especially with this COVID-19 pandemic situation. The case of teaching and learning, game-based learning, and online learning discussed a lot, but though the use of many interactive technologies and applications. For example, some studies wrote about game-based learning objects by explaining using emerging web 2.0-application technology. Another study used the rules of sharing Blog video by developing game-based learning and online learning with undergraduates at different universities. However, other

studies used the game-based learning advantages in the context of mobile devices [13]. Finally, the studies mentioned above used game-based learning, and online knowledge is necessary to understand how to apply media to the teaching and learning process.

III. Literature Review

This section will present some literature review articles that belong to the paper title and only review the papers related to game-based learning. [15][17]. Were mentioned several experiences in research on game-based learning applications to increase student engagement, and students have done to measure the effectiveness of games and education. Therefore, give education to students who don't have games and note the low student engagement [5][8][7]. Then, when some games added to the learning, many students became more active and interested in studying. Several educational studies use game-based learning to help students learn. Of these, education stimulus often used as an educational strategy to improve learning outcomes [7][8].

This type of game-based learning aims to stimulate the learner's learning motivation rather than the focus of the instructional instruction. Competitive knowledge is suitable for students, especially with game-based education, to compete and improve student learning effectiveness [9][10]. The educational game's placement is a special effort to achieve the academic game's goal to ensure that the educational activity can use for educational activities together with the coordinating part of the educational process. The most important thing in preparing an educational game is to gather reasons for training, refine the academic spirit, and separate the game [11][12][24] [28]. In conclusion, all these studies used game-based learning as the first indicator to motivate students to increase their knowledge and enhance their academic performance. However, these studies still missed the straightforward mechanism of presenting a course to encourage the students to engage in game-based learning. Also, what're the general factors determined to highlight the learning process towards game-based understanding [5].

Table 1 shows the full papers available in each year with each keyword. Science Direct filter was, four years period 2017-2020, only review article and educational research view [32].

Table 1: Article Analysis from Electronic Database

Type	Teaching Method	Learning Technologies	Game-Based
Science Direct	12,426	4,634	1,547
Springer Link	39,264	39,976	18,334
Ebsco-Hot	20,081	17,063	25,296
Web of Science (WoS)	15,161	1,126	1,078

Table 1, shows the results of three keywords form all types of papers as article, review papers, in all languages, with different fields not only in education. After filtering these duplication files in search, reviewing documents, medical reports, advertisement of universities, catalogues, and some university regulations and management issues. Also, some papers removed because it based on students only or instructors only without merging them or testing the influence of technology use.

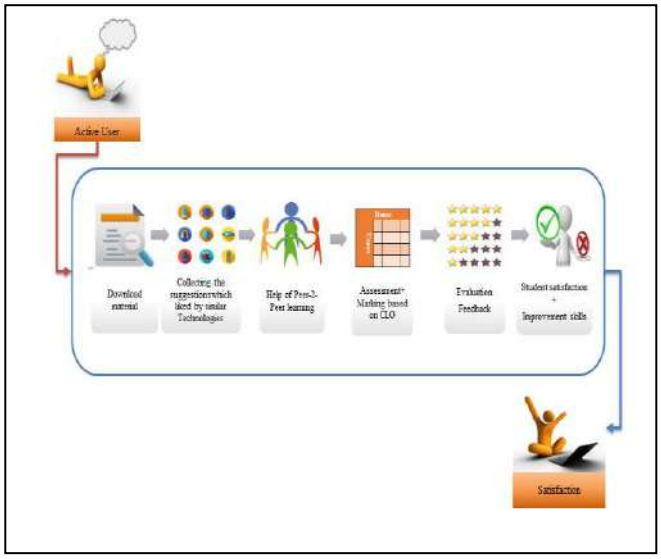

Fig. 1. Online learning and Game-Based Learning Acceptance

There are many challenges phased game-based learning applications; these challenges are not impossible to using game-based in education and developing teaching and learning procedure, even with some challenges through the full use of online learning and the same environment [6]. The main critical point is how it uses video Blog applications with game-based learning methods and how it can motivate and engage the students to simulate the work though student interest areas. As a suggestion offered to overcome this challenge as it related to use the web-mediated format as a solution to the best common excellent resource existing freely online

IV. Methodology

This mission aims to avoid tedious routine educational resources for students, maximize students' desire for study, and provide a pleasant learning environment that fits their game style. This method activates the Google engine has used and got numerous books and reviews related to the topic (Games for Education Enhancement). All surveys derived from strongly related papers, also revised by experts in the game programming field and grammatical languages [13][14][29][17] [19]. Then survey validation by checking the quality and the connection between the questions and understanding the central point from each item is clear enough to give the right feedback [14][3][23].

The steps of collecting data to finalize each stage's work can divide into 6 phases of development. The method started by understanding the business requirements determined by scheduling planning and identifying the project's problem [16]. The next step is to collect data related to the business need from the random data collection among the customers and the system operators and managers. Third, data preparation, modelling data to which type of method and most commonly used through parallel versions development to get good outcomes in a proper schedule. Then analysis these collected data through the evaluation process, as usual, used two of the recommended programs for statistical analysis by SPSS program or through PLS-SEM program to find each factor impact and influence. Finally, deployment of

the results as a full report to be submitted decision-maker to assess the system's acceptance and valuable benefits. [15]

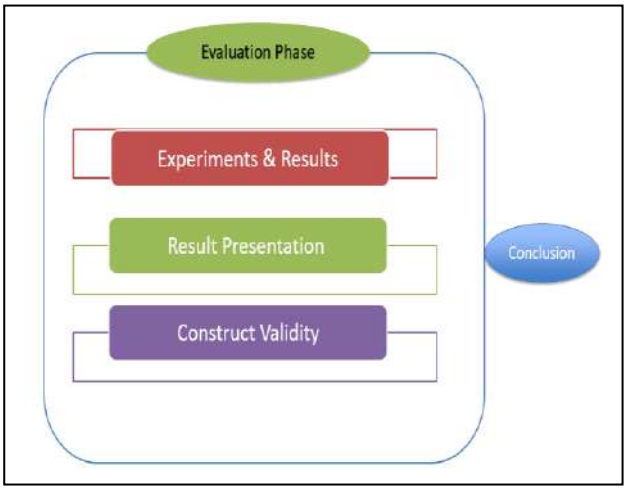

Fig. 2. Research Methodology

The survey shows that the elements of framework quality, data quality, and administration quality comprise LMS assessment's fundamental aspects. Articulating LMS assessment's educational elements with instructional quality, cooperation quality, and learning quality may better catch the subtleties that are significant for creative learning. The believability of this six-factor structure should approve.

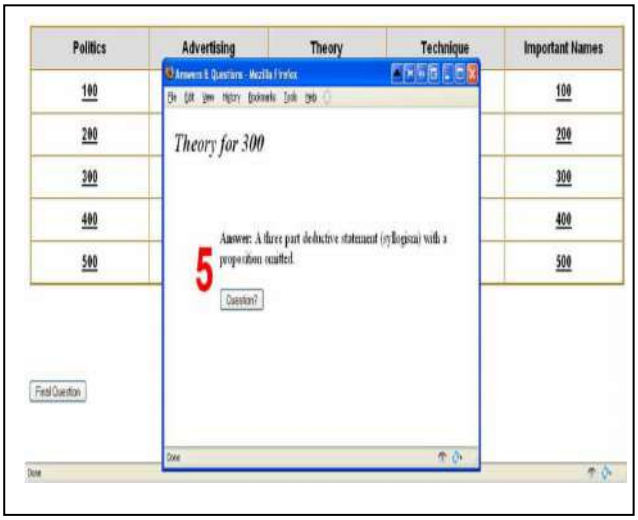

Fig. 3. Game-based Learning in Exam

Notwithstanding the developing acknowledgement of the significance of developing plan skills among understudies, there is yet a general absence of orderly investigations in the region of educator planning. With the quick improvement of ICT in instruction, instructors' interest in planning ICT-imbued exercises is also on the ascent [3][14][10]. Preservice educators should furnish with teaching conception using Moodle aptitudes to plan practical activities to meet individual contrasts to help develop structure limit among future understudies [31][22]. Conversely, a progressively ordinary way to deal with preservice instructor training will come in the public spotlight on planning forthcoming educators with centre encouraging information and abilities recommended in instructor training educational programs [18][9][12][20][2][19]. In some prior models, preservice instructors mainly prepared to perform alleged direct guidance or scripted encouragement in precisely the same words showing methodology [20][1]. There is generally less accentuation on the groundwork for the ability to expect the job of originator or hypothesis manufacturer with the necessary plan-thinking demeanour to take part in supported improvement for their showing rehearses [6][26]. Late conversation, in any case, has begun to concentrate more on developing versatile aptitude (e.g., see [7][16], just as configuration suspecting attitudes (e.g., [14]) among pre-service instructors. The configuration figuring required in instructing might be defined as subjective procedures that help educators deliver creative arrangements that adaptively address introducing related issues and issues in instructive settings. Such sort of reasoning is similar to what [20][6] called a "plan mode" of reason, which underscores the capacity to go past the quest for justified claims educate. It contends for the need for educators to work imaginatively with thoughts. Indeed, all innovative information work, overall, as a rule, requires such a structure method of reasoning [8][25][19]. It is almost inevitable for educators to consider instructing to be an undertaking from a progressively innovative point of view with configuration thinking. They would likewise be bound to consider educating to be an instrument to draw in understudies in profound learning and comprehension.

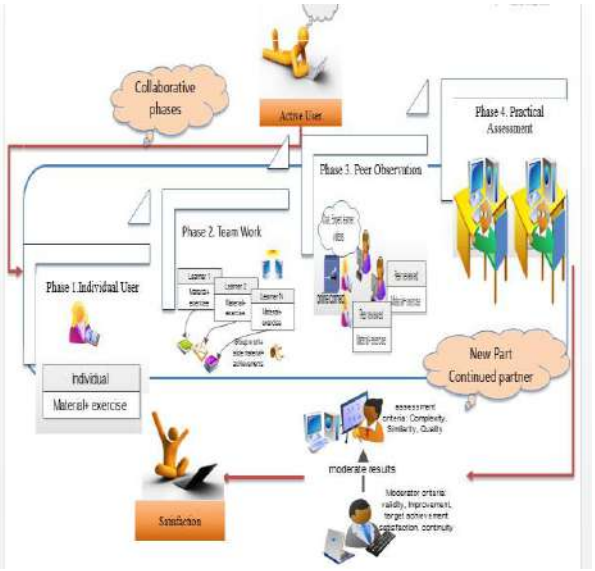

Fig. 4. Game-based Learning with peer-to-peer students

V. DISCUSSION

The use of digital games has great potential in higher education to provide active, fun, and engaging online education. According to the previous research data analysis, the results show the improvement of students' interest in using game-based even though the participants were limited in those universities, with its student of selected courses and sections. The improvement level was about 15% more than the regular class in programming courses, while the improvement limited to less than7% under challenging times even in mathematical methods [31][7][19].

Both students and teachers have found an effective way to develop and enhance a lecture-themed situation and encourage experimentation with new skills. Portable digital

games can improve both "hard" skills (e.g. skills or job-specific skills) and "soft" (e.g. teamwork) by adding complementary motivational elements (e.g. fun and competitive). Alternatively, this particular game can play by an individual or student pairs. The reduces coordination issues for large teams [7][14][24]. If the coach sets a large and continuous-time at his disposal, such as a 3-hour time slot, you can even play the game simultaneously. However, teachers should be careful when estimating how long it will take the time to play the game to complete until it needed to complete the game task. Finally, all digital games need to pay attention to students' learning curves when using technology and take appropriate steps to reduce technical barriers.

VI. CONCLUSION

There are many opportunities to implement the game concept in education, and there are many types of games available in the learning process, including problem-solving, practice, simulation, puzzle, and educational games. In this paper, the primary purpose was to highlights some of the literature reviews by analyzing six core-papers. The literature review also determined the studies related to game-based focused on the rapidly emerging learning paradigm and practice using computer games and encouraging the learning process, which determined positively for both of students and teachers in their experience. This review of general game-based learning summarizes some of the benefits of applying game-based learning to improve student performance. Social game mechanics increase student motivation and learning needs, develop stronger relationships with team members and colleagues, and ultimately help the knowledge discovery process. The methodology, explained in common steps, shows the six phases to follow through any system development to enhance a game-based.

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Blockchain Transforming Procure to Pay value Chain

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***Abstract*— Blockchain Technology can be highly relevant in the Procure to Pay (P2P) value chain helping the Organizations to bring Transparency in transactions, Better Working Capital Management, Improved Compliance to Environmental and Safety standards, Improved Supply chain Process and overall end to end Visibility & Traceability in the ecosystem.**

INTRODUCTION

Procure to Pay (*P2P*) value chain is the backbone for any Organization for sourcing and procuring the necessary Raw materials or Services. The Efficiency and Effectiveness of the Value chain decides the Organization capability to manufacture products or deliver services to their Customers Ontime in full with complete transparency and Compliance to Various standards.

Procure to Pay is a multi-step process involving various stakeholders namely Vendors, Logistics Providers, Bank, and multiple teams in the Client end - Procurement Team, Finance team, Warehouse team and Compliance team and they execute transactions as part of the ecosystem. Key steps involved are Release of Purchase Order, Creation of Sales Order, Delivery of Raw materials through logistics provider or Delivery of Services, Invoicing, Receipt of Raw materials, or Services including checking on Compliance standards, Accounts Payables process and Payment to Vendors through Bank. The value chain can be supported by multiple IT systems across the ecosystem which can be disparate making it difficult to have a single source of truth for the stakeholders and making the whole value chain very complex with inefficient processes.

Enabling the whole process value chain with Blockchain can bring immense value consisting of a main Blockchain of Procure to Pay and multiple side chains of Raw material traceability during production, handling of materials and fulfillment of delivery. Blockchain can make product and transactions traceable and auditable throughout the value chain by assigning unique and immutable digital identifiers. With the help of smart contracts, Blockchain can drive efficiency and effectiveness in each stage of the process.

Implementatation of Procure to Pay Blockchain

P2P Blockchain implementation should be led by Business SMEs, Data and Technology experts with a focus on clearly defining business outcomes along with the ecosystem partners across the value chain. Blockchain brings in the best of Business, Analytics and Technology in one implementation. The following section outlines the key steps involved in the Procure to Pay Blockchain implementation

Step 1 Process Study

As a first step, a detailed study to understand the current end to end process as depicted in Figure 1, its functions, current issues, data elements, baseline metrics for efficiency and effectiveness, contractual obligations, compliance requirements and application landscape supporting the process needs to be mapped. Highlighting the issues in the current process map as in Figure 2, will help to map the different elements to blockchain functionality in the future steps to solve the issues. For example, Goods would have been delivered by the Logistics Provider, but the Customer Warehouse team has not posted the Goods receipt in the relevant Stores application delaying the Accounts Payables process in the downstream.

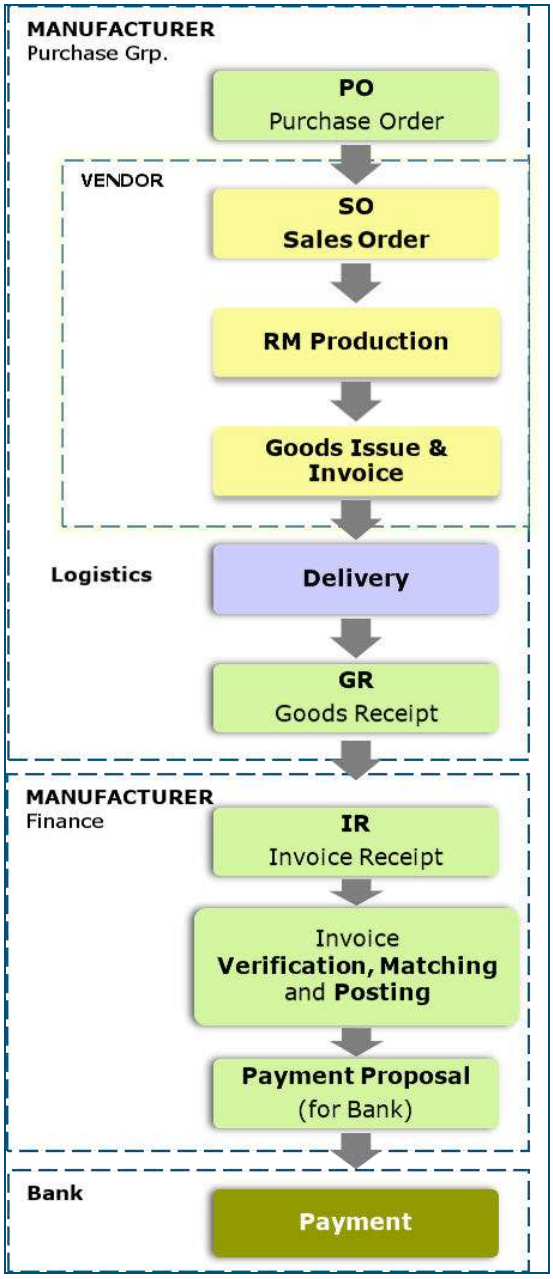


Fig 1 END TO END PROCESS OF PROCURE TO PAY

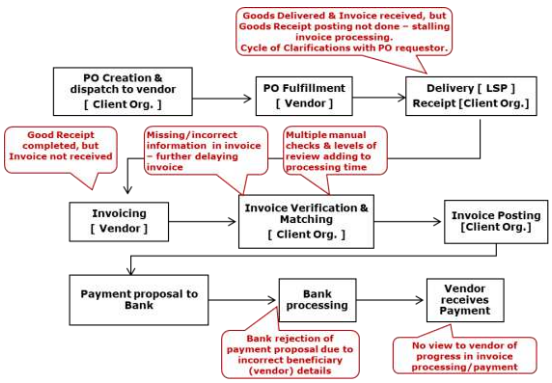
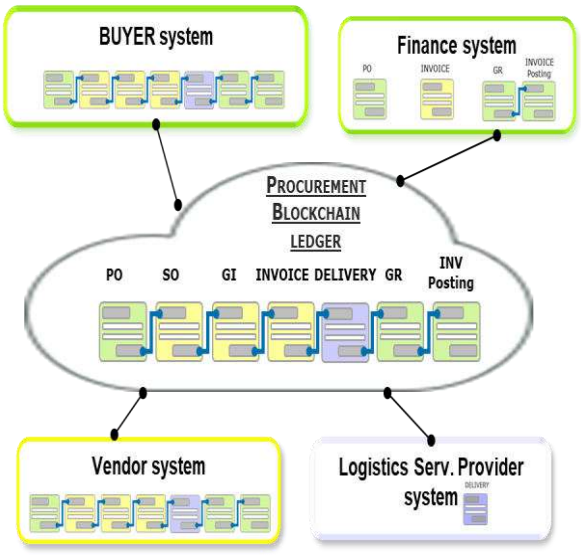


FIG 2 SAMPLE ISSUES IN THE CURRENT PROCESS

Step 2 Designing the Blockchain Solution

Once the current process and issues are understood by the ecosystem partners, the To-Be future process with information elements that need to be shared by each stakeholder is developed which goes into the build of the Blockchain DLT (Distributed Ledger Technology) solution.

The transformed Blockchain solution will include all the information elements which will be shared among the different stakeholders who are part of the ecosystem and the corresponding smart contracts which will be executed during the process execution at various stages. Figure 3 gives the illustration of the P2P Blockchain solution and the information elements shared among the ecosystem partners in an end to end Procure to-Pay value chain. This new Blockchain enabled process would significantly improve the transparency among the stakeholders and enable transactions efficiently and effectively. Once the future state Process is finalized which is depicted in Figure 4, ecosystem stakeholders principally agree to share the required information elements, decide on technology infrastructure (Blockchain technology like Hyperledger, Ethereum) required for implementation, enable the node at their end for decentralizing the peer to peer exchange and adhere to the Smart Contracts drafted in the Blockchain solution.



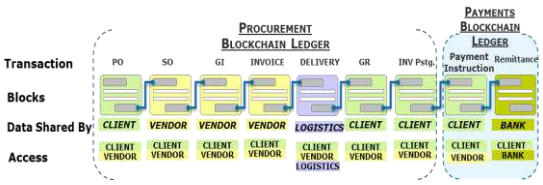


FIG 3 BLOCK CHAIN SOLUTION DESIGN

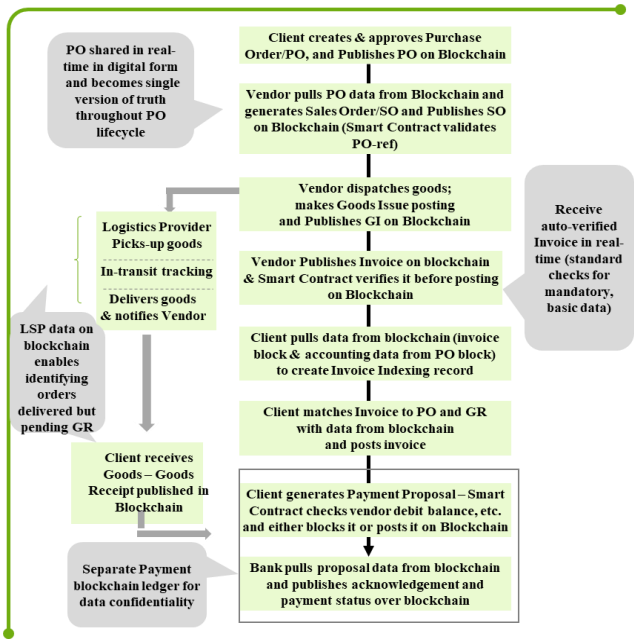


FIG 4 FUTURE STATE P2P PROCESS WITH BLOCKCHAIN

A clear governance is defined among the ecosystem partners who agree and commit to the end deliverables and timelines of the transformation project including the consensus mechanism for certifying every transaction.

Smart contracts play a vital role in the P2P value chain enabling a self-enforcing agreement between the parties with a list of fulfillment criterions for those participating in the Blockchain. Smart contracts help in providing audit trails which can be traced back for all transactions and the immutability functionality of Blockchains helps in smart contracts reducing the risks involved when disputes arise. Clear predefined rules are agreed and built in as smart contracts which when met, the agreement is enforced automatically without the need for unbiased intermediaries. This helps in reducing the monitoring work and improving the overall process efficiency and effectiveness. For example, Automatic review and detection of mismatch in information between purchase order, goods issue and invoice with the help of Smart contracts can improve the payment on time and remove inefficiency in the P2P process.

Apart from the main P2P Blockchain, there are few side blockchains which will be linked to the main P2P Blockchain. These side chains drive the Supply chain efficiency and Compliance requirements of the Industry

Let us understand one of the Side chains – Raw Material (RM) being Manufactured at Vendor end. While the Raw material is being manufactured by the Vendor in the factory, information of the contents (formulation and percentage) used to produce the RM will be instantaneously shared

through Blockchain. With the help of SMART contract which monitors the integrity and safety compliance standard, the Client can be assured of the RM compliance which the Organization will use for producing its end product. For example, Lead is a hazardous raw material and the amount of Lead that can be present in a material is highly restricted and tracked. If the Vendor is using Lead has one of the raw materials in the production of the final product, then the vendor is bound to share the Bill of materials through Blockchain which helps in transparency and traceability for the downstream consumer organizations to comply to the safety standards. Clients are demanding detailed information and assurance about the raw materials they are buying, how it's being sourced or produced, product authenticity, ethical practices of labor, and sustainable production, packaging and transport are of increased importance. This side chain also helps in recall process of products.

Similarly, when Raw material is shipped from Vendor site to Customer site, the parameters (Temperature, Pressure..) adhered during the journey can be shared in real time by the Logistics provider which helps in keeping up the safety and compliance standards for the downstream organizations who will be using this raw material in their Product Manufacturing cycle.

Once the Blockchain design, information elements, smart contracts and infrastructure requirements are agreed among the stakeholders, then the actual solution is built along with the systems integrations required to enable the Blockchain.

Step 3 Blockchain Implementation

Once the solution design is approved by the different stakeholders, technical implementation of P2P Blockchain is initiated. For illustration purposes, the P2P blockchain implementation is explained with Hyperledger Fabric. Hyperledger Fabric is a private blockchain network offering a foundation for business transactional enterprise application development. For data protection purposes, we will be using the Permissioned Blockchain framework which enables the parties in the ecosystem who are participating in the P2P value chain network the need to prove their identification and complete the verification through authentication. It allows each user to have a defined role, restricting the actions they can perform on the blockchain through fine-grained permissions. A sample Blockchain technical architecture with the components explained in Figure 5

- Enterprise systems of participating parties will connect to the solution via REST calls
- Channels are created so that transactions can be isolated such that only the right participants will receive these transactions. Channels offer an extra layer of transactional confidentiality.
- Hyperledger composer offers various high-level components and APIs which help easy and quick communication to the Hyperledger Fabric blockchain runtime. Composer enables to build and revamp business models and integrate existing systems and data within blockchain applications.
- The web server layer will expose business logic via REST and connect to Blockchain platform using platform's SDKs
- The Blockchain platform will contain the ledger that records transactions and smart contracts with business rules for those transactions
- Hyperledger holds various components as consensus and membership services to be plug-and-play
- Leveraging container technology, the smart contracts are hosted

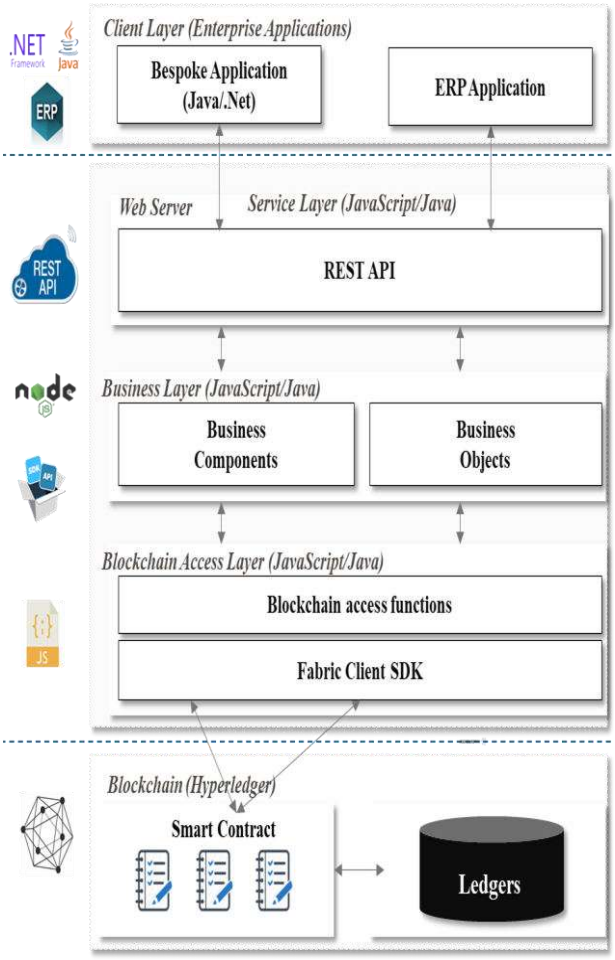


FIG 5 BLOCKCHAIN TECHNICAL ARCHITECTURE (Sample)

- Hyperledger offers a robust architecture thereby optimizing the security, resilience, flexibility, and scalability of blockchain applications

Once the whole solution architecture is built including the integration of various Business applications for transfer of information, user acceptance testing is conducted in the pilot environment in a controlled manner. In the Figure 6, the whole P2P value chain is clearly depicted and how in each step the transaction is successfully executed with transaction details which are real time shared among the Blockchain participants.

If any of the predefined rules as part of Smart contract is not met, then the Blockchain automatically triggers a notification to the interested parties as depicted in Figure 7. In this case, the invoice is not received by the Buyer or

Client on time and hence there is an automated notification to take proactive steps for resolving the same. This helps in mapping any legal obligations and provide greater degree of Contractual security for the participants in the overall P2P ecosystem.

One of the key aspects of Blockchain pilot is the learning experience for the different stakeholders in the ecosystem and the visibility of the various benefits including Cost optimization, faster revenue realization and complying to legal, environmental and social standards. As a next step, the pilot experience is reviewed among the ecosystem partners before going ahead with Production implementation in a large scale.

FIG 6 P2P BLOCK CHAIN IN ACTION

FIG 7 SMART CONTRACT ENABLED

Benefits of Implementing P2P Blockchain

- Purchase Orders are shared in real time with the Vendor. This in turn helps in automating the Sales Order creation process at the Vendor end eliminating errors in Supply chain
- Tracking of total lead time for Production, Packaging and Delivery creation at the Vendor end helps in better planning of Supply chain at the Client end and avoid delivery delays to their end customers
- Tracking of materials used in producing the products at the Vendor end helps in traceability for safety and environmental standards at the client end produced materials
- Easy coordination of logistics documents on Blockchain reduces the physical paperwork largely unnecessary. Approvals and clearance at customs will be quicker and very efficient, reducing lead times for goods at customs checkpoints.
- During transportation of raw materials, Blockchain ensures trustworthy data validation across the entire logistics ecosystem
- Elimination of reconciliation of data across the P2P value chain as every transaction is approved in the Blockchain which increases the efficiency of the whole process. For example, any errors in the invoice is immediately notified which eliminates the delay in the downstream accounts' payables process
- Smart contracts can be automatically triggered in the P2P process, resulting in decreasing administration and service costs while improving process efficiencies
- Elimination of fraudulent transactions and greater trust plus transparency among the parties. This leads to greater accountability and reduction in transaction delays which in turn avoids late payments
- Reduction in follow-ups from Vendor end for payments from Clients due to end to end visibility of transactions. Also, this leads to reduction in Collection follow up resources in the Vendor side

Current Challenges of implementing P2P Blockchain

- Cost of integration of Blockchain to existing application landscape of accounting systems, workflows need to be validated with feasibility of Business case. Blockchain handling in real-time the huge volume of transactions in the P2P ecosystem maybe a challenge
- P2P Blockchain involves a Client working with multiple Vendors to fulfill the Raw materials and Service requirements. All the Vendors need to sign off for the Blockchain implementation which becomes a big challenge
- In the same way, a Vendor may work with two different clients. Client A may have implemented Blockchain and Client B is still to do so. This

forces the Vendor to have two different ways of operations which leads to process inefficiencies at the Vendor end

- Clients may operate in different Blockchain platforms (Hyperledger or Ethereum or Corda) which may force the vendor to work with two different Blockchain platforms to conduct business with them
- P2P ecosystem parties agreeing to the engagement rules defined in the Smart contracts and share the information across channels will be big hurdle for adoption
- Employees involved in the P2P ecosystem need to undergo a significant change in their ways of working resulting in discomfort and resistance to change

Summary

Overall Blockchain transforms the traditional process and enables faster settlement of P2P transactions avoiding multiple manual interruptions for validation. Success of the P2P Blockchain depends on the integrated working of all the ecosystem partners. During the Conceptualization and Build stage considerable time is needed to correctly draft the data elements and smart contracts which decides the delivery of the Business outcomes. A very clear business case encompassing all the pre-requisites, security features and assets required to implement Blockchain should balance the benefits which will be realized on adopting Blockchain including the cost of technology integration to the existing applications in the overall ecosystem. One way to overcome the challenges and take the Blockchain initiative forward is to setup the solution in a consortium model – where a specific organization in a specific sector (for example Automotive or Chemical Industry) takes the lead along with few other Organizations in the same sector as core partners (part of design governance) and the rest of the companies are part of the consortium and simply use the solution or have partial say in the solution. This way vendors too can onboard the blockchain platform and cater to multiple Client organizations without having too many hassles.

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Multi-model PID Control of Interacting Two Tank Hybrid System

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***Abstract*—This paper is about design and analysis of Multi-Model PI and PI controller for a non-linear system. The system chosen is a benchmark system, Interacting Two Tank Hybrid System (ITTHS) which is a non-linear system with variable area tanks and interaction between the tanks. The PI and Multi-Model PI controllers are tuned using ZN-Closed loop method. The efficacy of the Multi-Model PI and PI has been validated on this benchmark process, Interacting Two Tank Hybrid System (ITTHS).**

Keywords — ITTHS, PI controller, Multi-Model PID

I. INTRODUCTION

Crucial processes variables in any industry dealing with chemicals are level, flow and pressure. Almost all processes in the industries are multi-input and multi-output (MIMO) systems. Level measurement is of utmost importance for all process industries as it ensures safety of humans as well as the equipment. Controlling of MIMO systems are fairly problematic due to the change in system parameters at different operating points and the interactions between various process variables. The most widely used controller in the world is PID controller due to its versatility in handling various applications and the ability to achieve satisfactory response. However, in actual practice, most of the chemical process are non-linear in nature and the conventional PID controller doesn't give satisfactory performance that is required.

The benchmark system, interacting two tank hybrid system (ITTHS) is studied here which is a non-linear two-input two-output system with dynamic interaction. The cross-sectional area of the both spherical and conical tank varies with respect to change in operating point or height of the liquid level, hence the process parameters changes. Due to interconnection between the tanks at the bottom, the ITTHS will have nonlinear dynamic interaction. The non-linear behaviour is due to the variable CSA of the tank as the level increases.

The control of a chemical process, design aspects of a process control system and modelling the dynamic and static behaviour of chemical processes, with which the modelling of interacting of two tank system can be developed are presented in [3]. The authors of [1] have studied the process of temperature control of injection mould and used a multi-model PI control technique to tackle the non-linearity present in the system. A non- linear PID and non-linear MPC for the control of CSTR has been designed and developed by [2] and they have highlighted the essential advantages and disadvantages in using non-linear PID and non-linear MPC. Enhanced PID controller being implemented by [4] for ITTS, provided better controller performance by fine tuning ZN tuned PI parameters with GA at various operating points. The idea of decentralised PID controller by using decouplers between various inputs and tuning using frequency domain, MIMO process can be controlled was published by [5]. The modelling of ITTHS along with its linearisation has been carried out by [6] which aids in the course of this paper. Authors of [7] provides valuable insights about the implementation of Multi-Model control schemes on various processes.

The organisation of this report is as follows: the process description is presented in section II, followed by the mathematical model and linearisation of ITTHS in section III, the open loop response of ITTHS is in Section IV the controller design is provided in section V, and the results are attained in section VI, along with conclusion in section VII.

II. PROCESS DESCRIPTION

The system considered here has two tanks, spherical and conical tanks which has interaction between them through the hand-valve (HV_{12}). Both the tanks have individual flow inlets as well as flow control valves CV_1 and CV_2 respectively. Let F_{in1} and F_{in2} be the inflows to conical and spherical tanks respectively while h_1 and h_2 be the height of the two tanks at time t. Thus, the system here is a MIMO process where h_1 and h_2 are the process variables whereas F_{in1} and F_{in2} are the manipulated variables. A block diagram of the ITTHS is given below in Fig. 1.

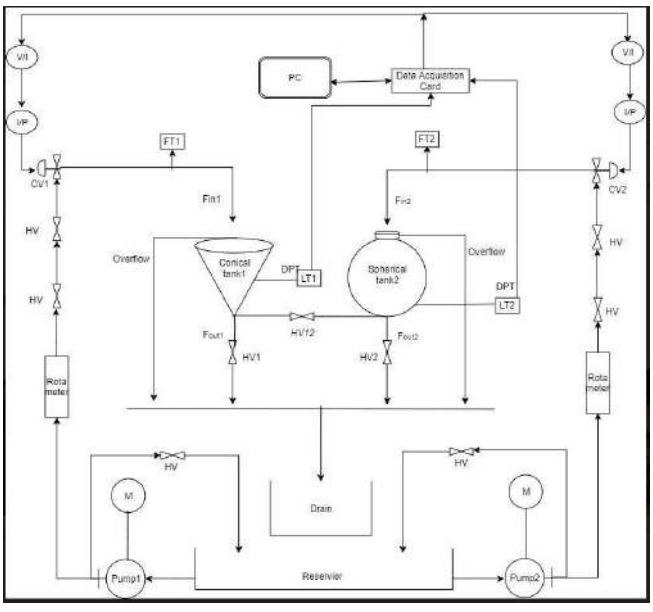


Fig.1: Schematic of ITTHS

The research on ITTHS has been done with parameters that are provided in table 1.

Table 1. Operating parameters of the ITTHS

Parameters	Description	Value
h_1	Level of tank1 (conical) at *t*	--
h_2	Level of tank2 (spherical) at t	--
H_1	Max level of conical tank	70.5 (cm)
H_2	Max level of spherical tank	52 (cm)
R_1	Top radius of conical tank	30 (cm)
R_2	Radius of spherical tank	25 (cm)
$F_{in}1$	Max inflow through CV_1	1500 (cm^3/s)
$F_{in}2$	Max inflow through CV_2	1500 (cm^3/s)
cv_1	Coefficient of CV_1	0.5
cv_2	Coefficient of CV_2	0.5
mv_{12}	Coefficient of HV_{12}	0.45
α_1	CSA of output pipe of tank 1	1.2 (cm^2)
α_2	CSA of output pipe of tank 2	1.2 (cm^2)
α_{12}	CSA of interacting pipe	1.2 (cm^2)
g	Acceleration due to gravity	981 m/s^2)

III. Process Model and Linearisation

Modelling of ITTHS

As per the authors of [6] the mathematical modelling of ITTHS has been carried out, which is based on the first principle method. According the mass balance equations the dynamic modelling of ITTHS is provide below in (1).

$$dh_1/dt = 1/(\pi/4(D/H)^2h_1^2)\left(u_1 - cV_1\alpha_1\sqrt{2gh_1}\right.$$
$$\left. -hv12\ \mathrm{sign}(h_1 - h_2)MV_{12}\alpha_{12}\sqrt{|2g(h_1 - h_2)|}\right)$$
$$dh_2/dt = 1/\pi(2Rh - h^2)\left(u_2 - cv_2\alpha_2\sqrt{2gh_2}\right.$$
$$\left. + hv12\ \mathrm{sign}(h_1 - h_2)MV_{12}\alpha_{12}\sqrt{|2g(h_1 - h_2)|}\right) \quad (1)$$

Linearisation of ITTHS

Linearisation has been carried out using Jacobean's method of linearization on the above equation 1 around the various operating points. The operating points of ITTHS are chosen depending on the rate of change of CSA of the two tanks. Here, three regions with height of the tanks at (20 cm,15 cm), (40 cm, 30 cm) and (60 cm, 45 cm) are chosen.

The state space parameters are provided in table 2.

Table 2. State space parameter of linearized ITTHS

Operating region	A	B
$[h_s]$ = (20 cm, 15 cm) $[u_s]$ = (176.24 cm^3/s, 50.56 cm^3/s)	$\begin{bmatrix} -0.0369 & 0.0237 \\ 0.0033 & -0.0054 \end{bmatrix}$	$\begin{bmatrix} 0.0043 & 0 \\ 0 & 0.0006 \end{bmatrix}$
$[h_s]$ = (40 cm, 30 cm) $[u_s]$ = (249.24 cm^3/s, 71.51 cm^3/s)	$\begin{bmatrix} -0.0065 & 0.0042 \\ 0.0021 & -0.0034 \end{bmatrix}$	$\begin{bmatrix} 0.0011 & 0 \\ 0 & 0.0005 \end{bmatrix}$
$[h_s]$ = (60 cm,45 cm) $[u_s]$= (305.26 cm^3/s, 87.58 cm^3/s)	$\begin{bmatrix} -0.0024 & 0.0015 \\ 0.0045 & -0.0073 \end{bmatrix}$	$\begin{bmatrix} 0.005 & 0 \\ 0 & 0.0014 \end{bmatrix}$

The C and D matrices remain constant throughout and is given by

$$C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \qquad D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$$

IV. Open Loop Response of ITTHS

A. Open loop resoponse of ITTHS

Fig 2 and fig 3 represents the open loop response when $h_1 > h_2$ and the interaction valve is closed

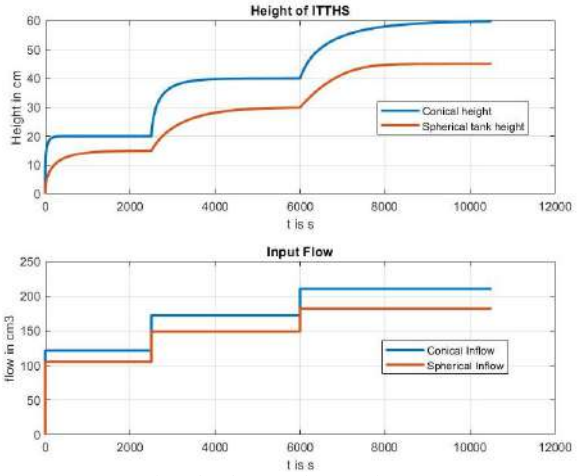


Fig.2: h1>h2 & Valve opening 0%

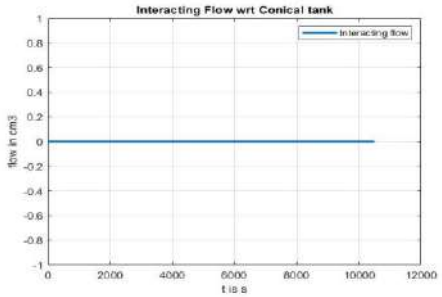


Fig.3: Flow from Tank1to Tank2, h1>h2 & interaction 0%

Fig 4 and fig 5 is the response when the valve is opened 90% and $h_1 > h_2$

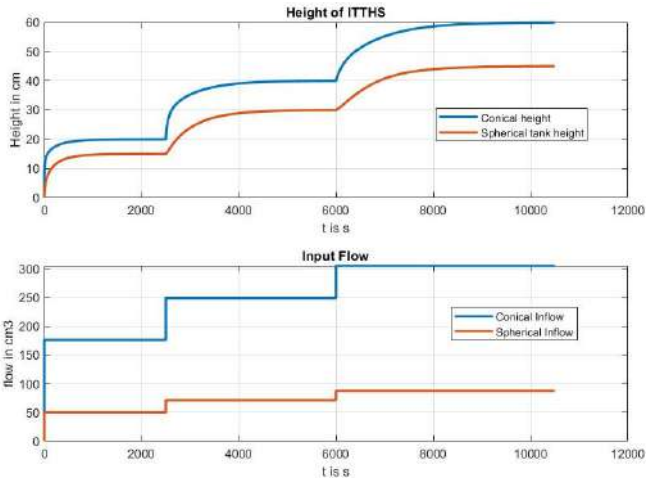


Fig.4: h1>h2 & Valve opening 90%

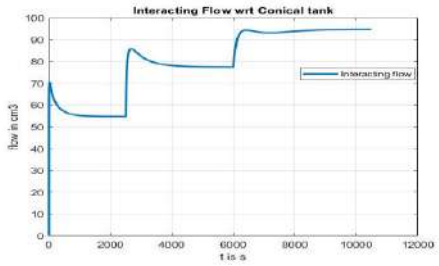


Fig.5: Flow from Tank1to Tank2, h1>h2 & interaction 90%

The open loop response of ITTHS when $h_2 > h_1$ and the interaction valve is at 90% is given in fig 6 and fig 7.

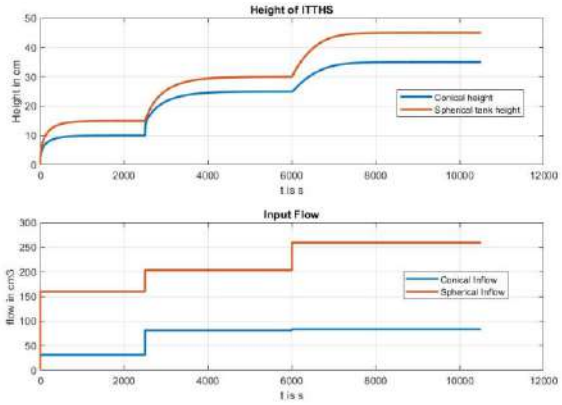


Fig.6: h2>h1 & Valve opening 90%

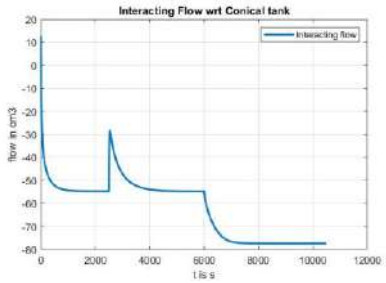


Fig.7: Flow from Tank1to Tank2, h2>h1 & interaction 90%

B. *Interaction Analysis*

- If the interacting hand valve is closed, the interaction between two tanks is nil.
- When the hand valve HV_{12} is opened, there is visible effect of F_{in1} on h_2 as shown in the figure 3 whenever height in tank 1 is greater than height in tank 2. Which tells the tank 1 has 1 input and 2 output, whereas tank 2 has 2 input and 1 output.
- Similarly, when height in tank 2 is greater than height in tank1 and hand valve is opened, the flow occurs from tank 2 to tank 1 as shown in figure 4. Thus, interaction between two tanks must be taken into consideration while designing controller

V. DESIGN OF CONTROLLERS

A. *Design of PI controller with integral windup*

The conventional PI controller output is given by (2) where K_P is the proportional gain and K_I is the integral gain of the PI controller and e(t) is the error between the setpoint and the actual height of the tank.

$$u(t) = K_P e(t) + K_i \int e(t)dt \quad (2)$$

Since flow cannot be negative the need to implement integral windup is required to reset the error integral. Fig 8 shows the PI with integral windup

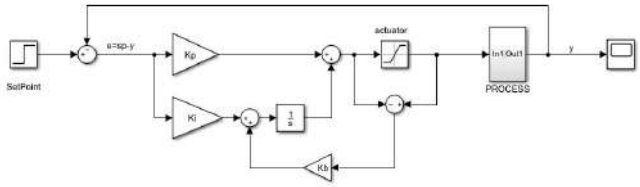


Fig.8: PI controller with integral windup

The PI controller parameters are designed for individual tanks using ZN closed loop method around the operating point (40 cm, 30 cm). The parameters are tabulated in table 3.

Table 3. PI parameters for ITTHS

PID 1	$Kp_1 = 27.1$	$Ki_1 = 0.89$	$Kb_1 = 0.11$
PID 2	$Kp_2 = 30.3$	$Ki_2 = 0.62$	$Kb_2 = 0.08$

B. *Design of Multi-Model PI controller*

The multi-model control scheme consists of a weight scheduler and a family of controllers. At a given sampling point, the objective of the scheduler is to provide weights for all the controllers and the output of weighted sum of the outputs is the input to the final control element. The weight scheduler manipulated different variables like process variables, manipulated variables to assign weight to each and every controller.

Multi-model controllers are mostly used for non-linear process as a single operating point cannot control the whole system, hence the system is linearised at 'n' operating points and controllers are designed for each operating point and a weight scheduler provides the weights to the controllers. In this work the ITTHS is divided into 4 regions.

- Region 1: tank 1 00-10 cm tank 2 00-05 cm
- Region 2: tank 1 11-30 cm tank 2 06-25 cm
- Region 3: tank 1 31-55 cm tank 1 26-37 cm
- Region 4: tank 1 55-70 cm tank 2 38-50 cm

For the above 4 regions the multi-model control scheme is developed. A total of 3 PI controllers with integral windup are considered. In region 1 only controller 1 will control the output, if the process variable is in region 2 then controller 1 and controller 2 share the controller effort, similarly for region 3 controller 2 and controller 3 aid in controlling the process. For region 4, controller 3 alone acts. the amount of contribution of each controller is controlled by the weight scheduler.

The schematic of Multi-Model control scheme is in figure 9.

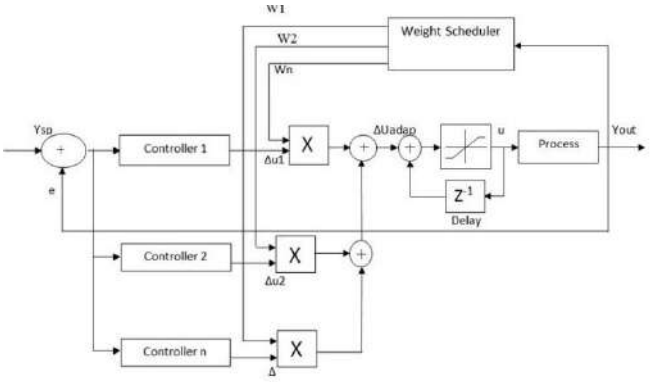


Fig 9: Schematic of Multi-Model control scheme

The controller output is given by

$$U1=(u1*w1) + (u2*w2) + (u3*w3) \quad (3)$$
$$U2=(u4*w4) + (u5*w5) + (u6*w6) \quad (4)$$

Here, U1 is the overall controller output to tank1 U2 is the overall controller output to tank2. u1, u2 and u3 are the controllers for tank1. w1, w2 and w3 are the weights to the controllers of tank1. u4, u5 and u6 are the are the controllers for tank2. w1, w2 and w3 are the weights to the controllers.

Each controller of the multi-model PI with integral windup controller is tuned using ZN open loop method from the state space model at the operating points. The controller parameters are provided in table 4.

Table 4. Controller parameters for MM-ITTHS

Region	PI of Conical tank			PI of Spherical tank		
	K_{P1}	K_{I1}	K_{B1}	K_{P2}	K_{I2}	K_{B2}
(20,15) cm	25.6	1.6	0.11	46.2	0.60	0.08
(40,30) cm	52.2	0.89	0.11	60.1	0.80	0.08
(60,45) cm	70.1	0.70	0.11	44.7	0.15	0.08

Switching and weighting algorithm are developed for selecting the controller to obtain the desired values. The weights are calculated by taking the slopes of the membership functions in the given operating region. The advantage of weighting scheduler is that it helps in smoother switching when it moves from one region to another region. The algorithm is provided in table 5

Table 5. Switching condition and weights

Condition for tank 1	Weights for tank 1	Condition for tank 2	Weights for tank 2
h1<10	w1=1 w3=0 w5=0	h2<5	w2=1 w4=0 w6=0
10≤h1<30	w1=1-w3 w3=(h1-10) / (30-h1) w5=0	5≤h2<25	w2=1-w4 w4=(h2-5) / (25-h2) w6=0
30≤h1<55	w1=0 w3=1-w5 w5=(h1-30) /(55-h1)	25≤h1<37	w2=0 w4=1-w6 w6=(h2-25) / (37-h2)
h1≥55	w1=0 w3=0 w5=1	h1≥37	w2=0 w4=0 w6=1

VI. Simulation Results

The simulation results are simulated using MATLAB® software.

A. Simulation results of PI controller

Servo response of ITTHS with 0% interaction is given in fig 10 and fig 11.

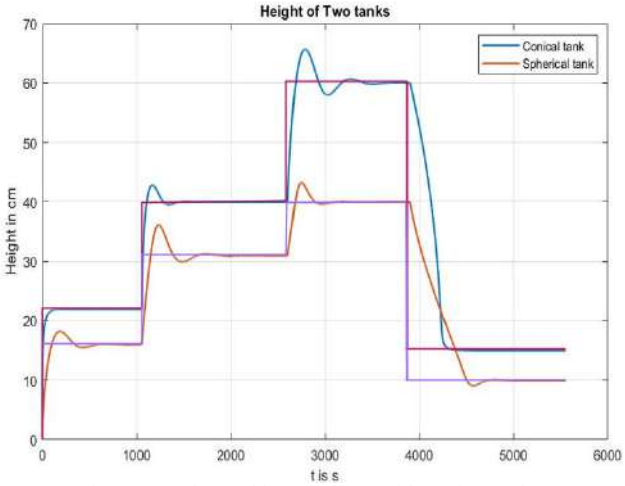


Fig 10: Setpoint tracking of ITTHS with 0% interaction

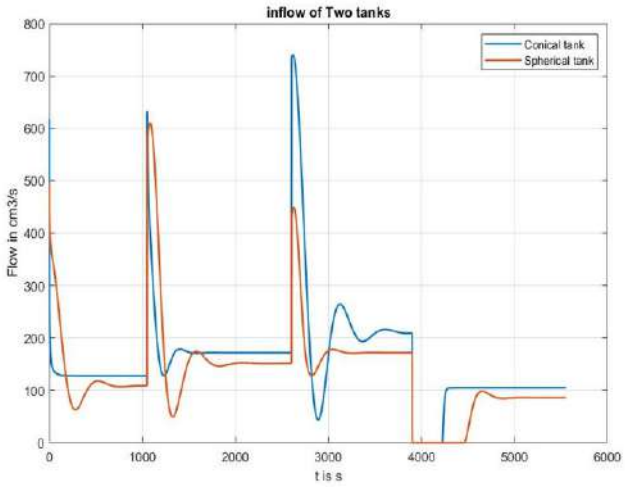


Fig 11: Controller output for ITTHS with 0% interaction

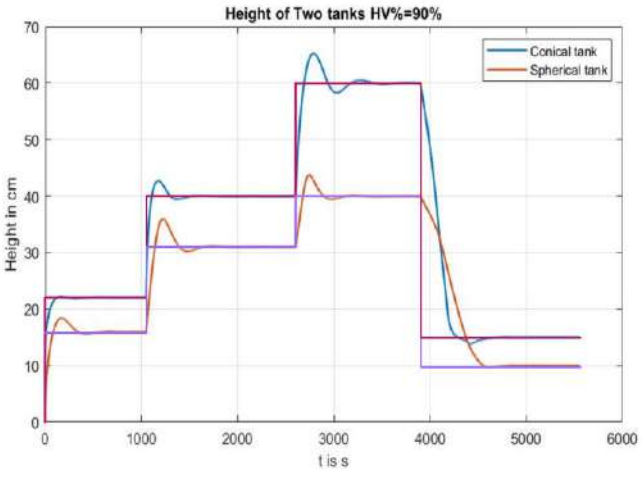


Fig 12: Setpoint tracking of ITTHS with 90% interaction and h1>h2

Servo response of ITTHS with 90% interaction makes it difficult to tune controllers individually. Choosing the

operating point and designing the controller parameter using ZN open loop from linearized transfer function yields the results as shown in fig 12, fig 13, fig 14 and fig 15.

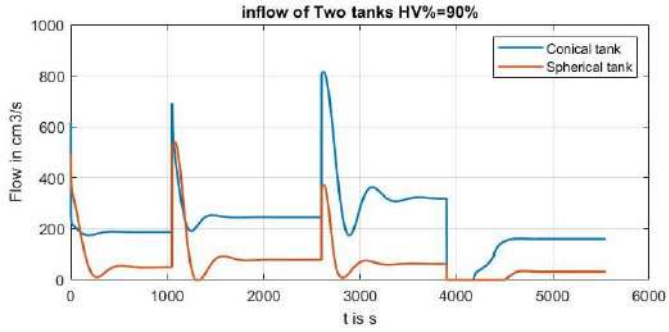


Fig 13: Controller output for ITTHS with 90% interaction and h1>h2

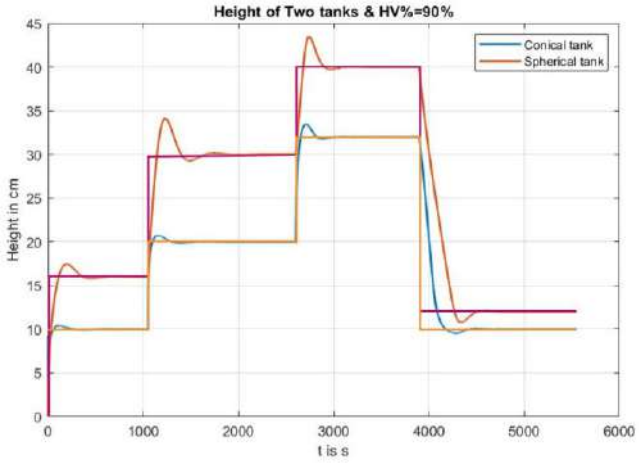


Fig 14: Setpoint tracking of ITTHS with 90% interaction and h2>h1

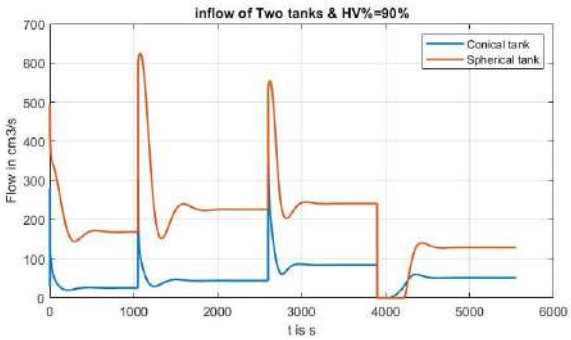


Fig 15: Controller output for ITTHS with 90% interaction and h2>h1

The above tuned PI controller for ITTHS cannot accommodate a steep step change of setpoint. So, the need to control the entire operating region using one PI controller the gains must be reduced drastically which affects the performance of the system invariantly.

The response obtained for the entire operating range is designed from the operating point of h_s = (20 cm, 15 cm). Figure 16 shows the response of PI controller for the entire operating region.

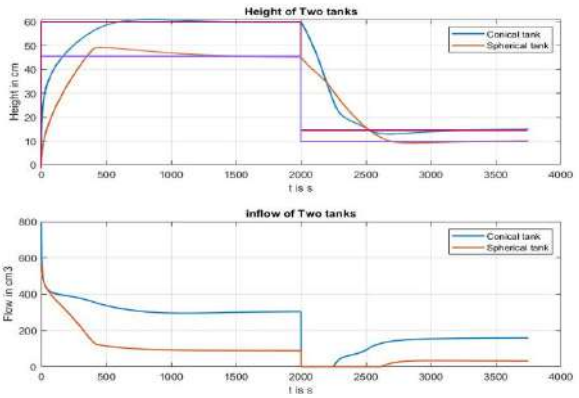


Fig 16: Servo response of ITTHS with max step change

The regulatory response of PI controller for ITTHS is in figure 17.

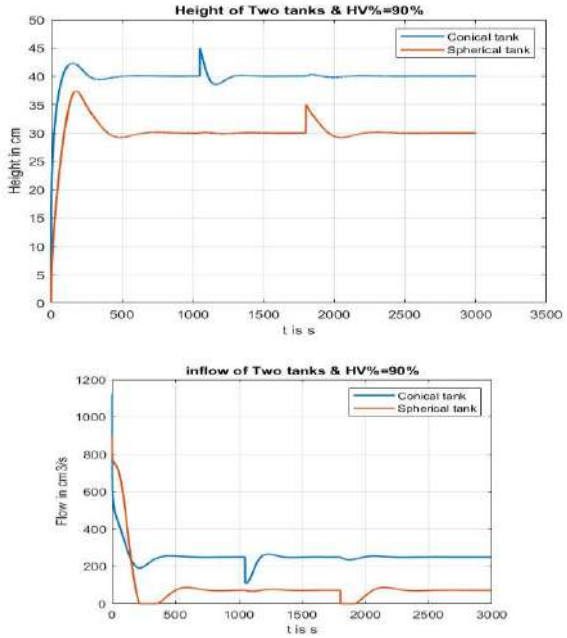


Fig 17: Regulatory response of ITTHS

B. *Simulation results of Multi-Model PI controller*

Servo response of ITTHS with 90% interaction is given in fig 18, fig 19 fig 20 and fig 21.

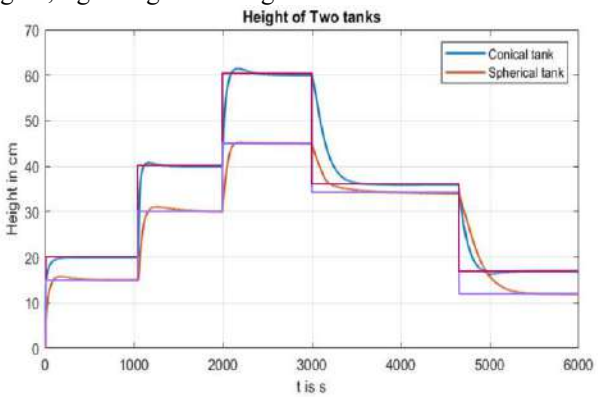


Fig 18: setpoint tracking of ITTHS with 90% interaction and h1>h2

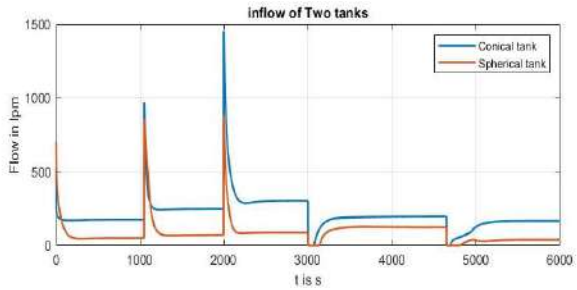


Fig 19: MM-Controller output for ITTHS with 90% interaction and h1>h2

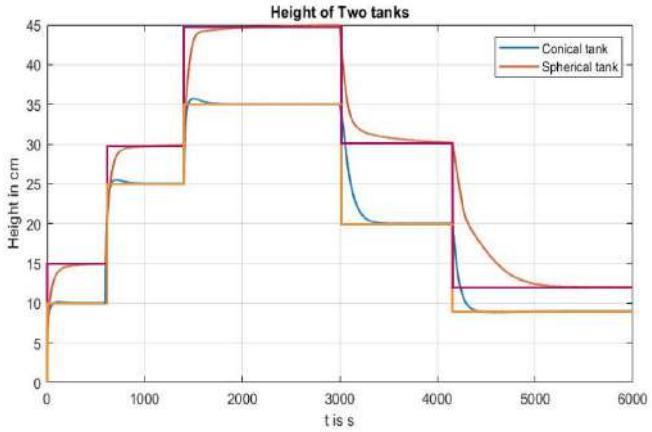


Fig 20: setpoint tracking of ITTHS with 90% interaction and h2>h1

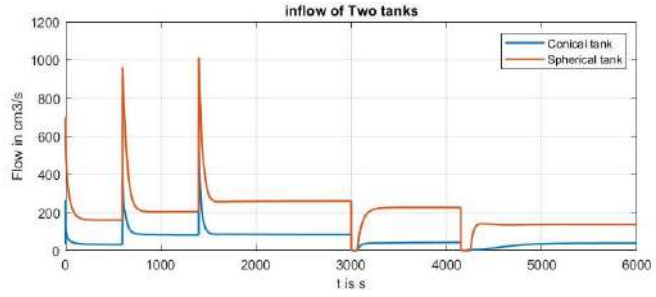
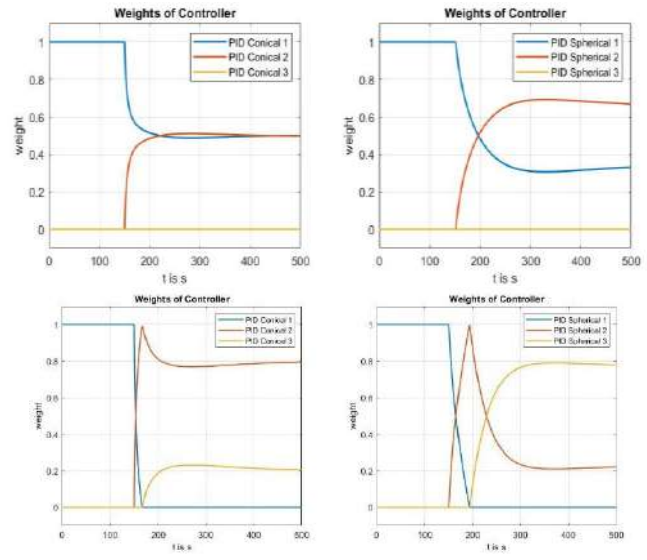


Fig 21: MM-Controller output for ITTHS with 90% interaction and h2>h1

Weight distribution among the controllers in multi-model is important since the controllers need to have a smooth transition when switching which is accomplished by the membership function is shown in figure 22



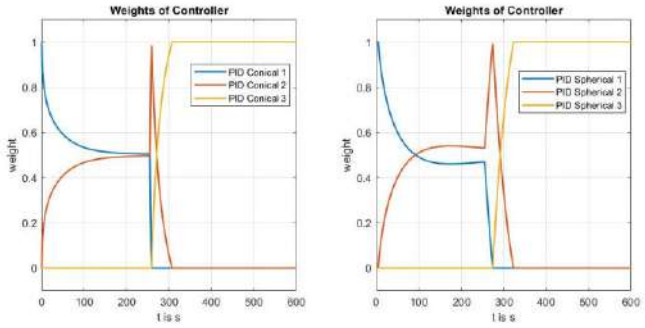


Fig 22: weight scheduler output when the setpoint changes from region 1 to region 2, from region 2 to 3 and from region 1 to 4

Max step change servo response for ITTHS is simulated in figure 23.

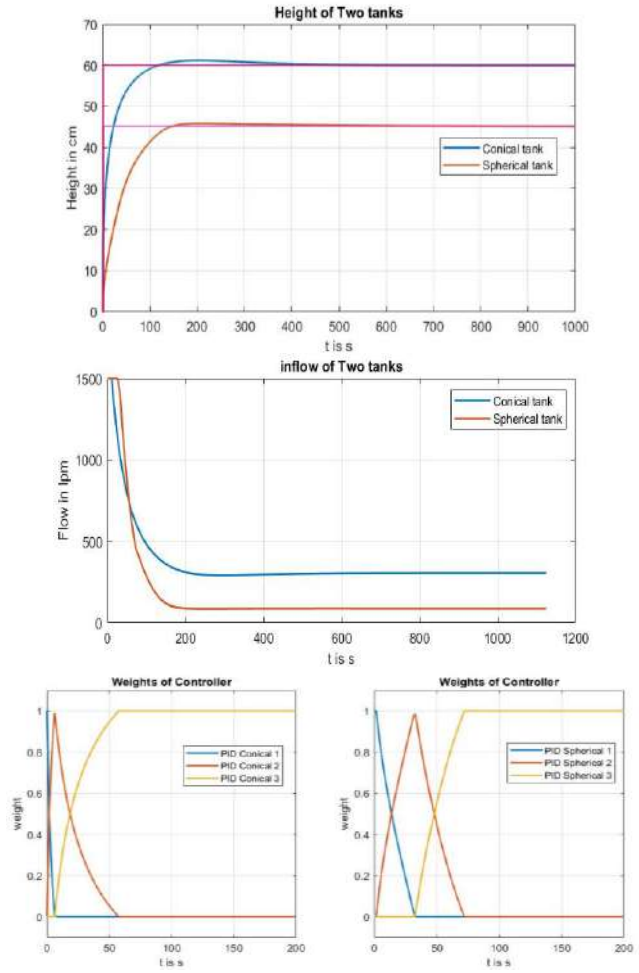
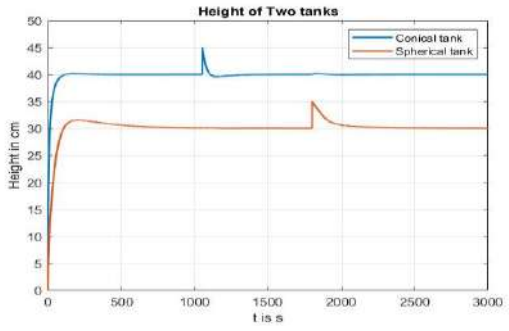


Fig 23: servo response by MM-PI of ITTHS with max step change

The regulatory response by MM-PI ITTHS is in figure 24.



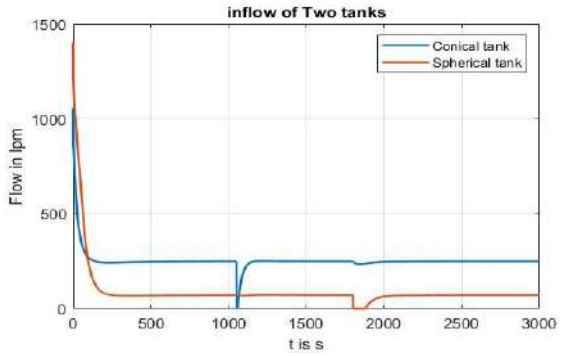


Fig 24: regulatory response by MM-PI of ITTHS

VII. CONLCUSION

The performance of the PI and the Multi-Model PI controllers are calculated using the performance indices of IAE and ISE. Table 6 and table 7 gives us the performance of PI controller. Table 8 and table 9 shows the performance of MM-PI controller.

Table 6. Performance of PI h1>h2

Setpoints	Conical tank		Spherical tank	
	IAE	***ISE***	***IAE***	***ISE***
(20,15) cm	197.86	1024.7	63.28	2151.5
(40,30) cm	279.41	6145.1	-28.75	14793
(60,45) cm	3370.4	50679	2142.7	50679

Table 7. Performance of PI h2>h1

Setpoints	Conical tank		Spherical tank	
	IAE	***ISE***	***IAE***	***ISE***
(15,20) cm	56.57	522	221	4590
(25,30) cm	90.51	1736.1	256.82	13387
(35,40) cm	130	4165.7	2581.2	40931

Table 8. Performance of MM_ PI h1>h2

Setpoints	Conical tank		Spherical tank	
	IAE	***ISE***	***IAE***	***ISE***
(20,15) cm	208.38	947.16	91.06	1488.9
(40,30) cm	304.4	4451	226.87	8689
(60,45) cm	543.71	15819	953.84	26192

Table 9. Performance of MM_ PI h2>h1

Setpoints	Conical tank		Spherical tank	
	IAE	***ISE***	***IAE***	***ISE***
(15,20) cm	61.32	470.82	327.23	3311.4
(25,30) cm	93.14	1305.6	506.49	8703.1
(35,40) cm	129	31135	1216.3	16989

Thus, from the above performance tables it can be concluded that the performance of Multi-Model PI controller is much better than conventional PI controller

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Assessment of a model using a framework for the validation of Information System artefacts

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***Abstract*—It is not a disputed fact the important role played by software project teams (SPTs) in the success of software projects, as numerous research studies have shown. However, it has also been indicated that these project teams have not received due recognition (not treated as key project stakeholders) from project managers (PMs) and project management researchers in the software industry field. In an effort to address the neglect of SPTs by project managers, a model was developed (in a previous study) by the authors of this paper to assist PMs in treating SPTs as key stakeholders. The aim of this paper is to present the results of the validation process of the model using a framework for validating Information Systems artefacts. One Agile project team was selected to participate in the validation process. The data collected from the participants using interviews was analyzed by means of statistical and qualitative methods. The results have shown that the model has met the assessment criteria stated by the framework. Future studies should include the validation of the model in various project environment setup other than Agile environment.**

Keywords—model; software project teams; stakeholders; validation; framework; agile

I. INTRODUCTION

There is no debate on the critical role played by software project teams (SPTs) in the success of projects in the Information and Communication Technology (ICT) industry [1], [2]. The important contribution made by SPTs in the delivery of successful ICT projects is well documented by many research studies including [3], [4] and [5]. Furthermore, many seem to agree that SPTs are key project stakeholders, but on paper seemingly [1], [5], based on the neglect of the SPTs' needs.

The treatment that software project teams have experienced from both project leaders and researchers in the field of project management has not been commensurate to what they are perceived to be, that is, key project stakeholders. Software project managers (PMs) do not consider the views and concerns of software project team members, thus not according them stakeholder status [5]. On the other hand, software project teams have not received much coverage as key stakeholders from researchers in the field, instead, the focus has been on stakeholders that are perceived to be possessing economic power [6], [7]. Furthermore, the previous research have examined the use of SPTs in isolation to their role as key project executing stakeholders to deliver successful projects. Some researchers and some PMs consider software project teams as mere skilled workforce, which is (well) paid to do their work and as such there is no need to pay special attention to them because they are paid "*for doing their jobs*" [7, pp 111].

In an effort to address the imbalanced treatment of software project teams by project managers, the authors of this paper developed a model (in a previous study, henceforth referred to as the original study) aimed at assisting PMs to pay necessary attention to the needs of their teams, thus treat them as key stakeholders. The model was then refined and evaluated using a Delphi methodology. Following this process, the model was then validated according to the assessment criteria proposed by [9] and thus contributing to the body of knowledge by operationalizing the framework suggested by [9]. The purpose of this study is to present the results of the validation process of the model.

The remainder of this paper is organized as follows. Section II presents a review of related work. Section III provides a brief discussion on the model. The research methodology and the research results are discussed in Section IV, while the conclusion, limitations and future work are presented in Section V.

II. LITERATURE REVIEW

Project stakeholders play a vital role in projects [10] and therefore their management and addressing of their needs should be prioritized by project managers. Stakeholders are defined as people (individuals or groups) or entities which may be positively or negatively affect or affected by the project [11]. The way stakeholders are managed has a bearing on the project outcome. It is on the basis of this that stakeholder management was added as one of the knowledge areas of the project management framework.

In software development, project teams are some of the key project stakeholders [1], [5], [12]. SPTs are executing key project stakeholders, contributing with their knowledge, skills and insight [13]. Successful delivery of software projects is on the shoulders of SPTs [14], [15]. In recent years the use of project teams has been on the rise [14], [16], thus pointing to the important role played by project teams. Moreover, organizations depend on teams for their global competitiveness

[17]. Reference [18, pp 189] sums up the vital role of software project teams, by saying, *"it is people who deliver projects, not processes and systems"*.

Despite all the critical role that project teams play in the software sector, they have remained on the side-lines [1], [5], as discussed in the previous section. The neglect of SPTs by project managers comes as no surprise because effective dealing with human resource related issues in projects are project managers' Achilles heel for which PMs are not trained to deal with [8]. The neglect of the SPTs has come at a huge price, in terms of high turnover of skilled team members, low-team morale, project failure [1], [19]. These sentiments are also echoed by [8] who state that project managers are number one causes of high turnover of team members. Reference [20] warn that the neglect of certain key stakeholders, software project teams in this case, is not sustainable for organizations.

As an attempt to address the neglect of software project teams by project managers, the authors of this study proposed and developed a model, which this study reports on its validation.

III. BRIEF DISCUSSION OF THE MODEL

Fig. 1 displays the model validated by this research study. The five critical stages of the model that must be followed by a software project manager are briefly discussed. The processes of the model start at the entry point; this would normally happen at the commencement of a project or project phase, thereby initiating Stage 1 of the model.

Stage 1: Identify each project team member of the ICT project team – The purpose of this stage is for a PM to identify each team member who is a stakeholder at this phase of the project or Sprint phase or a set period by the project management office (PMO) in conjunction with a PM or a Scrum master to start or continue the processes of the model. At this stage, all project team members are identified, with the aim of understanding their interests and needs. The outcome of this stage would be a project team stakeholder register.

Stage 2: Select engagement strategies for each identified team member – Engagement strategies for team members differ from one team member to the other because project team members are unique. A communication strategy may be an enabler or impediment to achieving intended results between a PM and a team member [21]; hence, a strategy should be tailored to each team member.

Stage 3: Collect the views and concerns of each team member – During this stage, the interests of each identified project team member are solicited by a PM using appropriate engagement strategies selected in the previous stage. During the assessment of the model, the validation team were asked to use the project management intelligence (PM*Int*) tool to gather team members' views and concerns. The tool performs sentiment analysis using text mining techniques on both structured and unstructured data pertaining to individual project team members [22]. It therefore provides a supporting function to the model.

Stage 4: Engage each team member of the project on the collected views and concerns – Using appropriate engagement strategies selected in Stage 2, a project manager converses with each team member to attend to individual needs.

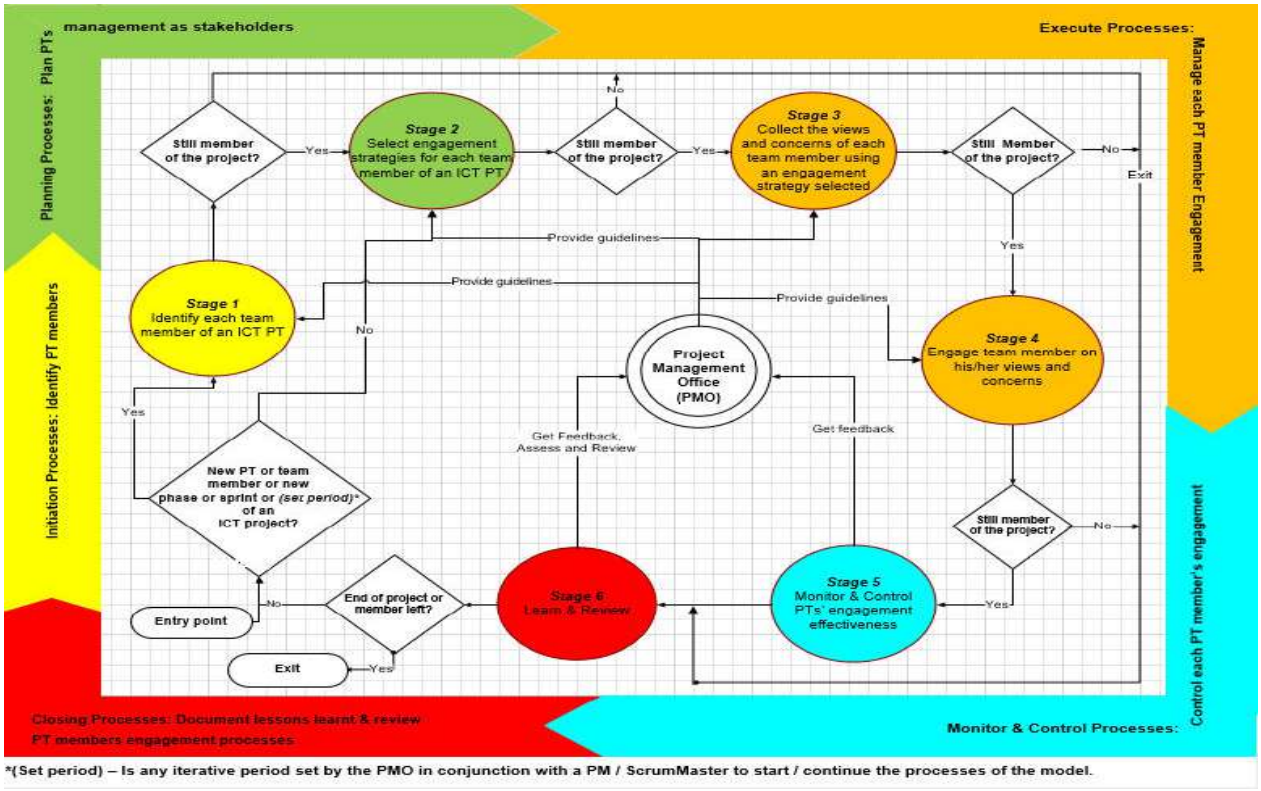

Fig. 1. A model to assist ICT project managers to treat project teams as key stakeholders

Stage 5: Monitor and control the project manager-project team engagement process – During this stage, a PM and the PMO as the custodian of project management practices within the organization should evaluate feedback received from each team member to improve the guidelines regarding engagement with project teams.

Stage 6: Learn and Review – The PMO as an office with authoritative leadership powers should ensure that project management practices are observed and followed by all concerned. In the case of this stage, the PMO would use the information provided as feedback by both PMs and project teams, as inputs to the process of reviewing project management standards, and guidelines regarding the effectiveness of engagement between project managers and project teams. The information would assist in determining what works and what does not work in the treatment of project teams as key project stakeholders.

IV. RESEARCH METHODOLOGY AND RESEARCH RESULTS

This study used qualitative case-study research design approach and descriptive statistical analysis for data analysis.

A. Procedure

In the original study five project teams, each consisting of five software team members and one project manager or Scrum master, were chosen to participate in the study. One of the five teams was purposefully selected to participate in the validation of the model. The team consisted of a Scrum master and four software developers and one software quality engineer who did not participate in the validation process of the model. The team was developing a mobile application for a client of the organization, and the project was scheduled to be completed in 18 months, and they were on the 11th month at the time of the request for the validation of the model and the tool. The organization to which the team belonged was a small-medium size company, with 28 employees, including 17 software engineers, three team leaders/project managers and one programme manager, who the project managers were reporting to. The organization did not have a project management office; instead, the programme manager was responsible for project management practices and policies in the organization. At the end of the validation period, which was three weeks, the project manager and the team members were interviewed. The first three questions were in a Likert scale format, while the last three were open-ended questions. The last question of the six questions was directed to the Scrum master only.

B. Assessment criteria used to validate the model

Khazanchi (1996) proposes eight criteria for evaluating and validating ICT models. The eight criteria are:

- *Plausibility* – The criterion requires that a model should be based on previous research.
- *Feasibility* – This criterion states that a model should be workable or opertionalizable, that is, open to verbal and graphical characteristics.
- *Effectiveness* – The effectiveness criterion is aimed at ensuring that a model is effective in solving the problem for which it is aimed to address.
- *Pragmatic* – The criterion requires that a model should not exclude previous models.
- *Empirical* – This criterion states that the model should be empirically testable.
- *Inter-subjectively certifiable* – According to this criterion a model should be testable by different investigators through observation, logical evaluation or experimentation.
- *Inter-methodologically certifiable* – This criterion provides that a model must be testable using different research methodologies.
- *Predictive* – The criterion demands that a model should explain a phenomenon that is expected to occur, given certain conditions.

Using Delphi experts, the model was assessed for *Plausibility, Feasibility, Effectiveness and Pragmatic* criteria and the results were published in a previous study. However, the *Feasibility, Effectiveness, Empirical and Inter-subjectively certifiable* criteria necessitate that the model be assessed empirically too (be subjected to evidence-based validation and testing) as suggested by [23], hence the model was again assessed using the same criteria together with the empirical and inter-subjectively certifiable criteria in this study. The last two criteria, namely, *Inter-methodologically certifiable* and *Predictive* criteria were considered to be outside the scope of this study and thus were not considered.

C. Data collection and data analysis

The data for this study was collected using telephonic interviews due to Covid-19 pandemic restrictions imposed by government. The interview instruments were pilot tested for clarity and to ascertain validity of the construct**.** The first two questions, which were in Likert scale format were pre-coded and thus yielding ordinal data. Graphic analysis and descriptive statistics including the mean, the mode and the standard deviation were used to interpret the data and determine the level of consensus amongst the experts. In a normal distribution, 68% of the responses are within one standard deviation of the mean. The information in Table I was used to establish the level of consensus reached by the experts.

Table I: Criteria for determining level of consensus [24]

Standard deviation range	**Consensus level**
$0 \leq X < 1$	High level
$1 \leq X < 1.5$	Reasonable/fair level
$1.5 \leq X < 2$	Low level
$2 \leq X$	No consensus

D. Research results

The first interview question was intended to understand whether the model was suitable for a real-life software project environment. Therefore, the question was aimed at validating the *Feasibility, Effectiveness, Empirical* and *Inter-subjectively certifiable* criteria. Three project team members indicated that it was indeed feasible, while the fourth team member said it was highly feasible, as Fig. 2 shows. The Scrum master mentioned that the model was feasible for a real-life project situation. The answers from the project team members and the project manager indicated a high level of agreement amongst the participants that the model was feasible for a real-life situation. The standard deviation value (0.4) of the responses of the participants also confirms that there was a high level of consensus amongst the participants about the feasibility of the model in a real-life project environment.

The second interview question was aimed at establishing how well the model fulfilled its purpose. Fig. 3 shows that all project team members and the Scrum master said the model fulfilled its purpose well. There was a very high level of consensus amongst the participants about the model's capability to fulfil its purpose, as the value of 0 for the standard deviation shows.

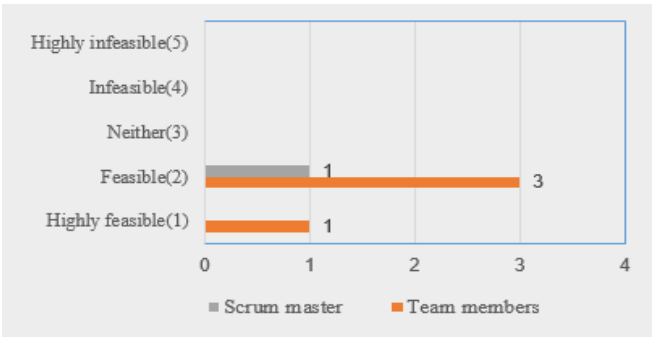

Fig. 2. Participants' responses to Question 1

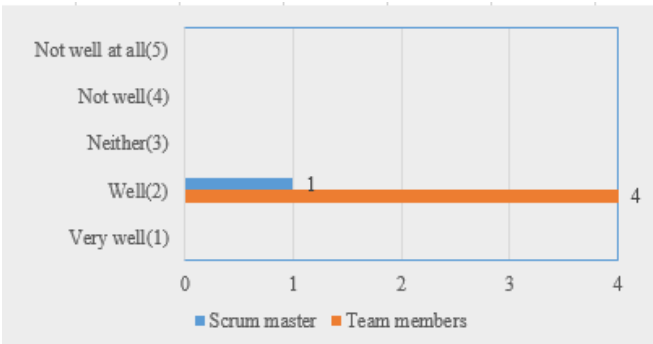

Fig. 3. Participants' responses to Question 2

The third question was directed to the Scrum master only with the purpose of understanding at what periods of the project phase(s) the different stages of the model were applied. The Scrum master stated that the stages of the model were applied during the following process groups in their Scrum process (the issues mentioned here are not exhaustive):

- *Initiation process* – Team members to be involved in the current Sprint would be identified, as well as their roles. Thus, Stage 1 of the model took place during this process group.
- *Planning process* – A Sprint backlog would be determined. Daily Scrum plan would form part of the planning. It was during this process group that engagement strategies for individual team members were also selected (Stage 2).
- *Execution process* – Daily tasks would be accomplished. According to the Scrum master, the collection of views and concerns of team members (Stage 3) was not a *'formal thing'*, but the collection was a *'standing item'* in his weekly individual engagement with team members (Stage 4). Furthermore, the views and concerns were addressed as promptly as possible, as and when they arose. The Scrum master said he ensured that before the next weekly engagement with a team member, feedback would have been provided. If not possible, a communication would be sent to the team member concerned. This strategy demonstrated, he said, his commitment to the team members' issues and in return, he expected their *'hundred percent commitment'* to their project assignments.
- *Monitoring and Controlling* – In daily or weekly Sprint meetings issues that cause hindrances and delays would be identified and resolved. The Scrum master mentioned that the monitoring and controlling of engagement strategies was a weekly process for him, where the effectiveness of individual strategies would be judged by: (i) his ability to get team members to openly voice their views and concerns to him; (ii) his ability to effectively provide feedback to individual team members.
- *Closing process* – Reflection on the completed Sprint product would take place. Lessons-learned would be noted and documented. The organization did not have a formal PMO, the office of the programme manager was carrying out the duties of the PMO office to a limited degree. The programme manager's office declined to participate in the validation process of the model and therefore, the role that should have been played by the PMO in the implementation of the model could not be validated here. However, the feedback given by the team members during the interviews seemed to corroborate the engagement strategies of the Scrum master.

V. Discussion of the Research Results

The responses of the validation team presented in the previous section, as well as the implementation of the model in a real-life project environment, has shown that the model is feasible ('operationalizable') and 'testable' in a real-life environment, thus meeting the *Feasibility*, *Empirical* and *Inter-subjectively certifiable* criteria set out by Khazanchi (1996).

The validation team was also unanimous in claiming that the model was effective in fulfilling its purpose, as the data analysis results in Section IV confirm, and this met the *Effectiveness* criterion. Furthermore, the validation process showed that the model can be tested by a group (a team of individuals) and therefore satisfied the *Inter-subjectively certifiable* criterion.

The use of different engagement strategies as demanded by circumstances proved to be effective, as the Scrum master attested. This is in line with claims by [25] and [26], who state that various team engagement techniques should be utilized, as there is no single method that is suitable for every circumstance.

The collection of project team members' views and concerns became a focal point (was a standing and planned issue) in the plan of the Scrum master, where the project team's views were to be collected weekly. Furthermore, commitment was made to provide feedback at least on a weekly basis, where possible, on the raised issues. In return, the team members committed themselves through their performance. The reciprocation act indicates and confirms the dependency of the team member on the Scrum master and vice versa. This finding confirms what other previous studies, such as [27]–[30], have established with regard to this social exchange theory. Moreover, the fact that the Scrum master was able, through the help of the model, to focus on the views and concerns (as mentioned in Subsection D that the collection of project team issues were made '*a standing item'*), indicates that the model does assist project managers to pay necessary attention to project teams' needs, thus treating them as key project stakeholders.

The model is applicable in the real-life environment. More specifically, the model is applicable in the (Agile) software environment, thus dispelling the 'concerns' raised by two experts (team members) involved in the evaluation processes of the model in the original study, that the model may not accommodate Agile projects.

VI. Conclusion, Limitations and Future Studies

The aim of the study was to present the results of the validation of a model developed in the original study by the authors of this research paper. The validation of the model was carried out using a framework proposed by [9] for validating Information Systems artefacts. The responses provided by the participants of the validation process show that the model satisfied the *Effectiveness*, *Feasibility*, *Empirical* and *Inter-subjectively certifiable* criteria. The results of this study indicate that the model has an important role in assisting software project managers to treat project teams as key stakeholders, as they ought to. The case-study research approach used by the original study limits the generalization of the study's findings. Moreover, the results of the validation process presented here is based on one Agile project and therefore future studies should validate the model in various project setups.

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Improving the Performance of Multivariate Forecasting Models through Feature Engineering: a South African Unemployment Rate Forecasting Case Study

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***Abstract*—The ability of machine learning models to forecast unemployment rates better than traditional statistical methods has been well documented in literature. The ambition of researchers over the last decade, has been to demonstrate that machine learning models are able to forecast unemployment rates as well as or better than traditional statistical methods. Feature engineering has thus far been applied to a limited extent when forecasting unemployment rates. This research used feature engineering to demonstrate that such techniques could improve the performance of twelve machine learning models. This was done by adding two lag values of the unemployment rate to the feature set. The addition resulted in the R-squared increasing by over 100% on average and the mean absolute scaled error decreasing by $\sim$1%. Therefore, the application of feature engineering resulted in an improvement in the performance of twelve machine learning models. The paper thus demonstrated that feature engineering techniques are of value when forecasting the South African unemployment rate.**

***Index Terms*—Forecasting, Machine Learning, Feature Engineering, Unemployment**

I. Introduction

The South African unemployment rate was 30.1% in the first quarter of 2020. This was the highest it had ever been since 1970 [1]. According to [2], many see the unemployment rate as a proxy measure for the health of a country. By this metric, South Africa is notably unhealthy. The country is in the top ten countries with the highest unemployment rates across the world.

Unemployment is typically forecasted using statistical methods such as autoregressive integrated moving average (ARIMA) and vector autoregression (VAR) [3], [4]. However, these models are better suited for linear data [4]. Unemployment rates are not typically linear. Hence, machine learning models have been introduced to the forecasting world [5], [6].

The introduction of machine learning models to time series forecasting has resulted in accuracy improvement i.e., lower errors [2], [7]. Thus far, there has been limited use of feature engineering techniques in these machine learning models. This research shows that machine learning models benefit from feature engineering as their accuracy and ability to explain the variance in the data improves.

Over 400 experiments were conducted, half of them without any feature engineering, and other half with feature engineering: the addition of two lag values to the feature set. It was observed that the addition of the lag values resulted in an improvement in the performance of twelve machine learning models. Demonstrating that feature engineering results in improved performance.

Concretely, this research i) demonstrates that the use of feature engineering reduces the mean absolute scaled error (MASE) of machine learning models when forecasting the South African unemployment rate, as well as ii) improving the ability of the machine learning models to explain the variation in the data (R-squared).

The research builds on the demonstration by [7] and [8], that machine learning models can forecast the South African unemployment rate more accurately than traditional models. The research used regression models, kernel-based models, decision trees, and neural networks. However, feature engineering techniques were not applied in those research papers. Hence, this research builds on previous work, by applying feature engineering techniques.

The rest of this paper is structured as follows. Section II discusses the foundational work by [7] and [8], i.e. multivariate models to forecast the South African unemployment rate. Section III discusses the results that were achieved by using feature engineering when forecasting the South African unemployment rate. Section IV is the final section, which discusses the contribution of this research, as well as opportunities for future research.

II. Related Work

[7] demonstrated that the use of machine learning, compared to the vector autoregression (VAR), improves the forecasting accuracy by over 100%. The VAR achieved a mean absolute scaled error (MASE) of 26.3, whilst the lowest MASE

from the machine learning models was 0.91. Therefore, the paper demonstrated that the application of machine learning models improved the MASE, making it 28 times better than VAR.

[8] investigated the impact of feature selection techniques on forecasting the South African unemployment rate. They found that the feature selection techniques improve the forecasting accuracy of machine learning models by at least 15%. Furthermore improving the compute requirements of the models.

Feature selection reduces the number of features by selecting a subset of them for use in the model [8]. If the initial features are not clear or known, the features are extracted from the data: this is known as feature extraction [11]. Feature engineering is different from both of these because it focuses on creating new features from the initial feature set i.e. by combining features, transforming features, performing statistical calculations on the features, etc [13].

Compared to feature selection and feature extraction, feature engineering has not been as widely used for unemployment rate forecasting. The benefits of feature selection and feature extraction have been well demonstrated through the usage of innovative data. Examples being the use of GPS data [9], Google search data [10], and smart metering data [11] to forecast the unemployment rate. This research contributes to the unemployment forecasting body of knowledge by demonstrating the performance improvement that can be achieved by using feature engineering to forecast the South African unemployment rate.

This section provided an overview of the foundational research on which this research is built on. The section discusses how the South African unemployment rate has been successfully forecasted using machine learning models. The next section discusses results from the application of feature engineering to forecast the South African unemployment rate.

III. Methodology and Results

The research builds on previous work to forecast the South African unemployment rate but focuses on feature engineering and the benefits that can be derived from it. The following subsection provides the research methodology and discusses the results of the analysis.

A. Performance Measures

[7] propose that mean absolute scaled error (MASE) be used as a performance measure for South African unemployment rate forecasting. Their proposal is because the MASE overcomes the asymmetry issues associated with the mean absolute percentage error (MAPE), which is the typical measure for multivariate forecasting [4]. For example if actual value is 10 and forecast value is 15 then MAPE would be (10-15)/10 * 100 = 50%, as opposed to the case where actual is 15 and forecast is 10, MAPE would be (15-10)/15 * 100 = 33% [4], [7]. Therefore, [4], proposed mean absolute scaled error (MASE) as an alternative to MAPE. MASE resolves issues associated with MAPE because it is symmetric. The MASE equation is show in (1):

$$MASE = \frac{1}{n}\Sigma_{i=1}^{n}\left(\frac{y_t - \hat{y}_t}{\frac{1}{n-1}\Sigma_{i=2}^{n} \mid y_i - \hat{y}_i \mid}\right) \quad (1)$$

where y is the actual value whilst $\hat{y}$ is the forecast value.

R-squared was also used as a performance measure. It evaluates the ability of the model to explain the variation in the data used to forecast the South African unemployment rate [4]. In other words, it answers the question 'how well does the model fit the data?' [4]. (2) show the equation of R-squared:

$$R^2 = \frac{\Sigma\left(\hat{y_t} - \bar{y_t}\right)^2}{\Sigma\left(y_t - \bar{y_t}\right)^2} \quad (2)$$

where y_t is the actual value being estimated, $\hat{y_t}$ is the forecast value, and $\bar{y_t}$ is the mean of the actual values. The denominator is also referred to as the total sum of squared (SST). Hence, R^2 can also be written as

$$R^2 = 1 - SSE/SST \quad (3)$$

where SSE is the sum of square errors i.e. $\Sigma\left(y_t - \hat{y_t}\right)^2$. Therefore, although R^2 should always be between 0 and 1. It can be lower than 1 when (3) is implemented.

B. Data Preparation

Data was accessed from SARB with 147 features and the South African unemployment rate being the label. The data was from January 1960 to December 2019. The data came with mixed frequencies, and the last known value data imputation strategy was employed. [7] demonstrated that this strategy was the most effective when forecasting the South African unemployment rate.

The number of features was increased by adding two lag values. The selection of lags was based on work by [12], who demonstrated that two lags resulted in the highest performance improvement when forecasting the South African unemployment rate.

The data was then split into train and test set, where 24 observations were used for testing and 746 for training. Previous literature used similar test sizes.

C. Experiments

A total of twelve machine learning models were deployed: elastic net (ENET), Bayesian ridge regression (Bayes ridge), LASSO, long shot-term memory (LSTM), gated recurrent unit (GRU), ridge regression (ridge), support vector regression (SVR), bi-directional LSTM (BiLSTM), random forest regression (RFR), linear regression (OLS), extreme gradient boosting (XGB), and multilayer perceptron (MLP).

The original dataset had 147 features. This feature set was reduced using feature selection techniques.

According to [13], there are three types of feature selection methods: filter, wrapper, and embedded. Filter methods rank features based on statistical scores representing their relative significance in predicting the target variable. Embedded

methods are feature selection methods that select a subset of the feature set and evaluates the performance (measured by error rate) of the subset. The feature subset with the lowest error rate is then selected as the most impactful feature set. Wrapper methods are similar to embedded methods but are not as computationally efficient. Wrapper methods evaluate the whole feature set or a subset for performance: iteratively removing or adding features based on the error rate. Hence embedded methods are computationally efficient relative to the wrapper methods.

Four filter feature selection methods were used in this research as well as two embedded methods. The four were;

- Removal of correlated features (referred to in this paper as 'No Corr');
- Analysis of variance (referred to in this paper as 'ANOVA');
- Mutual information gain (referred to in this paper as 'MIG'); and
- Removal of variables with low variance (referred to in this paper as 'variance').

Along with the four feature selection methods, the deletion of duplicated features was treated as a feature selection technique (referred to in this paper as 'unique'). The four feature selections were also combined to form a chain of filter methods e.g. 'unique, no correlation' or 'variance, unique, and no correlation'. The two embedded methods were LASSO and elastic net (ENET).

The recursive feature selection wrapper method was also used. However, it is a computationally inefficient method as it uses greedy search. The method easily leads to combinatorial explosion, i.e. choosing 5 features from the 147 requires evaluating over 500 million different options and choosing 6 requires over 12 billion. Hence, for this paper it was restricted to 5 features.

Therefore, a total of 216 experiments without lags included, and another 216 with lags included were conducted for this research, i.e., 432 experiments in total.

D. Analysis and Results

Using data from the South African Reserve Bank (SARB), 432 experiments were conducted. The experiments conducted in [7] were reproduced with a focus on the R-squared. Feature selection techniques were also used, similar to [8]. A key difference with the previous researchers is that the data was forecast over four horizons: horizon 1 (4-months), horizon 2 (8-months), horizon 3 (12-months), and horizon 4 (24-months).

A total of 432 experiments were run. The model that achieved the highest R-squared, without the inclusion of lags, was the SVR model. The model had an R-squared of 0.6705 and Bayes ridge with an R-squared of 0.5821. The results are the average over the four horizons.

Table I shows the R-squared for the top-performing models. Only three models achieved an R-squared above 0.5. The R-squared being below 0.5 was a cause for concern because it signalled that the models could only explain less than 50% of the variation in the data.

R-squared measures how much variation in the data the model is able to explain relative to a naïve model [4]. Hence, feature engineering was considered as a mechanism to improve this.

TABLE I
THE TOP TEN MODELS AS MEASURED BY R-SQUARED.

Model	Feature Selection	R squared
SVR	ANOVA	0.6705
SVR	MIG	0.6700
Bayes Ridge	MIG	0.5821
Ridge	ANOVA	0.4536
ENET	PCA	0.4411
LASSO	PCA	0.4310
Ridge	MIG	0.4118
Ridge	EM ENET	0.3679
Bayes Ridge	Variance	0.3438
Bayes Ridge	NO FS	0.3438

** NO FS = No feature selection was applied, Unique = removal of duplicated feature, MIG = Mutual Information Gain, ANOVA = Analysis of Variance, PCA = Principal Component Analysis, EM ENET = elastic net embedded method, and Variance = removal of low variance threshold features.*

In order to improve the R-squared, lag variables of the unemployment rate were added as features to forecasting the South African unemployment rate. Two lag variables were added as this was found as the most optimal (lowest error) number of lag variables [12].

[12] found that two was the optimal number of lags through trial and error. In [12] lags between 2 and 7 were tried. Adding that the lags were treated as a parameter that was set and updated based on the performance of the model.

Two lags were the best performing across the models and, therefore, this was used across the models. Figure 1 shows that the unemployment rate has a high correlation with its lag values [12]. Demonstrating that there is evidence of temporal dependencies in the South African unemployment rate.

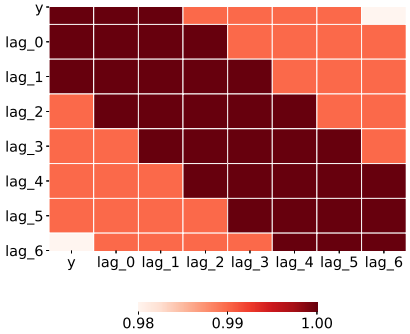

Fig. 1. The correlation map for the lag values of unemployment rate showing that the unemployment rate is highly correlated with the lag values.

The addition of the lag variables improved the R-squared by over 100% on average. The highest R-squared without the lag values was 0.6705, and with lag values, it was 0.7875. Only 87 experiments had a positive R-squared without the addition of lags, which improved to 132 after the lags were added. Furthermore, 73 experiments achieved an R-squared above 0.5, an improvement from 3. Table II shows the top ten R-squared changes.

The inclusion of lag values improved the R-squared of the models significantly. Some models, which had negative R-squared, improved by more than 100%. An example of this is the MLP with the recursive feature elimination feature selection method with elastic net (RFE ENET) (readers should read [8] for a brief overview of the feature selection methods). The model achieved the top MASE score when lags were not included, but the R-squared was -0.2127. After lags were added, the R-squared improved to 0.7273: a 439% improvement.

TABLE II
THE INCLUSION OF LAG VALUES OF THE SOUTH AFRICAN UNEMPLOYMENT RATE IMPROVES THE R-SQUARED BY OVER 100% ON AVERAGE.

		Without Lags	With Lags
Model	**Feature Selection**	**R-squared**	**R-squared**
Ridge	MIG	0.4118	0.7875
ENET	MIG	0.0171	0.7875
ENET	PCA	0.4411	0.7872
LASSO	XGBoost	0.3097	0.7872
LASSO	PCA	0.4310	0.7849
LASSO	MIG	0.0511	0.7849
ENET	XGBoost	0.2911	0.7842
LASSO	Random Forest	0.2244	0.7842
RFR	RFE LASSO	0.0092	0.7750
ENET	Unique	0.1513	0.7731
Bayes Ridge	NO FS	0.3438	0.7649

** NO FS = No feature selection was applied, Unique = removal of duplicated feature, MIG = Mutual Information Gain, XGBoost = Extreme Gradient Boost, PCA = Principal Component Analysis, Unique = removed duplicated features, and RFE LASSO = recursive feature elimination with LASSO estimator.*

The accuracy (reduction in MASE) also improved slightly. This was measured using the average over the four horizons. The average MASE was 0.2950 without lag values and was 0.2832 after the lag values were added. Therefore, the inclusion of lag values not only improved the percentage of variation that the model can explain, but it also improved the error achieved by the model.

After the inclusion of lag values, the deep learning models were all in the top models as measured by the average MASE over the four horizons. The LSTM, BiLSTM, and GRU improved their MASE by more than 20%. This improvement in the recurrent neural network models is because these models have a long term memory structure. Therefore, introducing lag variables enables these models to take advantage of their memory capabilities.

The results are shown in Table III, which shows the order change in the top models.

The overall top model after the inclusion of the lags was the SVR. Showing that the inclusion of lags also improves the linear separability of the dataset selected through analysis of variance (ANOVA) feature selection technique: the model was eighth without lags.

The MLP moved from first place to second after lags were added. The addition of lags had minimal impact when on the MASE of the MLP with RFE ENET feature selection. This shows the robustness of the MLP with RFE ENET: this result increases confidence in the model.

It is also worth noting that ANOVA is represented twice in the table with lags: one with SVR and another with MLP. The recursive feature selection with ENET as the black-box model is well represented in the top models, with and without lags.

Table III shows that 50% of the top models were all multivariate feature selection techniques. Most of these multivariate models used ENET as an estimator. This suggests that group dynamics should be considered or retained when selecting features regardless of the inclusion or exclusion of lags.

There is an increase in the number of univariate feature selection techniques (in the top models) when lags are included. This shows that when the lag values are added, the variation within a feature had a big impact on the ability of the model to forecast the unemployment rate. Removal of low variance features improving the accuracy. This can be noted by observing that four out of the six univariate features in the top models are concerned with variance: variance thresholds removals, the ratio between variance within features and variances between features, or removal of low variance features.

IV. CONCLUSIONS

This paper demonstrates that using feature engineering reduces the MASE of machine learning models by $\sim$1%. Furthermore, improving the R-squared by over 100%.

The work builds on previous similar work that has successfully demonstrated that the South African unemployment rate can be forecasted using machine learning models. This research builds on that work by using feature engineering techniques. These kind of techniques have been used to a limited extent in unemployment forecasting models.

Feature engineering improved the performance (reduced MASE and increase R-squared) of most machine learning models because of the temporal nature of the South African unemployment rate. The improvements were across all the different kinds of machine learning models used. Models with memory structures were able to improve a lot more than models without such structures. Hence, the deep learning models all improved because of the temporal nature of the recurrent neural networks.

TABLE III
THE COMPARISON OF HOW THE INCLUSION OF LAG VALUES CHANGE THE PERFORMING (MASE) OF THE TOP MODELS.

Without Lags				With Lags		
Model	**Feature Selection**	**AVG**		**Model**	**Feature Selection**	**AVG**
MLP	RFE ENET	0.3890		SVR	ANOVA	0.3827
RFR	RFE LASSO	0.4443		MLP	RFE ENET	0.3879
LSTM	RFE ENET	0.5201		GRU	RFE ENET	0.3894
Bayes Ridge	EM ENET	0.5251		LSTM	RFE ENET	0.4067
LR	EM ENET	0.5273		BiLSTM	EM LASSO	0.4101
RFR	RFE ENET	0.5285		MLP	ANOVA	0.4125
Ridge	EM ENET	0.5487		Ridge	VARIANCE	0.4176
SVR	EM ENET	0.5543		Ridge	NO FS	0.4176
SVR	ANOVA	0.5700		Ridge	VARIANCE UNIQUE	0.4179
SVR	RFE ENET	0.5712		Ridge	Unique	0.4179
ENET	MIG	0.6052		BiLSTM	RFE ENET	0.4324

** NO FS = No feature selection was applied, Unique = removal of duplicated feature, MIG = Mutual Information Gain, EM ENET = Embedded method using ENET, Variance = removal of low variance threshold features, and Variance Unique = low variance features are removed along with duplicated features.*

This research only used one feature engineering technique: inclusion of lags. Future research should look to including more features and seeing the outcome. There are over one thousand possible features that can be engineered for time series data.

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Waste Management Hierarchy as an instrument of subsumption of the accounting approach to waste valorization of industrial effluents.

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Abstract:

The commonly used strategy of command and control as a solution to industrial wastewater management is in need of a more robust and organization-driven strategy aligned with the Waste Management Hierarchy. With compliance posing operational difficulties in monitoring and manpower, a paradigm shift from a linear economy and grey chemistries to a circular economy and green chemistries is proposed through a system driven thinking encompassing the Waste Valorization Potential of industrial wastewaters viewed as a resource for recovery and reuse and the Waste Management Hierarchy. Primary data was collected from the Indian chemical industry, the analysis of which paves the way for a stepwise approach to environmental and economically sustainable manufacturing. Segregation of wastewater streams becomes the start point of waste valorization. Once segregated, chemical characterization of the individual streams allow for decision making based on the valorization potential placing the organization on the appropriate level on the Waste Management Hierarchy. This leads to the choice of technology options after due cost –benefit analysis which include the social aspects. There is a moderate positive correlation between the WVPS and benefits of adopting technologies higher up on the Waste Hierarchy. The three pillars of sustainability, namely; economy, environment and society are strengthened through the systematic approach of waste valorization that adds to the bottom line, waste hierarchy as a decision making tool for appropriate technology options leading to waste valorization over waste disposal, creating a positive impact on society by prevention of industrial water pollution.

Keywords: sustainability, industrial wastewaters, Waste Hierarchy, segregation, characterization, valorization.

1. Introduction:

Water is a natural resource that directly and indirectly affects our daily lives. Water scarcity fuelled by the increase in population and industrial growth coupled with a technology deficit to prevent and mitigate water pollution presents huge challenges to water security for industry, agriculture and humans (FICCI, 2011) as well as ecosystems (Hoekstra et al., 2012). Water scarcity is currently affecting one fifth of the world's population and one fourth of the global population is facing a shortage due to technology to retrieve fresh-water from rivers and ponds (Xiao-jun et al, 2012). India is projected to be severely water stressed by the year 2025 (UN Water 2008) and is predicted to rank 40th in the world by 2040 in terms of water scarcity, therefore needing to carefully evaluate water management options. (Luo T et al, 2015). Industrial wastewater is generated from practically all manufacturing activity and management of this wastewater can either become a cost or become valuable. Wastewater disposal, either through on-site Effluent Treatment Plants (ETPs) and Centralized ETPs are not able to handle large values of lumped parameters like COD, pH, TDS (CPCB, 2005). Chemical and allied process industries use water extensively, thus making them water-intensive industries (Sheldon, 2017). India generates nearly 6.2 million m^3 of untreated industrial wastewater every day (of the total ~ 44 million m^3/day wastewater). In India, only ~ 60% of industrial wastewaters are treated (Kaur et al., 2012).

2. Literature Review

As a public good, water withdrawals and disposal into waterways needs to be regulated to prevent pollution of water which would be an intended side effect called an externality. This externality imposes a social cost. Arriving at a social cost estimate, would require the identification of pollutants, their sources and pathways through the environment and the impact on the ecosystem and the ecosystem services. Water pollution endangers economic growth, the environment and social aspects. In short, water pollution is a danger to sustainable development requiring cost-effective solutions, smarter policies and better technologies (Damania et al., 2019). Water quality is one of the Sustainable Development Goals (SDGs) of the 2030 Agenda that has increased the focus of international action. Ezbakhe (2018) examined the potential links between water pollution and all 16 Sustainable Development Goals (SDGs) concluding that water quality can be improved by achieving SDGs. Industrial wastewater management is a vital component of sustainable development.

2.1 Environment: Waste Management Hierarchy (WMH)

Release of industrial wastewater has large environmental impacts if incorrectly treated. Strict legislation is in place to penalize release of untreated effluents and illegal dumping to limit these impacts. Industrial wastewater has a higher risk factor than urban wastewater due to the chemical compounds used in the industrial processes and the chemical transformation processes that can change the composition and structure of the discharged chemical (Speight, 2017).

The concept of industrial wastewater treatment has been changing in recent years to maximize the efficiency of the manufacturing process through the recycling and reuse of treated water and recovery of energy and chemicals. The WMH adopted by the European Union as a decision making tool forms the basis of solid waste management strategies. It is a five-tiered hierarchy comprising of the levels of waste prevention, reuse, recycling, recovery, and disposal (Waste Framework Directive 2008). However, the principles of the Waste Hierarchy can be adapted for industrial wastewater management. (Capacity building programme on implementation of Waste Management Rules 2016).

The recovery and reuse of chemicals and solvents (Garcia et al. 2013) from industrial process wastewater streams freeing up water for recycling supports the circular economy defined by the Ellen MacArthur Foundation as an "industrial system that is restorative or regenerative by intention and design" [Ellen MacArthur Foundation, p. 8]

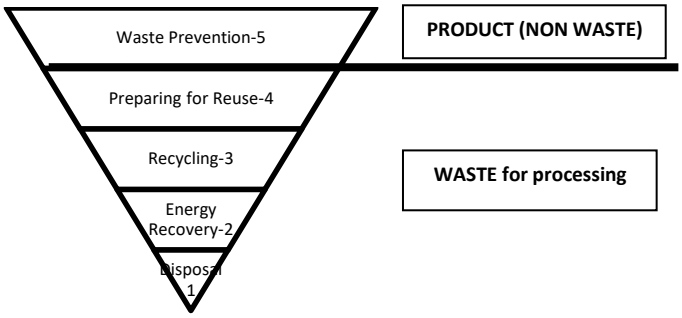


Fig. 1: The five tiered waste hierarchy of the Waste Framework Directive 2008/98/EC

(Source: EC, 2008. DIRECTIVE 2008/98/EC of the EUROPEAN PARLIAMENT and of the COUNCIL of 19 November 2008 on Waste and Repealing Certain Directives 312, pp. 3-30.)

2.1.1 Technology Options:

Husemann (2003) states that addressing water shortages through technological change may be limited due to the second law of thermodynamics, which posits that negative environmental consequences are unavoidable and result from all industrial and economic activities.

However, WWAP (2015) emphasizes that sustainable use of water coupled with suitable wastewater treatment technologies for obtaining fresh water can overcome this scarcity.

Based on the level on the Waste Hierarchy, some broad technology options are available (D'Sa et al, 2021).

2.2 Economics: Waste Valorization Potential Score (WVPS)

Economic development is compromised as non-availability of high quality freshwater supply hampers the operation of industries at full capacity (Renzetti, 1992).

Assessment of the Waste Valorization Potential Score (WVPS):

According to the second law of thermodynamics, a chemical manufacturing process through various reactions will generate some by-products and water which are considered as waste. Some of the constituents of wastewater are known and some are unknown. The amount of known and unknown chemicals that comprise the stream represents the level of knowledge of the wastewater or effluent stream. Based on the percentage of known or unknown constituents of the effluent water composition, it is possible to calculate the waste valorization potential based on market prices of recovered compounds.

As discussed by D'Sa and Patnaik (2021), there is various percentage ranges at which the information of the complete characterization is possible based on analytical tools and equipment available with the manufacturer giving a measure called Waste Valorization Potential Score (WVPS). The WVPS can range from Very low (1 for combined physico-chemical or lumped parameters like COD, TDS and pH) to very high (5 for knowledge of more than 95%) depending on the information known of the chemical characterization of the wastewater stream. The authors have found a strong positive correlation between the WVPS and the position of the manufacturer on the WMH.

Cost-benefit analysis (CBA) is one of the systematic decision making tool where the benefits must outweigh the costs. Costs are generally incurred at one time or it might be incurred gradually. Benefits, however are reaped after a period. Wastewater treatment processes have significant environmental benefits. However, because they do not have a market value, these benefits are usually not calculated. D'Sa et al (2021) have discussed a correspondence between technology options available to the chemical industry also known as Best Available Technologies and the levels of the Waste Management Hierarchy. Technology options available on the higher levels of the WMH have the potential to result in green growth and sustainable development through the strategy of cleaner production. The benefits both in terms of tangible as well as intangible outweigh the costs as seen in the case studies presented by the authors.

2.3 The three pillars of Sustainability - Economics, Environment and Society:

Sustainability can be achieved when the Environment and Economics are considered as the two sides of the same coin. In addition, the social aspect is considered by taking all stakeholders into confidence based on their requirements backed by policy decisions by the relevant institutions (D'Sa and Patnaik, 2020).

Social aspects include individual health, community goodwill and green credentials earned by the manufacturing unit.

3. Statement of Hypothesis:

Ha1 – There is an association between organizations that have are higher up on the Waste Management Hierarchy (>2) and overall (tangible as well as intangible; economic, environmental and social) benefits derived.

4. Methodology

In order to understand how the industry manages its wastewater, various aspects viz. regulation, wastewater streams with their characteristics and technology options were examined.

Literature was reviewed and various waste management systems were analyzed by collecting primary data using a structured questionnaire and administered through telephonic interviews during the period June – September 2020. Out of 150 respondents approached, 129 responded indicating a response rate of 86%. The respondents from the Indian chemical industry are manufacturers of agrochemicals, bulk chemicals, specialty chemicals, pharmaceuticals and fine chemicals in the states of Maharashtra, Karnataka, Goa, Andhra Pradesh, Telangana, Tamilnadu and Gujarat. The respondents were asked about their waste management method of segregating or mixing of their individual wastewater streams. Further, based on segregation or mixing, either the respondent

organization had two choices; one of measuring the pollutant levels based on the lumped parameters of COD, BOD, TDS, pH and others or characterization of the wastewater stream into its individual chemical constituents. A cost benefit analysis is required to understand the economic feasibility of the technology as well as its impact on social systems and the environment. Information on costs and benefits of the wastewater management technologies adopted was sought. However, due to the sensitive nature of data sought and dilution of the competitive advantage, costs and benefits data was accepted as a categorical variable of whether costs exceeded benefits or vice versa. Based on technologies adopted, the level of the Waste Hierarchy was assigned; 1 and 2 being disposal and energy recovery and 3 to 5 onwards for recycling and other resource recovery as well as technologies that reduced the toxicity of the wastewater at its source as denoted in the WMH in Fig 1.

5. Findings and results

Table 2: Costs and benefits for different levels of the Waste Management Hierarchy

			Economic Cost and Benefits				Overall (Economic + Environment + Social) Cost and Benefits		
Level No.	Level on WMH	Respondents	C > B	B > C	Total		C > B	B > C	Total
	Level > 2 on WMH								
5	Source reduction	6	2	4	6		0	6	6
4	Preparation for reuse	25	3	22	25		2	23	25
3	Recycling of wate r	67	33	34	67		29	38	67
	Total Level >2	98	38	60	98		31	67	98
		76%	39%	61%			32%	68%	
	Level ≤ 2 on WMH								
2	Energy recovery	3	3	1	4		2	2	4
1	Disposal	28	27	0	27		25	2	27
	Total Level ≤2	31	30	1	31		27	4	31
		24%	97%	3%			87%	13%	
	Level Total	129	68	61	129		58	71	129
			53%	47%			45%	55%	

In Table 2, 76% of respondents (frequencies) are on Level > 2 while 24% are Level ≤ 2. While 39% of respondents indicated costs greater than benefits, the percentage drops to 32% considering overall costs over benefits for respondents on Level > 2 or higher on the WMH. For respondents on levels ≤ 2, 97% indicate costs over benefits with that percentage dropping to 87% considering overall costs and benefits. Similarly, overall benefits show an increase from 47% to 55% with the percentage increasing across both Levels on WMH categories. The results indicate that there are overall benefits derived by adoption of wastewater management technologies. The findings also indicate that overall cost and benefits need to be considered for decision making on adoption of wastewater management technologies.

Table 3: Level on the Waste Management Hierarchy
and overall Costs (C) and Benefits (B) of level-appropriate wastewater management technologies.

Level on WMH	C > B	B > C	Total
> 2	31	67	98
≤ 2	27	4	31
Total	58	71	129

Calculation of Chi Square χ2:

χ2 = 29.28, df = 1

Table value of χ2 for 1 df at 5% significance level is 3.841

As the calculated χ2 is greater than the table value, the null hypothesis does not hold good. We therefore conclude that there is an association between the Level on the WMH that the organization is at and the overall cost and benefits that accrue to the organization that adopts appropriate wastewater management technologies.

Effect size of the test statistic

The Phi coefficient (ϕ) is used since the contingency table is 2x2.

ϕ = 0.48

A Phi coefficient value of 0.48 indicates a moderate positive correlation between the levels at which the organization is at on Waste Hierarchy and the overall benefits that accrue to the organization as a result of adopting the appropriate waste management technology.

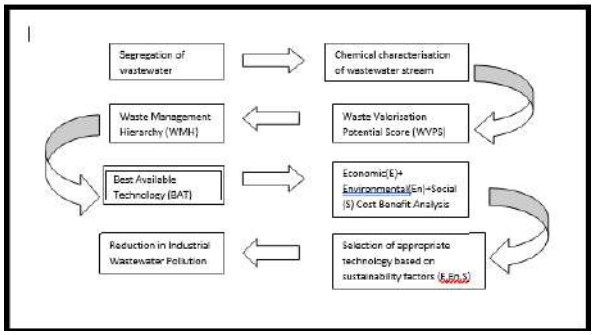
6. Discussion and conclusion

From the above results and findings, it is seen that technologies that are higher up (>2) on the Waste Hierarchy award greater overall benefit than those lower (<2) on the Waste Hierarchy.

The first and foremost step towards reduction industrial wastewater toxicity and pollution load is segregation of individual wastewater streams emanating from various manufacturing processes. Lean streams and rich streams are segregated. Toxic and non-toxic streams are segregated. This should be done to reduce cost of recovery from streams that are mixed. Characterized streams can be assigned a Waste Valorization Potential Score (WVPS) based on the completeness of the information of valuable chemicals present which can be identified by analytical methods. A higher WVPS has a strong positive correlation with a higher level on the Waste Hierarchy (D'Sa & Patnaik, 2020 in press). Best Available Technology (BAT) options can be evaluated and appropriate technology option selected based on the overall costs and benefits (economic, environmental and social) to reduce or prevent industrial water pollution.

The information obtained was used to propose a systematic approach providing the industry with a decision making process based on costs and benefits of wastewater management technologies adopted by organizations.

Fig 2: Schematic of the systematic approach towards reduction of industrial water pollution.



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A perspective on Electric Vehicle Adoption from an Indian Context

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Abstract: India has aimed for a 30% electric vehicle adoption by 2030. As a part of the electric vehicle adaptation, the government is moving towards coming up with a policy framework for electric vehicles and related sectors like raw material sourcing, battery manufacturing, charging stations, etc. This paper is intended to draw a comparative analysis between the ICE vehicles and Battery Electric Vehicles on operational aspects as well as its environmental implications. The paper stands out in highlighting certain important factors which are needed to be considered while devising a policy framework towards electric vehicle adoption. Based on the analysis, we claim that Electric Vehicle is a better option compared to existing ICE technology. Further, a few policy suggestions are made for a better sustainable policy framework for the effective adaptation of electric vehicles for the future in an Indian context.

Keywords: Electric Vehicles, Environmental Impact, Policy Framework, Lithium Batteries

1. Introduction

In the last decade, a collection of conducive factors has helped in opening up the concept of electric mobility on a mass scale. Various developed and developing economies are promoting electric mobility and devising policies for the same. India has pledged to cut the intensity of its carbon emissions by 33-35 % and boost the renewable energy capacity to 40 % by 2030 in the target submitted to United Nations Framework Convention on Climate Change (UNFCC) for a global climate pact (BBC News, 2019) . As part of achieving the set target, India is making a big push to promote zero-emission vehicles. The government has aimed to move to 30% electric cars by 2030 (Jha, 2017).

Apart from the environmental concerns, the country is burdened by economic stress due to the heavily fluctuating oil prices and its imports [3]. Thus, it has become crucial for India to switch to a more sustainable mobility solution and electric vehicle caters the need and reduces the dependency on the regular Internal Combustion engine-based vehicles (ICE).

As a part of the electric vehicle adaptation, the government is moving towards coming up with a policy framework for electric vehicles and related sectors like raw material sourcing, battery manufacturing, charging stations, etc. Also, they are promoting electric vehicle manufacturing in-country and also has envisaged becoming a manufacturing hub for electric vehicles considering its new policies to minimize the trade relations with China (Dogra 2020). Acknowledging the policy reformation, domestic auto manufacturers in the country started focusing on the EV manufacturing sector and few basic models of EV have already been introduced in the market.

In this prevailing context, this paper is intended to draw a comparative analysis between the ICE vehicles and Battery Electric Vehicles on operational aspects as well as its environmental implications. The paper stands out in highlighting certain important factors which are needed to be considered while devising a policy framework towards electric vehicle adoption. Based on the conclusion, few policy suggestions are made for a better sustainable policy framework for the effective adaptation of electric vehicles for the future in an Indian context. The paper is organized as follows- Section 2 gives a brief overview of the historical development of electric vehicles and previously existing studies. Section 3 deals with a comparative analysis of electric vehicles and the normal ICE vehicles based on the operational cost as well as the environmental impacts highlighting the country-specific factors. In Section 4, a conclusion from the analysis drawn up and certain policy suggestions are made which can help in establishing a more sustainable model for electric vehicle adoption using the existing battery technologies. We also try to highlight a future direction for technological advancements which can help in better environmentally friendly electric vehicles.

2. A Review

Though electric cars have gained popularity in recent years, it had appeared long before the internal combustion engine vehicles. The earliest electric vehicle came in the 1830s. Inventions of batteries had made the idea of electric cars possible (Wilson 2018). A battery is a device that stores chemical energy that is converted into electricity. Batteries are small chemical reactors, which produce energetic electrons that flow through the external device to make it work. The first kind of storage cell batteries came in the 1800s when the physicist Alexander Volta stacked discs of copper (Cu) and zinc (Zn) separated by a cloth soaked in salty water (Alarco, Talbot 2015). But the batteries were not rechargeable and thus electric vehicle was impractical.

Later, the first kind of rechargeable batteries the Lead-acid batteries, which are still extensively used in the ICE vehicles, were developed. Even with the innovation of rechargeable batteries, a sustainable electric vehicle model seemed far-fetched due to various problems like energy density, safety, etc. of the battery. There was a demand for more compact, higher capacity, safe, rechargeable batteries, which got fulfilled by the invention of Li-ion cells by the American physicist Professor John Goodenough in 1980 (Scrosati 2011, Crabtree, Kocs, Trahey 2015).

As Lithium is one of the lightest metals and has large electrochemical properties, it turned out to be an effective solution for producing high voltages from low and compact volume.

In a lithium-ion battery, Lithium is combined with a transition metal – such as cobalt, nickel, manganese, or iron – and oxygen to form the cathode. During

recharging when a voltage is applied, the positively charged lithium-ion from the cathode migrates to the graphite anode and becomes lithium metal. Because of the electrochemical properties of Lithium, it has a strong tendency to get oxides. It migrates back to the cathode to become a Li+ ion again and gives up its electron back to the cobalt ion. The movement of particles in the circuit gives us a current that we can use (Scrosati 2011, Crabtree, Kocs, Trahey 2015).

Further innovative leap happened when they found that using different transitional metals in the lithium-ion battery, the cell can have a higher capacity but can be more reactive and susceptible to a phenomenon known as thermal runaway (Scrosati 2011, Crabtree, Kocs, Trahey 2015).This led to the idea of using Lithium materials in nano-scale for making large format cells that can be rapidly charged and discharged and thus made the concept of electric cars feasible.

Previous Works

With the recent enthusiasm in adopting electric vehicles with the idea of reducing greenhouse emissions, many researchers have tried to understand the environmental impacts of electric cars. Various studies have taken up a comparative analysis of the environmental effects as well as sustainability factors of electric vehicles with other existing vehicle technologies. Such comparative studies are quite critical to support decision making with automotive sustainability.

A lot of studies follow the Life Cycle Assessment (LCA) methodology to measure and understand the environmental impacts of the vehicles. Several works evaluate the ecological effect of introducing electric and hybrid cars by taking into account the whole vehicle (Samaras, Meisterling 2008, Faria et. al, 2013, Bartolozzi et al. 2013, Donateo et al. 2013,Casals et al. 2016, Girardi et al. 2015). These studies make use of inventories based on aggregated data from published sources and investigate the production of BEV powertrain/battery with different levels of detail and transparency; additionally, some of them deal with only specific phases of the car Life Cycle (LC), such as use or vehicle production.

Some Life Cycle Assessment (LCA) studies have even looked at specific components of BEVs, such as traction battery and power electronics (Dailmer 2010, Van den Bossche et al 2006, Matheys et al 2008, Ellingsen et al 2014). Some of the most authentic papers that perform the environmental comparison of conventional and electric cars assess the entire vehicle LC, including both the high-voltage battery and the rest of the car components, employing different ecological impacts and basing on well-detailed inventories and model parameters (Samaras, Meisterling 2008, Faria et. al, 2013, Bartolozzi et al. 2013, Donateo et al. 2013,Casals et al. 2016, Girardi et al. 2015).

Certain studies have focused on the country-specific comparative analysis under how electric vehicles are suitable for a specific country (Ke et al. 2017, Skrucany et al. 2019, Tengstrom 2018, Girardi et al. 2015, De Souza 2018).

In this paper, we draw a comparison between the Electric vehicle and internal combustible engine vehicle in an Indian context, based on the operational cost to understand how well the public will adapt to the new technology even though there is a significant push from the government's end. Further, we review and highlight the environmental problems posed by electric vehicle usage and propose a few policy adoptions that help in technology adoption among the public and reduce the negative impacts of electric vehicle technologies.

3. A Comparative Analysis

To have a practical comparison between electric vehicles are ICE vehicle, we have chosen an Indian car model which has both electric as well as ICE variant. The car we have selected for the analysis is TATA Nexon. It is a subcompact crossover SUV produced by Indian automaker Tata Motors since 2017. In 2018, this particular model had achieved a 5-star rating in Global NCAP crash tests. As per upgraded motor policies in the country, the model has undergone various up gradation. Currently, under the ICE category, this model is available in 32 variants, two engine options, and two transmission options: manual and automatic class. At the end of 2019, they introduced the all-electric version of Nexon (Tata, 2019).

The ICE version of the vehicle comes with a 1497 cc -1.2 litre turbocharged petrol engine or a 1.5-liter turbocharged diesel engine that gives mileage from 17 km per litre to 21 km per litre based on the variant. The price of the vehicle ranges from Rs 6.92 lac to Rs 12 lac. In contrast, the electric version comes with a permanent magnet synchronous motor and a 30kWh high energy density Lithium-ion battery, which is promising a range of 312 km per charging cycle (Ke et al. 2017). The electric variant is priced in the range of Rs 14-16 lacs. Different specifications of the electric and ICE options are given as follows.

	Nexon ICE	Nexon EV
Dimension (Length x Width x Height (mm))	3993 x 1811 x 1606	3993 x 1811 x 1606
Wheelbase (mm)	2498	2498
Ground Clearance (mm)	205	205
Boot Space (Litre)	350	350
Kerb Weight	1370	1400
Brakes (Front/ Rear)	Disc/ Drum	Disc/ Drum
Front Suspension	Independent MacPherson strut with coil spring	Independent MacPherson strut with coil spring
Rear Suspension	Twist beam with dual path Strut	Twist beam with dual path Strut

Table 1: Specification of Tata Nexon (ICE vs EV) (Source: Tata 2019)

We can see from the above table that only the fundamental technological differences exist between the electric and ICE vehicle keeping all the major specifications same, thus making it an ideal candidate for our comparative analysis study. Let us take the lowest diesel variant in the ICE category and the lowest variant among the electric version. Our comparison is mainly based on Operational Cost of the Vehicle.

Operational Cost Analysis

A basic model of the diesel version of the Nexon cost Rs. 8.45 lac while the basic electric version is charging Rs 14 lacs. We can see that the electric vehicle is almost 40% costlier than the regular ICE vehicle. It is to be noted that the significant part of the electric vehicle cost is due to the battery in the car. As mentioned before, this vehicle is fitted with a 30kWh battery, costing around Rs 3-4 lakh. However, we know that in addition to the initial cost, the one has to keep spending throughout the lifetime of the car for its operation (Tata 2019).

In general, on average, it is considered that an ICE vehicle has a life of 15 years or 3 lac km while an average electric car is claimed to have an guaranteed life time of 8 years after which at least battery replacement is required for moderately used vehicle. Thus, a while one spends an amount of Rs 8.45 lac for 15 years in the case of an ICE vehicle, he or she has to pay almost double the amount for half the period for an electric car.

Further, ICE has a better running capacity that it can be used for running at least 300000 km while the electric vehicle is guaranteed only for running a total of 160000 km during its battery lifetime. Note that the battery life is estimated to be measured in terms of the number of charging cycles undergone by the battery. So, 30 kWh with a promised range of 300 km can work for maximum of 160000 km without replacement in an ideal condition. Hence, we will consider the tentative cost of running and maintaining each vehicle for 160000 km.

As mentioned above, for running 160000 km, it requires 512 cycles. Generally, it is said that a lithium-ion battery has a life of 300 to 500 charging cycles. Keeping on the optimal range, let us consider the cost of using the car for 500 charging cycles. Each charging cycle requires 30kWh for fully charging the battery, which translates into 30 units of power consumption. The battery can be subjected to a standard charging through a 15 V power outlet unit found at home or through a fast-charging unit at the charging station. While the charging station can fully charge the battery in 60 minutes, standard charging takes around 8- 10 hours for achieving 100% charge.

In India, the average cost of electricity is given out to be Rs 6 per unit (PHD Research Bureau 2013). Given the value of each power unit, the price of a charging cycle is approximately Rs 180. Government authorises are taking steps for faster steps for electric vehicle adoption by promoting commercial charging station by releasing the guidelines for setting up such public charging units and fixing the tariff limits for same (Government of India, 2018). Reports suggest the commercial charging station are planning to fix costs around Rs 160 -200 for a full charging cycle (IndianAuto Team, 2020) . Hence, it is justified for fixing Rs 180 as the average cost per billing cycle. Thus, overall, it will be costing Rs 90,000 for 500 charging cycles.

Let us consider a similar calculation for the ICE vehicle. The ICE version of this model is claimed to give an average mileage of 17 km per litre. Thus, for running a distance of 160,000 km, one requires 9412 litres of diesel approximately. Considering the current trends in diesel prices in India, consider Rs 80 to be the approximate average price for a litre of diesel (Diesel Prices, 2020). Thus, the total present cost of diesel for running the vehicle will be Rs 752,960.

Hence, a straightforward analysis says that fuel expenses for running an ICE are extraordinarily high compared to the electric vehicle of the same model.

Further, ICE vehicle comes with numerous moving parts which undergo extensive wear and tear based on the usage. Hence, an ICE vehicle requires regular oil, transmission fluid and coolant changes etc. Below given is a table containing a tentative service and maintenance schedule of the ICE model of TATA Nexon.

Service Number	Kilometers / Months	Total Cost (INR)
1st Service	1500/ 2 months	0
2nd Service	10000/12 months	2590
3rd Service	20000/24 months	2590
4th Service	30000/36 months	6070
5th service	40000/48 months	4590
6th Service	50000/60 months	6390

Table 2 : Service and maintenance schedule for Nexon ICE (Source: Cardekho, 2020)

From the data given above, we can see that maintenance charges increase as vehicle ages and usage increase. And these charges further add to the operational cost of having an ICE.

On the contrary, electric vehicles come with minimum moving parts and might not require service or maintenance during their lifetime. Certain studies have shown that electric cars' maintenance and service charges would be at least 35-40% less compared to ICE vehicles [34] throughout the lifetime initial battery.

Considering the above-discussed factors, we can conclude that though the initial out of pocket expenses for electric vehicles are quite high, the operational cost of vehicles is minimal compared to the ICE version. Thus,

analytically, the electric version stands out to be a better option than the ICE model.

However, a commercial vehicle in India runs an average of 50000 to 60000 km per year (Roychowdhury and Dubey 2018), suggesting that the battery will become obsolete in 2- 3 years of usage, calling for a replacement of the cell. Thus, operational perspective, an extensive vehicle user, can incur a battery replacement cost of Rs 300,000 to 400,000.

Environmental Impact of Electric Vehicles: A review and comparison.

The environmental friendliness of the electric vehicle has been the prime reason which has motivated research and development of electric cars. It has been widely accepted that ICE vehicles contribute extensively to atmospheric pollution due to emissions while operating. The world got a chance to witness the results of a scenario with almost nil vehicles running during the widespread COVID 19 pandemic. The pollution level fell all across the world during the pandemic. Considering the environmental hazards caused by the ICE's vehicular emissions and the fact that fossil fuels are non-renewable, and their reserves are depleting rapidly due to increased consumption, electric cars are an efficient and environment-friendly solution to the persisting problems. Electric vehicles have zero emissions compared with ordinary ICE vehicles and, hence promising a cleaner environment. However, electric cars are not 100% pollution-free. There are various ways electric vehicles can indirectly cause problems to the ecosystem. In this subsection, a thorough review is done to understand the possible threats posed by electric cars.

To assess and compare the environmental impacts of vehicle technologies, we review the possible effects of technologies at each stage of the Life Cycle Assessment (LCA). LCA is a standardized methodology for the systematic assessment of any product or system's environmental performance throughout its lifetime (Ke et al. 2017). The complete life cycle is categorized into two parts- the Well -to -Wheel part, which involves the life cycle of the energy carrier (fossil fuels or electric batteries) and the vehicle life cycle. In this study, we compare the environmental impacts of each technology at stages of the Well- to -Wheel cycle as well as the vehicle life cycle. The Well- to-Wheel cycle includes energy resource extraction, Energy carrier production, Energy carrier distribution, and Energy conversion.

First of all, the natural reserves of Lithium-ion on earth are limited. As per the estimate by USGS in 2010, total economically extractable world lithium reserves are at 9.9×10^{9} kg and identified lithium resources at 2.55×10^{10} kg (Eason 2010). These lithium reserves are found in igneous rocks or lithium chloride salts in brine. Studies suggest only 1% of Lithium will be consumed in the next several years, even with the increasing demand for batteries (Eason 2010). And further hopes are there that new reserves can be identified in the coming days. Hence, researchers feel that there will be enough lithium supplies to meet the growing demand for batteries. In addition to Lithium, as discussed before, battery manufacturing requires other elements like cobalt, nickel, manganese, etc. Even though there might be enough Lithium to serve the rising demands, there might be a shortage in the other materials used.

In contrast, fossil fuel reserves have depleted significantly over the last 200 years, and scientists believe that if the uncontrolled usage continues at this level, then the leftover reserves can be exhausted in the coming 50 - 100 years, which can lead to significant ecological imbalance (Shafiee, Topal, 2009). Thus, switching to cleaner electric vehicles can bring down heavy dependence on these fossil fuels.

Further, the mining of these elements needed for manufacturing these batteries is an energy-intensive process that is harmful to the environment. A report suggests it takes 250 tons of mineral ore spodumene or 750 tons for mineral-rich brine to produce 1 ton of Lithium. Further to it, these mining activities depletes water tables (Zhang et al. 2019). In Chile, at the significant centre of lithium production, 65% of the water in the region is used for mining activities, affecting the farmer's need. It is suggested that 1 ton of Lithium requires 1900 tons of water to extract. Similarly, mining of fossil fuels causes an equal amount of local environmental degradation based on the kind of reserves available at a place- surface, deep soil, or sea and the method used for extraction (Heubl 2019). Also, there is a tremendous amount of greenhouse gas emissions in the extraction process.

Another primary concern regarding these energy carrier technologies is their geographical distribution. The main components of the Li-ion batteries are concentrated in a handful of countries. The lithium reserves are concentrated in countries like Chile, Bolivia, Argentina, and China (Shafiee, Topal, 2009). Similarly, other crucial materials are distributed in different parts of the world. Thus, to meet the demand, the extracted metal needs to be transported to different parts of the world. The major problem arising in such a case is the emissions of Greenhouse gases during transportation and safety issues due to the toxicity of the involved materials (Ellingsen et al. 2014). In comparison, environmental impact of fossil fuel is no less as most of the categories of fossil fuel contributes heavily to environmental pollution and poses a danger to human life.

Thus, the presence of considerable lithium reserves compared to the fast-depleting fossil fuel reserves in the world favours the switching to electric vehicle technologies. However, it is to be noted that the extraction and transportation of the raw materials involved in making this technology is no way less polluting compared to the existing fossil fuel technologies.

Now, let us consider the energy conversion stage. On a positive note, Li-ion batteries are highly efficient compared to the ICE technology. Li-ion batteries are rated to have an efficiency rating of 99% compared to the ICE technology which is having an energy loss of almost 30% (Ke et al. 2017). In ICE vehicles, the energy generated is used to overcome its frictional factors,

leading to a lot of energy loss while running. Thus, the electric vehicle stands as a better solution compared to the existing technologies under these criteria.

Having discussed the environmental impacts of each technology considered at each stage of the Well to Wheel cycle, let us consider the different aspects of these technologies during the vehicle life cycle. The vehicle life cycle consists of the following stages- Material production, battery manufacturing, and equipment manufacturing, operation and maintenance, and end of life.

Both of the technology vehicles are made out of the same raw materials as iron, steel, aluminium etc, and thus, the environmental impact at this stage of the vehicle life cycle remains similar.

The next stage of the vehicle life cycle is equipment manufacturing. As discussed, electric vehicles come with a fewer number of moving parts compared to ICE vehicles. Specifically, an electric-powered car has three primary components. These are the electric engine, motor controller, and battery. In comparison, an ICE vehicle consists of hundreds of moving parts, which include engine, transmission, driveshafts, differentials, axles, emissions control, exhaust, engine cooling systems, etc. Typically, these components are manufactured by the high-temperature metallurgical processes that create air and thermal pollution. Because an electric vehicle has 60% fewer parts than an ICE vehicle (EVreporter 2019), electric cars contribute comparatively less to environmental pollution in the equipment manufacturing stage.

Another component of this stage of the vehicle life cycle is battery manufacturing. While battery serves as the main component of an electric vehicle, ICE vehicles are also fitted with low power rated batteries for minor power generations in the car. It is seen that the manufacturing of Li-ion batteries contributes significantly to atmospheric pollution. It is said that the emission in the manufacturing process can range from 39 kg CO2/kWh to 196 kg/ CO2/kWh (Maelin 2019). Additionally, studies have revealed that the human toxicity potential of these li-ion battery technologies is higher compared to fossil fuel power technology.

In the case of ICE technology, lead-acid batteries are used extensively, and manufacturing and use pose similar problems like in the case of Li-ion cells. Many lead poisoning incidents were reported in the past due to the manufacturing and careless handling of such lead-acid battery technologies. Further, fossil fuel processing contributes to a high level of environmental pollution through different poisonous emissions from the processes and the waste generated by the processing units.

Hence, we can note that, though electric vehicles stand out better in equipment manufacturing criteria, the environmental impacts of battery manufacturing are quite high. We can conclude that the production of electric cars is no way less harmful than ICE vehicles.

The next stage in the life of the vehicle is operation and maintenance. The advantages of electric cars are well-acknowledged and have served as the motivation for developing electric vehicle technology. Electric vehicles are clean, and tailpipe emissions are almost nil compared to ICE. Even though this is the case, certain factors specific to energy production in India requires to be considered. Existing data suggest that 64% of the country's power generation is from thermal power generation due to abundant coal availability. Thus, the running of electric vehicles in the country is indirectly again, dependent on fossil fuels. Based on the previous studies, the average rate emission per unit of electricity is 0.95 kg/kWh of CO2, 7.20 g/kWh of SO2, and 4.38 g/kWh (Mittal, 2012).

Further to it, as of now, there are no economical and energy-efficient methods for recycling the manufactured Lithium batteries because less than 5% of used-up cells are going for recycling. This suggests that most of these used batteries might end up in landfills. Going into the future, these accumulations of such used batteries are going to posing a more significant problem to our environment of no other alternative methods if reuse or recycling is adapted. Even for recycling, the steps involved like smelting require so much energy and cater to the release of various harmful gasses into the air. All these years, scientists had been focusing on the studies to prolong the life of these batteries. And because of their modest efforts, we have batteries that live for at least 15 - 20 years compared to the short-lived lead batteries. Unless and until, new methodologies for efficiently recycling these Li-ion batteries, the sudden increasing growth rate in electric vehicle consumption can pose a more significant environmental hazard.

As per existing surveys, the average usage of the personal vehicle is 12000km per year (Allirajan 2017). If we take the average lifetime of the battery to be 8-10 years, then as per the average usage rate, a battery fitted to the vehicle is not used up to optimal level during its life.

On the other hand, a commercial vehicle in India runs an average of 50000 to 60000 km per year, suggesting that the battery will become obsolete in 2- 3 years of usage, calling for a replacement of the cell (Roychowdhary, Dubey 2018). In such a scenario, the number of batteries getting disposed will significantly increase, if the taxi providers are switching to electric vehicles. This will pose a massive dilemma in a country like India, where the land shortage is a huge problem, and safe waste disposal is an enormous crisis. The absence of adequate infrastructure and limitations in enforcement for managing hazardous waste has resulted in ineffective management of the garbage in India. Burning in landfills is still one of the most common methods of disposal, resulting in harm to human health and the environment. Waste contractors collecting hazardous waste are mostly ill-equipped, untrained, and poorly paid, and the high-temperature treatment infrastructure in India is inadequate.

Further, there is a lack of awareness among the people regarding the disposal and recycling of Li-ion batteries. To add to it, currently, there aren't any government regulations on handling these used-up batteries. Thus, the

promotion of electric vehicles in larges without appropriate measures for treating the discarded battery can pose a massive threat to the environment.

Another advantage of electric vehicles compared to the ICE is that electric motors in electric cars give a smoother and almost noiseless driving experience to the passengers than the ICV and, hence, contribute less to noise pollution.

Further, the moving parts of the ICV vehicles are continuously subjected to friction while running. The resultant wear and tear in the components generate particulate matters that contribute to pollution. Relatively, electric cars are better off on such aspects.

4. Conclusion

From the operational cost analysis as well as environmental impact analysis, we can say that the EVs are not pollution-free, but they serve as a better option compared to the existing ICE vehicles.

As suggested, since EVs have a limited range, a person undertaking a long-distance drive must recharge during the journey. As per the existing technology, it takes at least 1 hour for a quick recharge. Thus, the driver loses one hour and takes more time to cover the distance than an ICE vehicle, where the refuelling takes only a few minutes.

Further, to add on, in a country like India, considering the road condition and the extensively different geographical land space, might affect the claimed range of the vehicle and thus require sooner recharging. This will, in turn, bring down the battery life.

Even though the battery life is guaranteed for at least eight years, and extensive use can demand a replacement in 3 -4 years, which implies that customers will be further burdened by the cost of replacement, which accounts for almost 20-30% of the initial vehicle cost.

Hence, even though people will be motivated to switch to the electric vehicle considering the high initial cost and the recurring battery replacement cost might severely affect the electric vehicle adoption in a low-income country like India. Reports suggests that there is a significant growth in taxi users in the country with penetration of Mobility-as-a-Service (MaaS) providers like Uber and Ola. In the 2019, a prominent MaaS provider Ola claimed to have covered a distance of 6 billion km over the year (Banerji 2019). Owing to the popularity MaaS sector, people prefer to hire taxis rather than owning a personal vehicle. Thus, to achieve the goal of a successful electric vehicle adoption, authorities need to promote electric cars among taxi service providers who might hesitate considering the battery cost.

Even though the reduction in the prices of raw materials and batteries is expected in the future, it is essential for developing a country to devise a sustainable strategic plan for incentivizing the public to adopt electric vehicles in the country without financial burdening them. Further, considering the environmental effects of the batteries, the policy framework towards electric vehicle adoption should take care of the negative impacts of the Li-ion cells overrides the positive aspects of zero tailpipe emissions.

Here, we present a few proposals for promotion and effective adoption of the electric vehicle while possibly minimizing the environmental threats posed by currently existing EV technology.

First of all, we propose a battery swapping policy that can effectively tackle the problems of the initial high cost of electric vehicles and time management problems arising due to the long recharging hours.

We propose a policy framework where vehicle manufacturers are made to stick to a uniform battery design, which can be easily fixed and removed from the vehicle. And the charging station can be replaced by battery-swapping stations that can be termed as 'battery providers.' The network of battery providers can be centrally controlled. A registered and licensed person can set up a battery-swapping station, which will be housing charged batteries available for the vehicle owners to swap his discharged battery for another recharged battery for a small amount of fee. Instead of having to pay for the cost of the battery while buying the vehicle, the vehicle owner can be separately asked to pay the value of the cell as a caution deposit to the battery provider against the battery service provided to him. Various advantages of the proposed system are the following:

1. Under the proposed system, the effective cost of the battery, which forms a sizeable part of the initial value of the vehicle currently, can be deducted. Hence, the price of cars can be brought down significantly, which can boost electric vehicle adoption in the country. The vehicle owners are required to pay the cost of battery as a caution deposit to the battery provider. Since caution deposit is an amount which will be returned to the user at the end of the proposed contract term, psychological it can work can nudge for the user to adopt electric vehicles.
2. As discussed before, an average user in the country runs 12000 km per year, which suggests that a battery might not be optimally used to its capacity in its lifetime of 8 to 10 years. Thus, battery swapping can ensure that every cell is efficiently used.
3. These battery swapping stations can be used as a point for effectively and centrally controlled collection points for used up battery that can be further put for reuse or recycling and thus reducing the environmental impact of disposal of these Li-ion batteries.

Second, the government can implement incentive schemes like discounts in taxes, etc. for the purchase and use of electric vehicles for promoting the widespread adoption of these electric vehicle technologies.

Third, owing to the hazardous nature of the materials used in the batteries, coining up with a policy framework for waste management is necessary for

the country. Additionally, reuse and recycling of these Li-on batteries can be effectively implemented. Studies have shown that these used batteries from cars can be refurbished and reused for domestic purposes. So planning and framing policies can help to reduce the impacts of these batteries on our environment.

Fourth, as pointed out before, the country is heavily dependent on thermal energy as a source of power generation. Policies for identifying and promoting the use of non- conventional power generation methods for running these battery stations can bring down indirect dependence of these electric vehicles on fossil fuels.

Finally, the government can promote further research and development to find improved battery technologies that are more environmentally friendly and can further help indirect problems caused by these electric vehicles. A study conducted in Japan had shown how the batteries developed from cotton could potentially replace these Li-ion batteries. These batteries are called Dual carbon battery (Jiang et al. 2018). These uses carbon filers from cotton to make batteries that were claimed to be safer, long-lasting, cheaper and more sustainable than conventional battery. Exploring such possibilities can help in further moving towards cleaner and safer vehicle technologies.

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Sewage Monitoring System for Smart City using Internet of Things

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***Abstract*—Recent advancements in science and technology has facilitated development of smart cities across the globe. The development of smart city involves various factors such as smart infrastructure, smart health, smart transportation, smart electricity, smart sewage treatment etc. All these parameters should be properly managed to ensure the public life safe and healthy. Due to urbanization and faster development of industries sewage monitoring has become a crucial parameter in realizing a smart city. Several parameters are needed to monitor in controlling a sewage system. In-order to improve the efficiency of the sewage system, we propose a sewage monitoring system, which is based on Internet of Things (IoT). We implement a system which can monitor the drainage water level continuously and sense any toxic gases at the drainage locations. This information will be passed on to the remote staff through wireless communication. Our system uses sensor technology and wireless communication technology for realization. Data has been collected though IoT and is processed in the cloud. This work uses Arduino UNO board for sensor data collection and ultrasonic sensor for drainage level detection and MQ135 sensor for toxic gas sensing. The system has been implemented in real-time environment which gave impressive results.**

***Index Terms*—Infrastructure sustainability, Internet of things, Smart city, Sewage monitoring, Hardware development board**

I. Introduction

Smart city project tries to achieve the goal of efficient management of the resources for faster development of the country. This is possible only if a healthy and safe public life is ensured. Development of smart cities require considerations of various parameters, including smart electricity, smart transportation, smart health, smart water supply, smart drainage system, etc. In a country like India where the drainage system is built underground, it is essential to keep the drainage system working efficiently to maintain the cleanliness of the city and to ensure safety to public health. Sewage monitoring and treatment has become crucial in the current world as the process of industrialization rises in a fast pace. Sewage has also become a critical infrastructure due to urbanization and evacuation of waste-water. Sewage allow transmitting residual water to treatment plants and thereby preventing flood due to rain water in cities. Several issues can happen in drainage infrastructure, such as leakage of drainage pipes, spilling of waste-water due to block in the pipe, power supply failure in the pumps etc which results in blockage, are some of them. Even-though additional pipelines are available for mitigating these issues, an efficient sewage monitoring system is required for better resource utilization and thereby developing a smart city. The system should continuously detect the sewage data in real-time to avoid any critical situations.

The concept of Internet-of-things (IoT) is generally used for smart city projects. IoT enables us to develop ”smart” objects, and ”connect the unconnected”, where devices are connected to the cloud. These devices can be designed with better connectivity and can be made intelligent too, where real-time decisions can be made based on the environment. Data is generated at the source which may consist of several sensors and is transmitted and interpreted at the other end of the IoT link. IoT finds application in wide range of fields including healthcare, transportation, military and defence, autonomous vehicles, etc. [12]–[14]

In this paper we develop an efficient sewage monitoring system using IoT, which is based on ultrasonic level sensors for monitoring the drainage level and giving an alert to the authorized person, in case of any changes in the level, beyond the threshold level. Proposed system gives information about the specific drain where the blockage occurred and immediately the location is pointed out. The system regularly checks the level of sewage. In addition, gas sensors are also used in the system to get real-time alert about poisonous gases like methane and other natural gases.

Rest of the paper is organized as follows. Section II gives the background and related works. Section III discusses the proposed architecture for sewage monitoring system using Internet of Things. Section IV gives the implementation of the architecture. Results and discussions are also included in this Section. Section V concludes the paper.

II. Background and Related work

Sense smart city architecture has been proposed in [1], where the challenges in deploying the smart city sensor system are discussed in detail. A wireless sensor network based sewerage control system has been proposed in [3], where mathematical models for monitoring the velocity of water has been discussed. The sensing layer, network layer and application layer of sewage monitoring system has been discussed in [2]. A safety monitoring system for sewage workers has been presented in [5]. In this paper the health of the sewage worker is monitored in real time and is reported to the control room. They have also used Arduino microcontroller based monitoring system and experiments were done on three

individuals. Wireless sensor networks have been widely used for smart cities in recent years. A water quality monitoring system is presented in [4], where the system is based on ZigBee wireless sensor network. Design of drainage systems using wireless sensor network is also presented in [8]. Various smart city architectures were proposed in different research papers, and architectures for smart health, smart agriculture were also presented in many papers [6], [7], [9], [10]. Machine learning algorithms or deep learning techniques [11], [16], [17] can be used for making the device an intelligent IoT device. Wireless sensor networks are also very popular in applications where human beings do not get easy access or reach. For example in battlefields and military [15] and in dangerous mining works, these networks are applied.

III. IoT Based Sewage Monitoring System

Sewage monitoring system is a part of the smart city project, which is based on internet-of things. IoT based system find very useful in situations where humans cannot get access easily and manually monitor the process. Blockages in sewer is a major problem resulting in sewer flooding and pollution. Drainage plays an important role in urbanization, in preventing the danger caused due to floods. To eliminate the critical condition in the sewage system, continuous detection of sewage data or drainage level has to be done. We develop a hardware model to continuously monitor the drainage level and an alert is generated when the threshold level is crossed. Also, we monitor and detect the toxicity of the gases in the underground sewage which is a major concern to the public health. Different sensors are used for these purposes. The sewage monitoring system in this work is described in Section III-A.

A. System Components and Architecture

Our model is based on sensor technology and wireless communication technology. We use Arduino microcontrollers in developing the system. Arduino microcontrollers are one of the fastest growing community which are used by electronics beginners all over the world. Arduino boards are generally based on ATMEL microcontrollers. It consists of both analog and digital pins, where the analog input data is converted to digital data using the inbuilt ADC. In this work, we have used Arduino UNO board, which uses ATMEGA32 microcontroller in it. The proposed architecture contains two sensors connected to a Arduino microcontroller. Sensors will sample the physical parameters and convert them to voltage level for measurement. Further the microcontroller sends the data obtained from sensors to the cloud using Wifi module. The system architecture is shown in Fig. 1.

An ultrasonic sound sensor is a device that measures distance of the target. Sound waves are used to measure the distance in this kind of sensors. This sensor converts the electric signals into ultrasonic sound waves and the transmitter present in the sensor transmits them. The four pins of this sensor are

(i)VCC: The supply of 5 Volts is given to this pin

(ii) TRIGGER: This is an input pin where 10microseconds pulse is given to this pin

(iii) ECHO: This pin is output pin which remains high until the echo sound wave is received

(iv) GROUND: This is connected to 0 Volt

Gas detectors and sensors are generally used to find leakage of gases in particular region as a part of the safety mechanism. Gas sensors play key role in safety since there are several gases which are harmful to the living beings. Sewage and manholes generally consist of methane and natural gas in large quantities. MQ 135 gas sensor is used to detect the concentration levels of methane and natural gas in ppm. The conductivity of the material increases when it comes in contact with these harmful gases. So, the output voltage across the load resistor also increases and is measured by the microcontroller. Thus this value is used to calibrate the methane level. The pin descriptions for this sensor are as follows.

(i) VCC: A supply of 5V is given through this pin

(ii) AOUT: This is an output pin. This gives output analog voltage level depending on the concentration of methane

(iii) DOUT: This is a digital output pin

(iv) GND: It is connected to ground

IV. Implementation and Results

We have implemented a model which is capable of getting the water level in cm and also the concentration of methane gas in ppm. Fig. 2 shows the circuit diagram of the proposed system, consisting of gas sensor and ultrasonic sensor connected to the microcontroller.

The real-time readings were taken from the implemented hardware where smoke has been sensed by the gas sensor and ultrasonic sensor was able to detect the height levels. The readings obtained are in ppm and cm respectively. Table I shows the results obtained from the implementation. Drainage level readings are obtained in cm and gas readings are in ppm. We have shown the readings for methane gas in the table.

The ultrasonic sensor, which is used for monitoring the water level, has a range of about 10-20 meters, depending on the quality of the sensor used. By continous monitoring, we can be sure that if the reading gets closer to 1 meter, the drainage needs to be cleaned. In case of gases like CO, the reading should be 90 ppm for about 1-2 hours, CH4 has a reading of about 500 ppm to 900 ppm, according to WHO and NIOSH safety rules. If the readings are under or above these threshold values, then the clearn must be cautious about his safety while cleaning.

The system set-up at real-time environment is demonstrated in Fig. 3. The result obtained is shown in Fig. 4. Remote monitoring is essential for sewage system as the controlling authority will be available at a distance apart from the location where an issue has occurred. The measured data will be communicated to the authority or staff, through wireless communication. Therefore a device is equipped with WiFi. Measured data is transmitted through the network and is collected via a gateway. Data processing and storage will be performed in a cloud database. Each data is compared with a

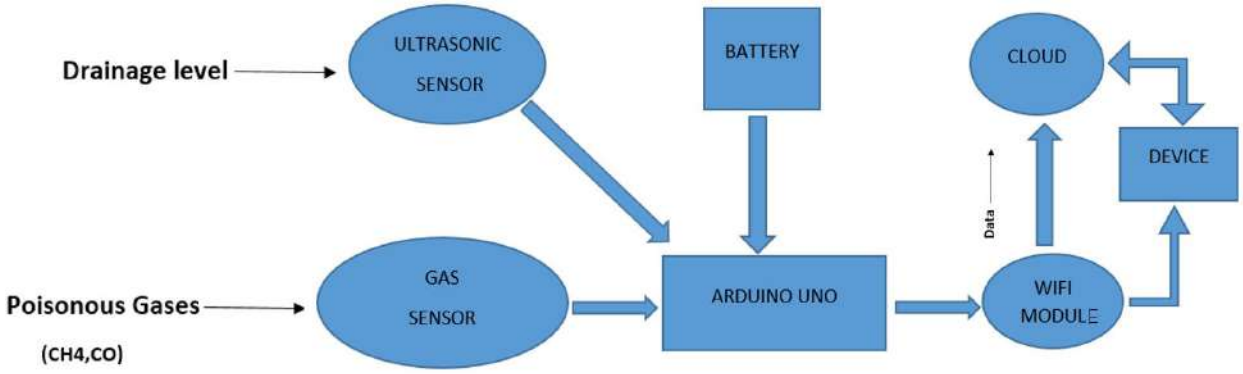

Fig. 1. System Architecture for Sewage Monitoring

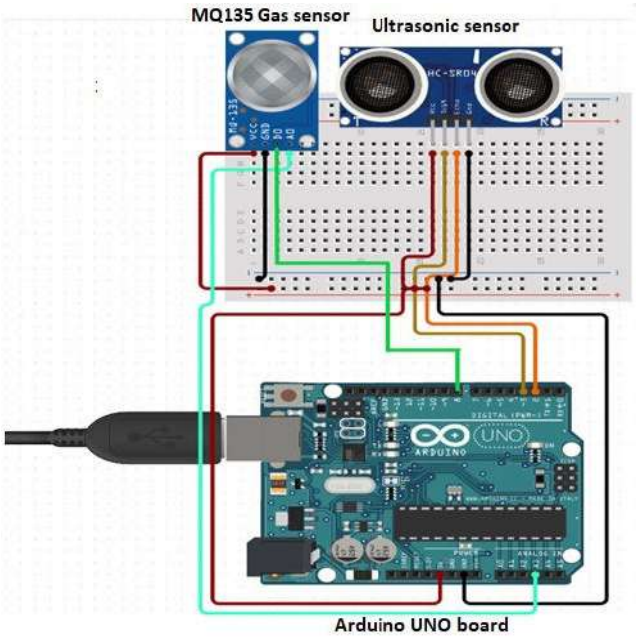

Fig. 2. Circuit diagram for Sewage monitoring system

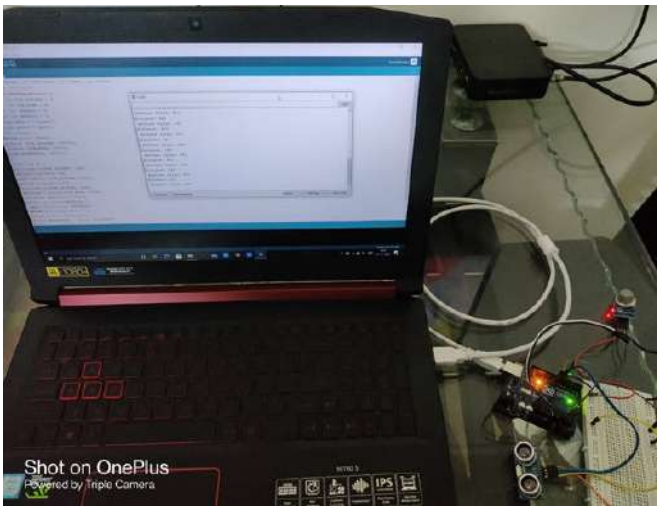

Fig. 3. Demonstration of Sewage Monitoring System

threshold value and an alarm is generated if any boundary is exceeded.

There are several limitations to be addressed in real-time implementation of this system. The entire system needs to be mounted on underground sewage, which should last long for atleast 12 months, which is the typical time period for the maintenance work of the drainage system. Hence battery life is very crucial while hardware implementation. Energy consumption is high in transmission of data when compare with processing of data as presented in [8]. Therefore it is a challenging task to minimize the energy consumption in these kind of networks.

V. Conclusion

In this paper we have presented an real-time sewage monitoring system for smart city applications based on IoT. We develop a hardware model to continuously monitor the

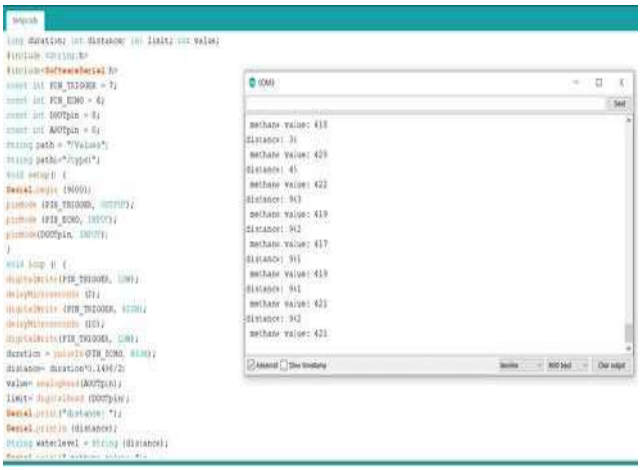

Fig. 4. Sensor Readings

TABLE I
SENSOR PARAMETER READINGS

LEVEL READING (in cm)	GAS READING (in ppm)
203	396
18	398
62	395
195	386
167	465
943	483
38	461
34	418
45	422
945	401
943	396
942	431
944	432
149	441
1040	620
1041	613
1043	608

drainage level and an alert is generated when the threshold level is crossed. Also, we monitor and detect the toxicity of the gases in the underground sewage which is a major concern to the public health. Proposed system consists of a gas sensor and an ultrasonic sensor connected to the microcontroller. The processed data is provided to the concerned staff through Wifi technology. An alert is generated in case of any blockage in the pipeline or other undesirable factors happen. This system is highly efficient for sewage staffs or officers, since they are remotely located from the drainage network. The system has been implemented in real-time environment and gave impressive results. Future work includes addition of more features on to the existing system.

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A Comparative Study of Optimization of Cylindrical Liquid Antenna using Different Feeding Techniques

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Abstract—**This paper illustrates the outcome of different feeds used in cylindrical liquid antenna. They are as follows: Co-axial feed, L-shaped feed, Conical feed and Circular Disc feed. These are the contacting methods for feeding of liquid antennas. We have used CST Studio Suite and the PSO (Particle Swarm Optimization) algorithm to simulate the results of different feeds and optimize the resonant frequency respectively. This experiment was conducted at a frequency of 4 GHz by changing the feed lines and keeping the inner radius of the cylinder, height of the liquid and dielectric constant to excite the different modes of antenna for multiple applications. Investigation interprets that the varying electric field line for different feeds changes the maximum gain over frequency and the resonant frequency is constant for all feeds since height, radius and permittivity do not change. The graphs obtained by changing different feeds shows that the directivity are maximum for circular disc feed and angular width is maximum for conical feed.**

Keywords—cylindrical liquid antenna, feeds, Particle Swarm Optimization(PSO).

I. INTRODUCTION

Antennas are the building blocks of the communication system. A pile of conductors that are connected electrically to the receiver/transmitter is designed for transmittance or receptance of radio waves in any direction. A new technique has been derived using these electrically conducting liquids such as water, gallium liquid metal alloy, and mercury which can sustain mechanical deformation known as liquid antennas. Liquid materials have some fascinating properties such as liquidity, reconfigurability, and conformability which magnify research in areas of different radiation pattern, operational frequency, VSWR, and bandwidth. Here, we have successfully designed a prototype model of the liquid antenna with different feeds such as Circular Disc feed, Coaxial feed, Conical feed, and L-shaped feed, keeping the rest of the parameters(such as inner radius of the cylinder, height of the liquid, dielectric, etc.) constant. This antenna is operated at 4 GHz with the help of the PSO (Particle Swarm Optimization) algorithm with water as the dielectric medium because of its flexibility, no air-gaps between probe and dielectric.

Water is considered as the radiating element in a liquid antenna. It comprises a cylindrical holder placed on top of the dielectric substrate, and a feed projecting out through the substrate into the holder and the water is accumulated in the holder part. The radiation pattern and the resonating frequency can be honed by changing the dimensions of the holder, the substrate, feed, etc. When medium is saline water, the dielectric response will be decreased and the antenna becomes a conducting antenna. This water antenna will be of two types when conductivity is either zero or very high. In both these cases, the productivity of the liquid antenna increases.

II. FEEDING TECHNIQUES

Here, in our paper, there are four feeding techniques that we are going to implement in liquid antenna, namely: Circular Disc Feed, Co-axial Feed, Conical Feed, and L-shaped Feed.

A .Circular Disc Feed

A Circular disc feed is fed into the substrate which is attached to a holder that contains water in it. This feed is efficiently used as radiators in satellite communication and also enhances the probability of transmittance and receptance of signals on all planes.[6] Due to its circular shape, it provides us with higher directivity and a wider aperture. This antenna is very suitable for microwave wireless system which requires compact, low cost and higher performance circuits[13].

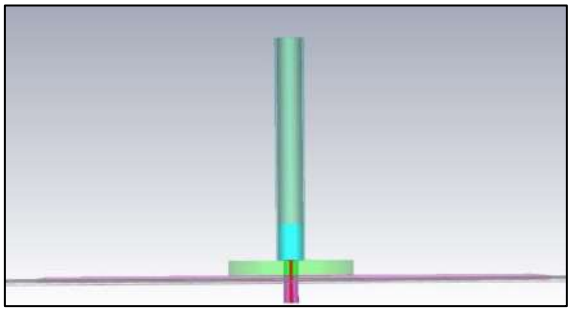

Figure : Circular Disc Feed

B. Co-axial Feed

The co-axial probe feed which has been used in our antenna is a very common method to match with its input impedance[14]. The inner conductor of the co-axial connector outstretch through the dielectric and is soldered to the holder, while the outer conductor is attached to the ground plane.[3,10] This type of feed can be positioned at any preferable location and is easy to design and has low spurious radiation.[11]

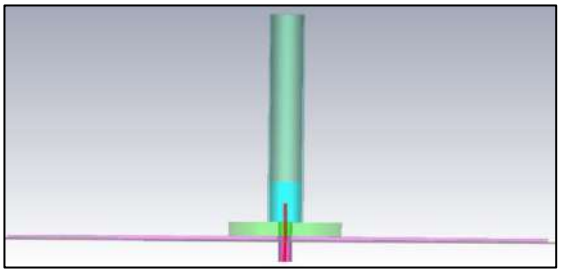

Figure : Co-axial Feed

C. Conical Feed

The conical feed is used for implementation of a water-based frequency reconfigurable antenna. A cone-shaped feed is projected from the substrate into the holder which contains water. The size of the antenna and the volume of water required for tuning should be large. The function of this feed is to design a

uniform phase font[8] with a wider aperture as compared to the waveguide, hence it provides greater directivity.[5]

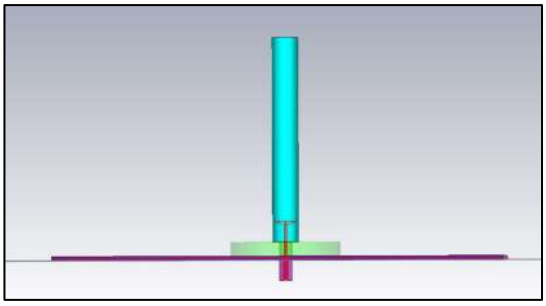

Figure : Conical Feed

D. L-shaped Feed

The L-probe feeding method is a very fascinating way to feed water patches as well as it is extensively used in metallic patch antenna[15]. Physically, it cannot be joined to the water patch, so it is easy to design. It comprises a water patch, air substrate, and metallic ground plane having an L-shaped feed attached to the SMA connector for feeding the antenna.[7] The SMA connector comprises a pin that is made of pure copper and it is covered by a dielectric material Teflon. The performance of the bandwidth can be efficiently calculated by this water dielectric patch antenna[12].

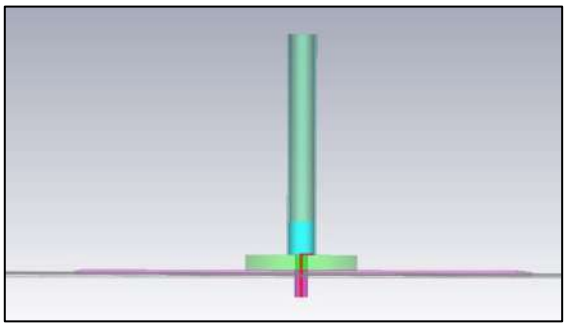

Figure : L-Shaped Feed

III. RESULTS

Simulation of distinct feeding methods and their results are shown explicitly below:

A. Circular Disc Feed

The value of the S-parameter at the operating frequency of 4 GHz is approximately -24.2 dB and a bandwidth of approximately 0.4 GHz is achieved. In this, the main lobe magnitude which is called directivity is 18.4 dB(V/m). The angular width of 41.1 degrees is observed in the far-field radiation pattern. The sidelobe level is observed to be -11.1 dB and the main lobe direction is directed towards 63.0 degrees. The maximum gain over frequency is optimized at 4 GHz which is equal to the operating frequency we have taken as depicted in Fig. 3.

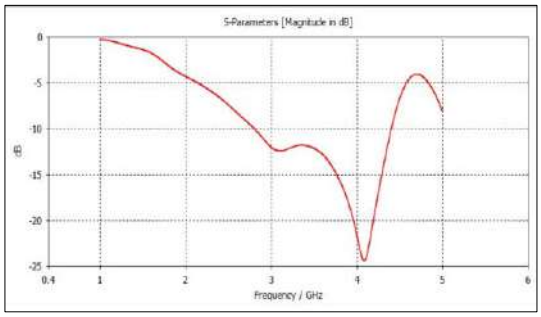

Figure 1: S- Parameter

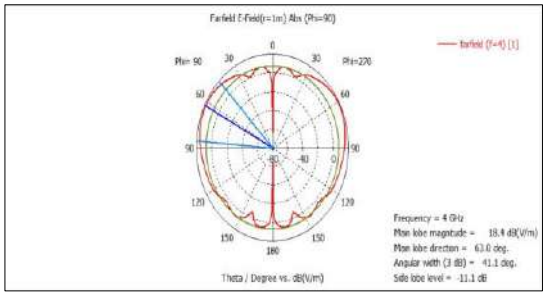

Figure 2: E- Field(4GHz)

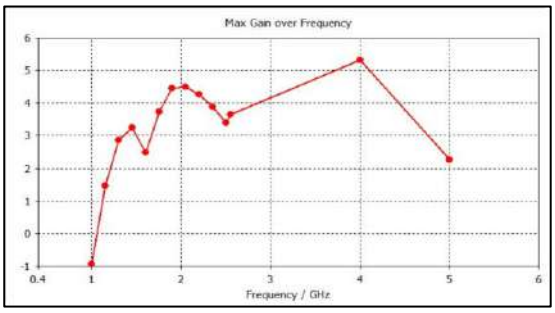

Figure 3: Maximum Gain Over Frequency

B. Co-axial Feed

The S-parameter of -23.3 dB at the operating frequency of 4 GHz and a bandwidth of approximately 0.2 GHz is achieved. The directivity of the far-field radiation pattern is 15.4 dB(V/m). The main lobe direction is directed at 63.0 degrees. The angular width of the radiation pattern is observed to be at 38.9 degrees and the sidelobe level is -9.6 dB. The maximum gain over frequency is optimized at 5 GHz as depicted in Fig. 6.

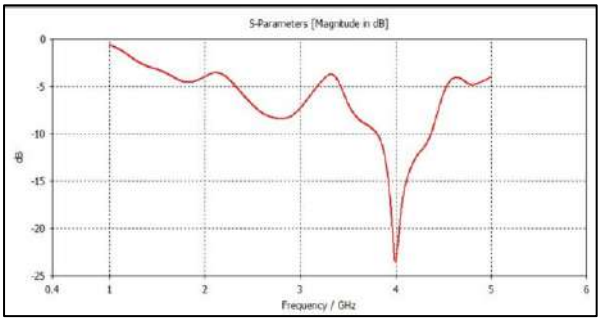

Figure 4: S- Parameter

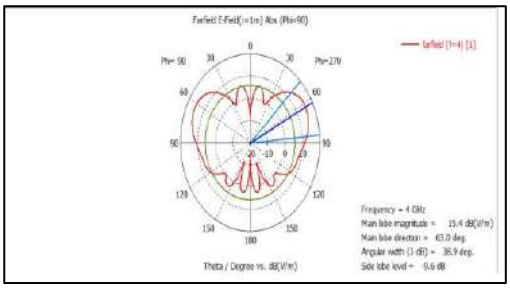

Figure 7: E- Field(4GHz)

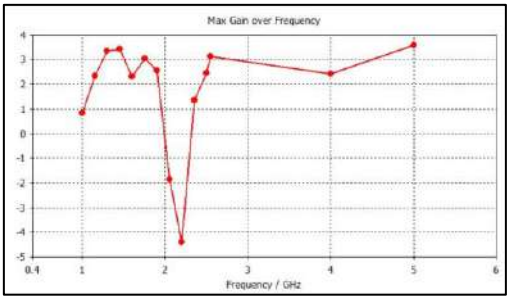

Figure 8: Maximum Gain Over Frequency

C. Conical Feed

The S-parameter of -35.7 dB at 4 GHz and bandwidth of approximately 0.8 GHz which is the highest among all feed, is achieved. The directivity of the radiation pattern is 18.1 dB(V/m) and its angular width is observed to be 41.7 degrees. The main lobe direction is directed at 62.0 degrees and the sidelobe level is seen to be -11.2 dB. In this feed, maximum gain over frequency is identified at 4 GHz(operating frequency) as depicted in Fig. 9.

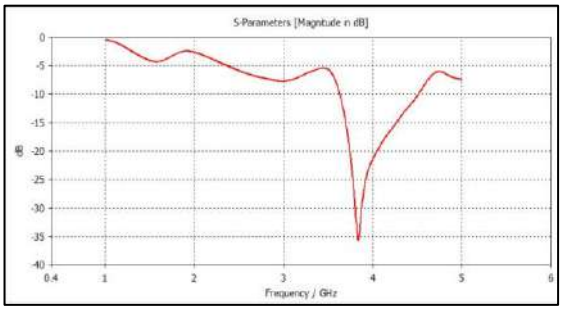

Figure 5: S- Parameter

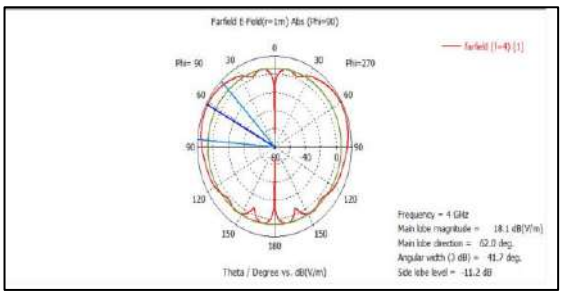

Figure 6: E- Field(4GHz)

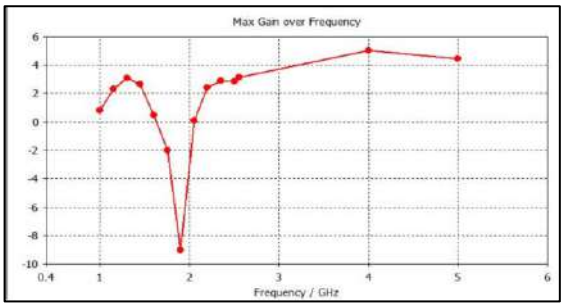

Figure 9: Maximum Gain Over Frequency

D. L-Shaped Feed

The S-parameter of -21.5 dB at 4 GHz and a bandwidth of approximately 0.2 GHz. The directivity of the radiation pattern is 17.1 dB(V/m) and its angular width is observed to be 40.3 degrees. The main lobe direction is directed at 63.0 degrees and the sidelobe level is seen to be -9.0 dB. In this feed, maximum gain over frequency is observed as 2.07 GHz as depicted in Fig. 12.

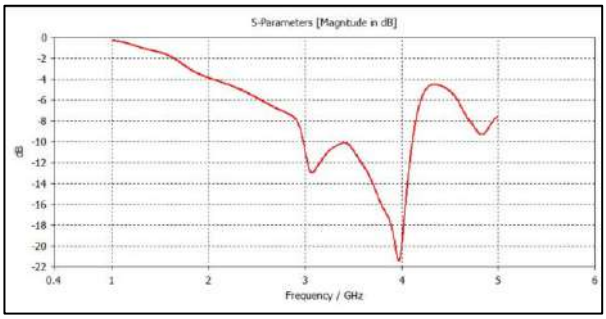

Figure 10: S- Parameter

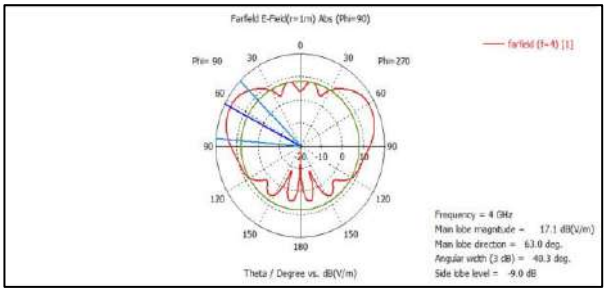

Figure 11: E- Field(4GHz)

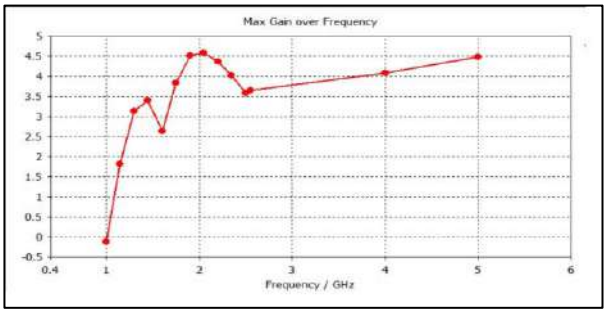

Figure 12: Maximum Gain Over Frequency

IV. COMPARISON OF RESULTS

The simulation results are assembled and compared in the table below: (all the results in comparison table are approximate value)

TABLE I COMPARISON TABLE

	Circular Disc Feed	Co-axial Feed	Conical Feed	L-shaped Feed
Radius(meter)	1	1	1	1
Bandwidth(GHz)	0.4	0.2	0.8	0.2
S-parameter(dB)	-24.2	-23.3	-35.7	-21.5
Directivity(dB)	18.4	15.4	18.1	17.1
Angular Width(deg.)	41.1	38.9	41.7	40.3
Side Lobe Level(dB)	-11.1	-9.6	-11.2	-9.0
Main Lobe Direction(deg.)	63.0	63.0	62.0	63.0
Maximum Gain Over Frequency	5.45	3.8	5.2	4.6

V. CONCLUSION

Here, in our paper, we have derived the following conclusion of the four types of feeds and compared their bandwidth, S-parameter, directivity, angular width, maximum gain frequency, and sidelobe level. These are mentioned below:

- Different types of feed is an important parameter for the realization of the water-configurable antenna because it affects the bandwidth, S-parameter, radiation efficiency, impedance matching, beamwidth(angular width), and smith chart.
- With reference to bandwidth, the conical feed antenna tops the chart, and co-axial feed and L-shaped feed are approximately equal and minimum. This makes co-axial feed antenna useful in narrowband applications like GPS, etc.
- The conical feed antenna has the highest beamwidth and the co-axial feed antenna having the least beamwidth. Hence, the conical feed antenna is utilized in the beamforming technique.
- Circular Disc feed has the highest directivity that is the magnitude of the main lobe is maximum while Co-axial feed has the lowest directivity. The conical feed has a greater directivity than L-shaped directivity.
- Circular disc feed has the highest maximum gain over frequency and co-axial having the lowest.

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Improving Library Book Retrieval By Using Topic Modeling

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***Abstract*—Given the increasing number of books that libraries have, it becomes increasingly difficult for students to find books. We note that the current methodologies like the Dewey Decimal system, are becoming inefficient with book retrieval as the number of books increases. In this paper, we attempt to provide a content-based classifier to organize books to significantly improve retrieval over the current retrieval method. Support Vector Machine (SVM) was the best performing model achieving an accuracy of 79.8%, while latent Dirichlet allocation achieved an accuracy of 28.1%. We also note that the SVM model predicts each news headline in constant time. On average it takes 0.0029s to predict the category of a news headline.**

I. Introduction

As more documents, texts, articles, magazines, and information continue to be digitized and uploaded on the world wide web, it becomes increasingly difficult to search, classify and perform sentiment analysis by just using traditional techniques such as keyword search and manual text classification.

Libraries face a similar problem. Given the increasing number of books that the library has, it becomes increasingly difficult for students to find books. Attempts to solve the classification of books historically included separating them by author, genre, using manual methods that are not effective. These books are then sorted into a database and book retrieval is done linearly. The rise of machine learning provided content-based methods to organize their books for easy retrieval.

As the number of books increases, the more inefficient the current retrieval methodology becomes as book retrieval is done linearly ($O(n)$ runtime). This paper addresses this problem. This is achieved by organizing hundreds of texts by their respective topics using only content-based features. News headline texts are used to predict the category each headline text falls in.
We trained latent Dirichlet allocation (LDA) which is a generative model that explains the topics of observations by using a latent component, as well as a support vector machine(SVM) to predict the category of each news headline. Confusion matrices were used to gauge model performance. The best-reported accuracy was the support vector machine which achieved 79.8%.

II. Background and related work

A. Dewey Decimal system

The Dewey Decimal system was developed to organize and arrange collections of libraries. It was initially developed for Amherst College Library, in the 1800s, but over the years has been adopted by many libraries all over the world.

The Dewey Decimal system makes use of numbers to organize books and arrange books via the subject. Each book in the library is issued a shelf-number which is usually found on the spine of the book, and arranged in numerical order. The Dewey Decimal system is usually in this format: 945.805 TAB. The first set of numbers refers to the broad subject area and the next set of numbers after the decimal point refers to the sub-section of the subject area. After the numbers, there are usually 3 letters that refer to the author or title of the book. An example of the Dewey Decimal, taken from a library is shown on the next page. It should also be noted that

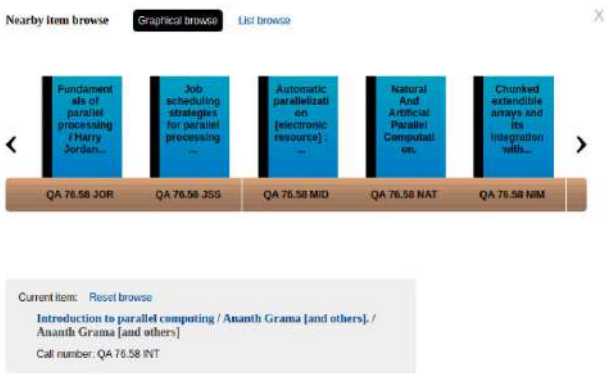

Fig. 1. Graphical representation of the Dewey Decimal system

the implementation of the system is usually done manually by librarians. The books are then stored sequentially based on this method. Another widely used library system to manage books is called the Library of Congress Classification (LCC) [17].

III. Related Work

There have been multiple techniques that were used to solve questions or problems related to the research question

proposed in this paper. One technique is to use a solution proposed by [4] to manage large sets of documents by using LDA as described in section 2.2. The main weakness of this paper is that how people would interact with the model output is not clearly defined and we are also not given any clear explanation on how to evaluate the performance of the algorithm.

1) Model Output Interaction: An important aspect of topic modeling is providing a way for users to be able to interact with the generated topics. One way to do this is by making use of network analysis, which enables us to find groupings of similar topics and provide navigation based on how the topics are related, as discussed by [8]. The key problem with this approach is that a link between topics is dependent on a user-defined value which will determine the effectiveness of the visualization and analysis. For example, having a document linked to just a few documents destroys much of the rich data that went into the topic model. [13] presents and provides an open-source implementation method for visualizing topic models by using browsing interfaces with two main types of pages: one for displaying generated topics and another for the documents. Selection bias on this method is a potential concern because a preliminary user study was only conducted on seven individuals. There are several similarities between the methods provided by [8] and [13], one being that both allow end-users to explore topics/documents via connections. Selecting features using an entropy weighting scheme to train an SVM model as done in [1], significantly improved the classification of text on the Reuter and TREC corpora.

2) Modern Implementations Of LDA: One disadvantage of using traditional topic modeling techniques is that they perform poorly on small datasets which could result in poor performance when organizing library books into various topics. [6] introduced a hierarchical topic modeling system with 2 stages named Dirichlet Multinomial Mixture mode (GSDMM) and latent features latent Dirichlet allocation (LFLDA) to gain competitive performance on small datasets. This technique performed better than LDA and topic models in clustering performance as well as topic coherence. However, this method was only applied on a twitter-tweet data set. The approach of using hierarchical topic modeling is similar to that used by [5]. The evidence presented thus far supports the idea that introducing some form of hierarchy in the implementation of LDA results in an improvement of the quality of topics generated. [11] is also an example of this.

Recently, researchers have shown an increased interest in merging deep neural networks and LDA. [7] provides a variation of LDA by using a deep neural network named two deep neural networks (2NN DeepLDA) and three deep neural network (3NN DeepLDA) to decrease computing processing in large corpora. This technique would potentially be useful in solving some of the computational challenges that might occur when developing a system to solve the proposed research problem.

IV. Methodology

In this paper, we attempt to classify categories in which news headline belong to by using content-based features, as a way of improving the retrieval time of a news article. We will train LDA as well as SVM to achieve this goal. More specifically, for SVM, we used a multiclass, error-correcting output codes (ECOC) model that reduces the problem of classification with three or more classes to a set of binary classification problems [2].

A. Data collection

The dataset used in this research is the "News of India" dataset, which consists of 3 features and contains over 2 million headlines. The initial dataset contained 3 features: "category", "publish date" as well as "headline text". Each data belongs to one of the 42 classes within "category". To train our models, we reduced the dataset to 4 classes, namely, "College", "Comedy", "Environment" as well as "Taste". The class distribution of each of these categories is even.

B. Preprocessing

To successfully implement our models the following steps were applied to the dataset to achieve a high degree of separation among classes:

1) Tokenization: Splitting text into word then converting all of those words to lowercase as well as removing punctuation.
2) Lemmatization - words in the third person will be converted to first person as well as converting past tense verbs to the future tense.
3) All words will be stemmed and stopwords will be removed

C. Feature selection

To train our models, we had to convert our text into a bag-of-words representation. This results in a 3576×1982 matrix (i.e, number of documents $\times$ number of words), which we then used to train our models.

V. Prediction and Evaluation

We use the following models to predict the category of a given headline: latent Dirichlet allocation (LDA) as well as support vector machines (SVMs).

A. LDA

[3] proposed a generative probabilistic model named LDA by introducing Dirichlet prior to Probabilistic Latent Semantic Analysis (PLSA), which is a statistical technique for the analysis of co-occurrence data. The concept behind latent Dirichlet allocation is that:

1) Each document can be represented by a distribution of topics.
2) Each topic can be described by a distribution of words.

The first step is to select the number of topics to be discovered and then once the number of topics has been selected, LDA will go through every word and randomly assign the word to

one of the selected numbers of topics. After this step, we will have a non-optimal distribution of words in each topic as well as the documents represented in terms of topics, as stated in the 2 points mentioned above. Since this is not yet optimal, to better this representation LDA will analyze per document the percentage of words within the document that were assigned to a particular topic. For each word in the document, LDA will analyze over all the documents, the percentage of times that particular word has been assigned to a particular topic. The algorithm will then go through each word in the document and calculate 2 probabilities:

1) $p(topict \mid documentd)$ = probability of words and that are assigned to t.
2) $p(wordw \mid topict)$ = probability of new assignments to t over all documents that come from the given word w.

After the above steps are repeated over multiple iterations, a "steady" state will be reached, where topic assignments are good.

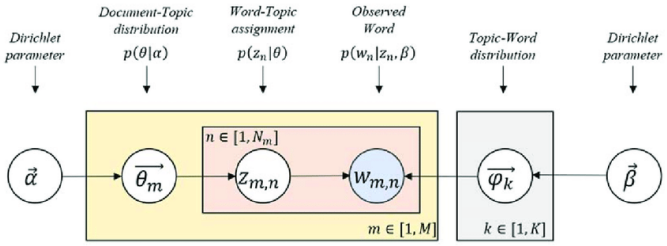

Fig. 2. Graphical representation of latent Dirichlet allocation proposed by [4]

We use LDA to explain the observed topics by using a latent component.

B. SVM

SVM is a supervised machine learning algorithm for regression and classification problems. SVMs objective is to find a hyperplane that best divides a data points into their respective classes. The equation of the hyperplane is given by:

$$f(x) = x^{'}\beta + b = 0$$

where $\beta \in R^d$ and $b \in \mathbb{R}$. The minimization problem is formulated by finding β and b that minimize $||\beta||$ such that for all data points (x_j, y_j):

$$y_j f(x_j) \geq 1$$

The support vectors are the data points that are the closest to the hyperplane as shown in the image below:

VI. Results and Discussion

In this section, we present the results of predicting the category of a new headline by using content-based features. In figure 4, we present our results for our SVM model and in figure 5 we present our results for our LDA model. For our LDA model, target classes are translated as follows: 1 - College, 2 - Comedy, 3 - Taste, 4 - Environment.

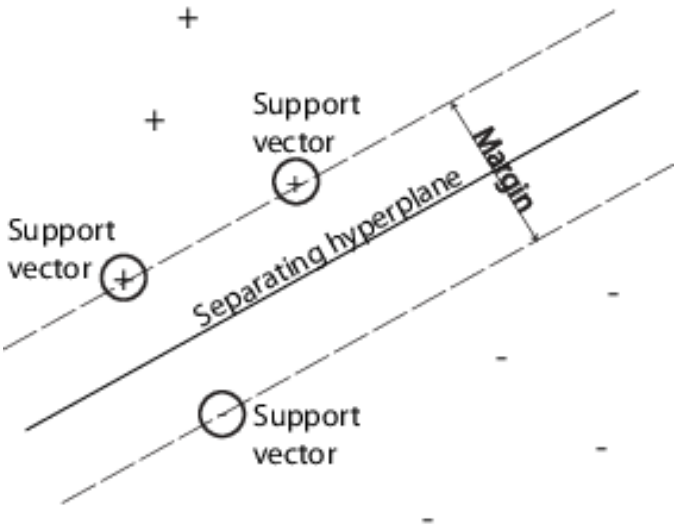

Fig. 3. Graphical representation of support vector machine

A. Classification

In this section, we will present the results of the classification algorithms.

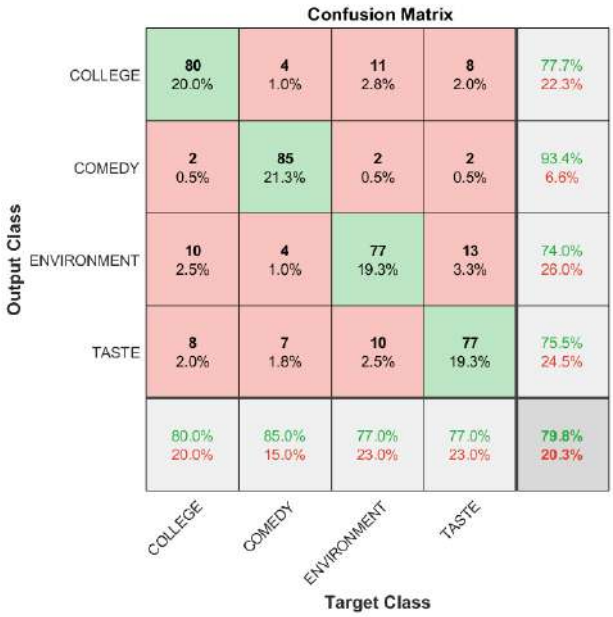

Fig. 4. Confusion matrix illustration the SVM model on a set of test data. The SVM model achieves 79.8% accuracy with 319 correctly classified instances

We note that the SVM model outperformed the LDA model by a large margin. LDA could have performed poorly due to the short length of the headlines. We also note that the SVM model predicts each news headline in constant time. On average it takes 0.0029s to predict the category of a news headline.

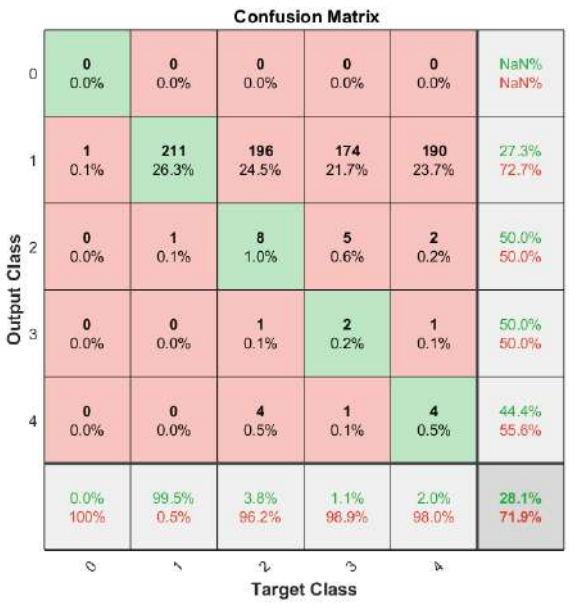

Fig. 5. Confusion matrix illustration the LDA model on a set of test data. The LDA model achieves 28.1% accuracy with 225 correctly classified instances

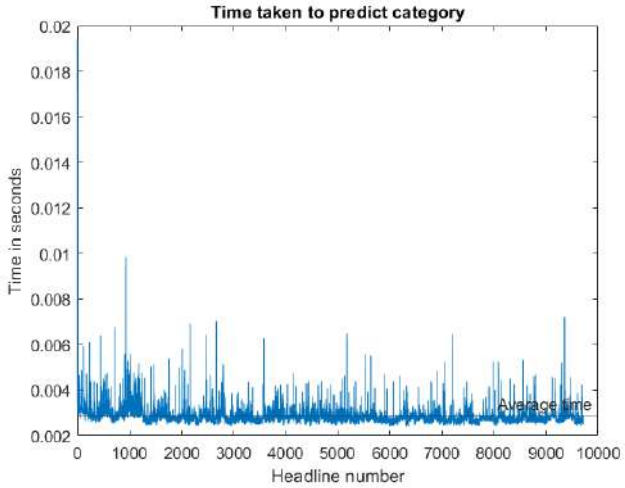

Fig. 6. Time it takes to predict respective categories across 9000 news headlines.

Although LDA achieved a low accuracy score, it can organize headlines into different categories based on just the content of the headline as well as make predictions. The LDA model allows multiple topics for each document, by showing the probability of each topic. An example of this is shown in figure 7.

LDA is suitable when the categories of the headlines are not known, i.e, only the headlines are given. However, this method would require manual observation to label each of the clusters generated by the model.

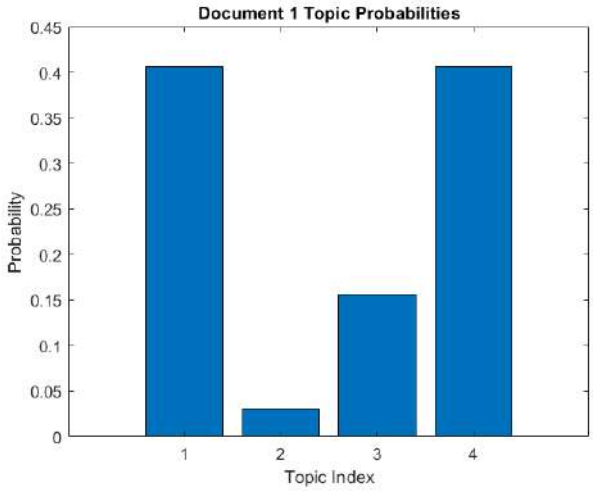

Fig. 7. Distribution of topics for document 1. Topic 1 and topic 4 have an equal probability while topic 2 has the lowest probability.

VII. Conclusion

We note that the current library classification methodologies, like the Dewey Decimal system, are becoming inefficient as the number of books increases. In this paper, we provided a content based classifier to organize books to significantly improve retrieval time. We implemented LDA as well as a multi-class support vector machine ECOC model. The support vector machine is the best performing model achieving an accuracy of 79.8%, while LDA achieved an accuracy of 28.1%. LDA's relatively poor accuracy performance could be attributed to the length of the headline being short, resulting in a low degree of separation among the 4 classes. For future work, we suggest introducing some form of hierarchy in the implementation of LDA results in an improvement of the quality of topics generated. [11] is also an example of this.

In section 1, a high-level overview of the problem domain, as well as the aim of this paper is stated. In section 2, a brief, high level, overview of the Dewey decimal system is given. In section 3, related work, as well as the results found in research papers related to the proposed research question was discussed in-depth and how those solutions could potentially solve the proposed question in this paper. In section 4, the methodology used is given as well as the steps taken to preprocess our dataset. In section 5, a brief description of the models used is given. Finally, in section 6 we present our results.

VIII. Acknowledgement

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Challenges and strategies for effective Stress Management in the New Normal - An empirical study

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***Abstract*— Stress, as a concept, isn't something new but the new normal has changed the way it was perceived earlier. With the sudden arrival of COVID-19, lockdowns were imposed all over the world which led to the creation of an atmosphere of anxiety and confusion in the day-to-day lives of individuals. This necessitated the need for stress management in greater intensity than earlier. At the initial stages of lockdown, an immense sense of urgency was evident. People were stressed about the uncertainty that prevailed at that time. All the segments of society were hit drastically by the so-called pandemic. The education sector was no exception. Regular activities of education had to be suspended temporarily. Eventually, the activities of teaching-learning had to be switched over to the online mode of education to ensure its continuity. As soon as the online mode of education became regular, it was noticed that it came with its own set of pros and cons. On one hand, this mode facilitated ease of learning while on the other hand, it led to students and teachers facing stress quite often. This study aims to look into all those dimensions which are influenced by psycho-neurotic disorders such as stress and also try to address how such conditions can be managed with efficacy, thus, maintaining the balance of life.**

Keywords*— *New normal, Psycho-neurotic disorders, Perception, Online education, Lifestyle Adjustment, Stress, Stress management

I. INTRODUCTION

A. A New Normal in the education sector

When the Covid-19 pandemic struck, it derailed the entire education system. Schools and colleges had to be shut, bringing the conventional model of education to a halt. For a knowledge-obsessed society, the uncertainty was too much to bear. Students and parents were forced to adapt to a new normal of an online education system. This new normal came with its own advantages and disadvantages. It provided students a platform to learn at ease while it also presented a challenge to faculties to upscale their technical skills to teach students online. Kerala became the first state in the country to shift public education to online platform in the new normal.

With the new normal coming in, B-schools have also ushered in a great many changes in their methodologies of teaching and learning. A paradigm shift in skills of managing strategy and innovation, managing tools and technology and interpersonal management in the new normal necessitated the implementation of a robust online education system by B-schools.

B. Stress

Situations That Release Emergency Signals Or Stimuli

Stress can be defined as a reaction of body due to change in the emotional, physical, psychological strains which reduces one's power to cope any situation and results to pressure that is unmanageable.

C. Stress Management

Stress management is a psychological technique aimed at controlling an individual's level of stress.

Stress is of two types-

- Positive Stress
- Negative Stress

The positive stress results in helpful consequences which are known as Eustress whereas the negative stress affects the individual's body, mind and career in future which are known as Distress.

It is very difficult to handle the negative stress. So a proper stress management approach is very essential which provides variety of ways to manage anxiety and maintain a balance in life.

II. OBJECTIVES

A. Primary objectives

1) To do an extensive research on the impact of COVID 19 on the Education sector.
2) To identify and address the issue of stress related problems, source of such problems and devising necessary coping strategies in the New Normal.

B. Secondary Objectives:

1) To find out the level and kind of stress among students and teachers alike in the COVID 19 era.
2) To analyze the symptoms and consequences of stress.
3) To understand and analyze the transition in the mindset of individuals pertaining to the handling of stress post/after COVID-19's arrival.
4) To interpret the findings of our research on the aspect of stress management.
5) To suggest recommendations and corrective measures to overcome stress in the New Normal.

III. LITERATURE REVIEW

In order to understand the impact of stressors in the new normal, we tried to look into previous literary works to generate a fresh insight and expand our knowledge of stress management in the present scenario. Accordingly, we noted the following:
Jamal.M in his study finds the stressors related to job, the employee's psychosomatic problems, absenteeism, dissatisfaction etc. The relationship between the stress and its outcome was set by an important moderator after the Type A behaviour was found.

Hans Selye, one of the Founding Fathers of stress research, in his 1956's report says that "stress is not necessarily something bad- it all depends on how you take it." He believed that the physical and psychological effects will be experienced regarding the nature of issue was positive or negative.
Building upon the work of Hans Selye, we further tried to analyze the impact of psychosomatic stressors by categorizing it into two categories- stress management in the pre-COVID period and stress management in the post-COVID period.
Studies show that prevalence of stressors prior to COVID's arrival was still on the rise and therapeutic intervention was still need of the hour to tackle depression, anxiety and other neurotic disorders. With the arrival of COVID onto the scene, these numbers increased significantly and it led to creation of an atmosphere of gloom and doom with conditions like social stigmatization further isolating mentally-turbulent individuals from the society, thus, drastically contributing to the fall of their mental health.
Studies also suggest that some stressors that have evolved during pandemic outbreaks have long-lasting effects (Brooks, 2020). It means that they remain even after the disappearance of this pandemic. At the time of writing this paper, COVID-19 is still present. Thus, it is not possible to accurately identify its effects on individuals' mental health after its disappearance. However, if we build on recent literature related to COVID-19, literature related to previous pandemics and epidemics such as SARS, some predictions can be made concerning the potential stressors post COVID-19 which may have a negative impact on employees' mental health. In this case, besides posttraumatic stress disorder related to the recovery from a life threatening physical illness (Wu, 2005), it seems that stigma, financial loss and job insecurity may have a long-lasting effect after COVID-19.
It appears, according to the study of Siu (2008), that stigma persists in the post SARS era. The author argued that SARS victims were still experiencing stigmatization up to four years after the SARS outbreak, which maintained their social isolation, increased their level of stress and worsened their mental health. Participants have reported that they have encountered stigmatization and isolation in their

workplace after SARS, from their colleagues and even from their employers.

Prior to the new normal, educational stress was still relevant. A great influence of such kind of stress would be on school going children who would be under constant pressure to perform and excel in studies. The excess baggage would cumulatively lead to stress of acute to chronic level among students.

As the status-quo stands right now, the educational stress is assumed to be greatly impacted in the times to come. With the ongoing need of new educational practices and technological innovation, it will be very interesting to see how the entire system pans out in coping stress in the near future.

IV. ANALYSIS

A. Sources of stress

1) Online classes

In the post-COVID situation virtual classes have become the new norm. Depression, anxiety and confusion about the online academics have led both teachers and students to chaos.

A great chunk of the time during online classes is spent in asking students if they could hear or not. Teachers have to assume that the students are hearing their lectures.

On the other side, due to long class hours and minimum breaks, students feel demotivated and irritated.

2) Lack of control

Teachers can't always keep an eye on every students and understand whether they are concentrating or not. This leads to dissatisfaction among the teachers and they feel stressed to handle this situation.

3) Limited feedback

Due to online classes the students can't always communicate their problems on a certain topic. This limitation in feedback makes the students confused.

4) College Competition and tendency to cheat

In online exams there is a great tendency to cheat. This leads to honest students doubting their capabilities.

5) Social Media (push notifications)

During online classes continuous notification from the apps and social media sites leads to distraction. Students ultimately learn nothing which leads to stress.

B. Factors of stress

1) The new normal impacting students with disabilities

The online education system in the new normal has immensely impacted students with disabilities. Learning disabilities fall under the category of learning and attention issues, which include a range of disabilities and disorders like dyslexia, dyscalculia, attention deficit hyperactivity disorder (ADHD), and executive functioning issues. Such issues become way more crucial when it comes to online education as students with learning disabilities may not be able to fully comprehend what they are taught online. This can be very stressful to such students.

2) Psychological factors

Sitting for long hours in front of computers and mobiles to attend and conduct online classes can be very frustrating for students and teachers alike. In addition to this, it has also been noticed that many teachers are in constant fear of job loss as they find it difficult to upgrade themselves technically to adapt to new teaching methodologies of online education platform.

3) Lack of technical knowledge and accessibility

Current conditions of formal educational systems can be described using Philip Strong's (1990) model of epidemic psychology consisting of three consecutive and overlapping epidemics: those of fear, explanation, and action. Lack of technical knowledge makes it very difficult for some teachers to educate their students online as this new way of teaching is relatively new to them.

Accessibility to devices and internet services is also one of the contributing factors to stress caused by the new normal. In a recent survey of 733 students studying in government schools in Bihar, only 28% of the girls had smartphones in their homes, in contrast to 36% of the boys. These smartphones almost always belonged to male adults, often being

lesser accessible to girls than boys, and half of these families could not afford internet data packages. Therefore, lessons aired on television were the main option for a majority of the students participating in this survey.

4) Limited options to play and exercise

The arrival of COVID-19 ensured that people stay indoors for most of the time during lockdowns all over the world. They were very limited options to exercise our motor skills. The students were also impacted by this as they couldn't get ample space to play at homes. Such circumstances made sure children pursue less physical activity and sat more.

5) Disruption of life at home and 24*7 work overload

The new normal saw the rise of work from home culture on an unprecedented scale. The education sector was also impacted by this new culture where teachers would teach and students would learn from their homes respectively. This resulted to creation of cubicles at homes which ultimately disrupted the ambience and life at home. The pressure of meeting ever increasing work demands became overwhelming ultimately.

C. Levels and kinds of stress

Level-1: Acute stress Acute stress is an intense, troublesome and dysfunctional reaction which occurs due to a traumatic event and lasts less than a month. If symptoms last more than a month, people are diagnosed as Post-traumatic Stress Disorder (PTSD).

Level-2: Episodic stress If a person experiences acute stress frequently then he is diagnosed to have Episodic Stress. This happens to those persons who think too much and have both personal and professional stress. This results to aggressive and irritable behavior.

Level-3: Chronic stress Chronic stress is a continuous feeling of stress that negatively affects one's health if it goes untreated or neglected. It can occur due to regular pressures of personal nature and that of work-life or by any traumatic experience as such.

D. Symptoms and consequences of stress

As mentioned earlier, stress occurs due to external event's reaction and makes a transition in the general behavioral pattern.

It is a prime factor to know when one's stress level goes out of control.

Stress not only affects the behaviour of an individual but also affects the body, mind and sometimes one's career also gets endangered.

Stress is a very subjective issue. Different people experience it differently.

In this COVID situation, due to lockdown stress has evolved like a fever in every individual's life. The massive upgradation to new normal also failed to lessen the stress of human in general. The whole education system has adopted the online mode of education, which has created a stressful troublesome situation for both teachers and student.

Due to the presence of stress, the kinds of inconveniences have been divided into four parts:

1. Physical
- Fatigue
- Reduce Life Expectancy
- Headaches
- Heart palpitations
- Gastrointestinal Upset

2. Psychological
- Depression
- Anxiety
- Autism
- Discouragement
- Cognitive Difficulties

3. Behavioural
- Aggression
- Mood swings
- Irritability

4. Career-related
- Job Retention
- Bad Performance
- Fear of not getting a Job

E. Perception of individuals about stress management prior to the new normal

In a country like India, stress management has always been a very poorly addressed issue. As far as the general mindset of the people is concerned, it is assumed that the treatment of stress management as a disciplinary study is totally uncalled for. Consequently, people shy away from seeking medical help in the fear of being called 'mentally unstable'.

As per a study, 89% of Indian people suffer from conditions of stress, depression and other such neurotic ailments. Cases of such conditions skyrocketed during the lockdown when people were compelled to stay indoors and didn't have much to do.

F. Transition in the mindset of individuals regarding stress handling after the arrival of COVID-19

With the arrival of COVID-19, lockdowns were imposed all over the world. People were restricted to their homes and were allowed to function in highly controlled surroundings of their homes. Cases of neuro-psychological disorders took a leap in numbers and people were forced to see the impact of such ailments. With job losses on the rise, suicidal tendencies in individuals became a common sight for psychologists. Metropolitan cities saw the highest number of such cases where people tried committing suicide due to financial losses. As per a report, in the city of Noida only, a total of 195 people died of suicide in the first five months of lockdown.

Dr. Ramchandra Guha highlights that lack of social security is at the core of these problems.

Apparently, people started treating neurotic ailments more seriously in the new normal. Their attitude regarding stress handling has changed drastically since then. Although it will take a great chunk of time for our society to be fully aware of psychological disorders as such, the transition in the mindset of people when it comes to taking such disorders seriously has been revolutionary so far.

V. RESEARCH METHODOLOGY

A. Approaches:

Descriptive Approach is one of the most popular approaches these days in which a problem is described by using a well-structured Questionnaire to explore new areas of investigation.

B. Research Design:

A well-structured Questionnaire is framed in Google Forms.

C. Data Sources:

Here both Primary and Secondary Data are used.

Primary Data – Interactions, Observations, Survey Questionnaires and Online Google Forms.

Secondary Data – Annual Report, Website, Articles, Records.

D. Data Collection Method:

Survey Method through Google Forms

E. Sample Type:

The sample type is non-probability sampling which involves deliberating selection of particular units constituting a sample, which represents the universe.

F. Sampling Technique:

We have applied Stratified sampling technique in this study. In this method, the population is first divided into subgroups (or strata) who all share a similar characteristic. The participants included, have been divided into three strata, which encompass- teachers, school students and college students.

G. *Research Tools:*

Multiple Choice Questions

H. Statistical Methods Used:

Quantitative Analysis

I. Statistical Tools Used:

Microsoft Excel and Graphs (Column & Bar)

J. Sample Size:

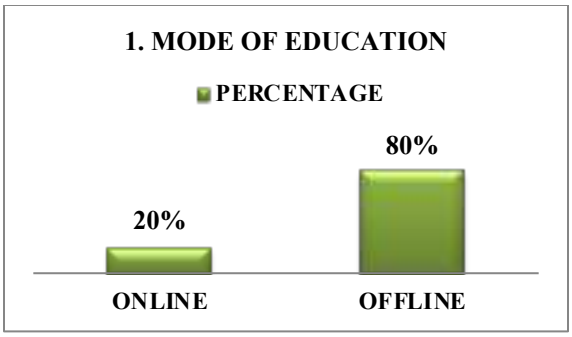
The Sample size that has been chosen for the study is 300 individuals (including Teachers and Students)

Participants	*Number of Respondents*	*Percentage*
Teachers	93	31%
School Students	60	20%
College Students	147	49%
Total	300	100%

VI. DATA ANALYSIS AND INTERPRETATION

1. Preferred mode of education:

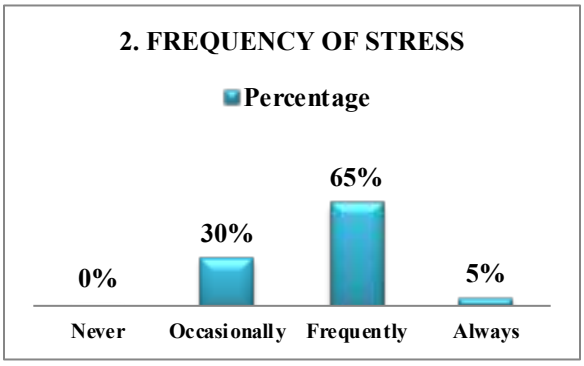
Participants	*Number of Respondents*	*Percentage*
Online	60	20%
Offline	240	80%
Total	300	100%



Interpretation:
As far as the mode of education is concerned, 80% of the participants preferred offline education to classes on online mode while the rest found online education to be more satisfying.

2. Frequency of stress faced by the participants due to the post lockdown new normal education system:

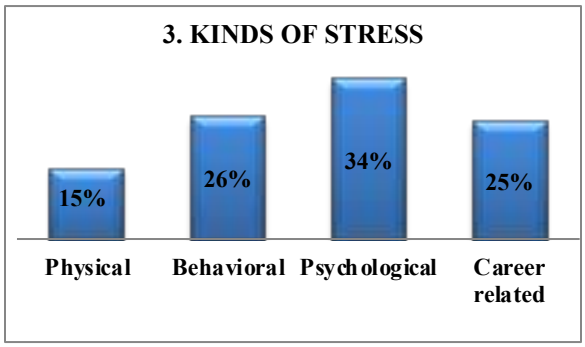
Frequency of stress	*Number of Respondents*	*Percentage*
Never	0	0%
Occasionally	90	30%
Frequently	195	65%
Always	15	5%
Total	300	100%



Interpretation:
When the participants were enquired if they found the new normal education system stressful, it was found that 65% of them found it stressful quite frequently, 30% of them were occasionally disturbed by this while 5% of them reported to be stressed all the time on account of the new normal education.

3. Factor analysis of the kinds of stress:

Kinds of stress	*Number of Respondents*	*Percentage*
Physical	45	15%
Behavioral	78	26%
Psychological	102	34%
Career related	75	25%
Total	300	100%



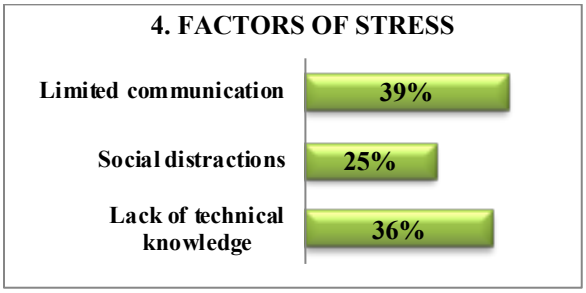
Descriptive statistical summary for kinds of stress			
Number of Respondents		*Percentage*	
Mean	120	Mean	0.4
Standard Error	45.901	Standard Error	0.15
Median	78	Median	0.26
Mode	102	Mode	34
Standard Deviation	102.637	Standard Deviation	0.342
Sample Variance	10534.5	Sample Variance	0.117

Interpretation:
On analyzing the kinds of stress, we found that 102 individuals (the highest frequency out of all the respondents) out of 300 participants identified psychological stress as the most affective kind of stress. Further, we have obtained a descriptive statistical summary report for better understanding.

Descriptive statistical summary for Psychological stress			
According to the Ratings		No. of Respondents	
Mean	3	Mean	20.4
Standard Error	0.707	Standard Error	8.121
Median	3	Median	17
Mode	4	Mode	49
Standard Deviation	1.581	Standard Deviation	18.16

4. Factors of stress affecting respondent:

Factors of stress	*Number of Respondents*	*Percentage*
Lack of technical knowledge	108	36%
Social distractions	75	25%
Limited communication	117	39%
Total	300	100%



Interpretation:
When asked about the factors causing stress in the new normal, 39% of the participants cited lack of proper communication and feedback as the primary source of stress to them while 36% and 25% of them were stressed by lack of technical knowledge and social distractions respectively. So, it is evidently clear that lack of proper communication channels serves as a barrier to effective communication and hence, contributes to stress.

5. The most effective coping strategies of stress management:

Coping strategies of stress management	*Number of Respondents*	*Percentage*
Upscaling of technical knowledge	27	9%
Meditation and yoga	66	22%
Proper feedback mechanism	81	27%
Lifestyle adjustment	66	22%
Time management	45	15%
Counseling	15	5%
Total	300	100%

Interpretation:
When the respondents were asked about the coping strategies that they would like to adopt to battle stress and associated neurotic disorders, it was found that 27% of the participating populace found proper feedback mechanism as the most effective way of tackling stress, lifestyle adjustment and yogic and meditative activities tied at 22% as effective stress-relievers.
Furthermore, 15% of them cited time management as a productive tool to combat stress while 9% and 5% of them were convinced that counseling and upscaling of technical skills and knowledge could be more efficacious in tackling psycho-neurotic conditions respectively. It turns out that coping strategies like robust feedback mechanism, meditation, life adjustment etc., are the most effective techniques of stress management.

VII. FINDINGS

Through this research paper, we have come to know that all the strata of the sample have been impacted by psychosomatic disorders in which the young adults feel anxiety even more intently.

Stress of all kinds including – physical, behavioral, psychological and career related are prevailing in abundance especially in the new normal. This paves a path for effective usage of various coping strategies to tackle such neurotic ailments.

VIII.RECOMMENDATIONS

In purview of the impact caused by neurotic disorders, following coping strategies are recommended.

A. Personal strategies

1) Upscaling of technical knowledge:

Teachers and students who aren't tech-savvy and face a hard time operating devices during online classes, need to upgrade themselves with the necessary technical skills so as to avoid any nervousness that may be caused by their lack of knowledge.

2) Lifestyle adjustment:

With the new normal coming in, it has been noticed that our lifestyles have changed drastically. This has paved a path for bad habits to creep in our lifestyles which can only be avoided if we adjust our lifestyles accordingly and follow healthy living patterns.

3) Meditation and yoga:

The good old practices of yogic activities and meditation can go a long way in handling stress aptly. Spending a mere span of half an hour daily doing yogic asanas and doing periodic meditative activities while working can also benefit students and teachers alike in tackling neuroticism.

4) Getting ample amount of sleep and spending time with near and dear ones could also help one in overcoming stress.

5) Acoustic relaxation:

Music can be used as a relaxation therapy in stress management. It can help an individual channelize his feelings of nervousness and stress into a productive and hopeful state of being.

B. Organizational strategies

1) Role redesigning:

In order to ensure highest participation from students and best productive efforts from teachers in class, the educational institutions need to re-define their roles in the new-age education system in the new normal which demands a great deal of creativity to ensure its effectiveness. Thus, re-designing tasks and roles accordingly is the need of the hour to avoid any psychologically bad experience which may happen otherwise.

2) Upgrading recreational facilities with respect to latest educational demands and needs:

As basic recreational activities such as playing and other such tasks can no longer be performed staying indoors, it's mandated that educational organizations include recreational activities which can be performed online which may involve holding hosting playful events on platforms such as zoom, g-meet etc. Virtual meet ups can also be very helpful in ensuring effective communication among participants which can help manage stress effectively.

3) Counseling:

Institutes need to organize counseling sessions at times to check the level of mental stability of educationists as well as young learners and advice them on how to take care of their mental wellness in these tough times.

4) Proper feedback mechanism:

For any educative endeavour to be conducted and run smoothly, proper communication is most needed. If students couldn't follow what's being taught in classes, all the efforts of teachers would turn futile. Thus, effective channels of communication and feedback must be in synchronization to facilitate smooth conduct of educational processes of teaching and learning in the new normal so as to avoid any communication gap which may prove to mentally harassing if not addressed properly.

5) Training and development programmes:

These programmes can play a big role in helping teachers in handling students, thus, making sure that their growth and development are taken care of. Sessional T&D events can be hosted through webinars to train educationists in the new normal.

IX. CONCLUSION

Stress has evolved like the black plague. The effect of the New Normal in Education sector has changed the definition of education which is not only troublesome for the students but also for the teachers. It creates a huge gap between the expectation and experience. Most of the students as well as the teachers are suffering from stress on account of the new status-quo brought about by the new normal. This transition in education sector has changed the

mindset of both teachers and students regarding stress management.

COVID-19 has taken a toll on the mental health of individuals. An unprecedented and precarious state of being has been introduced to us which lies in conformity with the ever changing world of the new age education system. The post COVID educational style of teaching-learning is marked by its characteristic creativity and ease but it also has many challenges to it as well, which eventually become a source of wary to educationists as well as the young learners."Educational stress" thus evolves as its byproduct. However, stress of this kind can be dealt with proper coping strategies which have been mentioned in this study. Conclusively, it can be noted that even though neurotic disorders, caused by the transitions brought about by the new normal, are troubling to the society as a whole but we still can lead a happy and healthy lifestyle with proper stress management.

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A Systematic Literature Review on the Use of Facial recognition in Human Resources using Deep learning

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***Abstract*- In the era of Artificial Intelligence, Human Resource Analytics is growing at a significant pace and it will even grow faster. Face recognition has become a very integral part of various domains which include the recruitment industry. Starting from surveillance to identity recognition to sentimental analysis it has proved to have a wide impact. However, this paper has taken a deep dive into the advancement of facial recognition in the field of Human resources based on the deep learning approach. Firstly, it explains the basic application of facial recognition and the idea of the deep learning model, and how it is evolving. Then the various research applications are summarized such as the method of facial recognition based on CNN (convolutional neural network), video monitoring facial recognition model and a literature review has been done to present the available models which are currently used by a different recruitment agency to better analyse candidates' state of mind, detect the patterns in their responses to have better perform suitability analysis with the help of psycholinguistics. The paper also attempts to analyse the limitations of the current available deep learning models concentrated on facial recognition and specifically used in the field of Human Resources. Finally, there are proposed ideas for further research and development in better sentimental analysis, candidate profiling, personality analysis using a deep learning model.**

Keywords—HR Analytics, Deep learning, Face Recognition, Convolutional neural network(CNN), Principal Component Analysis (PCA), Linear Discriminant Analysis),Artificial Neural Network (ANN), Sentimental Analysis, Recruitment.

Abbreviations and Acronyms

CNN	Convolution Neural Network
LDA	Linear Discriminant Analysis
LPP	Locality Preserving Projection
RNN	Recurrent Neural Network
ASM	Active shape model
PCA	Principal component analysis
LSTM	Long short-term memory
AAM	Active appearance models
CFAN	Coarse to fine auto encoders network
TBI	Teleview Behavioral Insights
NLP	Natural Language Processing
LFW	Labeled Face in the Wild

INTRODUCTION

Introduction of Face Recognition Methodologies

There exists different kind of face recognition techniques. Based on their methodologies they can be categorized to either local or global. Some of them are Active Shape Model, Active Appearance Models. These models are considered relatively traditional. Along with the use of local descriptor Gabor, Binary Pattern etc , there are also global methods such as LDA (Linear Discriminant Analysis) or classic facial recognition method such as EigenFace method and LPP (Locality Preserving Projection) algorithms which are widely used(Wu,2015,pp234-241).

Though three-dimensional facial recognition is considered to be the next big thing with wide applications, traditional face recognition methods have their respective limitations because there are various important factors to be considered such as attitude, sentiment, occlusion and most importantly huge amount of data. The learning algorithm causes direct computation of the original image to properly learn the discriminatory features of the face in the framework of deep learning. Face recognition based on deep learning has achieved far more than human when it comes to speed and precision with the help of massive amount of face data.

DEEP LEARNING MODELS FOR FACE RECOGNITION

Deep learning models are equipped with graphics processors (GPU) which has in-built computing power to handle large data analysis and the accuracy level which can be achieved are capable enough to exceed the human intelligence(Cao,2012, pp.2887–2894) .

The Lenny Miller Research Group (Kalenichenko,2010,pp-815-823) first started the successful application of the deep learning in the field of face recognition of the Labeled Face in the Wild (LFW) database.

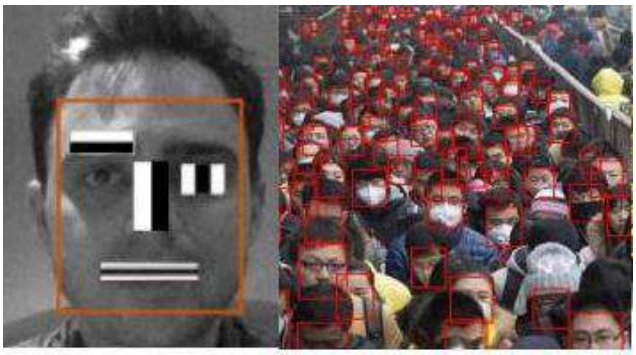

Figure: 1: Improving facial recognition using deep learning models

Along with deep learning open-source projects available in Github, extensive developer's communities are present for help regarding research. Facebook 's AI Lab , Google's famous team of Groffrey Hinton and Caffe has a highly sophisticated deep learning framework for the DeepDream project (You et al,2016, 4651-4659) .In 2016, system parameters have been published with huge impact on the deep learning research after Google's Tensorflow. There exists many open source frameworks for deep learning such as deep learn Tool-box, Torch7, deep learning 4.1, MXNET, Theano, ConvNetJs, Brainstorm, Neon which ensures high level research to dive deep into deep learning algorithms

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A. Detailed modeling of face pose based on deep learning

Face recognition technology applied in controlled conditions and semi-controllable conditions are only mature . In non-control conditions, the popularity rate isn't adequate due to posture, expression, age, and occlusion etc. Attitude change is a significantly complex nonlinear change which can only be detected by 3D models. A combination of shallow neural networks can be modelled very efficiently to create a deep neural network, which can achieve effective image transformation. Once all the angles in dynamic view can be presented and their movements can be tracked, that can provide a very elegant solution.

B.Nonlinear face shape extraction method in Deep Learning

Facial feature plays significant role in facial recognition or face animation synthesis process. Different parameters such as gestures, light, occlusion, expressions etc. are important in face alignment. In general for face alignment classical methods such as ASM (Active shape model) and AAM (Active appearance models) (Alahi et al., 2012) are considered. These methods mostly use Linear Principal component analysis (PCA) techniques in order to model changes in texture or shape and to model parameters to be perfectly fit into the image. But in case of complex face shape or large posture or even exaggerated expression or serious change in light these models provide poor results. The solution is to predict the part of the shape and to do it effectively Coarse-to-fine auto encoders network or CFAN is used which has the ability to cascade the multiple non-linear regression models by implementing the stack self-coding networks. Therefore, the deep learning method does a sophisticated job in predicting face shape and face restructuring to get geometric structure information

LITERATURE REVIEW

Sentimental analysis (Cao,2012)of a candidate can be done in different ways while the person is presenting any topic in front of a group of people or answering questions in the interview.

While speaking, certain muscles of the human face changes which leads to create various micro expressions continuously. With the right analysis these the behavior can be predicted in real time. Recent research applications showed that with the study of these micro-expressions it is possible to predict whether that person is about to do shoplifting or not. The AI algorithm which was used is called LSTM (Long short-term memory), it is basically an artificial recurrent neural network (RNN) architecture (Harwell ,2019) used in the field of deep learning, it is definitely a very strong and powerful structural form to make efficient prediction base on time series data. Famous shoplifting stopping model, "VAAKEYE" (Ming Wang,2019) was trained with more than 100 thousand hours of video data set, and use more than 100 features, such as the face, the clothing, and the pattern of moving pattern, in order to predict the possibility of customers making shoplifting. In the year 2018, VAAKEYE successfully caught a pickpocket in Yokohama, and the news was broadcast by NHK nationwide. In recruitment industry, many consultancy firms in the USA outsourced their data to companies who instruct the candidates to upload their video resumes to a drive and send. The recent trend also includes most Universities of the USA and Europe asking their applicants to send video resume (Metaview team ,2020) while applying. Now so far these video resumes help the selectors to know briefly about the candidates' personality, body language, likability, etc. But, with the help of deep learning models it will be possible to conduct precise analysis of candidates psychological profile in real time (Dominique Simmons ,2017) such as their mood, confidence level while answering, whether they are inclined to tell the truth or lie. There are many companies who have developed the primary base of this type of software and currently working continuously to make sure they can avoid the bias and come up with a better accuracy level(Opatha,2020). In order to get more accuracy, the researchers have shifted from Machine Learning algorithms to Deep Learning algorithms. This paper concentrates on the recruiting companies, their models and their area of improvements. Companies such as Talview (HRTech &AI ,2020) conducts AI interviews via extremely efficient native apps which is available both in iOS and Android platform. Candidates have the option to attend the interview from their smartphones or their ipad or any iOS device and the facility takes low internet bandwidth usage. Talview's product is available in various languages which actually help candidates to choose their preferred language during interview and it helps the company to achieve a broad level of consumer base globally. The most unique feature is the TBI (HRTech &AI ,2020) (Talview Behavioural Insights) Engine, which was initially developed by organizational psychologists who were responsible for creating development guides, interview questionnaires and suitability reports. Talview Behavioural Insights (TBI) (HRTech &AI ,2020) is the

world's first hiring cognitive technology that has successfully used psycholinguistics(Chen B,2011) NLP (Natural Language Processing) , tone analysis.This procedure's efficiency eliminates the requirement of additional behavioural assessment. Because the engine analyses the subtext of any written interview or video and most importantly it has the ability to see through fake responses. With the help of its self -learning capabilities, the system knows when to calibrate the reporting as per the requirements of the organization or even any specific small segment within an organization.

Figure:2 : AI analysing candidate's face expression during interviews(Manokha,2019)

In USA, there are recruiting companies such as HireVue (hirevue,2020),harver(harver.com,2020)Modernhire(modernhire.com, 2019) are using emotion detection and even drowsiness detection technologies.

AI is making sophisticated analysis from candidate's face structure and voice intonation from their video interview clip. Currently more than 700 companies , including Facebook, Vodafone, Hilton, even Urban outfitters (Manokha ,2019) are using the same process for their hiring .

HireVue (hirevue,2020) currently has more than 200 clients—including Nike, Starbucks, and Walmart, the payment is dependent upon the project volume, between $5,000 and $1 million.

Technology which they have used also involve Relu and Softmax activation and the model is quite accurate, haar cascade files (Neelie ,2020)for face and eye detection are used in general.

Technology developed and used by Metaview (Metaview team, 2020) basically analyse the recordings of job interviews in real time and provides insights for organizations to make better hiring decisions quickly.

The interview insights can help organizations understand how effective your interviewers are and how to improve the process (Manokha, 2019). In terms of insights, you can, for instance, consider the information about the most commonly asked questions by candidates and even that can be used as effective classifier (Modernhire, 2020) at times while doing suitability analysis.

COMPARATIVE ANALYSIS

Table-I Critical Analysis of different models

MODEL NAME	LFW PERCENTAGE	AREA OF IMPROVEMENT
ArcFace,2018	99.83%	Verification rate close to 100% but poor annotation, noise , image quality
SphereFace ,2017	99.42%	
FaceNet,2015	99.63%	
DeepFace ,2014	97.35%	Accuracy loss in case of low-resolution, make up, cross-pose
PCANet,2015	86.28%	Failed in case of Non-linear structure of face.

Source: Self compiled from literature.

As shown in Table-I, MegaFace models have severe challenges. Although MegaFace has verification rate close to 100% but the identification rate is still low around 82%. In most cases serious improvements are needed regarding pose, illumination, occlusion and pose. In DeepFace , the verification accuracy has increased and surpassed the human level but still needs focus on research front, especially on Deep learning methods using CNNs but the high computational costs are to be checked and further research are to be made to make it cost effective and make it efficient in situations which involves cross-pose or age , low resolution, makeups, spoofing etc.

CONCLUSION

Major findings as conclusion are:

1. Verification accuracy can be increased with the use of deep learning models.
2. Using deep learning models instead of machine learning models can save number of psychological interview rounds.
3. Training data similar to successful candidate data are not to be used to avoid homogeneity bias.
4. Any sorts of discrimination bias in the model are to be consciously monitored and removed by increasing the model's accuracy.

LIMITATIONS

There are various limitations which have been mentioned in table-II. While the paper provided detailed overview of how things work and the industry leaders and their existing tools. There are concerns about their biases and accuracy. Finding the right candidate and analysing their behaviour during interview is extremely complex. Many industry experts suggested that deep learning has showed improved and better result compared to machine learning models the

accuracy level must need a major upgrade. Since deep learning models deals with significantly more data to take decisions, certain bias can be removed as a result of it. But the concern remains due to models lack of common sense. Inaccurate judgement of expressions can result in issues such as gender or race bias. This happens when the models came to decisions based on the available data. Due to the enormous scale, mistake of deep learning models can be pricy and irreversible.

Even for a sophisticated model representation of an image may not end up being robust if the face is complex nonlinear in nature. If these factors are not taken into consideration soon it may leave employers with serious potential risk under anti-discrimination laws.

The main reason is the trained data used in these models is based on similar type of the data of successfully selected candidates and that leaves homogeneity in hired candidates. This bias can be towards gender, race or even certain body types, the model may end up misread the candidates' physical and verbal cues and it may cause individuals to be rejected.

In order to avoid these legal issues , employers are to be consult legal help and to avoid any privacy related issue the candidate's proper briefing is necessary.

WAY FORWARD

Further research may probe the reliability of these models and it is important that the candidates appearing for the interview has complete understanding about how they will be evaluated via AI and what are the assessing parameters. Candidate's consent and privacy issues to be taken care of and while selecting training data for the existing deep learning models it is to be selected in a way to ensure there are no selection bias especially involving any gender , race etc. Further research on facial recognition accuracy in case of non-linear face shape extraction, facial recognition in live feed , better analysis of micro expression are very much encouraged.

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Essentials of Abstracting and Indexing For Research Paper Writing

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***Abstract*— "One of the earliest forms of recording human experiences on earth has been through rock paintings found in most parts of the world" (National Research Council 1986). Indexing and abstracting are very much encouraging words for authors, editors, reviewers, publishers, and all the stakeholders in the research domain. It showcases different aspects of researched information in a way how it is stored, searched, found, measured, and cited so on. These index methods are used for quality assessment of the journals and articles. Web of Science of Clarivate Analytics, Scopus of Elsevier, EBSCOhost (Elton B. Stephens Company), ProQuest, and many more are the organizations taking care of Abstracting and Indexing databases processes. In this paper the authors give the overall idea of Journal Indexing and rules to get indexed, ethical practices, peer-review types and processes, different research metrics, about COPE (Committee on Publication Ethics), A case study on Scopus, types of indexes, and citation indexing. Finally, a comparison of Journal indexing for two indexing agencies is analyzed.**

Keywords*— *Elsevier, Scopus, Web of Science, Clarivate Analytics, Abstracting, Indexing, peer-review, research metrics, COPE.

I. INTRODUCTION

Information repositories, the so-called libraries, work as providers of knowledge. These establishments take care of the demands of the users, and it processes the resources and gives access to those hungry users. The information kept might be in the form of books, or digital contents, abstracts, etc. can be searched and accessed. Such information is organized in indexed databases to help retrieve easily by researchers around the world. Basically, research information originates through reputed Journals from authors of different countries. Journals should be indexed in Indexed Agencies.

Journal Indexing is a process of listing the quality Journals; which reveals how many abstracting and Indexing services cover that Journal. Indexing is an ordered list of cited articles (reference) and is associated with a series of citing articles (Source). The Journal must be documented in all the index databases such as local, regional, and continental. It should be available online. If a journal needs to be indexed, it has specific procedures and criteria to follow to get indexed in a reputed database. The Journal has to satisfy the requirements such as Timeliness of publication, quality of the peer review, distinctive aims and scopes, Internationality, Number of citations. When these things are at par with the standard, the Journal Publisher can apply to any indexing services. This will follow a series of correspondence about permissions and infrastructure at the place. There are plenty of indexing services available. These indexing services are categorized based on content discipline and access. The subject includes various domains such as Philosophy, physics, classical studies, Education, Linguistics, Medicine, healthcare, law, humanities, Economics, multidisciplinary, and so on. The access of articles can be through subscription, free abstracts, free searching, or completely open access.

Academic information in journals can be extracted using the indexing and abstracting services. Abstracting service lists out only the Meta data part of any article. TheMeta data includes the title of the article, name of authors(s), name of the Journal, number of pages, keywords present in the abstract, Document Object Identification, content domain, volume number and issue number, and so on. The Meta data of any article is permissible for access by any reader, most of the time the full-text of the article is not available, due to the restriction publisher. Only in the case of open access Journals the full-text article is readily available to the user. There are various organizations providing Abstracting and Indexing facilities (De Gruyter). These are categorized based on the type data it holds. The Institutions that are covering every domain like Web of Science, Scopus and Google scholar. Some institutions handles only specialized academic databases like EBSCOhost, ProQuest. Some follow particular subject area like PubMed, SCiFinder. Few follow open access publications like DOAJ, DOAB (Directory of Open Access Books).

II. IRESEARCH METRICS IN JOURNAL INDEXING

Academic assessment and completions of significant programs are based on publishing outcomes in well-known journals. Provided those Journals are indexed in Scopus (Elsevier), WOS or Journals having high Journal Impact Factors (JIF), SJR (Scimago Journal Rank), source Normalized Impact Factor (SNIP), H-index, etc. Fundamentally, Journals have different coverage and metric methods. Authors are suggested to go through several Journals and compare the metrics used and take the decision to publish their work. Here are a few of the metrics explained below.

The impact factor (Haddad 2014) is a metricto evaluate the regularity with which a published article in a journal has been cited in a specific year; also it is to assess the rank or relevancy of a journal in determining the number of articles cited. Journal Impact Factor figured out as follows:

Let the published articles count during the year 2018 and 2019 is X; were cited by indexed journals during 2020. Let Y be the number of "citable objects" published in 2018 and 2019. It is given by the relation: X/Y is the 2020's impact factor. What is the reliability of the Impact Factor? How are these determined? There are techniques to measure Journal Impact Factor, using JCR, SJR, and SNIP.

JCR gives a ranking for Journals in domains such as Social Sciences, Technology, and science. It also provides specific additional attributes, article counts, source data listing cited journal listing, subject categories, immediacy index, etc. This is restricted to the citation data of journals indexed in the Web of Science. There are approximately 13,000 indexed journals available.

SJR is a portal containing Journal as well as country ranking. This information is extracted from the Scopus database (Elsevier). Scopus housed greater than 15,000 journals, and over 4000 overseas publishers, over 1000 OA journals. The SJR ranking is determined by, the citations obtained by significant journals will be more vital than the other.

SNIP, initiated by professor Henk F. Moed of Centre for science and technology Studies; measures the impact of situational reference by weighing references based on the count of citations in the area of a subject. The effect of one reference gives more value in the subject domain, where texts are low and conversely.

Citation Analysis,a process whereby the quality of an article is reviewed by measuring the count of other authors mentions it in their study. These citations are identified from well-known research portals such as Web of Science, Scopus, Google Scholar and other databases. H-index uses citation analysis to determine an individual's impact. Web of Science gives the count of citations indexed within it for the article relating to the Social science, sciences and humanities over 10,000 journals. There is provision for individual author citation analysis. Scopus has a facility to find the citation counts of individuals using a search option, where it displays a list of publications and the article cite count. Google Scholar provides citation counts for the material found within it, depending on the discipline and cited article. It sees more cited references than Web of Sciences or Scopus; however, it is due to the more number of publication types than others. Individual authors can maintain their citation records and publications in the Google Scholar itself. This can be used for improving authors' citations and calculating their h-index.

H-index is another form of indexing researchers' contribution that plays a vital role in judging once research and helps in promotions, the award of projects, etc. H-index is a numerical indicator of how successful and eminent a researcher is. This was developed by Jorge Hirsch in 2005(Beirlant 2007), a physicist at the University of California. For instance, a researcher who publishes irregularly will have a low score in h-index, because, if you post a widely cited paper and then never edit again, you will be technically stressed. In such cases, outsiders have an unwanted and distorting effect on researchers. Add to that the overall evaluation of the contribution made by the researcher also affects. To correct this problem, Hirsch suggested h-index. Thus, each article is cited at least a fixed number of times which is equal to the total count of the articles are mere h-index of an author.

For example: an author having 25 as their h-index then, 25 papers of them are cited at least 25 times each by other research papers.

This is to indicate that a researcher has consistency in terms of published papers count and citation count that each article has rather than one or two outliers with very high citations. These numbers often motivate a researcher and others to work hard to aim for an even higher h-index. Higher h-index will bring researchers a rise in increase in institutional positions, research grants for researchers. This makes it easier for non-experts to evaluate the excellent work of researchers in the field.

III. Indexing and Abstracting Services- A case study on Scopus

It is a generally accepted that every Journal striving to get indexed in any reputed indexing agencies. One such reputed Indexing agency is Elsevier-Scopus. Once Journal is indexed, it is available worldwide to every International reader, and it ensures the quality of the research content. There are many benefits, a Journal can Collaborate with International researchers in turn increases the citation score, and improved accessibility.

A. Journal Qualifying for Scopus review

The Journals always require pursuing some strict rules from Scopus to get indexed in it. Every Journal should have a valid ISSN number, published articles regularly. The content should be peer-reviewed content, pertinent and must be readable content to any international reader specifically in English. Journal always follow and display guidelines for publication ethics and good practices on their Journal website. Scopus further enforces on a journal that it needs to have a publication history of at least two years before being reviewed for Scopus coverage. Scopus accepts articles from different languages provided its Title Abstract, and Keywords must be in English. Presently the number of full-text different styles allowed in Scopus is 40. This is because international researchers must be able to access the content and encourage collaboration.

B. Scopus accepts only peer-reviewed articles:

Scopus insists firmly on peer-reviewed contents to maintain the quality of the research material. Journal should adhere to these guidelines for article review and evaluation process (Burnham 2006).

Journal receives an article from an author through the Journal submission system, and it is forwarded to the experts in the field for reviewing the content. The experts are from the same domain as the author, and they are the peers of the author. The reviewers have evaluation criteria to follow, and they must be neutral in the review process. The decision to accept or reject the article is based on the proper evaluation of the research problem, the methodology used and the final outcome reported in the article. The acceptance of the material depends on the revisions and resubmissions of paper. The reviewer prepares the final report of the evaluation and submits it to the Journal editor. Journal editor then sends the peer-review result to the authors along with the review report.

The peer-review process has several types; Scopus insists on these types, and each has its guidelines to follow by the Journal. These are 1. The Single-blind review, 2. The double-blind review, 3. Triple blind review, and 4. Open review.

A. Single-blind review

In this type of analysis, the authors do not know reviewers to make impartial decisions, and reviewers have no pressure from the author side. However, reviewers may be partial or impartial because they very well know the author.

B. Double-blind review

This is an anonymous review; both the writer and reviewer are unfamiliar to each other. Obviously, it is advantageous; because of fewer chances of reviewer partiality. However, any well-known author's article can be easily identified by the reviewer based on the substance of the material.

C. Triple blind review

In this method editor, reviewer, and the author all are strangers, better when compared to the other two; however there is a chance that if an author is a well-known writer, then editor and reviewer might identify the author. Then a sort of partial parameter affects the review process.

D. Open review

A more significant transparency during and after review process can be ensured. Here the writer and reviewer are familiar to each other. No hidden agenda of the reviewer is possible; a prompt review can be expected here.

Scopus follows COPE for Publication Ethics and Publication malpractices guidelines:

Scopus insists. Journals adhere to the publication ethics and principles stated by COPE (Committee on Publication Ethics). It is the code of conduct ethical practice that every Journal has to follow. The following material is taken from the COPE website.

IV. COPE

It is an institution to up skill and assist editors, publishers and those associated with publication ethics and cultivating a culture of publishing. Since 20 years, COPE has been instrumental in bringing ethical publishing attitude among editors, publishers, related organizations, and the public. COPE engage discussions among Trustees, council members often; to prepare the plan of action to improve the infrastructure of different research disciplines. COPE practices focus on advice, guidance, education and programs(Williamson 2001).

In April 1997, the first COPE-meeting took place, a relatively informal gathering of a group of concerned editors, initiated by Mike Farthing. In that year, four cases of misconduct were identified. In 2004, a code of conduct for editors was launched, and it was published on the COPE website. During the same period, COPE memberships were enhanced to 350 members. In 2006, COPE released flowcharts of the process of dealing with suspected misconduct. In 2009, the code-of-conduct was revised for publishers, compromising ethical editing. In 2009, more guidelines were released, including peer-reviewers to follow principles of transparency for scholarly publishing. In 2017, COPE guidelines were translated into Chinese and Spanish. In 2019, the instructions were updated, to include the guidance on predatory publishing, as of the year had more than 600 cases, 12,500 memberships from 103 countries. There are plenty of e-learning contents prepared for educating the stakeholders on selective reporting, reviewer misconduct, redundant publishing, plagiarism, publication ethics, falsification, fabrication, corrections, conflict of interest, and authorship in the COPE website.

V. TYPES OF INDEXES

A. Search Engine Indexing

Search Engines are most widely used to search scholarly articles by researchers and the general public. Even though there are specific academic indexes available, people first choose search engines indexing as a first choice. Searching for any journal requires a search engine index as a starting point. Google, Google Scholar, Microsoft Academic, Academic info, iseek Education, Virtual LRC, Refseek, etc. are significant examples of Search Engine Indexing. Every researcher has a habit of checking their scholarly information or information about a Journal initially with Search Engines. Keyword search/document search can be done without any access restriction (Mcgrego 2009).

This type of indexing process implemented in every search engine uses specific software called "crawler or spider" it looks for web pages in the entire net and strips out the HTML text content. Indexing mechanism stores all pages viewed by the spider, upon clicking search, it is this database that is being searched. The search algorithm used to sort through the database of spidered webpages to find those that are most relevant (Ortega 2014).

However, Google Scholar and Microsoft Academic do refinement of scholarly information based on the content type and quality and ensure the websites they index are of academic origin (Gusenbauer 2018). In addition to the above, they fall into the category of SEO (Search Engine Optimization) best practices in case publishers who need their Journal SEO friendly. Further, they must make their journal websites and articles readable from smart handheld devices, indexed by Google Scholar, publish materials understandable not only by humans and also by machines and follow a rolling publishing model.

B. Discipline-specific scholarly and general indexing databases

Indexing of this kind is the most precise way of searching and retrieving academic information from public databases and/or discipline-specific databases (Willinsky 2001). The following are some of the well-known indexing databases:

Scopus: is a multidisciplinary and most prominent citation and abstract repository of peer-reviewed researched literature. It contains more than 20,000 titles from greater than 5000 overseas publishers. The access is subscription-based, the copyright holder is Elsevier. Social science Citation Index: This is purely based on Social science discipline and part of the Web of Science. Scopus provides subscription-based access and is owned by a London-based company Clarivate Analytics. In 2019 it was merged with Churchill Capital.

Web of Science: It is subscription-based multiple databases that provide complete citation data for most of the academic disciplines. It was basically created by ISI, and of late it has been maintained by Clarivate Analytics.

Science Direct: A subscription-based, database of scientific and medical research. It covers not only Journals but books also(ScienceDirect.com). It has got worldwide coverage of physical sciences and engineering, Life sciences, health sciences and Social sciences and humanities articles.

PubMed: The United States of the National Library of Medicine at the institutes of health maintains the database. It is a free search engine having collections of references from the Medline database and abstracts of Life sciences and biomedical contents.

Embase: is a subscription-based, biomedical and pharmacological bibliographic database. It contains more than 32 million articles out of more than 8500 published Journals. Embase is produced by Elsevier.

CiteSeer: is a digital library, freely available, containing scientific and academic papers, specifically Computer and Information science. This is owned by Pennsylvania State University, from 2008. CiteSeer prohibits access to publishers' metadata and indexes only papers available free. The search in CiteSeer results in more on sites like Google Scholar that have publisher metadata than the citation counts.

ArXiv: It is open access, Science database of coverage Mathematics, Physics, Electrical, Computer Science, etc., currently owned by Cornell University. Google Scholar and Microsoft Academic can also be used to search for items in arXiv.

Deepdyve: Its Multidisciplinary free search engine covering over 18 million articles and over 6 15,000 peer-reviewed Journals of scientific and scholarly content. Initially, one can access all information without subscription and after a few weeks need to pay, and an online rental facility is also available. The company was initially founded by two bioinformatics scientists who were disappointed by the inconvenience and cost of finding and accessing peer-reviewed articles.

DOAJ (Directory of Open Access Journals): It was initiated in 2003, comprising a list of Open Access Journals. The content is available multi-disciplinary, free, no-delay, no registration, high-quality standards, peer-reviewed or editorial quality journals. Over 14,000 Journals listed in DOAJ. DOAJ is owned by the Lund University of Sweden, one of the oldest universities of Europe(DOAJ site).

IEEE Xplore: Product of Institute of Electrical and Electronics Engineers, a subscription-based digital Library. The coverage of research materials restricted to Computer science, Electrical and Electronics Engineering. As of February 2020, No of records on the database are 5,110,535. IEEE Xplore has 193 Journals, more than 1700 conferences, more than 6200 technical standards, 4000 e-books, over 425 online courses. Every month a new 20,000 documents are added.

V. Citation Indexing

Indexing is a method of recognizing the information value or measuring the quality of the information that it makes an impact on people who use it. Researchers use and cite it as original material.

After World War II governments invested lots of money on research and developments; the consequence of it was the creation of an overwhelming amount of researched data(Garfield, E 1955). Therefore an indexing method was needed. Initially, the indexing process was not automated; it was difficult, time-consuming, and cost-inefficient. The new innovations were taking a long time to get indexed; subsequently, researchers had to wait for a longer duration to find out the research gaps in their domain (Kaur 2016). The researchers who were in the cross-domain discipline are found a tough time to retrieve relative meanings of the terminologies used.

The researchers from Interdisciplinary subjects had to work with other disciplines to make themselves aware of the topics. All these reasons led to the evolution of the automated citation indexing in the year 1950, which could generate indexes through the machines. Eugene Garfield, a language analyst and an instigator of bibliometrics from ISI. ISI now it is named as Clarivate Analytics was instrumental in bringing automated indexing process for the first time on medical Literature. The project name was the Welch Medical Library Indexing project, funded by the National Library of Medicine, in the US. One of the best parts of this project was to implement a completely automated indexing with no human element (Web of Science Group).

Another pilot project initiated by Garfield in 1960 to check the efficiency of the patent indexing and achievability. Later in 1962, a project comprising indexing of Literature on genetics was started, and it was very much more complicated than patent indexing. Since the government sponsors for the project did not support it, and then Garfield took the decision to continue the project for multi-disciplinary citation index of his private publications. The first edition of it is called SCI (Science Citation Index). Eugene Garfield's works continued to include Journal Citation Reports (JCR), Index Chemicus, and founded a magazine "The scientist".

VI. DOAJ vs. SCIE: A Comparison of Journal Indexing

The comparison here mainly focuses on the guidelines for any journal to get indexed by the indexing agencies. The two reputed indexing agencies such as the Directory of Open Access Journal and Science Citation Index Expanded are taken for comparison.

A. DOAJ- Directory of Open Access Journal

The details of the Journal to be furnished are (DOAJ site):

i) Basic Journal Information is as follows: Journal Title, URL, Alternative Title, Journal ISSN (print and online version), Publisher name, and Society or Institution name. Then followed by Email-id, Country of the publisher, Journal having article processing charges, Journal having article submission Charges, Journal allow Crawling of Journal Content. Lastly, Journal provides article download statistics.

ii) Quality and Transparency of the Editorial Process: Mention of URL for the Editorial Board page: Here Journal has to give details about an editor and editorial board, in case of arts and humanities, only two editors and no editorial board required. Otherwise, the editorial board member's names, identification and affiliation information to be furnished. The review process for papers: Includes editorial

review, Peer review, Blind peer review, Double-blind peer review, open peer review or none. The Journal has to select the nature of its review process. A set of Journal URLs: To be furnished for Journal Aims and Scope, Journal Instructions for authors, Journal policy for screening plagiarism. Mention of the Average number of weeks between submission and publication.

iii) How open is the Journal? An URL having Journals open access statement must be available immediately upon release.

iv) The Content-Licensing needs, URL of the site where license terms are stated, and the kind of access that the Journal allows, deposit policy.

v) Copyright and permissions

B. SCIE - Science Citation Index Expanded

The guidelines to Journals get indexed in SCIE database (Rajagopalan):

i) Journals should have publications regularly for at least 3 issues, online journals continuously at least 9 months, one article per month, at least 20 items per year.

ii) Journal with the English language of international quality.

iii) The time for submission to publication should be less than 1 year.

iv) The Journal should satisfy research and publication ethics and standards.

v) The references are formatted exactly as per the instructions to the author.

vi) At least 10% of the research articles are supported by research funds.

vii) The articles written by the editorial board as corresponding authors should always be less than 40%.

viii) A unique Aims and scopes, precisely more than 300 words.

ix) Editorial board members and consultants are from different countries and at least 15 countries.

x) The recent issues of the Journal should contain at least 10 countries authors.

xi) The Journals last two years manually counted IF is greater than 20% of the JCR ranking of the same category. xii) Manually counted total citation number is higher than the number of citable articles in a year.

xiii) The URL's relating to Aims and scopes, Editorial board, archives, instructions to the authors, and contact information are to be furnished.

xiv) DOI is provided for each article.

xv) Journal should be an open-access journal.

VII. CONCLUSION

One can compare and contrast the present indexing and abstracting facilities available to the researchers are like Lungs of any animal without this organ the existence is impossible. The days there were people who were into research taking years together to research and the indexing facilities like Scopus, Web of Science, PubMed, etc. were not there. People were depending on the manual indexing was very much time consuming and researched data or articles were not organized to retrieve that easily. Entirely the research those days was an uphill task. However, things have changed now people with minimal knowledge of research can start publishing the articles in reputed Journals. This is because of the automated indexing and abstracting facilities, Paperpile and Mendeley systems much useful in bibliographic indexing. The worrying part is unethical practices in publishing and malpractices; COPE is handling very well in curbing those wrong things.

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Concept of Indexing and Concepts associated with Journal Publishing

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***Abstract*—The objective of knowledge acquisition is to disseminate it within the society. Academic research and publishing the outcome through journals is one of the primary avenues for the dissemination of knowledge. There are various concepts associated with journal publication. Indexing, review methods, types of journals, journal quality measures are some of the concepts which are important for an academic researcher need to grasp. Aim of this article is to draw the basic concepts related to the aforesaid topics.**

Keywords— Indexing, Impact Factor, Review Methods, Journal Management.

I. INTRODUCTION

Much of Human evolution in the technological world can be attributed to the ability of building on knowledge of previous generations(Cleveland & Cleveland, 2013). Throughout the known period of human civilization which dates back somewhere to 3000BCE -10000BCE, we have experienced many technological inventions and transfer of technologies amongst different civilizations across generations. The cycle of dissemination and assimilation of knowledge has enabled a rapid growth of human intellect resulting to a gradual development of society from civilized to modern and ultramodern society to twentieth century. The very fact of mortality made human minds realize the necessity of storing knowledge in a logical and sensible way which can be retrieved and used in the future. 'Indexing' has been proven to be the most effective tool to store and retrieve knowledge easily when it's needed. The foundation principle of indexing is so strong that the enormous growth of information technology also has not nullified it but has changed the procedures and forms of indexing keeping the basic principle intact.(Cleveland & Cleveland, 2013) Civilization needs social ordering and organization which needs sharing of information which needs information technology. Information technology was present in different forms throughout the civilizations. Before the invention of the printing machine every document were manuscripts and production of a single page was time consuming. Printing technology in the late middle age changed the whole approach of production of multiple copies of documents, books, etc. Indexing and other bibliographical tools were noticed since the beginning of the printing technology. Then comes the era of computers along with digital printing and Internet which completely revamped the way indexing has been perceived in the past(Cleveland & Cleveland, 2013). Indexing is a method which points out or guides a seeker to the relevant information by effectively searching through the ocean of information present in either structured or unstructured manner in a physical or digital world of information. Often, we find a term 'Classification' closely attached with the concept of indexing but it's not the same. Classification is the act of arranging information in schematic approach whereas indexing is a pointer which helps connecting a symbol to a relevant topic. But classification complements the indexing by schematically arranging the body of knowledge into clusters. During indexing a new symbol is generated and stored within the index for the content after analysing and abbreviating it. A perfect index is something which always leads the searcher to the pertinent and never to trivial information. It is evident that, such a perfect index is rarely possible in the real world but indexing strives continuously to attain such perfection. Ana D Cleveland, Donald B Cleveland, in their book called "Introduction to Indexing and Abstracting", mentioned four possibilities of the outcome of consulting an index(Cleveland & Cleveland, 2013).

1. Information is present in the store, but it's not found.
2. Information was found but not relevant.
3. Information was found partially.
4. Information was found exactly as per expectation.

The goal of an indexing is to minimize the possibility of the first three outcomes and maximize the fourth one as much as possible. A great advantage of the outcome of an indexing system, is that sometimes the seeker just does not know that a knowledge is present. But through the search, he/she comes to know about the existence of the knowledge. The criteria that are predominantly used during the creation of the indexes are author, subject, keywords of the topic, etc. An index, as perceived sometimes, is not a list of nouns, of words and phrases arranged alphabetically in a text. Is more than simply generating terms in the attaching locators to them. It is neither a rearranged table of content. It must be said that it is a distinct record having its own validity and consistency (Adetoro, 2014).Indexes are of different forms and serve various purposes. According to Ana D Cleveland, Donald B Cleveland (2004) name indexes, subject indexes, map indexes are some of them. Indexes are created for databases, books, periodicals, images, etc. It can be both manual and automated. An indexer has a huge role to play in the making of a quality of an index(Adetoro, 2014). It is not possible to understand indexing as an isolated subject. It needs to be understood in the context of human history, progression of societies along with the information management. The role of information behavior and management in the modern society has to be fully

comprehended, to successfully grasp the need and approach of indexing, through which the further progression of the indexing system can be merged with the next generation technologies and we shall find many more philosophers and thinkers being assisted with indexing and echoing the great saying of Sir Isaac Newton, "If I have seen further it is by standing on the shoulders of Giants."

II. Indexing Agencies

There are several Journal Indexing agencies that provide services related to publication. Every agency has its own rules and regulations for indexing(Aghaei Chadegani, et al., 2013). But there are certain generic rules which every agency follows. Due to the regulations, the journals which are indexed are considered to be qualitatively superior than the non-indexed journals. It also makes the articles accessible to a larger user base. From the perspective of the end users, the indexing helps the researchers to find good quality articles and gives them opportunities to compare the articles(De Winter, Zadpoor, & Dodou, 2014).

Some generic rules which every indexing agencies follow are as follows.

- Journals must have eISSN and pISSN
- Journals must have five issues, or the journals must be at least one to three years old
- The editorial board of the journals must have at least sixty percent foreign members
- Agencies take a time between 10 to 180 days for approval of the indexing process.
- Indexing is renewed after a specific interval and it depends on the indexing agencies.
- Here is the list of some very popular journal agencies.
- Google Scholar
- Scopus
- PubMed
- EBSCO
- IJIFACTOR
- EMBASE
- DOAJ
- ISI Indexing
- SCIE
- SCIMAGOJR
- OAJI
- Index Copernicus
- Open J Gate
- Ulrich's International Periodical Directory
- BASE
- Indexing Parameters

Indexing parameters are those factors which help assessing the quality of a journal. These factors provide a quantitative measurement based on various quality factors and gives credibility to a journal. Some parameters are impact factor, cite score, h-index, g-index, m-index etc(Dhammi & Haq, 2016). Journal receives an article from an author through the Journal submission system, and it is forwarded to the experts in the field for reviewing the content. The experts are from the same domain as the author, and they are the peers of the author. The reviewers have evaluation criteria to follow, and they must be neutral in the review process. The decision to accept or reject the article is based on the proper evaluation of the research problem, the methodology used and the final outcome reported in the article. The acceptance of the material depends on the revisions and resubmissions of paper. The reviewer prepares the final report of the evaluation and submits it to the Journal editor. Journal editor then sends the peer-review result to the authors along with the review report.

III. Impact Factor

Eugene Garfield, the founder of Institute for Scientific Information (ISI) proposed the impact factor (IF) also known as Journal Impact Factor (JIF) which measures the average frequency of citation received by the articles published in a journal(Garfield & others, 1994). This measurement provides a ranking based on the above factors but is questionable sometimes. There are many latent factors which influences the citation frequency and not always the quality of the article. For example, an article written for a field which is popular tends to get more citation than an article which is less known or popular in research domain. A review article tends to receive more citations that an original work article because review articles are often cited by researchers in their literature study or background study. Impact factor of a journal for a given year is calculated by the below formula. Impact factor is a measure for the journals which are indexed in web of science(Garfield & others, 1994).

Impact Factor $_{2020}$ = (the number of times articles published in 2018 and 2019 were cited by indexed journals during 2020.) / (the total number of "citable items" published in 2018 and 2019.)

A. Cite Score

Like Impact factor, cite score is another measure of measuring the citation frequency of the articles published in journals that are indexed in Scopus. So, the term 'Cite Score' is copywrite by Scopus. The formula used by Scopus to calculate the Cite Score is as below (Da Silva & Memon, 2017).

Cite Score $_{2020}$ = (Citations received in 2020) / (Number of articles published in 2019,2018 and 2017)

There are some key differences between the two metrics to rank journals based on the citation. The differences are as stated below. Due to these differences, it is not possible to compare these two parameters directly to compare the quality of two journals.

	Impact Factor	Cite Score
Evaluation Period	2 years	3 years
Indexing Agency	Web of Science	Scopus
Access Right	Only to Subscribers	Open to everyone
Publication types considered	Only Articles and Review Articles	All publications

Table1: Comparative study

B. H-Index (Hirsch Index)

This was proposed by J.E. Hirsch in 2005. This metric is used to measure primarily the significance or importance of an author based on his/her publication and the citation factor (Bornmann & Daniel, 2007). Unlike the previous two parameters, this is applicable to an individual or a university or a group and not to a journal. H-index is defined by Hirsch as below.

A scientist has index h if h of his or her Np papers have at least h citations each and the other (Np – h) papers have ≤h citations each."

For example, A scientist has H-index 5 corresponds to the fact that, among all the publications of the author 5 articles received at least 5 citations. Hirsch himself pointed out certain shortcomings of H-Index. H value cannot be used to determine the significance of an author across fields. H-index depends on many other factors because of which it should be used for measurement within a certain field. H-index of an author who has a very few papers with extraordinarily high number of citations may not give an appropriate picture of his accomplishments.

C. m-Index

To address some of the shortcomings of H-Index, it was modified to another index with a minor variation in the calculation process. The formula to calculate the m-index is

(H-index)/n where n=publication age of an author

D. g-Index

Another such measure is g-index. It is calculated as the maximum g such that the top g articles are cited a total of g^2 times. As H-index ignores the articles which are highly cited but in rare in count, to take that factor into account g-Index is proposed.

E. i-10 Index

In 2011, Google scholar proposed this new index measure to quantify the significance of individual authors. As per this method, the score is calculated based on the number of articles of an author which are cited at-least 10 times.

F. H-5 Index

It is the largest number h such that h articles published in [the past 5 years] have at least h citations each". Thus, an H5-index of 10 means that that journal has published 10 articles in the previous 5 years that have 10 or more citations each(Bornmann & Daniel, 2007).

(H-index) / n ; where n=publication age of an author

IV. JOURNAL BOARD

Peer review is a process followed by journals to assess the quality of a journal; the possibility of an article being published in a journal. A journal has majorly three bodies which are responsible for managing the whole lifecycle of publication(Acosta, 1980).

- Journal Manager
- Editorial Board
- Reviewers

A. Journal Manager

Journal Manager is an individual or a group which manages the journal website, keeps all the latest information related to journal available to the all end users and manages the publication process as a whole. This group of people is primarily involved in the administration of the whole process but not directly involved in the review process.

B. Editorial Board

Editorial board of a journal is often a respectable position for someone to hold. Scholars and experts in the field of the journal are generally given the position of an editor. The responsibility of the editors is review, regulatory consultation, promotion of the journals among the peers etc.

C. Reviewers

Reviewers are often invited by editors of the journals. Editors give this responsibility to the researchers, scholars and experts of a domain to review the submitted articles. It is a voluntary service provided by the reviewers by spending their valuable times to review works related to their own expertise. Some journals provide option for the authors to choose reviewers in certain scenarios.

V. REVIEW PROCESS

A. Purpose

The purpose of peer review is to maintain the quality factor of publication as well as making sure that the article content is in alignment with the purpose and subject of the journal(Blank, 1991).

B. Pre-Publication Review

The primary review process which is associated with journal peer review is pre-publication review. It is a very rare phenomenon to have an article reviewed post publication.

C. Post-Publication Review

Unlike traditional pre-publishing review, there are journals which allow an open and transparent review process

after the publication to get rid of editorial bias. But this review process is still not very common.

D. Desk Review

Desk review is usually done by editorial board or person assigned by the editorial board before the article is passed on for peer reviews. In this review process, all the compliances of the articles related to the journals are verified. For example, journals have certain compliances mentioned such as the referencing style, paper format, font size, line spacing etc.

VI. Types of Peer Review

A. Open Review

Open review is a modification of traditional review process in three aspects. Firstly, both the authors and the reviewers are aware of each other's identity. Secondly, Review reports along with the main article are published. Finally, anyone from the research community can participate in the review process. This review process is still not very common across journals.

B. Closed Review

Closed review is the traditional way of peer review where the review process can be conducted in three possible ways.

a.1. Single Blind

In this peer review process the reviewer knows the author but the author does not know the reviewer(Blank, 1991).

a.2. Double Blind

Both reviewer and author do not know each other.

a.3. Triple Blind

Editor, Reviewer, Author, no one knows each other. Only the Journal Manager is aware about the others involved in the publication process.

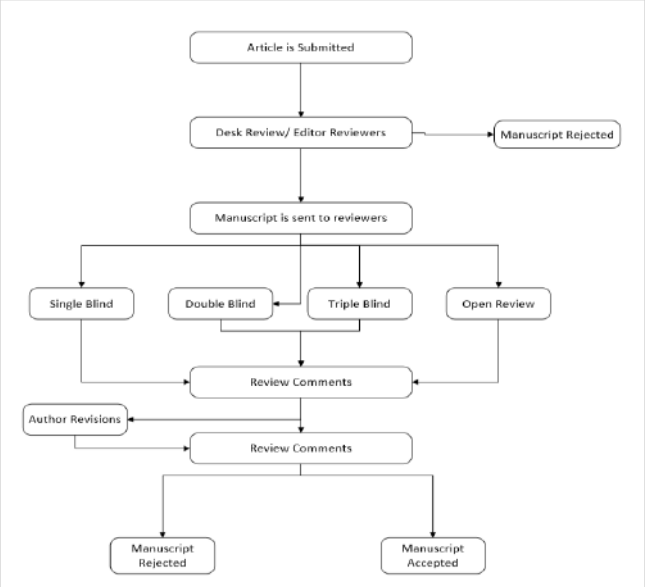

Figure1: Flow-Chart of Journal Review Process

VII. CONCLUSIONS

More than a million journals across different fields are available today to the research community to search for the knowledge to publish their work and make the world aware of their inventions. There is a continuous thrive from all the aspects noticed to improve the process of managing knowledge through indexing. The evolution is going hand in hand with the technological advancement. It is expected to improve beyond our imagination soon and every individual from the research community is part of this evolution directly by improving the system or indirectly by publishing the articles and enriching the knowledge store. Entirely the research those days was an uphill task. However, things have changed now people with minimal knowledge of research can start publishing the articles in reputed Journals. This is because of the automated indexing and abstracting facilities, Paperpile and Mendeley systems much useful in bibliographic indexing. The worrying part is unethical practices in publishing and malpractices; COPE is handling very well in curbing those wrong things.

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Covid 19 and its impact on financial firms in India

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1. Abstract

The Reserve Bank of India publishes a half yearly report on Systemic Risk providing the insights of the systemic risk in the country which affects the financial system. Since, after 2008 there have not been any financial crisis events in the country which had made the markets volatile. The recent Corona Virus epidemic which started in December 2019 and has ruined the economy in form of lockdowns and affecting the health and financial infrastructure in its initial phases and is continuing. The objective of this paper is to find out whether any relationship exists between the market capitalization of the top financial firms and the crisis events in the economy. In this paper we have made an attempt to relate the events during 2008 global financial crisis with the recent Corona virus pandemic. We conclude that Nifty First 50 financial firms are responding to the economic stress periods and are indicators of the stress in the system. There is strong negative correlation between the market capitalization and the SRISK Capital which is capital required by a financial firm during financial crisis and the correlation becomes very strong during economic recession period indicating a period of financial crisis event.
On the other hand Nifty next 50 financial firms do not respond in the same way and they are not having a strong negative correlation between Market capital and SRISK Capital during recession period and may withstand the stress in a better way

2. Keywords

2.1Systemic Risk**:** Systemic Risk is the risk which is embedded in the complexity and globalizations of financial services. The widespread losses and failures of the financial institutions can impose an externality on the rest of the economy and the recent global crisis provides ample evidence of systemic risk associated with it.
2.2 SRISK**:** measured as the expected capital shortfall of a firm in a crisis. In particular, *SRISK*, of firm *i* at time *t* is defined as the capital that the firm is expected to need (conditional on available information up to time *t-1*) to operate "normally", i.e., not face a "run" of its creditors, if we have another financial crisis. This concept refers to hypothetical crisis situation when market declines 40% in six months.
2.3 Nifty 50: Officially called the Nifty50, the index is computed using the free float market capitalization method, which is essentially the count of shares in active circulation in the market at any given point of time. Nifty 50 comprises of top 50 companies according to market capitalization.
2.4: Nifty Next50 (Junior Nifty): It comprises of companies from 51st to 100th ranks according to market capitalization.
2.5: Corona virus Disease (COVID-19): It is an infectious disease caused by a newly discovered Corona virus. (WHO, website)

3. Introduction

The global financial crisis during the year 2008 has focused attention on Systemic Risk to the financial system and led to an explosion of research in the field. The recent pandemic due to Corona Virus Disease has been across the globe and has affected the economies also. The Indian economy shrank 7.5% yoy in Q3 2020, less than expectations of an 8.8% drop, amid easing of lockdown restrictions from June, higher demand during festival season and a rebound in manufacturing and utilities. It follows a record 23.9% plunge in Q2, bringing the economy into recession for the first time on record.
The systemic risk measures are based on market observed data on daily basis such as stock prices of financial institutions. In our Country Reserve Bank of India has been conducting Systemic Risk Survey with the purpose of capturing views of market participants and other stake holders of the financial system. The first such survey was conducted in October, 2011.Various methods are available for estimation of Systemic Risk but one of the widely accepted methods of estimation of Systemic Risk is "SRISK" which is measured as the expected capital shortfall of a firm in a crisis.

4. Literature Review

Very few literatures are available to correlate the stock prices with systemic risk. Several authors have used different methods for estimation of the systemic risk.
Acharya, Engle and Richardson (2012) proposed a measure of systemic risk contribution of a financial firm, called *SRISK* and measured as the expected capital shortfall of a firm in a crisis. In particular, *SRISK*, of firm *i* at time *t* is defined as the capital that the firm is expected to need (conditional on available information up to time *t-1*) to operate "normally", i.e., not face a "run" of its creditors, if we have another financial crisis. This concept refers to hypothetical crisis situation when market declines 40% and capital requirement for the financial firms in Asia/India is considered as 8%.

5. Data and Research Methodology

In this paper we have the monthly data related to SRISK percentage of the total financial firms for the period of January 2008 to June 2020 which is obtained from New York University V lab website (https://vlab.stern.nyu.edu/analysis/RISK.WORLDFIN-MR.GMES). This data in percentage reflects the risk which a financial firm is expected to disseminate in the financial system.

For comparison we have the monthly data on market capitalization weightage in percentage of Nifty first 50 financial firms and Nifty next 50 financial from NSE website(https://www1.nseindia.com/products/content/equities/indices/archieve_indices.htm).This data reflects the market capitalization percentage of various financial firms separately in Nifty First 50 and Nifty Next 50.We have considered those financial firms which are in the SRISK data only.

We have used R package for analysis of the data.

During the comparison first we have conducted Shapiro Wilk test to determine whether the data is having a normal distribution in order to determine whether Parametric or non-parametric methods of hypothesis testing will be used.
Since, in this case the data is not normally distributed we consider Spearman Rank correlation method to determine whether any relation exists between the SRISK % of financial firms and market capitalization weightage in percentage of the firms.
Therafter,for hypothesis testing we use Wilcoxon Ranks sum test(right tailed test) since it is a non parametric test which allows two groups to be tested or compared without the assumption that data is normally distributed and it can be used in random and independent samples. We have tested the hypothesis using Wilcoxon Ranks Sum (Right Tailed Test) in order to find

out whether the market capitalization is higher or lower than the SRISK Capital.

Hypothesis Testing and Spearmann Rank Correlation Coefficient of SRISK Capital in Percentage of Nifty First 50 and Normal Capital weightage in percentage

Period	Hypothesis	Hypothesis testing results(Wilcoxon Right Tail test)	Spearmann Rank Correlation(Between SRISK Capital percentage and Normal Capital Percentage Nifty first50)	Median SRISK Capital Percentage	Median Normal Capital Percentage
January 2008-June2008	H0:SRSIK Capital(Percentage)(G1)< or = Nifty First 50 Normal Capital(Percentage)(G2) H1:GI<G2	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty First 50 Capital Percentage)(P value=0.2873)	-0.98561	13.19	8.91
July 2008-December 2009	**H0:G1<or = G2 H1:GI<G2**	**H0 Rejected(SRISK Capital Percentage higher than Nifty First 50 Capital Percentage)(P value=3.442e-05)**	**-0.6429**	**30.76**	**10.47**
January2010-December 2012	H0:G1<or = G2 H1:GI<G2	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty First 50 Capital Percentage)(P value=0.4021)	-0.1437	23.07	21.00
January 2013-December 2013	**H0:G1<or = G2 H1:GI<G2**	**H0 Rejected(SRISK Capital Percentage higher than Nifty First 50 Capital Percentage)(p value=3.698e-07)**	**-0.7902**	**37.26**	**21.01**
January 2014-December2015	**H0:G1<or = G2 H1:GI<G2**	**H0 Rejected(SRISK Capital Percentage higher than Nifty First 50 Capital Percentage)(p value= 9.603e-09)**	**-0.77408**	**29.79**	**23.86**
January 2016-December 2018	H0:G1<or = G2 H1:GI<G2	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty First 50 Capital Percentage)(pvalue=0.6657)	-0.49356	25.43	25.68
January 2019-December 2019	H0:G1<or = G2 H1:GI<G2	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty First 50 Capital Percentage)(P value=0.9999)	0.03497	23.33	30.02
January 2020-June 2020	H0:G1<or = G2 H1:GI<G2	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty First 50 Capital Percentage)(p value=0.4686)	-1	28.77	26.81

6. Results and Findings

6.1 Shapiro Wilk Test

Here we have two different variables one is the SRISK Percentage of Nifty First 50 and Market capitalization in percentage of Nifty First 50 on one side and SRISK Percentage of Nifty Next 50 and Market capitalization in percentage of Nifty Next 50.

From Shapiro Wilk test statistic we find that SRISK percentage data of Nifty first 50 firms do not follow normal distribution..Similarly the Data of Nifty First fifty Market capitalization in percentage also do not show a normal distribution .Now, the Data on Nifty Next fifty SRISK percentage do not have a normal distribution .The data on Nifty Next fifty Market capitalization percentage also do not have a normal distribution.

6.2Testing Of Hypotheses

We go for testing of Hypothesis where we are using the Wilcoxon Right Tail test between the two groups and results are presented in Table 1 and 2.The test is conducted between two groups to find out the years where SRISK percentage becomes higher than the market capitalization depicting risk percentage higher than market capital

Table 1

Table 2

Hypothesis Testing and Spearman Rank Correlation Coefficient of SRISK Capital in Percentage of Nifty Next 50 and Normal Capital weightage in percentage					
Period	**Hypothesis**	**Hypothesis testing results(Mann Whitney U test) Right tail test**	**Spearmann Rank Correlation(Between SRISK Capital percentage and Normal Capital Percentage Nifty first50)**	**Median SRISK Capital Percentage**	**Median Normal Capital Percentage**
January 2008-June2008	H0:SRSIK Capital(Percentage)Nifty Next 50(G3)< or = Nifty Next 50 Normal Capital(Percentage)(G4) H1:G3<G4	H0 Rejected(SRISK Capital Percentage higher than or equals Nifty Next 50 Capital Percentage)(P value=0.001)	0.2571	53.72	35.45
July 2008-December 2009	H0:G3<or = G4 H1:G3<G4	H0 Rejected(SRISK Capital Percentage higher than or equals Nifty Next 50 Capital Percentage)(p value=0.0006373)	-0.3188	37.54	31.18
January2010-December 2012	H0:G3<or = G4 H1:G3<G4	H0 Rejected(SRISK Capital Percentage higher than or equals Nifty Next 50 Capital Percentage)(p value=4.552e-06)	-0.3472	40	28.72
January 2013-December 2013	H0:G3<or = G4 H1:G3<G4	H0 not rejected(SRISK Capital Percentage lower than or equals Nifty Next 50 Capital Percentage)(p value=0.5563)	-0.1958	23.34	23.52
January 2014-December 2015	H0:G3<or = G4 H1:G3<G4	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty Next 50 Capital Percentage)(p value=0.8511)	0.12263	22.00	23.09
January2016-December 2018	H0:G3<or = G4 H1:G3<G4	H0 Not Rejected (SRISK Capital Percentage lower than or equals Nifty Next 50 Capital Percentage)(p value=0.9901)	0.64363	8.345	14.38
January 2019-December 2019	H0:G3<or = G4 H1:G3<G4	H0 Not Rejected(SRISK Capital Percentage lower than or equals Nifty Next 50 Capital Percentage)(p value=0.9775)	0.59441	7.885	12.49
January 2020-June 2020	H0:G3<or = G4 H1:G3<G4	H0 Rejected (SRISK Capital Percentage higher than or equals Nifty Next 50 Capital Percentage)(p value=0.007576)	-0.6	21.39	13.51

During the stress period in economy the null hypothesis is rejected. We compare the results with Spearmann Rank Correlation Coefficient as depicted in table no:1 and strong negative correlation is found under economic stress period with very strong correlation during the Pre-crisis period from January2008 to June 2008 and COVID 19 period ranging from January2020 to June 2020indicating erosion of Market capital during the stress periods. These results supports the fact that whenever economy is under stress the Hypothesis results and rank correlation are found to complement each other in case of Nifty First 50 financial firms/Banks.

Similarly, the null hypothesis for Nifty Next 50 SRISK .But, the Spearmann Correlation Coefficient is not having any strong negative correlation and we find a strong positive correlation during the period of January 2016 to December 2018.So, nifty next fifty correlation results do not complement the correlation.

The summary of results has been discussed in Table 3.

Table 3

Summary of the results

Period	As Per RBI Systemic Risk Survey Report /Financial Stability Reports	Phases	NIFTY FIRST 50(As per Hypothesis)	NIFTY NEXT 50(As per Hypothesis)	Correlation(NIFTY FIRST 50 capital) with SRISK Capital	Correlation(Nifty Next 50 capital with SRISK Capital
January 2008-July2008	Economic Slowdown(Stock prices have tanked to more than 70% of their peaks in jan2008)(As per Financial Stability Report,March2010)	Beginning of Global Economic crisis	Low SRISK	High SRISK	Very High negative Correlation	positive correlation weak
July 2008-December 2009	Economic Slowdown(As per Fiancial Stability Report, March2010)	Global Economic crisis	High SRISK	High SRISK	Strong negative correlation	No Correlation
January2010-December 2012	Stress Free/Stable(As per Financial Stability Report June,2011 and Systemic Risk Survey,October2011)		Low SRISK	High SRISK	No Correlation	No Correlation
January 2013-December 2013	Exchange rates volatility and macroeconomic risks(Systemic Risk Survey, April 2012,October2012,April 2013,October2013)		High SRISK	Low SRISK	Strong negative Correlation	No Correlation
January 2014-December 2015	Global macroeconomic risks shifted from advanced economies to emerging economies(Systemic Risk SurveyApril2014,October2014,April 2015,October2015)		High SRISK	Low SRISK	Strong negative Correlation	no correlation
January 2016-December 2018	Resilient Economy (Systemic Risk Survey April2016,October2016,April 2017,October2017,April 2018 and October2018)		Low SRISK	Low SRISK	No correlation	Strong positive correlation
January 2019-December 2019	Stable Economy(Systemic Risk Survey April,2019,October,2019)		Low SRISK	Low SRISK	No correlation	Moderate positive correlation
January 2020-June 2020	As per Systemic Risk Survey Report April2020 all the major risk groups on macroeconomic conditions, financial institutions are perceived as high.	Beginning of COVID 19 Pandemic	Low SRISK	HIGH SRISK	Very strong negative Correlation	Very Strong Negative correlation

8. Concluding remarks

In this attempt to identify the similarities in the pattern of market responses during Global Financial Risk, 2008 and COVID 19 episode we find a big similarity and pattern that NIFTY First 50 financial firms/Banks are having very strong negative correlation between the market capitalization weightage in percentage and SRISK Capital percentage of the financial firm/Banks indication high capital erosion due to volatile markets.

During the crisis period Nifty First 50 financial firms/Banks were on higher side of capital erosion and they responded higher to crisis. When there is a stress scenario in the economy Nifty First 50 responded with higher erosion in capital with strong negative correlation indicating capital erosion. Similarly, we find some strong positive correlation in Nifty Next 50 indicating increase in market capital with increase in SRISK Capital. So, Nifty Next 50 may not respond to stress events but indications are there under crisis period erosion of capital is there.

So, we can conclude that NIFTY First 50 financial firms which are dominating the market responds to market volatility and stress in the economy as compared to Nifty Next 50 and this could be an indicator of financial stress period and NIFTY Next 50 financial firms can withstand the stress in a better way.

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Impact of Facebook as Online Advertisement on Consumer Behavior towards Purchase Decision: Study based on Kolkata

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I. ABSTRACT

This study focuses on the impact awareness, promotional elements and reviews through Facebook advertisement towards purchase decisions of consumer behavior. An empirical study has been conducted on 124 respondents in Kolkata city area. After data collection through online survey, it is analyzed using multiple regression analysis to figure out the significance of individual predictor as stated above.

The findings provide clear picture that the variables (promotional elements and reviews) highly influences consumer behavior towards their purchase decisions. After data analysis data shows that male respondents having monthly income ranged from 0 to 30,000 with an age group ranged from 25 to 35 highly influential in this study. However, higher income of make respondents and highly influential promotional elements are highly correlated with each other towards purchase decision of consumers. The overall findings of study provide implications to advertisers, marketing managers and brand owners to design their future strategies accordingly towards consumer's purchase decisions.

KEY WORDS: Facebook; Online; Advertisement; Awareness; Promotion; Reviews

II. INTRODUCTION

Communication is important to convey the message to the individuals concern and for that we need a medium. That medium can be the language of our communication and is dependent on the culture of the society. In marketing also we need a medium to communicate and that medium is the form of advertising that the company is trying to flow. Form of advertisement is important now-a-days because of the variations that we experience in our everyday life.

All forms of advertising are important to communicate the ultimate message to the target consumers but it is proved in our recent life that online platforms are highly influential while having an impact of purchase decision of consumers.

We use to interact via SMS through mobile phone network. In recent days we follow social media platforms like Facebook, Instagram or Whatsapp. A platform where everyone can give their opinion on a particular incident or funda; the circle may be a professional or non professional; may be within friends or relatives, office colleague's or college students. Depending on some rules and regulations that every participants need to follow so that any nonsense activity can be avoided.

The effectiveness of online advertisements is dependent on some factors. We have taken some factors are into consideration which are whether Facebook creates brand awareness, promotional

elements through Facebook and the reviews available through a particular product or service page through Facebook. The dependent factor is whether Facebook as online advertisement affect the purchase decisions by the customers.

Creating brand awareness is an important factor of marketing process. Without knowing the brand or the features of the product the target customers will not approach to purchase the product or service the companies are offering in the market. Market is highly competitive and all the companies are setting their strategies keeping in focus on the desired customer profile.

Promotional elements through Facebook affect the decision on purchase by customers. Customers keep on searching the added benefits or the features they expect after buying the product or the services.

Reviews provided by the peer group effects the purchase decision by the customers. Customers are naturally influenced by the peer group always for a high priced purchase and through Facebook they are in contact with them. They use to take suggestions from their friends or relatives for the purchase process.

Facebook as an online advertisement platform influence the purchase decision of the customers. Targeting the prime audience is important and the companies are doing that by using facebook.

But if we segregate these from further then we see a branch of social media advertising. Facebook, Twitter, Instagram and various extended social media platforms to do the same. We have taken Facebook advertisement as an option to study in this paper.

III. LITERATURE REVIEW

A. Social media as a platform of communication

Advertisement from social media is growing in India because of its reach in every corner of the society although it is in its primary stage. Companies need to implement strategies to effectively use this tool in current market scenario. This will simultaneously increase the share of the company in the market embalming as an innovative firm in near future.

In order to clarify the efficacy of social networking sites as a marketing tool, (Bashar et al. 2016) conducted an empirical analysis and an attempt was made to examine the degree to which social networking sites assist customers in purchasing decision-making. It is important for every brand to have a large social media presence, as social media is a place where users spend lots of time on social media networks (Darragh, 2009).

Marketers should try to develop strategies through social media platforms depending on the preferences and choices of the end consumers this will lead to a better and healthy competition among the competitors and will force them to serve better or make better products for the consumers.

Another study conducted an analysis on the experience of consumers and advertisers in the state of Punjab on social networking sites (Vijai and Sharma, 2015. The paper suggested steps for effective advertisement on social networking sites (SNS) strategies based on the findings of the study and examined literature that above all; social networking sites sell content "Interesting", "informative", "interactive" and "reliable".

A company tries to solve problems by providing the desired product or service to the consumers or end users based on their opinion to them. This simultaneously builds a healthy relationship between the company and the customer. It was addressed that the shift in the marketing strategy. By "peppering" clients with various commercials, it used to be about persuading customers to purchase goods (Rust, Moorman, and Bhalla, 2016.

Social media is one good communication tools among the individuals in the society that we are residing in and this can be used as an effective medium to promote brands or service by the companies that we all know. Communicating to the end users about their product or service is important to the companies. This has been propounded by (Yadav, 2015) in his paper on social media advertisement.

In contemporary times, social networking has expedited unprecedented growth in human association. In particular, it has altered the way consumers perceive (Mir and Zaheer, 2012). This digital media acts as a general stage for people around the world to communicate with each other and provide information and experiences association with goods, events and problems (Heinrichs et al., 2011)

B. Effectiveness Of Facebook Advertisement

Most of the individuals in Facebook prefer to refer products or services to their friends or relatives which in turn spread the advertisement or create awareness

among individuals. They spread their choices and indirectly spread the information. A study specifies that they disclose their personal details and their link to Facebook groups as users pass on ads promoting brands (Chu, 2011).

As per age group are concerned students from college or institutes prefer this type of Facebook groups which increases day by day. They like Facebook as the best form of social platform as per services available via the same platform. It also states that young college-age users show the more favorable attitudes towards advertisements on social media and are the largest rising demographic group (Chu (2011).

Facebook help the advertiser to reach the target audience as this is the prime factor in creating an image of the product or services among the customers. Clarifying facts about the product can be presented by advertisement and this needs to be reached to the customers depending on the requirement. Social networking platforms such as Facebook are different than other advertisement media, (Curran et al. 2011), because it stores data on all its users, suggesting that advertisers enter targeted segments.

Make a proper budget plan to make the advertisement effective is very important for the companies because of the optimal use of resources. Facebook helps to communicate with the end user at a very low rate and this has been narrated by some researchers in their paper. Communication costs have dropped dramatically because of Facebook, creating opportunities for companies to connect directly, easily and reliably with millions of individual customers (Mize, 2009; Palmer & Koenig-Lewis, 2009).

Interactive facility among the consumers and also between business and consumer is possible through Facebook. It provides users with interactivity, thereby strengthening the relationship between clients and businesses (Logan, K., Bright, L.F and Gangadharbatla, H. 2012). The growth and usage of social networks is higher than other online forms, like blogs and user groups (Hutton & Fosdick, 2011).

Companies have started to search for ways to learn the 'likes', 'shares' and 'comments' of Facebook users, considering the impact of Facebook in engaging consumers (Andriole, 2010; Culnan et al., 2010). There is no easier and cheaper way of telling consumers about the launch or availability of new products and services than Facebook (Sarah E Needleman, 2011). Companies have a way to build a strong online presence for themselves, using web-based social networking in a constructive, well-considered way, and are therefore in a stronger position to provide credible viewpoints on issues (Kotler and Keller, 2012).

IV. OBJECTIVES OF THE STUDY

1. To understand the impact of Facebook as online advertisement on consumer behavior towards purchase decision;
2. To analyze how the advertisement through Facebook increases awareness among consumers that affect purchase decisions;
3. To study how the promotional elements through facebook advertisement affects purchase decision;
4. To analyze the impact of product reviews on consumers through Facebook platform towards purchase decisions.

V. FORMULATION OF HYPOTHESES

Awareness: Creating awareness through online advertisement is a new age tool now a days and it can be promoted through social media websites. According to the research advertisement effectiveness is the degree to which advertising produces a certain desired effect (Corvi and Bonera, 2010). It was stated that social media can affect the overall understanding of the image of a brand (Jokinen, 2015).

Research Question 1: Does Facebook advertisement increases awareness among consumers that affect their purchase decisions?
Hypothesis 1: Facebook advertisement positively increases awareness among consumers that affect their purchase decisions.

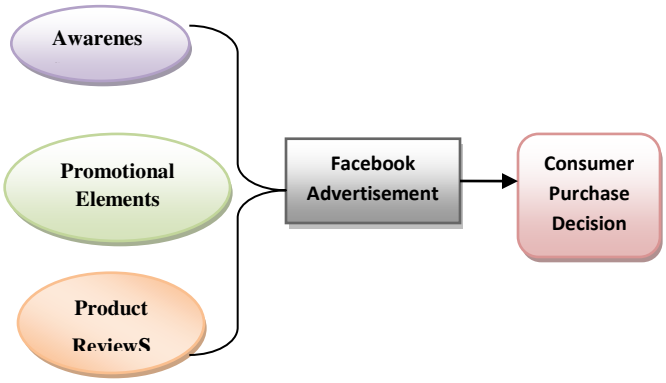

Figure 1: Conceptual Model

Promotional Elements:

According to a study, customers can gain experience from surrounding environment that may be useful for products promotion and selling (Adelaar et al., 2003). Different surrounding environmental conditions affect the consumers buying behavior. For example, outlook and atmosphere in retail store and background music while purchasing (Morris & Boone, 1998).

Research Question 2: Does the promotional elements through Facebook advertisements affects purchase decisions?

Hypothesis 2: Promotional elements positively affect purchase decisions through Facebook advertisements.

Product Reviews: Word of mouth on social media offers remarkable information power for new goods where customers in cyberspace affect each other (Nail & Jim, 2005). This has been proved by many researchers. Social Networking Sites (SNS) are a crucial factor for online content creation and user sharing that share mutual interests (Boyd & Ellison, 2007).

Research Question 3: Does the impact of product reviews through Facebook platform affect purchase decisions among consumers?

Hypothesis 3: Product reviews through Facebook platform positively affects purchase decisions among consumers.

VI. METHOD OF STUDY

This study has design for causal study between independent variables namely awareness, promotional elements and product reviews and dependent variable was the impact of Facebook advertisements on consumer purchase decisions. Before executing, a pilot study has been done pre-designed questionnaire. With the help of this, we have tried to judge the feasibility and scope of this study.

Data Collection: Primary data were collected through online questionnaire consist of close-ended questions followed by impact of independent variables i.e. awareness, promotional elements and product reviews through Facebook advertisement towards consumer's purchase decisions. The data generated with the help of questionnaire were examined through SPSS to test hypotheses. Secondary data were collected from published journals, internet and news articles that helped a lot to frame the above literature reviews. An online questionnaire was circulated among students, office workers, professors and housewives through various online media. Respondents were invited and asked to forward the invitation to others, however creating a convenience sample. Each item was analyzed on a 5-point Likert scale, where 1 indicates *strongly agree* and 5 indicates *strongly disagree*. Finally, we have received 124 responses for this study.

Validity and Reliability of Data: To ensure validity of data, principal component analysis (PCA) was undertaken for this study as shown below:

Table 1: Kaiser-Meyer-Olkin and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.813
Bartlett's Test of Sphericity	Approx. Chi-Square	432.344
	df	45
	Sig.	0.000

Source: Validity Data

Table 1 reflects that KMO value of this dataset is 0.813. However, KMO values between 0.8 and 0.9 are adequate. Here, Bartlett's test of sphericity with an associated p value of <0.001 indicates strong evidence of validity of the measures. To evaluate the reliability of the questionnaires, Cronbach's alpha was used as depicted below:

Table 2: Reliability Statistics

Cronbach's Alpha	No. of Items
0.847	10

Source: Reliability data

Table 2 indicates that Cronbach's alpha value for questionnaires was 0.847 which is significantly higher than the recommended value of 0.847 (Hair Jr., Anderson, Tatham, & Black, 1995).

VII. ANALYSIS AND INTERPRETATION

Table 3: Demographic profile of the respondents

Respondents	Frequency	Percentage
Gender:		
Female	33.1	33.1
Male	66.9	66.9
Total	**100**	**100**
Age:		
25-35	96.8	96.8
36-45	2.4	2.4
46-55	0.8	0.8
56 and above	0	0
Total	**100**	**100**
Marital Status:		
Married	10.5	10.5
Unmarried	89.5	89.5
Total	**100**	**100**
Income:		
0–30,000	79	79
31,000–50,000	8.1	8.1
51,000-70,000	2.4	2.4
71,000 and above	10.5	10.5
Total	**100**	**100**
Occupation:		
Student	89.5	89.5
Teacher	2.4	2.4
Private Sector	8.1	8.1
Employee	0	0
Businessman	0	0
Homemaker	**100**	**100**
Total		

Source: Computed data

Table 3 indicates that of male respondents belong to the age group of 25 to 35. The data shows that the male respondents with an age group were highly influential regarding the impact of Facebook advertisements towards purchase decision. However, this research study reflects that the demographics play an imperative role on the effect of awareness, promotional elements and product reviews through Facebook advertisements towards purchase decisions of consumers.

In order to test the hypothesis, multiple regression analysis has been adopted to analyze the impact of independent variables namely awareness, promotional elements and product reviews to dependent variable which is Facebook advertisement affect purchase decision of consumers.

Table 4: Multiple Regression Analysis

Variables	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin - Watson
Awareness, Promotional elements, Product Reviews	0.614[a]	0.377	0.362	0.63717	2.000

a. Predictors: (Constant), Awareness, Promotional elements, Product Reviews

b. Dependent Variable: Facebook advertisement effect on consumer purchase decision

Source: Regression Data

Table 4 shows the impact of awareness, promotional elements and product reviews through Facebook advertisement has positive influence as R=61% and R^2=37% variation the variable brings towards purchase decision of consumer. The value of Durbin-Watson=2.000 as we know the test statistics values of Durbin-Watson in the range of 1.5 to 2.5 are relatively normal and considered.

Table 5: Coefficients[a]

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
(Constant)	0.983	0.224		4.381	0.000	0.539	1.428
Awareness	0.089	0.098	0.080	0.914	0.362	-0.104	0.282
Promotional elements	0.381	0.084	0.397	4.562	0.000	0.216	0.547
Product Reviews	0.270	0.090	0.257	2.987	0.003	0.091	0.449

Source: Regression Data

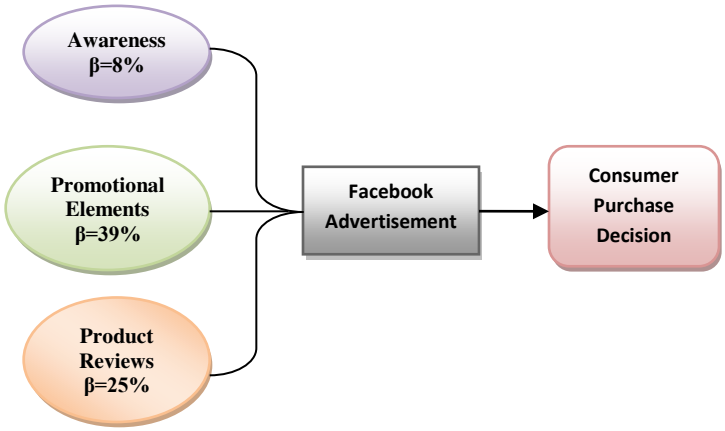

Figure 2: Conceptual Model

Figure 2 reveals that promotional elements (β=39%) of Facebook advertisement highly influences the purchase decisions of consumers whereas awareness level (β=8%) through Facebook advertisement does not have that much influence on consumer purchase decisions. Through this study we can come to the fact that positive influence of variables (awareness, promotional elements and product reviews) towards purchase decision of consumers through Facebook advertisements.

VIII. MANAGERIAL IMPLICATIONS

Advertisers can design their advertising strategies and present that to the customers according to the feedback that they can take and analyze from the review section through Facebook platform.

Marketers and brand owners may design their products and services according to the requirements mentioned by the customers through the comment section of the post from particular product and service page of the Facebook. These steps will gradually and slowly lead to make customer more loyal and aware about particular product and service.

However, loyal customers will usually carry more customers through the spread of positive reviews regarding various features of the product and service. This will someway inform and provides knowledge to other unknown consumers also.

IX. CONCLUSION

According to the result of this study it can be concluded that awareness, promotional elements along with reviews (both positive and negative) through Facebook advertisement have a significant effect on consumer behavior towards their purchase decisions. It is realized from the survey data that youth generation of India can be seen as an influential category of users by sharing information through the most impactful social media platform "Facebook".

This empirical study was conducted and analyzed the fact that effectiveness of online advertisement through Facebook platform to promote products or services. Certain essential mind-boggling revelations are made by analyzing the responses of 124 respondents in India. After analysis it can be seen that there is a high influence promotional elements, product reviews and awareness through Facebook towards purchase decision of consumers.

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A Conspectus Study on the Blockchain Technology in Indian Banking Sector

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***Abstract*-The study is intended to analyze the utilization of blockchain innovation or blockchain technology (BCT) in the Indian banking sector and its advantages in financial tasks. It also covers the field examination concerning how existing BCT is pushing banks to adequately and productively screen and control the financial cycle. The final results show that COVID -19 has given a push to digitization in the sector. The sample data for the study are the 4 Commercialized banks and a number of FinTech organizations in India. Google Trend and Statista method are adopted for the study of perception of consumers. The key advantages of BCT application identified are decentralization, trust, and security in exchanges.**

Keywords: Blockchain Technology, Banking, financial, decentralized, Application Programming Interface (API), industry, organizations.

I. INTRODUCTION

A Blockchain is a digital, immovable, scattered record that consecutively records exchanges progressively.[10] Blockchain is a chain of squares – each is being a storage facility that stores data alluding to an exchange and connections to the prior square in the equivalent exchange. These associated blocks structure a successive chain giving a pathway of the essential exchange. Conventional duplicates of all data are shared on the Blockchain. Members independently approve data without a solidify authority. Indeed, in the event that one hub comes up short, the leftover hubs keep on acting or work, with guaranteeing no disturbances. [12,13] An exchange on Blockchain can be cultivated just if all the gatherings on the organization aggregately support it. Be that as it may, agreement, based standards can be altered to suit various circumstances. Squares built are cryptographically fixed in the chain. This implies that it become ridiculous to erase, alter or on the other hand duplicate previously made squares and afterward put it on network, after that making the valid computerized resources and guaranteeing a significant level of strength and trust.

Some sorts of Blockchain's

- Public Blockchain.
- Half breed blockchain.
- Permissioned or shut circle Blockchain.
- Private Blockchain.

II. LITERATURE OVERVIEW

According to Satoshi Nakamoto (2008) [5] in his white paper proposed "a shared rendition of electronic money which would permit online installments to be sent straightforwardly starting with one gathering then onto the next without experiencing a monetary organization or outsider". This arose as an establishment for the most famous blockchain application for example bitcoin. Melanie Swan (2015) [4] in his paper clarifies that the "blockchain is a decentralized public record that can be utilized for the enlistment, stock, and the exchange of all resources in accounts, property just as in theoretical resources, for example, votes, programming, wellbeing information, and thought". He considered the hypothetical, philosophical, and cultural effect of digital forms of money and blockchain innovations. Whereas, Yli-Huumo J, Ko D, Choi S, Park S, Smolander K (2016) [2] separated 41 essential papers from logical information bases and contemplated the ebb and flow exploration,

downsides and the future viewpoint of blockchain innovation from the specialized perspective. The measurements shows that 80% of the exploration is just on Bitcoin when contrasted with other blockchain applications. A large portion of the investigations are focusing on advantages of blockchain innovation. Notwithstanding, a large number of the Blockchain adaptability related difficulties have been left unstudied.

III.RESEARCH GAP AND PROBLEM STATEMENT

There were literatures discussing various scopes of BCT in previous studies. However, no studies have been undertaken on the study of perception of banking consumers towards the applications and advantages of BCT in Banking sector.

IV.SCOPE OF THE STUDY:

The scope of this study is to analyze the blockchain technology in the Indian banking sector, its implementation by various banks in India, the role of COVID-19, for the push to digitization. The future outlook of this innovation in the Indian banking sector.

V. OBJECTIVE

- Usage of BCT in Indian banking sector comparing.
- Challenges in implementation of BCT in the Indian Banking sector.
- Impact of COVID 19 in Indian Banks in Digitization
- Future Look: How Blockchain will change Banking Industry

VI.APPLICATIONS OF BLOCKCHAIN IN THE BFSI SECTOR

A. *Capital Market*—Trade settlement in a continuous premise with diminished expense and issuance of business paper, settlement of conveyance and installment depends on smartcontract.

B. *Banking*—Shortening exchange account measure with least mediators in worldwide exchange and disposes of mistakes related with manual examining.

C. *Insurance*-Online guaranteeing and guarantee handling.

VII. USAGE OF BCT IN BANKING SECTOR.

In the Indian financial area, there are 27 public area banks, 23 private (enormous size) banks and 46 unfamiliar banks which are the likely clients on BCT.[9] Anyway right now, just few private banks, public area banks, and two unfamiliar banks are utilizing BCT in India.

KOTAK MAHINDRA Bank:

Utilizing BC EdgeVerge (Infosys) stage joined forces with Deloitte Decreased the time taken for a letter of credit to not many hours from 20 to 30 days Exchange money, Cross fringe installment, KYC on BC.

AXIS Bank:

Utilizing Ripple BC stage tied up with the fintech firm Exchange Finance installment also, settlement, money trade through Ripple BC network (RTXP) Have in excess of 100 clients around the globe on BC stage

ICICI Bank:

Utilizing EdgeVerve Blockchain Stage joined forces with Emirates NBD First bank (2016) in the nation and to go for BC in exchange in cross-outskirt exchange Exchange Finance and cross outskirt settlement on BC 250 huge business houses on BC network.

SBI:

With IBM's Enterprise Service Transport (IIB) for consistent joining with existing Programming interface banking usage Mechanized handling of exchanges with zero manual intercession KYC, Smart contacts, misrepresentation counteraction on BC

VIII. CHALLENGES

A. Interoperability: Currently nobody regular global standard is accessible for the blockchain frameworks being used over the globe. [8,9].Consequently, its reconciliation into existing practices for interoperability isn't occurring. This won't permit the operational practicality for different gatherings on the equivalent blockchain framework making diverse interoperability

issues among them.

B. Security: For safely getting to the framework utilizing BCT, it is important to have staggered security covering approval for parties utilizing framework with the goal that exchange security can be guaranteed from malevolent insiders or cyberattacks.

C. Legal structure: BCT with its applications, the clients are topographically boundless. Right now no public and worldwide guidelines on the locale issue. Subsequently, a reasonable command should be set up for purviews in instance of debates emerging in cross-outskirt exchanges.

IX.IMPACT OF COVID 19 IN INDIAN BANKS IN DIGITIZATION

The COVID-19 circumstance won't just animate the selection of innovation, however will restore center around the following four regions of banking:

A. Embracing new Technology – In the effect of the pandemic and financial ambiguities Indian banking area has just executed the part of innovation in accomplishing the scope and scale. Forecast higher paces of reception of microservice engineering by dropping vertically coordinated stacks, APIs, containerization, distributed computing, AI and blockchain. These advances will assume basic parts in computerized change of Banks and Financial.

B. Channels of digitization –Banks will empower its clients to collaborate over various mechanized and advanced channels to offer the astounding channel blend. Banks will consider significant angles, for example, socioeconomics, admittance to web, last mile network, client banking standards of conduct and so forth to empower sufficient reception by the Indian financial buyers.

C. Security, protection and client trust – According to RBI, for the monetary year 2017-18, India's banking area saw a spike in digital cheats and fix the misfortunes at $ 13.7 million. With expanded utilization of credit only what's more, computerized economy, it will be essential for the banks to actualize secure structures and frameworks. Banks need to find a way to recognize both inside and outer framework weakness. They ought to be in fact reinforced by precise KYC, solid client confirmation (SCA), monetary evaluation APIs, firewalls, brilliant organizations, and so on, for secure and coherent exchanges. Powerful financial arrangements and digital security activities help defend against wicked assaults.

D. Strategy and consistence – The emphasis should be on expanded advanced installment framework, only in rustic India, with a goal to make a monetary environment for the unbanked and underbanked populace of our nation.

X. BLOCKCHAIN TRENDS IN INDIA: STATISTICAL ANALYSIS

Collected data reflects the boost in the trends of perception of people in India about blockchain being a convenient payment method in India.

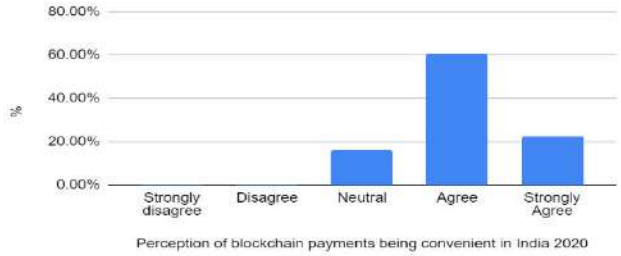

Fig1: Perception of blockchain being a convenient payment method

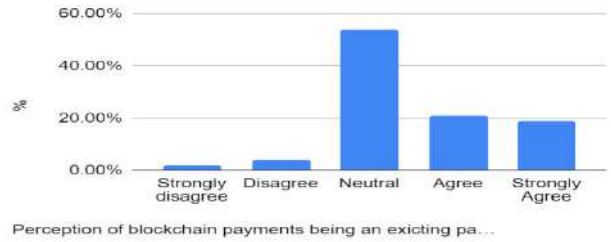

Fig2: Perception of blockchain being an exciting payment method

The analysis also covered the following:

- Perception as an exciting payment option.
- Share of business cases for blockchain financial services in India.

- Volume of payment trends

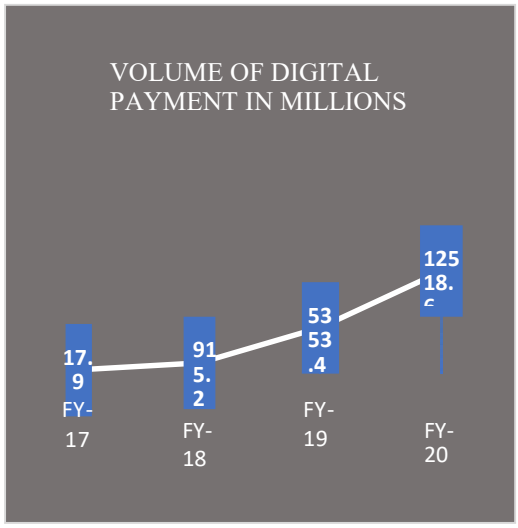

Fig 3: Representing volume of payment

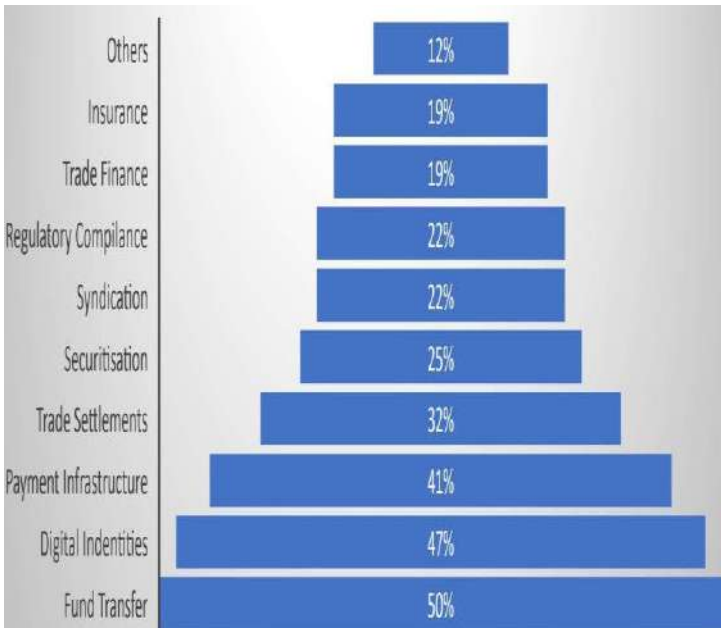

Fig 4: Share of Business using blockchain

XI. FUTURE LOOK: BLOCKCHAIN TECHNOLOGY WILL CHANGE BANKING INDUSTRY

That is the reason blockchain is something beyond the basic innovation for cryptographic forms of money like Bitcoin or Ethereum.

Here are few use instances of blockchain in banking to assist you with seeing how the monetary administrations industry will endeavor blockchain soon.

A .Quicker installments

By building up a decentralized channel (for example crypto) for installments, banking foundations can utilize arising advancements to encourage quicker installments and lower the charges of handling them.[12] By offering higher security and lower cost of sending installments, banks could present another degree of administration, carry new items to the market, lastly have the option to rival imaginative fintech new businesses.

1. *Leeway and settlement frameworks*

A conveyed record innovation like blockchain could empower bank exchanges to be settled straightforwardly and monitor them better than existing conventions, for example, SWIFT. A normal bank move takes a couple of days to settle since it's restricted by the manner in which our monetary framework was assembled.

B. Purchasing and selling resources

By eliminating the broker and resource rights move, blockchain brings down the resource trade expenses and decreases the flimsiness of the conventional protections market.

Purchasing and selling resources like stocks, products, or obligations depend on monitoring who possesses what. [12,13]Monetary business sectors achieve this through an unpredictable organization of trades, representatives, clearinghouses, focal security vaults, and overseer banks. These various gatherings have been built around an obsolete arrangement of paper possession. As we can figure, the framework isn't just moderate however filled with mistakes and inclined to trickiness.

C. Gathering pledges

Blockchain organizations are quickening the cycle by raising assets with a few other options. These incorporate Initial Exchange Offerings (IEOs), Equity Token Offerings (ETO), and Security Token Offerings (STOs). STO is as of now the most mainstream choice since it's legitimately secured. To profit by this model, ventures need to pass a due perseverance measure. Pioneers of STOs incorporate Switzerland and Malta where organizations like Scerri and Concise Ltd offer such administrations. The most conspicuous ETO exchanging stage today is Neufund.

Beforehand, Initial Coin Offerings (ICOs) were more well-known however are presently considered underhanded and untrustworthy.

D. Credit and advances

Customary financial establishments guarantee advances by utilizing an arrangement of credit detailing. With blockchain, we're taking a gander at the fate of shared credits, quicker and safer advance cycles as a rule, and even complex modified advances that can inexact partnered advance structure or home loans.

Banks that cycle advance applications assess the danger by taking a gander at variables, for example, FICO rating, homeownership status, or relationship of debt to salary after taxes. To get the entirety of that data, they need to request your credit report gave by specific credit offices. In the United States, that adds up to three establishments.

E. Exchange money

Another zone blockchain is set to alter the exchange account area. Exchange money alludes to the entirety of the monetary exercises identified with worldwide exchange and business. Many request the executives frameworks permit doing this work on the web, yet the cycle takes a great deal of time.

Blockchain-based exchange account will smooth out the exchanging cycle by disposing of such tedious manual cycles, desk work, and administration.

F. Computerized personality check

With blockchain, buyers and organizations will profit by quickened check measures. That is on the grounds that blockchain will make it conceivable to reuse character confirmation for different administrations safely. The most mainstream advancement here is Zero Knowledge Proof. A few nations and enormous enterprises are presently chipping away at arrangements dependent on ZKP.

On account of blockchain, clients will have the option to pick how they wish to distinguish themselves and with whom they consent to share their personality.

G. Bookkeeping and inspecting

Specialists accept that the innovation will improve consistence and smooth out the conventional twofold section accounting frameworks. Rather than keeping separate records dependent on exchange receipts, organizations can add exchanges straightforwardly into a joint register. Allthe sections in the register will be circulated.

XII.CONCLUSION

In India banking area is in the front line in embracing what's more, actualizing BCT. Be that as it may, they have still not found an unmistakable response to sharing the 'Bank Ledger' with different accomplices to get into Open Banking API System, which is a stage ahead.

In nutshell BCT can be utilized in Banking and Finance by joining shared information bases and cryptography, permitting accomplices (banks, clients, clearing specialists, reserve houses independent of their areas and associates) to have a ongoing asynchronous reach to a computerized record, which continuously accessible in a refreshed variant and that can't be adjusted by any accomplice. BCT safely communicate information and esteem. It is an open-source and a confided in stage to help banks to decrease the expense of handling installments make new items and administrations to create another stream for producing income.

BCT will improve access for hindered clients, make organizations more responsible, and increment security in client co-operations. For any exchange, BCT permits it to happen without a solitary position to direct it. BCT records exchanges on an electronic 'record' that everybody can get to. Duplicates of the exchange will be accessible on PCs that are associated with record organizations, empowering exchange check on constant premise. Accordingly, in BCT clients won't need to depend on any unified position what's more, any time delay in having the exchange started and get wrapped up. Consequently, it is an open-source and intelligent stage for clients.

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Assessment of academic performance through SQC: An application of control charts

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***Abstract*— The key output of a quality focused education system is well qualified and knowledgeable students. It is the most important function of a quality intensive education system to continuously assess and improve the student's academic and overall performance. Quality means degree of excellence or fitness for use. Total Quality Management practices particularly Statistical Quality Control (SQC) is used for the systematic reduction in the variation in quality of a product/services. Education institutions have also executed TQM practices in order to improve the grading system for assessment of the performance of students. This study applies SQC in assessing the academic performance of the students. Systematic application of control charts is indeed helpful to identify the areas considered for assessment/evaluation of student's academic performance which needs development and improvement. This SQC based approach may allow the faculty/mentors/teachers/instructors to assess the performance of the student more objectively so that appropriate measures can be initiated by the education institution to improve the level of academic performance of the student in accordance with educational standards. In addition, it allows and fosters delivering quality education. An attempt has been made in the present study to assess and compare student's academic performance with control charts. Study also compares the academic performance of the students in theoretical and practical subjects. With systematic application of SQC in the assessment process, academic performance of students found better in theoretical subjects comparatively and it has been recommended that that improvement is required in the numerical based subjects.**

Keywords— Quality Education, Control Charts, Assessment, Academic Performance, Statistical Quality Control

I. INTRODUCTION

"Quality is not an act it's a habit" quoted by Aristotle. Quality can be defined as the excellence of product or services which meets the customer specifications. It is the degree at which products gratify the requirements of customers at the start of products life (ISO 19000). Organizations emphasis on quality of products and adopt different methodologies to achieve a desired level of quality. Quality is the main focus point for getting desired results. Dr. Walter A. Shewhart of Bell Telephone Laboratories, called father of quality control first introduced the concept of Statistical Quality Control in 1920 to achieve the desired level of quality. It is the basic concept which does not only help to improve the quality but also helps to achieve the desired output. SQC is the technique which uses apt statistical tools to ensure the quality in production as well as in the service industry by minimizing the variations from quality attribute [9]. Dr. Shewhart was the first who emphasized more on process than product and so introduced the concept of control charts in 1924 (Shewhart, 1931). Control charts are graphical representations based on normal distribution [22]. Control charts monitor the production process and identify the causes of variations in quality. It is the concept which notifies that there are two types of variation in the production process: Random variation and Assignable variation, due to which there exists discrepancy in quality of product. Process is said to be in control if it runs with only chance causes and if there exist assignable causes also then control charts indicate process is out of control and there is a need to remove these assignable causes to control the quality of process and then to the quality of product. For qualitative data Control charts for Attribute are taken into consideration while for quantitative data Control charts for Variables are taken into consideration. Control charts consist of three limits: Upper Control Limit, Lower Control Limit and Central Line. To identify the assignable causes in process one has to represent process graphically, and if points of process plotted out of these control limits process is considered to be out of control process and if all points exist within these limits entire process is considered to be in statistical control [2].

Quality is one of the most important factors in education since the last few decades. TQM can be a tool through which educational institutions can set their own quality standards and also improve quality standard practices for students [25]. Assessment of students is always a parameter through which quality of education can be reviewed [8]. Assessment can be defined as evaluation of students competencies with the help of their scores on examinations as well as their assignments and these quality characteristics can be evaluated with the help of control charts [11]. Education is a process in which improvement is needed continuously. Control charts can be helpful to identify the causes which may be responsible for a dissatisfactory level of quality in education [10].

Shewhart control charts are useful in measuring student's performance [20]. As and when a significant statistical change is occurred in the performance of the student, faculty may establish a benchmark depending upon the existing educational process [26]. In another research work where means of developing a technology for identification of problems in mathematical preparations of students were charted [6], analyzed that mathematical tests can identify problems related to student's knowledge. Further, Shewhart control charts are helpful because they allow us to understand the problem with graphs. As the grading process is the most important and sensitive function of an education institution, control charts could be a tool to make it more

effective [18], it is a more reliable method which can work in the right direction for quality control in the education system. In a research carried out on students of higher education, an application of Statistical Quality Control has been conducted [3] in order to change students' Quantitative Results (QR) into Qualitative Grades (QG), it has been proved in the study that the new grading system (QG) is more reliable. Statistical Quality Control charts can be used to govern the discipline in the study where the education process goes on and it will be helpful to identify [10] rreasons that the learning and studying process will remain in controllable state. Assessment methods can be classified into categories [17] : qualitative, quantitative and mix of both. A comprehensive framework for assessment of engineering education has been carried out by the author.

Application of TQM concepts is one of such measures, which will go a long way in revolutionizing the higher education system. TQM is inevitably a common factor that will shape the strategies of higher educational institutions in their attempt to satisfy various stakeholders including: students, parents, industry and society as a whole [27]. 'leadership', 'vision', 'measurement and analysis', 'process control and evaluation', 'programs design and resources allocation' and 'stakeholder focus' emerge as the critical success factors of TQM in Higher Education [1]. However, it should be admitted that the quality of a learning process depends on co-operation between the learner and a robust learning environment [28]. The education system has changed in the 21st century as E learning and different pedagogy of teaching has been adopted by the education system, in such context TQM in education is an important factor which will be helpful to achieve the vision and short term objective of an education institution [13]. This paper tries to discover the application of control charts in the field of education for academic assessment of the student.

A. *Acronyms & Symbols:*

- **SQC (Statistical Quality Control):** The application of statistical techniques for measuring and improving the quality of processes. Statistical Quality Control includes statistical process control, diagnostic tools (pareto charts, flowcharts, fishbone etc.), Sampling plans, and other statistical techniques [12].
- **UCL=** Upper Control Limit
- **CL=** Central Line
- **LCL=** Lower Control Limit
- $\bar{\bar{X}}$ **=** Average of subgroups average
- $\bar{X}$**=** Average of subgroups
- $\bar{R}$ **=** Average of subgroup range
- $\bar{S}$ **=** Mean of the standard deviation
- **A2 =** constant depending on the subgroups size
- **A3=** constant depending on the subgroup size

II. OBJECTIVE

Study tries to identify the use of control charts to assess the performance level of students and also compare the academic performance of students in Theoretical and Numerical subjects. It permits to remove the assignable causes and improve the performance level of students.

III. CONCEPT AND METHODS

The study is exploratory and analytical in nature based on secondary data. Data was gathered through a non-probabilistic convenience sampling method. An attempt has been made to assess the academic performance of the students through Shewhart control charts. Study also compares the performance of the students in Theoretical subjects and their performance in Numerical subjects. 576 students of management discipline (First year) were considered as the sample of the study. Marks obtained by the students in their end semester final examinations conducted by Devi Ahilya Vishwavidyalaya Indore (Madhya Pradesh) were considered as a database for the study. These examinations were conducted for the academic year July 2018 - June 2019. First year of Management discipline includes two semesters where a group of three numerical subjects and five theoretical subjects (Total eight subjects) in each semester are being taught to the students. In one year of tenure, student studies total 16 subjects. The overall assessments of students were based on academic performance in both the groups in two semesters. Present study used X bar and S charts to assess the overall academic performance (club performance of Theoretical and Numerical subjects both) of students as well as in Theoretical subjects separately. While X bar and R charts were used to assess the academic performance of the student in Numerical subjects only. Three control limits of charts were drawn with the help of Microsoft Excel to analyze the data. When the observation goes out of the control limits, it indicates there are assignable causes present and hence there is a need to take corrective action to improve performance of students, assignable causes are those tangible causes which are responsible for the variations in quality and can be removed in order to maintain quality standards.

IV. RESULT

As UCL is the limit which represents the largest value expected from a process when assignable causes are present, while LCL is the smallest value expected with assignable causes [29]. There are some points in the process where points are outside the upper limit of control charts, indicating the higher level of performance whereas there are points which are outside the lower limit of control charts indicating the below standard performance of students.

Control charts for variables are used to monitor the process variability. Subgroups obtained for practical subjects less than 10 therefore X bar and R charts were used to analyze the performance of practical subjects, whereas X bar and S charts were used to analyze the overall performance as well as performance of students in theory subjects as the number of subgroups were greater than 10. Control limits were calculated with the help of formulas in Microsoft Excel.

TABLE I. CONTROL LIMITS USED FOR X BAR AND R CHART

Control limits used for X Bar and R chart				
S. No.	Control Charts	UCL	CL	LCL
1	$\bar{X}$ & R chart	$\bar{\bar{X}} + A_2\bar{R}$	$\bar{\bar{X}}$	$\bar{\bar{X}} - A_2\bar{R}$
2	R chart	$D_4\bar{R}$	$\bar{R}$	$D_3\bar{R}$
3	$\bar{X}$ and S chart	$\bar{\bar{X}} + A_3\bar{S}$	$\bar{\bar{X}}$	$\bar{\bar{X}} - A_3\bar{S}$
4	S chart	$B_4\bar{S}$	$\bar{S}$	$B_3\ \bar{S}$

TABLE II. CONTROL LIMITS FOR OVERALL PERFORMANCE

Control Limits for overall performance				
S. No.	Control Charts	UCL	CL	LCL
1	S chart	24.64	15.88	7.11
2	$\bar{X}$ & S chart	70.95	58.84	46.72

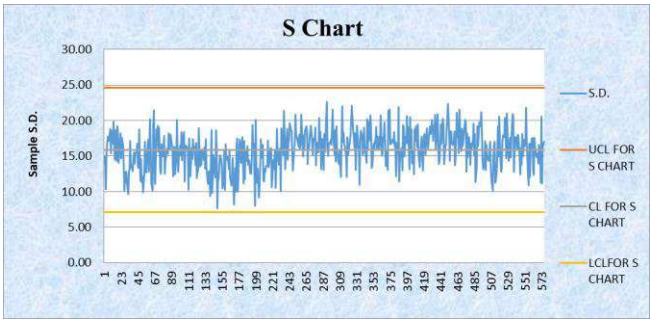

Fig 1: S Chart for all subjects

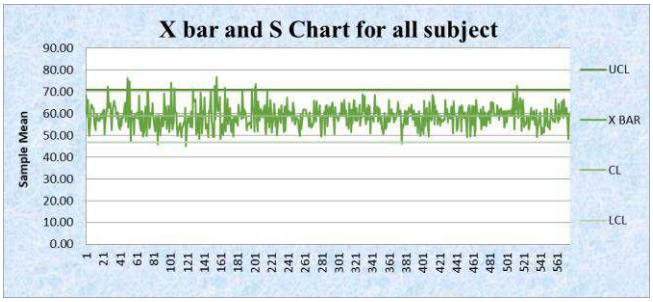

Fig 2: X bar and S Chart for all subjects

TABLE III. CONTROL LIMITS FOR NUMERICAL SUBJECTS

CONTROL LIMITS FOR NUMERICAL SUBJECTS				
S. No.	Control Charts	UCL	CL	LCL
1	R chart	95.59	45.22	0
2	$\bar{X}$ Chart	84.48	58.26	32.02

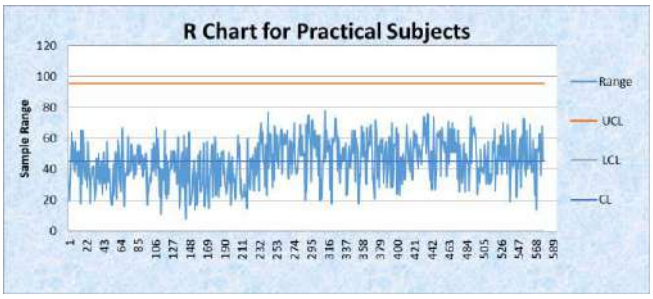

Fig 3: R chart for practical subjects

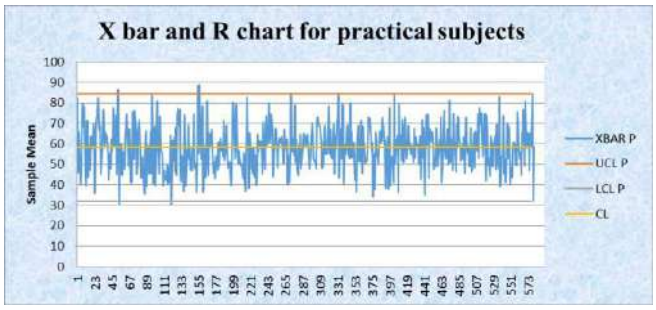

Fig 4: X bar and R chart for practical subjects

TABLE IV: CONTROL LIMITS FOR THEORITICAL SUBJECTS

Control Limits for theoretical subjects				
S. No.	Control Charts	UCL	CL	LCL
1	$\bar{X}$ chart	71.68	59.10	46.52
2	S chart	22.78	13.57	4.36

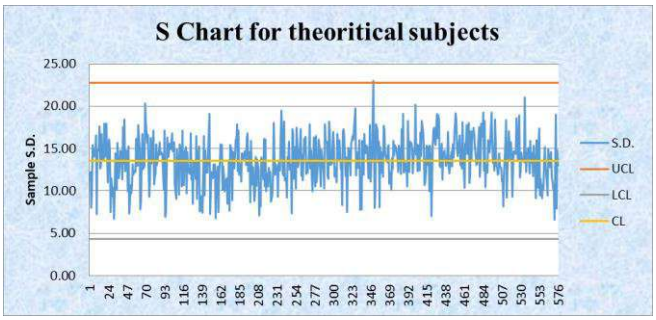

Fig 5: S Chart for theoretical subjects

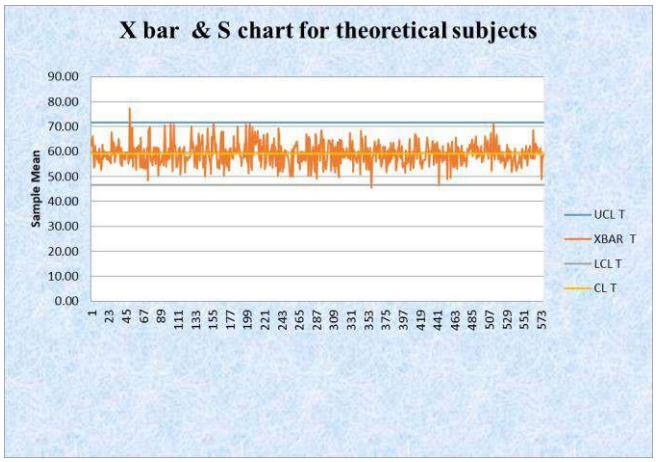

Fig 6: X bar and S chart for theoretical subjects

V. FINDINGS

Control charts are useful to determine whether process variability exists or not. students enrolled for management education goes through the fundamental roadmap of operations management i.e. input > process> output. As far as input is concerned students get enrolled for the management programme with a management institution. In the process part, students go through education/lecture delivered in classrooms or other teaching ads followed by assessment through examination. As an output students become learned and ready for placements or ready to start their own business or service venture. In this phenomenon the process part is longer and requires continuous and keen attention whether students are getting whatever is delivering into the class or through other teaching ads or not. This is possible though assessment of the students in their theoretical and practical subjects.

It have been observed that most of the students belong to the sample size are required to focus more on numerical subjects as the charts-3 and chart-4 suggested that students performance in numerical subjects lie near to lower control limit, which indicates in numerical subjects students have to put more efforts for better score. In theoretical subjects performance is near expectation which explicits students do possess better understanding about theoretical subjects and are better in writing the answers of theoretical questions. chart-5 and chart-6 suggested that performance of the students is upto satisfaction level in theoretical subjects. Overall academic performance is observed above satisfaction level as chart-1 and chart-2 suggested. In totality the overall academic performance level of the students is far better, which indicates students scored overall good marks as a whole.

VI. CONCLUSION

Statistical quality control has been a widely used statistical tool for the systematic assessment of variation in the quality of product since the beginning of the 20th century. It has also been applied in the service sector in order to assess the quality of service. Present study focuses on application of SQC in the education sector and attempts to assess student's academic performance with Shewhart control charts. This approach would help to understand problem areas graphically so that effective measures can be initiated or educational modules can be implemented that can ensure that students are developing their learning in accordance with the educational standards.

The academic performance of the student may be found to degrade their ability and competence due to improper or inefficient evaluation process. This study tries to outline the statistical way to understand, analyse and explain the key areas, where a student's academic performance is up to the mark or it needs improvement. The limitation in this regard is, there might be a variety of subjects (Theoretical/practical) like case analysis/case study where analysis done by students can not be measured or variation in the performance cannot be observed through statistical quality control.

Continuous and close observation is required to assess the academic performance of the students in order to maintain the quality education delivered in the classroom or through other teaching ads, control charts are useful to diagnose the areas where improvement is needed. Such measures are needed for the preparation of corrective measures which will lead to achieve the targeted performance level in academics and in other areas as well. The limitation in this regard is there might be variety of subjects (Theoretical/practical) like case analysis/case study where this approach may or may not be effective for the purpose of assessment of academic performance of the students.

In general, students take place in higher education institution to grow their subject knowledge, understanding and improving the skill set which are required to build their career in long run. Their efforts to develop the understanding about their study curriculum must be evaluate and analyze through an accurate and reliable valuation process. This study has attempted to device the application of statistical quality control for the comprehensive and reliable assessment of the academic performance of the students.

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Waste Management in Sri Lanka in line with European Union Techniques

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***Abstract*— The Sri Lankan scenario as far as waste management is concerned is not much enlightening. When the population was low, dump areas served the purpose of dumping garbage which rotted away given time. However, with increase in population and expansion of urban areas, dumping sights is being restricted. Solid Waste Management is mostly done by the municipalities and town/urban councils and at times their expertise is found wanting as there is a lack or weaknesses in the management system for collection, transporting and disposal. Waste generates mostly at a household level while the rest is generated from industries and plantations such as paddy cultivation et.el. This paper examines the means of taking advantage of research results from advanced countries like European Union (EU) and tailor same in line with the local needs.**

Keywords*— *waste, management, Sri Lanka, European Union, environment, sustainability

I. INTRODUCTION

More than the developed countries in the world, the developing country sector faces the problem in disposing the increasing volume of waste generated therein[1]. There is solid, water, increasing amounts of plastic, e-waste the volume of which has become at times unmanageable year after year. In 2014, it was estimated that big cities around the world, generated 1.3 billion tons of solid waste per year, amounting to a whopping amount of 1.2 kilograms per person, per day and no need to say that with urbanization and rapid population growth, the municipal waste generation is expected to go up to 2.2 billion tons (MT) by 2025[2]. In Sri Lankan case, it is estimated that each person generating around 0.64 kg waste per day with an estimated 4.8 billion MT of waste collected per annum in the country. As such, it is to our benefit that the extent of the problems is understood in its proper perspective so as to find solutions to this smelly, unhealthy problem.

Having given a general introduction above, it could be pointed out that mankind or humans as we call ourselves are the generators of most of the waster matter in the world. Not so, the other species whom we label as sub human. The non-human species generate the least of garbage. For instance their fecal matter such as droppings, dung is easily absorbed into the nature and their cadavers does not make much of an impact. On the contrary in addition to huge amounts of sewage generated by about 7 billion humans worldwide, human generate other types of garbage such as food left overs, discarded packaging materials, plastic waste such as pet bottles and a myriad of other stuff, all of which is thrown away to be disposed by their respective municipalities and local bodies[3]. When local bodies cannot dispose off the huge amount of garbage they are left over to rote on sidewalks thus creating health hazards et.el. After smothering the land area of the planet with garbage, human have turned oceans into garbage drops, dumping vast amount of treated and untreated sewage matter, liquid waste, toxics into the oceans. The impression was that the oceans having an area of 70% of the areal planet could be used intensively for human dumping activities. It is not so and the oceans have become polluted at times infecting the fish population which provides food for humans. It is reported that ocean bottom has mega ton after ton of plastics such as abandoned fish nets, plastics sheets threatening the sea creatures[4]. Even after having polluted the earth land mass and its oceans humans have now proceeded to dump waste matter into the stratosphere as well. It is said that there is lot of space debris circling the outer stratosphere of the earth[5]. These are abandoned satellites, parts of bombs detonated into the stratosphere and many others. It is now found out that these debris threaten the active Satellites as well as they are bound to crash into each other.

In this paper section II describes the Sri Lankan Scenario. A Commitment to Waste Reduction and New Approaches are given in sections III and IV. Conclusion is given in section V.

II. SRI LANKAN SCENARIO

A survey on waste amounts and Composition Surveys (WACS) conducted by the University of Peradeniya in 2014, revealed that, nearly three fourth of total waste is generated from kitchens.

TABLE I. THE BREAKDOWN CATEGORIES OF WASTE IN SRI LANKA

Biodegradable (ST) - Stent Thrombosis	56.57%
Biodegradable (LT) Lithium Thrombosis	5.94%
Paper	6.47%
Wooden	6.35%
Saw Dust/Paddy Husk	6.04%
Polythene/Plastic	5.19%
Building	3.89%
Metal	2.76%
Slaughter House	2.34%
Glass	2.03%
Others	1.6 %

It seems that there are a lot of Institutions that deal with Waste Management, the main institution being the Central Environmental Authority (CEA). Nevertheless, by its own

literature the CEA identifies certain weaknesses and challenges which hinder the proper execution of the management of waste.

The Challenges of Waste Management in Sri Lanka:

- One of the biggest problems in Sri Lanka is to manage the management of Solid Waste in a sustainable manner.
- The prevailing system of waste collection, transportation and disposal are yet to be resolved. It is possible to identify these issues which are discussed below as the challenges of Waste Management in Sri Lanka.
- Waste segregation: Segregation is the systematic process that waste is separated into different types. It can be done manually at a household level or mechanically. Basically, waste could be divided as dry and wet waste. Then, it could be further divided into solid waste, bio-degradable. non-biodegradable, toxic waste and recyclable waste. Thus far, we do not have a proper system or the proper practice of segregation at the generation or collection points. Every individual has the responsibility to practice such a segregation system. Nevertheless, only a few are practicing it.
- Waste collection and transport: Waste collection, storage and transporting of waste are essential elements of any Waste Management system and can be major challenges in towns and cities. As mentioned above, the collection of Solid Waste is done by the PS, TC and MCs. All 111 local bodies have been collecting waste to keep their territories clean. The Waste Management Authority of the Western Province is responsible for more than 60% of the total waste collection of the country. The Collection of waste from house to house and entire industries, commercial areas

There is enough literature written about Waste Management in Sri Lanka and in Developed countries. Rather than inventing the wheel, Sri Lanka could take advantage of research results from advanced countries and tailor same in line with the local needs. Advanced countries in Europe (EU) have come to the realization that today's 'take-make-dispose' economic model is wasteful and unsustainable. To this end, Governments, businesses, research institutes and NGOs are therefore exploring ways to reuse products or their components via the circular economy and restore more of their precious materials and energy. The European Union is on the forefront of this cutting-edge technologies and Sri Lanka could benefit enormously by connection to European Research, in addition to pursuing the problem of Waste Management on our own.

Currently the projects pursued by the European Union are very much in line with the strategy and priorities put forward by the new European Commission Parliament under the European Green Deal and the New Circular Economy Action Plan. Those are going to focus on sustainable resource use, specially in high impact and high resource-intensive sectors like construction and textiles. Europe's growing prosperity has resulted in the extraction and use of more resources, thereby producing more waste. Currently, on average citizen generates around 5 tons of waste per year, of which only a limited amount is recycled, most of the remainder is landfilled or incinerated. The challenge of managing increasing quantities of waste, particularly from growing urban areas, represents a significant cost to society and puts pressure on the natural environment. But this discarded material also represents a valuable resource, which can be exploited by embracing a more circular economy that reduces waste and allows for the continual use and re-use of resources. This will help to conserve Europe's environment and resources, as well as to protect society from the impacts of climate change.

III. A COMMITMENT TO WASTE REDUCTION

Thus it can be seen that boosting eco-innovative solutions in this way complies with the EU's Resource Efficient Europe policy which outlines how Europe's economy can be transformed into a more sustainable one and proposes ways to increase resource productivity and decouple economic growth from resource use and its environmental impact. In addition, EU has formulated a 'Waste Framework Directive' which establishes the basic concepts related to waste management, defining waste, recycling and recovery. The EU is thus committed to implementing the principles of the waste management hierarchy, which promotes the prevention of waste, its reuse and recycling and its energy recovery. This will need resource-efficient products and eco-innovative solutions, services and processes such as the model of urban metabolism, which analyzes the flow of materials and energy in cities. If Sri Lanka is interested we could obtain these research results from the EU.

IV. NEW APPROACHES

The EU's latest researches showcase innovative solutions proposed by new projects funded by the EU throughout the year 2020 that promote waste reduction and improved resource efficiency in the steel, textile, photovoltaic, construction industry, bulky and urban waste sectors. The initiatives that are focused on Industrial Symbiosis, is key driving material for realizing the next step in a circular economy with a pretty much reduction in Green House Gas emissions, and also its contribution to reaching a climate neutral economy by 2050 (zero emissions/zero waste), in line with the political guidelines which are formulated by a specialist Commission. Another EU project is tackling textile waste by creating a new circular economy concept which transforms it into feedstock for the textile and chemical industries. Also, another research is lowering demolition and construction waste via new standardized circular method of designing buildings, enabling the construction sector to repair, reuse and recover building materials. Moreover, EU has developed a circular economy for not only the photovoltaic (PV), but also the glass and electronic industries to form new business opportunities via the recovery of high-value materials found in End-of-Life PV panels. This indeed shows a new paradigm built on an

innovative industrial symbiosis model with the zero-waste method to the construction and demolition value chain. Meanwhile, another project is designing an innovative bulky waste management system to enhance waste prevention and encourage new forms of waste treatment to obtain high added value recycled products. Later, there is a project with the name "Waste4Think" which uses information and communication technologies to enhance all stages of the waste value chain, by adapting a global approach focused on participation of citizen to move for a circular economy and build more eco-friendly, sustainable cities.

Studies have identified several challenges, of which the absence of waste segregation, poor waste collection mechanisms and the lack of public commitment on waste management, to be some of the underlying causes of the prevailing issue. Hence, the existing systematic process on waste disposal, transportation and collection aspects are however supposed to be an issue that requires to be resolved. The reason for this is the lagging of technological knowledge, the lagging of awareness and education among the people on management of waste and the absence of applying 3R principles. In this context, awareness through education and a changing in attitude of the public may be suggested as precautionary methods towards maintaining a sustainable waste management system. The participation of the public is to be quoted as essential, and it should be borne in mind, that this is not a feat that can be accomplished via limited system, however rather one which required to be maintained and continued throughout ongoing tasks, by keeping the menace at a minimum. Therefore, a new model for waste management is needed for disposal, transportation and the collection of waste, which must neither be harmful to the environment nor to the society. The current policy on management of waste in the country need to be developed further by thinking the concept of alternative ways of waste management such as sanitary landfills, waste to energy, zero waste and the accelerating composting methodology, by leading the way towards increased sustainability.

As an afterthought, it would appear that the waste disposal problems constantly evolves. For example, now that the COVID-19 is at its height, face masks have become the newest form of waste. One can find face masks thrown carelessly even on roads in Sri Lanka, which could set a dangerous precedent. Add to that, increasing amounts of Medical waste such as used syringes, bandages disposed off into our rivers and waterways could form another threat to the Health scenario in Sri Lanka. Now that certain countries of the world has said to found a vaccine for COVID-19 in to the future one could find used syringes and connected waste aplenty in this country. Finally, it appears that waster is like hives of 'deadly' bees chasing humanity wherever it goes offering no respite / rest.

V. CONCLUSION

As a conclusion, it could be added that unlike say the COVID 19, Global Warming, Climate Change requiring multi faceted intervention by authorities and countries, which leaves very little space for individuals to operate and in the case of COVID 19, strictly observing the rules set out by the medical fraternity. It could be surmised that Waste Management offers individuals enormous space and time to operate with a view to solve the problem and invent a mechanism to deal with the problem. Waste Management is inherent on individuals as they are the consumers who throw away things after consumption, packaging included. If, say all house owners make it their determination to construct compost bins rather than burdening the local authorities with their mostly kitchen waste, a burden will be shifted from such authorities who could extend their efforts to deal with other forms of Waste Management and do away with pollution. They could extend their efforts to purify local waterways which are already waste carrying and polluted. When one has compost fertilizer to spare they could sell same or start a market garden thus earning money and also providing vegetables etc., to local consumers. Obviously the 'onus' falls on us, as citizenry of countries and by connect of the world.

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Health Care Provider Perception Towards Disaster Preparedness in Goa

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***Abstract*—The aim of this paper is to analyze healthcare providers' perception of health disaster preparedness in the pre-Covid-19 world in Goa. For this analysis, we have randomly surveyed 518 medical staff consisting of 123 doctors and 395 nurses working in Private Health Centres, Community Health Centres, Sub District Hospitals, District Hospitals, and Private Hospitals across Goa during 2018-2019. The survey collects information about the demographic characteristics of the responding health care professional, the type of hospital they work in, and their perception of preparedness on the five different disaster management parameters. These parameters include the available procedures for receiving clients, a defined disaster management committee, clear definitions of emergency protocols, adequate ambulance availability, and medical staff's preparedness. Our analysis revealed that the responders' demographic characteristics did not play much of a role in explaining their perception of various parameters of disaster management. However, the type of hospital they worked in and their field of work significantly defined their perception of disaster preparedness. The results show that healthcare providers working in government-managed hospitals and medical institutes were statistically significantly less likely to be satisfied with the current state of the considered disaster management parameters compared to healthcare providers working in private hospitals.**

Keywords—satisfaction, healthcare providers, probit model, disaster management

INTRODUCTION

According to Talati et al. (2014), hospital disaster is a unique challenge for every healthcare institution in terms of infrastructure. A disaster from the hospital's point of view exists when the client load exceeds the capabilities of an emergency department. As per the "Disaster Management Act, 2005" of India, it is mandatory for government hospitals in India to prepare a disaster plan

Doctors & nurses are important frontline warriors in any disaster management plan. These healthcare providers respond to health threats in the community, saving as many lives as possible (Slepski, Fernandez). HCP must form a committee to coordinate with state legislators, emergency management personnel, and policy-makers. Disasters data have shown a gap in education and training of HCPs at different levels, i.e., personal /system level.

A study by Ali & Ibaid, 2015 revealed that male participants were more likely to perceive themselves as prepared, have better knowledge, and have better skills than females. Crane et al. in Texas, United States, found in a logistic regression model that male participants were 1.32 times more likely to be prepared for managing bioterrorism disasters than female participants.

A study by Magnaye et al., 2011 & Mobi, 2009 revealed that the largest healthcare personnel group includes the nurses in hospitals who mostly work with limited resources. During any disaster, they play an important role as coordinators of client care and emergency services by serving as first responders and triage officers. However, healthcare systems and health care delivery in disaster situations will be successfully provided; nurses have the fundamental disaster competencies to respond to situations effectively.

Nurses' experiences and on-the-job training (Seyedin et al., 2015) affect their self-confidence, emergency preparedness, and management skills in disaster response, thus decreasing their vulnerability to unpredictable events. Due to inadequate disaster management guidelines, most nurses are not ready to face mass casualties, as they lack education and skills on preparedness.

The study on nurses' perception towards emergency nursing services during disaster situations (Afaf, 2018) highlighted that although they scored lower percent less than one-third of satisfactory perception regarding safety measures and triage skills. Yet, they had a satisfactory perception regarding the administration of medication skills. This result may be due to a lot of the studied nurses didn't perform triage technique in their hospital and had poor knowledge due to safety measures… Perception of Nurses' Regarding Role, Preparedness, and Management Skills during Hospital Disasters.

A significant and positive correlation existed between nurses' role, preparedness, and management of disaster with their age and years of experience in the present study. This with the study of Loke and Fung (2014) who noted a significant relationship between the nurses' demographic profile variables and their performance of nursing functions.

Landesman (2011) stated that nurses during disasters are organized according to specific functions and professional qualifications. The organized and well-coordinated effort is followed to avoid overlapping of responsibilities towards skillful disaster management procedures.

Kumar's (2012) stated that a fire accident in a major city of India led to the death of 89 bedridden clients due to inability to evacuate them immediately, of whom 85 were clients and 4 were staff members, while an explosion in an allegedly ill-maintained ambulance killed a one-day-old baby in Santacruz, NDTV, 2015). Yet another incident in Maharashtra reported by Pankaj & Sahi (2021) from India Today (Jan 9, 2021) disclosed that a nurse noticed smoke emanating from the ward and alerted doctors. The hospital (

Bhandara District General) staff tried to save the children. However, ten children died.

Janardhanan, A. (2015) divulged information on the Chennai flood that affected a tertiary hospital where 18 clients admitted in Intensive Care Unit (ICU) died due to failure of support system (monitors, ventilators, and lack of oxygen supply).

In BHU hospital (Varanasi), India, an oxygen cylinder blast resulted in 12 injuries in an emergency ward, killing 93 and injuring more than 120 people in a bomb explosion at a civil hospital in Quetta, the southwestern Pakistani province of Baluchistan.

Obinna et al. (2020) reported that the government and its institutions' response to the pandemic were rated as poor. Communication (50.0%) and prevention messages (43.7%) received the highest perception of good rating. The availability of social and economic support from the Federal Government(82.9%) had the highest poor rating score.

Sequeira, 2018 said that people lacked interest in disaster management. Goa's disaster management plan is ready but only on paper," as narrated by one of the government employees. The state has also failed to organize a statewide disaster management mock drill to test the efficiency after November 2009.

The study by Almutairi et al. (2020) found that stakeholders were of the opinion (92.9%), that specialized hospitals must be kept ready by the government to isolate clients with Covid-19. While (94.7%) agreed for travel restriction from affected areas by Covid-19 and (93.6%) felt safe that the government initiated curfew and implemented restriction periods.

DATA AND METHODOLOGY

For our study, we have randomly surveyed 518 medical staff consisting of 123 doctors and 395 nurses working in Private Health Centres, Community Health Centres, Sub District Hospitals, District Hospitals, and Private Hospitals across Goa during 2018-2019.

Study participants included doctors and nurses of selected north and south districts of Goa. Ethical clearance was obtained from the Directorate of health services, Goa, and a private hospital in Goa. The healthcare providers required at least one year of experience to be able to participate in the study, as this would enable them to be familiar with the policies and procedures of the ward /hospital setting. Doctors and nurses in the internship period were excluded from the study. The head of the respective hospital/center was approached, and permission was taken to hand over the sets of a structured questionnaire to the participants. A sampling frame was prepared, which included every third person from the list provided by the ward in which they were working. HCPs who were available and agreed to be a part of the research study and were on duty at the time of data collection were provided with a structured questionnaire after explaining the need for study, and consent was obtained for the same. Each HCP was approached individually in their working area.

This paper uses probit models to establish the relationship between socio-demographic variables and the perception of healthcare workers on the considered parameters of disaster management preparation. These parameters are:

- Available procedures for receiving clients
- A defined disaster management committee
- Precise definitions of emergency protocols
- Adequate ambulance availability
- Medical staff's preparedness

Our analysis is conducted by estimating models denoted by equations 1-5. The dependent variables Y_1, Y_2, Y_3, Y_4 and Y_5 represents whether the healthcare provider is satisfied with the current situation of availability of procedures for receiving clients, defined disaster management committee, definitions of emergency protocols, adequate ambulance availability, and medical staff's preparedness, respectively. It is equal to 1 if the healthcare is satisfied and 0 if not.

$$Y_{1_i}^* = X_i'\beta + \epsilon_1$$
$$Y_{1_i} = 1, \quad if \quad Y_{1_i}^* > 0 \text{----------(1)}$$
$$Y_{1_i} = 0, \quad if \quad Y_{1_i}^* = 0$$

$$Y_{2_i}^* = X_i'\beta + \epsilon_2$$
$$Y_{2_i} = 1, \quad if \quad Y_{2_i}^* > 0 \text{----------(2)}$$
$$Y_{2_i} = 0, \quad if \quad Y_{2_i}^* = 0$$

$$Y_{3_i}^* = X_i'\beta + \epsilon_3$$
$$Y_{3_i} = 1, \quad if \quad Y_{3_i}^* > 0 \text{----------(3)}$$
$$Y_{3_i} = 0, \quad if \quad Y_{3_i}^* = 0$$

$$Y_{4_i}^* = X_i'\beta + \epsilon_4$$
$$Y_{4_i} = 1, \quad if \quad Y_{4_i}^* > 0 \text{----------(4)}$$
$$Y_{4_i} = 0, \quad if \quad Y_{4_i}^* = 0$$

$$Y_{5_i}^* = X_i'\beta + \epsilon_5$$
$$Y_{5_i} = 1, \quad if \quad Y_{5_i}^* > 0 \text{----------(5)}$$
$$Y_{5_i} = 0, \quad if \quad Y_{5_i}^* = 0$$

In the above equations, X_i is a vector of individual-level characteristics, β is a vector of parameters, and ε_{1i} is the error term that is normally distributed. The above probit equations are estimated by the maximum likelihood method.

RESULTS

Table 1 gives the summary statistics for all the independent and dependent variables considered in our analysis. Whereas table 2 gives the marginal effect estimates for the probit analysis done to study the impact of individual-level variables on their satisfaction level on the considered parameters of disaster preparedness.

From table 2, the first thing we observe that for almost all the criteria considered for disaster preparedness, we find hospital type to be statistically significant in determining it.

TABLE 1: RESPONSES OF HEALTHCARE PROVIDERS ON DEFINING CHARACTERISTICS OF DISASTER MANAGEMENT BASED ON THE INDIVIDUAL'S SOCIO-DEMOGRAPHIC

Variable	Composition
Dependent Variables	
(% of responders satisfied)	
Adequate procedure for receiving and triage of Clients	64.29%
Disaster Committee has been constituted	50.97%
Emergency Protocols are clearly defined	63.32%
Hospitals ensure timely availability of ambulance service	73.55%
Hospital staff are well equipped to deal with any disaster	57.14%
Independent Variables	
Gender	
Male	18.41%
Female	81.59%
Education Level	
Diploma	42.08%
Graduate	28.38%
Postgraduate and above	29.54%
Years Of Experience	
<5	43.30%
>5-10	23.88%
>10-15	15.73%
>15-20	7.38%
>20	9.71%
Income	
<25,000	39.30%
25001-50,000	31.71%
>50,000	28.99%
Working Field	
OPD/Casualty/Emergency	30.17%
Indoor	69.83%
Medical Staff	
Nurses	76.25%
Doctors	23.75%
Hospital Type	
Primary Health Centre (PHC)	10.04%
Community Health Centre (CHC)	12.93%
Sub District Hospital (SDH)	35.91%
District Hospital (DH)	22.39%
Private Hospital	18.73%

[a.] Source: Health care provider's perception database collected by the authors

On all the parameter, the government managed hospitals seems to underperform the private-owned hospitals in Goa. We start with the most basic but essential parameter, the disaster management committee, and a clear definition of emergency protocols. We observe that that healthcare providers at Community Health Centre (PHC), Sub District Hospital (SDH), and District Hospital (DH) were 27.2%, 18.9%, and 37.9%, respectively, less likely to be satisfied with the state of the disaster management committee as compared to the healthcare providers in private hospitals. Similarly, medical staff at Primary Health Centre (PHC), Community Health Centre (CHC), Sub District Hospital (SDH), and District Hospital (DH) were 34%, 23.1%, 25.4%, and 33.5%, respectively less likely to be satisfied with the state of emergy protocols definitions as compared to the medical staff at private hospitals.

Further, we observe that healthcare providers at PHC, CHC, and DH were 27.4%, 42.9%, and 24.1%, respectively, less likely to be satisfied with their current availability of procedures for receiving clients than the healthcare providers in private hospitals. Similarly, when we analyze the satisfaction level for ambulance availability, we observe that the healthcare providers at CHC, SDH, and DH are statistically significantly less satisfied (17.5%, 15.6%, and 25.4%, respectively) when compared to health care workers at private hospitals. Finally, when we consider the healthcare workers' perception of the medical staff's preparedness to deal with the casualties during a disaster, we find a similar pattern of healthcare workers in government hospitals being less likely to be satisfied with their training (CHC: -37.3%, SDH: -25.3%, DH: -34.3%) as compared to healthcare providers in private hospitals.

When we consider the effect of other variables in our analysis, we find that most of them don't play a significant role in explaining healthcare workers' satisfaction on disaster management preparedness parameters. Table 3 shows that the years of experience has a major significant role in explaining the satisfaction level for current availability of procedures for receiving clients and shows that as compared to medical staff with experience less than five year, more experienced staff are less likely to satisfied with the current state of this preparedness parameter. Similarly, doctors also seem to be less satisfied with the current state of availability of procedures for receiving clients during disasters in their respective hospitals as compared to nurses. When we look at the effect of the field of working on the healthcare providers' satisfaction with preparedness for disaster management, we observe that healthcare providers working in indoor services were significantly more likely to be satisfied with the current state of the disaster management committee, emergency protocol definition and medical staffs' preparedness as compared to healthcare providers working in OPD/Casualty/Emergency.

Table 2: Satisfaction of healthcare providers based on their socio-demographic variables

Variable	Receiving Clients	Disaster management Committee	Protocol Definition	Ambulance Availability	Staff Equipped
Gender					
Male	(Reference)				
Female	0.0396	0.111*	0.0774	-0.0196	0.0593
	(0.0623)	(0.0633)	(0.0638)	(0.0602)	(0.0654)
Education					
Diploma	(Reference)				
Graduate	-0.0207	-0.000715	-0.0309	0.0525	-0.0289
	(0.0543)	(0.0556)	(0.0540)	(0.0505)	(0.0571)
Post graduate and above	0.0255	-0.0560	-0.0563	-0.0147	0.0205
	(0.0526)	(0.0562)	(0.0540)	(0.0533)	(0.0562)
Experience					
<5	(Reference)				
>5-10	-0.180***	0.000194	-0.150***	0.0193	-0.0514
	(0.0545)	(0.0569)	(0.0546)	(0.0516)	(0.0567)
>10-15	-0.168***	-0.0371	-0.0985	-0.0314	-0.0940
	(0.0626)	(0.0653)	(0.0620)	(0.0612)	(0.0651)
>15-20	-0.168*	-0.132	-0.168*	0.101	-0.149
	(0.0902)	(0.0887)	(0.0884)	(0.0743)	(0.0927)
>20	-0.211**	0.141*	-0.0594	0.00106	-0.0672
	(0.0835)	(0.0812)	(0.0797)	(0.0781)	(0.0833)
Income					
<25,000	(Reference)				
25001-50,000	-0.00779	-0.00493	-0.0783	0.0393	-0.0445
	(0.0557)	(0.0588)	(0.0567)	(0.0544)	(0.0587)
>50,000	0.188***	0.223***	0.109*	0.0873	0.102
	(0.0565)	(0.0650)	(0.0605)	(0.0613)	(0.0660)
Working Field					
OPD/Casualty/Emergency	(Reference)				
Indoor	0.0197	0.154***	0.134***	0.0690	0.165***
	(0.0472)	(0.0482)	(0.0485)	(0.0472)	(0.0491)
Medical Staff					
Nurses	(Reference)				
Doctors	-0.140**	0.0457	-0.000326	0.0831	0.0567
	(0.0678)	(0.0687)	(0.0656)	(0.0595)	(0.0683)
Hospital Type					
Private Hospital	(Reference)				
Primary Health Centre (PHC)	-0.274***	-0.0657	-0.340***	-0.0563	-0.120
	(0.0845)	(0.0851)	(0.0809)	(0.0676)	(0.0814)
Community Health Centre (CHC)	-0.429***	-0.272***	-0.231***	-0.175**	-0.373***
	(0.0752)	(0.0797)	(0.0724)	(0.0716)	(0.0781)
Sub District Hospital (SDH)	-0.0878	-0.189***	-0.254***	-0.156***	-0.253***
	(0.0538)	(0.0602)	(0.0530)	(0.0486)	(0.0581)
District Hospital (DH)	-0.241***	-0.379***	-0.335***	-0.254***	-0.343***
	(0.0662)	(0.0667)	(0.0626)	(0.0615)	(0.0668)

a. Standard errors in parentheses

b. * p < 0.10, ** p < 0.05, *** p < 0.01

c. Source: Health care provider's perception database collected by the authors

CONCLUSION

The paper gives insight into the institutional preparedness of health units in the pre-COVID 19 Goa. COVID-19 pandemic has shown the world to invest in the healthcare sector, especially from the disaster management perspective. Our analysis shows that healthcare workers' satisfaction level on the disaster preparation parameters in government-managed health is much lower as compared to private hospitals. This shows the government's lack of investment in this area, and there is a need to study how it has affected the government of Goa's response to the pandemic. We hope that the government learn from the crippling of healthcare systems around the world and invest optimally in an accountable and transparent manner and surpass the benchmark set by the private players in disaster handling.

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Improving the Productivity of the Machining Process of a Manufacturing Company - A Six Sigma Case Study

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***Abstract*—Micro, Small and Medium Enterprises (MSMEs) generally face problems maintaining high productivity levels in their processes due to various reasons including lack of skilled workforce and unawareness of quality tools. Low productivity in the manufacturing process results in high costs, low profits and sometimes, losses. Hence, it is crucial that productivity be increased in order to minimize the losses. In this study, the productivity of the machining process of Pole (50 XT), which is used in public address (PA) driver unit, was improved. To achieve this, DMAIC (Six Sigma) methodology was used. The process capability was increased with the help of control charts and Ishikawa diagrams. In addition to this, the process mean was shifted to better comply with specifications after surface treatment. When compared to the original process, an improvement of approximately 10 seconds in production time per piece and 15.7 percent in process productivity were achieved.**

Keywords—Quality, Six Sigma, DMAIC, Productivity, Manufacturing, MSME

I. INTRODUCTION

The manufacturing sector is crucial to the economic growth of a country. Manufacturing sector in India has witnessed significant growth in the past few years. The Government of India has launched many initiatives such as 'Make in India' for the growth of this sector, recognizing the opportunities that underlie this sector for the growth of economy and the potential to generate large-scale jobs. Under this initiative, the government aims to increase the share of manufacturing sector to the country's GDP to 25% by 2025 [1]. About 31% of all MSMEs in India are of manufacturing nature and have an employment share of 32% [2]. During the years 2011-2016, MSMEs contributed about 33% towards the country's overall manufacturing Gross Value of Output [3]. In this emerging scenario, MSMEs need to improve their efficiency and productivity to be able to compete both in the local and global markets.

Productivity is a measure of the efficiency of production. It is measured as the ratio of an aggregate output to a single input. In this study, productivity has been calculated based on effective production time per good piece manufactured. The causes of low productivity include ineffective use of resources, poor information flow, non-productive activities, low labor productivity, excessive rework, and excessive inventory [4].

This study shows the implementation of DMAIC (Define-Measure-Analyze-Improve-Control) methodology which is most often associated with Six Sigma activities. Almost all implementations of Six Sigma use this methodology for project management and completion. Quality tools such as histogram, check sheet, pareto chart, cause-and-effect diagram (Ishikawa diagram), defect concentration diagram, scatter diagram and control chart are beneficial to productivity improvement. These are often called 'The Magnificent Seven' [5]. The application of some of 'the magnificent seven' is demonstrated in this study.

There are limited studies available on improvement of productivity in the MSME sector in India. Undertaking the task of quality/productivity improvement requires resources such as time and money amongst other efforts on the organization's part. This study contributes in by providing a case study utilizing Six Sigma methodology to achieve improvement in productivity. A roadmap for improving the quality and productivity of the machining stage of the production process of a manufacturing MSME is presented in this study.

II. OVERVIEW OF SIX SIGMA

Six Sigma is a structured methodology that focuses on reducing variations, assessing defects, and enhancing the quality of products, processes, and services. Originally developed by Motorola in the 1980s, a Six Sigma process is one which targets a goal of 3.4 defects per million [6]. In 1995, Jack Welch made Six Sigma principal to his business strategy at General Electric. Six Sigma is a method that provides organizations with data-driven decision-making tools to improve the capability of their business processes. There are three aspects that Six Sigma addresses: process, defects, and variation. Process is the set of repetitive steps that are performed to achieve some result. Six Sigma implementation involves studying the process and making it as efficient as possible. Defects are the measurable features of the process or its output that do not conform to specifications. Six Sigma helps in eliminating the defects and maintaining consistency thereafter. Variation refers to any significant difference between standard measurement and actual output of the process [7]. Six Sigma helps reduce the variations by utilizing statistical tools to target a goal of 3.4 defects per million as mentioned before. This study primarily focuses on the 'variation' aspect of Six Sigma.

III. CASE STUDY

This case study is conducted on XYZ company which is an Indian MSME and a manufacturer of speaker and loudspeaker parts. The company is engaged in B2B sales.

They have been raising concerns regarding productivity of their machining process. They have observed an excessive number of pieces being reworked due to inconsistency in critical dimension. This study shows the productivity improvement project undertaken by the company. This case study follows the DMAIC methodology which comprises of 5 phases: Define, Measure, Analyze, Improve and Control. The define phase helps understand the problem by clearly pronouncing the problem as well as the goal, scope etc. [8]. The measure phase is the data collection stage, its purpose is to measure and establish the process performance baselines [9]. In the analyze phase, causes and root causes of the problem are identified. The improve phase is aimed at identifying, testing, and implementing a solution to the problem. Control phase involves tracking of improvements made to sustain gains and ensuring corrective action is taken when necessary [10].

A. Define

In the define phase, a SIPOC (Suppliers-Inputs-Process-Outputs-Customers) diagram is created to map the complete process for the manufacturing of the component 'Pole (50 XT)'. SIPOC diagram is a Six Sigma tool which is used to document business processes. It visually documents the business process from start to finish [11]. The SIPOC diagram for the process is shown in fig 1.

It was identified that the finish turning process, which generates the critical dimension, resulted in the maximum number of pieces that required reworking. Hence it was selected for productivity improvement. A drawing of the component showing the critical dimension is shown in fig 2.

The machining process is as follows: First, rough turning of the faces and diameters, keeping allowances of 0.5mm on the face and 0.3mm on the diameter is done. Then, finish turning of all dimensions is carried out. Thereafter, grooving, drilling and bore finishing with internal radius machining is done. The tools, parameters and cutting fluid used are as shown in Table 1.

TABLE I. TABLE 1: TOOLS, PARAMETERS AND CUTTING FLUID

Process	Tool used	Cutting parameters	Cutting fluid
Turning	Holder: PCLNL 2525M12 Insert: CNMG 120408	Constant 1500 rpm Feed = 0.2~0.3mm/rev DOC = 0.7~1.2mm (roughing) 0.3~0.5mm (finishing)	Non-synthetic, water soluble cutting fluid used in flood condition directly on cutting edge.
Grooving	Special purpose holder Insert: SOMT 060204	Constant 800 rpm Feed = 0.06mm/rev	
Drilling	U-drill: dia = 26mm Insert: SPMG 07T308	Constant 1000 rpm Feed = 0.04mm/rev	
Boring	Boring bar: dia=20mm Insert: CNMG 120408	Constant 1500 rpm Feed = 0.2~0.3mm/rev	

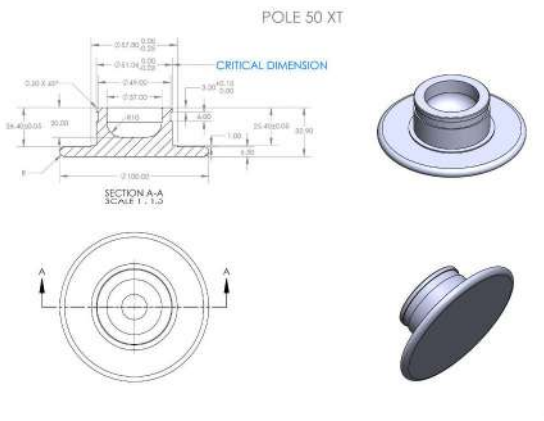

Fig. 2. *Component Drawing*

B. Measure

In the measure phase, the process was examined without any alteration. The CTQ (critical to quality) considered was the critical dimension as mentioned in the define phase. Variation beyond specification limits in this dimension causes variable air gap in the diaphragm coil resulting in inefficient output of the speaker. After machining, the critical dimension was measured with the help of a micrometer. For conducting the study, 28 batches of components containing 5 samples each were randomly selected over the course of 7 days. They were then used to plot control charts on a time scale according to the time of the day the samples were taken [12]. Fig. 3 shows a histogram of the total sample and figs. 4 and 5 show $\bar{X}$ and R charts of the sample data, respectively. It was observed from the control charts that the process was not in control. The process capability indices and production time per good piece were calculated as follows:

1) Process capability indices:

$$C_p = \frac{USL - LSL}{6\sigma} = 0.7143$$

$$C_{pk} = min\begin{cases}\dfrac{USL - \bar{\bar{X}}}{3\sigma} \\ \dfrac{\bar{\bar{X}} - LSL}{3\sigma}\end{cases} = 0.7143$$

2) Production time per good piece: The data for 140 samples showed that 32 pieces required rework. Each piece required 54 seconds of complete cycle time (including loading and unloading time). Each rework also required the same cycle time. Hence effective cycle time for manufacturing a good piece is:

$$Time/good\ piece = \frac{140\times(54)+32(54)}{140} = 66.34\ seconds$$

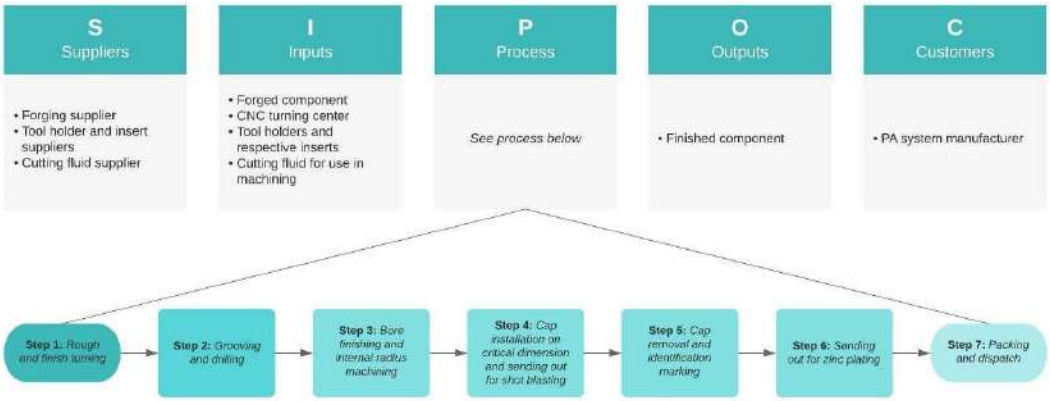

Fig. 1. *SIPOC Diagram*

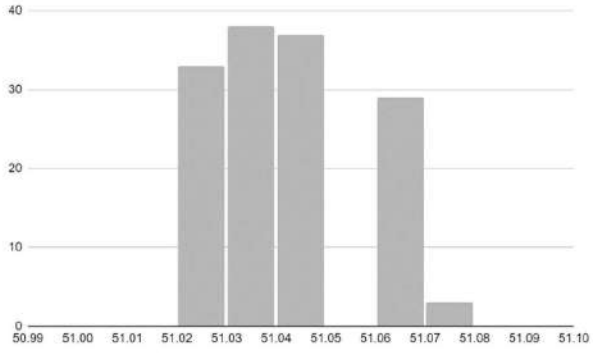

Fig. 3. *Histogram*

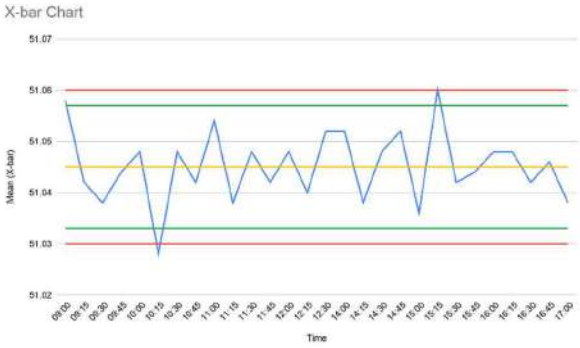

Fig. 4. $\bar{X}$ *control chart (Legend: :* $-$*USL and LSL;* $-$ *UCL and LCL;* $-\bar{\bar{X}}$*;* $-$*Plot of* $\bar{X}$ *w.r.t. time..)*

C. *Analyze*

In the analyze phase, a cause-and-effect diagram was made to list the possible causes of variations observed in the process. Fig. 6 shows the cause-and-effect diagram of the problem. After careful consideration, the root causes were identified as follows:

At the start of the shift, the chart shows that mean of the samples is beyond the upper control limit. The cause for this variation was identified as 'cold start' of the machine. When the machine is shut down for a long duration, all machine components tend to shrink to their minimum dimensions. After running for some duration, all the machine parts reach

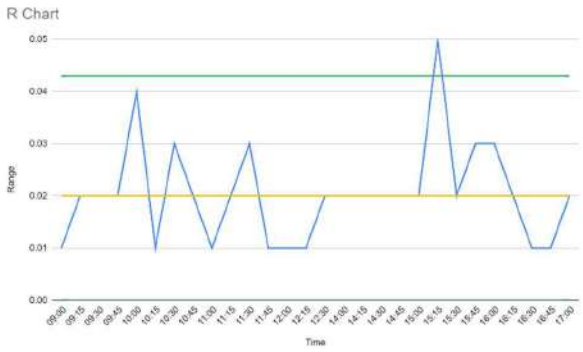

Fig. 5. *Range chart (Legend:* $-$*UCL and LCL;* $-\bar{R}$*;* $-$ *Plot of R w.r.t. time.)*

their operating temperature. This was the root cause for variation at the start of shift. The cause for a sudden dip in the chart was attributed to 'overcorrection' resulting from wrong inspection of the size. The root cause for sudden spike in the chart was attributed to defective forging, which on analysis showed chill points along the machined surface. Its effect is also reflected in the R-chart.

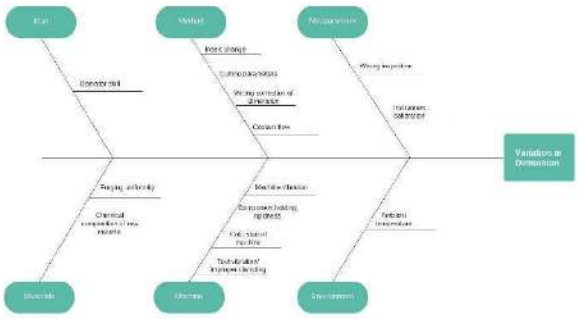

Fig. 6. *Cause-and-effect diagram*

D. *Improve*

In the improve phase, the following improvements were made: To address the problem of cold start, it was practiced to

run the machine idle for at least 5-10 minutes after starting it for the first time in the shift. During this period, the machine lubrication cycle was also run manually while moving the slides to ensure that the machine attains a working temperature while getting forced lubrication of all the moving parts. Inspection using a micrometer sometimes creates a problem of wrong inspection. Instead, snap gauges were introduced which helped in easy inspection while also reducing the skill, time of inspection and the idle time. The problem of defective forging was discussed with the forging supplier. The supplier was requested to check the chemical composition of each rod before cutting them to be used for component forging and to ensure that there is no instantaneous cooling of forged components. Also, the process mean (mean dimension) was shifted towards 51.04 mm as opposed to 51.045 mm previously with the objective of keeping dimensional allowances within specification limits after zinc plating (of thickness 3-5 microns) of the component.

E. Control

In the final stage, that is the control phase, the process was re-sampled for 7 days as before and control charts were again plotted on a time scale according to the time of the day the samples were taken. Fig. 7 shows a histogram of the total sample and figs. 8 and 9 show $\bar{X}$ and R charts of the sample data, respectively. The process capability indices and production time per good piece were calculated as follows:

1) Process capability indices:

$$C_p = \frac{USL - LSL}{6\sigma} = 1.3021$$

$$C_{pk} = min\begin{cases}\dfrac{USL - \bar{\bar{X}}}{3\sigma} \\ \dfrac{\bar{\bar{X}} - LSL}{3\sigma}\end{cases} = 0.9549$$

2) Production time/good piece: The data for 140 samples showed that 5 pieces required rework. Each piece required 54 seconds of complete cycle time (including loading and unloading time). Each rework also required the same cycle time. Hence effective cycle time for manufacturing a good piece is:

$$Time/good\ piece = \frac{140\times(54)+5(54)}{140} = 55.93\ seconds$$

3) Process capability improvement: Improvements of 82.29% (C_p) and 33.68% (C_{pk}) were accomplished.

4) Productivity improvement: The effective time required for producing a good piece went down from 66.34 seconds to 55.93 seconds. Hence productivity improvement accomplished was:

$$\frac{66.34 - 55.93}{66.34} \times 100 = 15.7\%$$

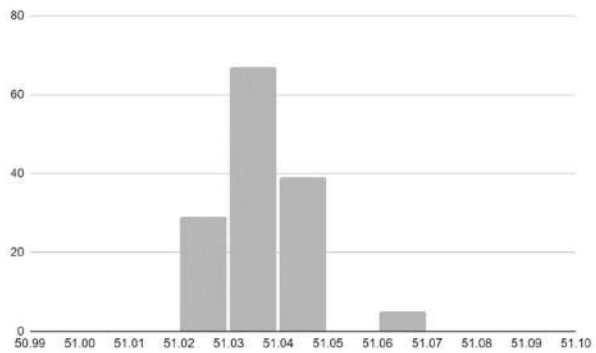

Fig. 7. *Histogram*

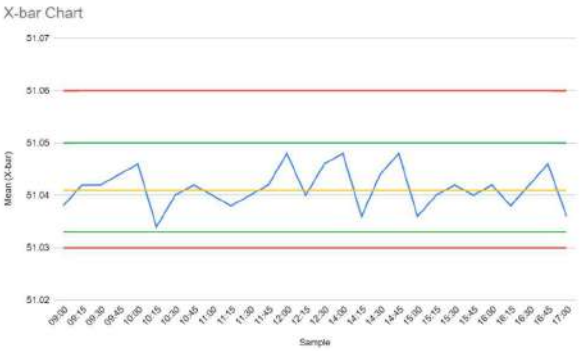

Fig. 8. *$\bar{X}$ control chart (Legend: –USL and LSL; –UCL and LCL; –$\bar{\bar{X}}$; –Plot of $\bar{X}$ w.r.t. time.)*

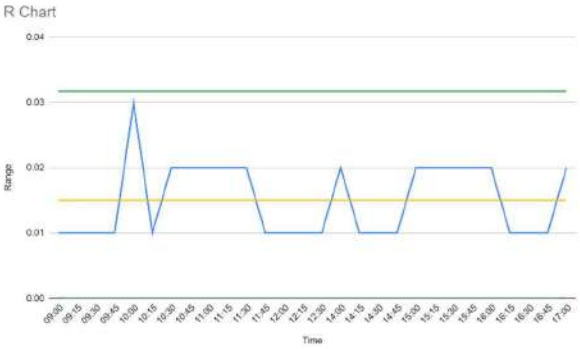

Fig. 9. *Range chart (Legend: –UCL and LCL; –$\bar{R}$; –Plot of R w.r.t. time.)*

IV. Conclusion

This study presents an implementation of the DMAIC (Six Sigma) methodology to improve the productivity of the machining process of a manufacturing MSME. Baseline measures in the form of process capability indices and production time per good piece were established, control charts were prepared and shortcomings in the process were identified. Root causes were identified with the help of Ishikawa diagram. Various measures were put into place to eliminate the root causes. Improvements of 82.29% (C_p), 33.68% (C_{pk}) and 15.7% in productivity were accomplished.

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Groundwater Level Estimation using Recurrent Neural Networks: A Case Study of the Grootfontein Aquifer

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***Abstract*—Precise estimation of groundwater levels is essential for the management and sustainability of groundwater resources. The main objectives of this study are therefore (1) to quantify the influence of groundwater extraction, precipitation, temperature and discharge on the prediction of groundwater levels in the Grootfontein aquifer, (2) predict groundwater levels under different climate and groundwater extraction conditions using a recurrent neural network and (3) compare results of each case scenario with the base case for analysis. Selected datasets from feature analysis were fed into a recurrent neural network architecture to simulate the seasonal groundwater level changes. Feature analysis results revealed that the variables selected indeed had a strong influence on the prediction of groundwater levels on the selected boreholes. Discharge, groundwater abstraction and precipitation were the highest contributing factors to groundwater level fluctuation. A recurrent neural network model was used to simulate different case scenarios. The model results reveal that the neural network model was able to predict groundwater level change under the adjusted input variables. Groundwater level fluctuations were no more than 2 m below the base case for all scenarios tested. The deep learning techniques introduced in this study to estimate groundwater level change under different case scenarios can be convenient for groundwater management as drought warnings and/or water restrictions could be issued in a timely manner. We therefore suggest the use of the modelling framework used as an alternate approach to simulating groundwater level change specifically in areas where subsurface properties are not known.**

***Index Terms*—recurrent neural networks, long-short term memory, groundwater levels, prediction, scenario testing, groundwater sustainability**

I. Introduction

In many countries groundwater plays a crucial role in supplying water to a significant part of the population for industrial, agricultural and drinking purposes. One of the most invaluable resources in semi-arid countries such as South Africa is groundwater [1]. Groundwater supplies are often less susceptible to drought than surface water due to the larger reservoir. Where surface water, such as lakes and rivers, are scarce or inaccessible, groundwater supplies many of the hydrologic needs of people. In South Africa, groundwater resources not only provides water supplies for domestic use but also for the mining, agricultural and tourism industries [2]. However, due to extreme changes in weather conditions and the increase in population resulting in higher groundwater extraction rates, groundwater resources have been under enormous stress [2].

The Grootfontein dolomite aquifer is located in the North West Province of South Africa. The aquifer serves as a key source of water supply for municipal and irrigation purposes. Several ecosystems, wetlands and towns such as Mahikeng, Litchenburg and Grootpan rely on the aquifer as their main source of water [3]. The aquifer is also ecologically important in supplying springs that feed important rivers.

In 2017, groundwater levels in the Grootfontein aquifer had fallen by more than 28m compared to their pre-abstraction levels. This drop has been attributed to high groundwater extraction rates in the region [3]. In this context, it is evident how improved understating of groundwater level response to pumping and climate change are essential for sustainable planning and management of groundwater resources particularly in areas of changing weather conditions and increasing groundwater demands such as South Africa.

Machine learning models based on non-linear interdependence's serve as an attractive alternative to the traditional physical process models. One of the challenges in using physical process based models is their large data requirements for model development and calibration [4]. Machine learning

models on the other hand are able to predict groundwater level changes without the deep knowledge of the underlying physical processes making them a more appealing choice. These models recognize patterns hidden in historical data and then uses those patterns for future prediction [5].

The Grootfontein aquifer was selected as the focus of this study. Temporal data including monthly temperature, precipitation, natural groundwater discharge from a groundwater-fed spring and groundwater extraction were used as model inputs and groundwater levels from four monitoring boreholes as model outputs. Root mean squared error (RMSE), mean absolute error (MAE) and r-squared (R^2) were used as model evaluation metrics.

The main objectives of this study are therefore (1) to quantify the influence of groundwater extraction, precipitation, temperature and discharge on the prediction of groundwater levels in the aquifer, (2) predict groundwater levels under different climate and groundwater extraction conditions using a recurrent neural network and (3) compare results of each case scenario with the base case.

To quantify the relationship between each feature and the groundwater levels mutual information was performed. Mutual information results revealed that the variables selected indeed had an impact on the groundwater levels at the borehole sites selected for modelling with abstraction, precipitation and discharge carrying the highest weights. Using a recurrent neural network model specifically the Long Short-Term Memory (LSTM), different case scenarios were tested and each case scenario modelled was compared to the base case for analysis. Numerous studies have successfully predicted groundwater levels using recurrent neural networks; however, the way to take into account various case scenarios under specific weather conditions or using specific groundwater extraction cases is not well apprehended. Necessities are more into simply predicting groundwater levels. We therefore suggest the use of the modelling framework used in this study as an alternate approach to simulating groundwater level change specifically in areas where subsurface properties are not known.

This document is structured as follows: Section II discusses the contributions of machine learning in the domain hydrogeology; Section III will focus on data acquisition, data preprocessing, and model development; Section IV will outline and discuss the findings of the study and Section V will conclude this paper and also offer recommendations for future work.

II. Literature Review

The introduction of big data and machine learning in hydrology has brought about significant new advances in the sustainable management of groundwater resources around the world. By assessing data and using it to learn themselves, machine learning models can identify complex patterns present in the data for future analysis. Due to their ability to model complex nonlinear relationships, artificial neural networks (ANNs) have been the most widely used algorithms when studying hydrological systems particularly feed forward neural networks (FFNNs) and recurrent neural networks (RNNs) [6].

As previously highlighted machine learning models offer several advantages over the process based models. Recent studies suggest that data driven models can achieve performance comparable to or at times even more accurate than process based models. [7] conducted a comparative study between machine learning models and groundwater flow models to simulate groundwater dynamics in the Heihe River Basin in northwestern China. MODFLOW (a computer code that solves the groundwater flow equation) was used to simulate the groundwater dynamics together with three different machine learning algorithms; support vector machines, multiplayer perceptron and, radial basis function network. Results revealed that the accuracy of the machine learning models was significantly better than the groundwater flow model. The groundwater flow model achieved a coefficient of determination (R^2) score of 0.51 while the multilayer perceptron, radial basis function network and support vector machine achieved R^2 scores of 0.71, 0.75 and 0.76 respectively, proving capabilities of machine learning techniques in groundwater level prediction.

[8] also did a comparative study between artificial neural networks and the groundwater flow model to simulate groundwater levels in Aghili plain, urban area of Gotvand in southwest Iran. A groundwater flow model had previously been developed to predict groundwater levels in the area therefore the accuracy of their machine learning model was quantified by comparing it to the groundwater flow model. Within this context, the results of the artificial neural network were compared to the results of the groundwater flow model. The plots/graphs in the study show that the predicted groundwater levels by the artificial neural network better fitted the observational data trend than the groundwater flow model. Hence, the study concluded that artificial neural networks were better suited to predict groundwater levels in the region than the previously computed groundwater flow model.

Several other studies used FFNNs ([9], [10], [11], [12], [13]) and RNNs ([14], [15], [16]) to predict groundwater levels while other studies compared the performance of FFNNs and RNNs in predicting time dependant patters ([17] and [18]). In most studies FFNNs were able to accurately predict future values for a short period while RNNs were able to predict future values over an indefinite lead time. While FFNN are more popular in modelling hydrological systems, they lack the feedback connections necessary to model dynamic systems making it difficult for them to model time dependant patterns [19]. On the other hand, RNN have feedback connections that make them inherently dynamic in nature. In several studies mentioned earlier, RNNs were able to cope with the seasonality trend and time-varying behaviour of the semi-arid aquifer systems better than FFNNs. Hence, most studies concluded by recommending RNNs as useful tools for predicting hydrological systems.

These recent studies show how machine learning models are able to recognize patterns hidden in historical data and then

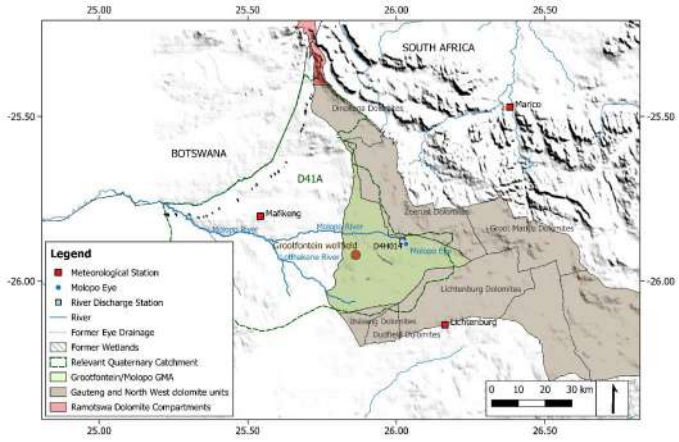

Fig. 1: Grootfontein location map (*for credit of image see acknowledgements).*

apply those patterns to make future predictions without deep knowledge of the study area.

Due to our data being time-dependant we focused on the use of RNNs in this study particularly the LSTM model.

III. Methodology

In this paper we attempt focus on three main objectives. Firstly, we quantify the influence of groundwater extraction, precipitation, temperature and discharge on groundwater levels in the aquifer using mutual information, secondly, we attempt to predict groundwater levels for four boreholes under different climate and groundwater extraction conditions by training and testing an LSTM model and finally comparing results of each case scenario with the base case to give recommendations.

This section is structured as follows: Section III-A describes the case study area; Section III-B discusses data acquisition and pre-processing; Section III-D outlines the feature selection method used; and Section III-E will provide a brief descriptions of model setup and evaluation metrics employed in this study.

A. Study Area

The dolomite aquifers located in the northern part of South Africa are one of the most important aquifers in the country [3]. The Grootfontein dolomite aquifer specifically is a highly productive aquifer that contains good quality water used for industrial, agricultural and domestic water needs of people in the region [20]. Several towns and settlements such as Mahikeng, Lichtenburg and Itsoseng largely rely on groundwater as their main source of water. Average rainfall in the region is between 300 to 700mm annually while average temperatures in the region range between 2 to 16 degrees in winter (May to July) and 22 to 34 degrees in summer (August to March) [21]. Further details of the Grootfontein aquifer can be found in [3]. Figure 1 shows the map of the area under study.

TABLE I: Description of each case scenario

Scenario ID	Defintion	Description
1	Decrease rainfall peaks	If monthly rainfall peak $>$ 100mm then minus 100mm
2	Increase groundwater abstraction	Double the monthly abstraction
3a	Simulate worst case scenario	Combination of scenario 1 and 2
3b	Simulate average case scenario	Decrease rainfall: Half all monthly rainfall datapoints
3c	Increase rainfall peaks	Increase rainfall peaks: If monthly rainfall peak $>$ 100mm then add 200mm
4	Long term prediction (15 years)	Use 100% data for training and predict groundwater levels for the next 15 years using long term averages of input variables

B. Data Collection and Pre-processing

This study made use of data obtained from the Department of Water and Sanitation (DWS), Water Authorization and Registration Management System (WARMS) and South African Weather Service (SAWS). Monthly groundwater levels and discharge rates where obtained from DWS while monthly rainfall and temperature datasets was obtained from SAWS and abstraction dataset was obtained from WARMS. Four boreholes were selected of those obtained from DWS. Selection criterion of these four was based on boreholes that had the longest continuous time period and least missing data points. The selected boreholes therefore ran for over 30 years and had less that 15% missing data points.

For climate data 3 weather stations were present within close proximity of the compartment as evidenced in Figure 1. One was within Marico (North of the compartment), one within the Mafikeng region (North West of the compartment) and another in Litchenburg (South of the compartment). A time series of monthly temperature and precipitation was compiled from the three stations. The three stations were selected due to their positions relative to the compartment boundaries providing an indication of the temperature and rainfall variability across the compartment. The stations were also selected due to the availability of longer historical data.

Discharge data used was from station D4H014 (location shown in Figure 1). The spring discharge at Molopo is considered hydraulically connected to groundwater across the Molopo/Grootfontein, and is therefore used as a representation of groundwater discharge from the compartment.

It should be noted that the groundwater abstraction dataset obtained for this study was licensed water use and not actual water use. Therefore, the registrations obtained may be over-estimates in an attempt to secure a supply or under-estimates for the purposes of securing a license. Furthermore, several individuals may not be registered (unlicensed abstraction). However, this is the dataset that was readily available. Therefore, total groundwater abstraction was calculated using the registrations obtained.

C. Scenario tests

The LSTM model was run under different cases to explore the future trends of groundwater behaviour under different scenarios. The scenarios in table I were created to mimic possible changes in groundwater abstraction and climate conditions. Amplifying and decreasing rainfall peaks are case scenarios seen in climate variability and doubling abstraction amounts were also tested to verify whether the the neural network can replicate the impact on groundwater levels which is essential for groundwater planning. When running model simulations the training data was left unchanged and the test dataset for the rainfall or abstraction variable was altered according to the case scenario to be modelled. Table I defines each scenario case tested.

D. Feature Analysis

Generally, input parameters are not equally informative in predicting the target variable. This is because some parameters may correlated, noisy or have an insignificant relationship with the target variable.

To quantify the influence of each feature (groundwater abstraction, temperature, precipitation and discharge) against the target variable (groundwater levels for the four boreholes) feature analysis was performed. Using mutual information (MI), we were able to quantify the relationship between each feature and each target variable. MI is a statistical method that is used to measure the degree of relatedness between variables [22]. MI is greater than zero when X and Y exhibit mutual dependence regardless of how nonlinear that dependence is because MI is able to model both linear and nonlinear relationships. Therefore, the stronger the relatedness the higher the MI value.

In the next section we will discuss the machine learning model employed in this paper.

E. Regression and Evaluation

RNNs take two sources of input. To determine how it will respond to new data the model combines the current input example it sees (the present) and the previously computed output (the past). RNNs can be distinguished from FFNNs by the feedback loop that connects their present to their past decisions. The sequential information stored in the RNNs hidden state spans several time stamps as it cascades forward to affect the processing of each new example [23]. Therefore an event downstream in time depends upon, and is a function of one or more events that came before. Figure 2 shows an example of a RNN where W_x represents the weight vector for the hidden layer, W_y represents the weight vector for the output layer, W_h represents the same weight vector at different Timesteps, x_n and y_t are the input vector and output result at time t and h_n represents the activation function.

F. Evaluation Metrics

The LSTM model was evaluated using three metrics, namely: RMSE, MAE and R^2. RMSE is used as an indicator of how much much error the predicted results contain by

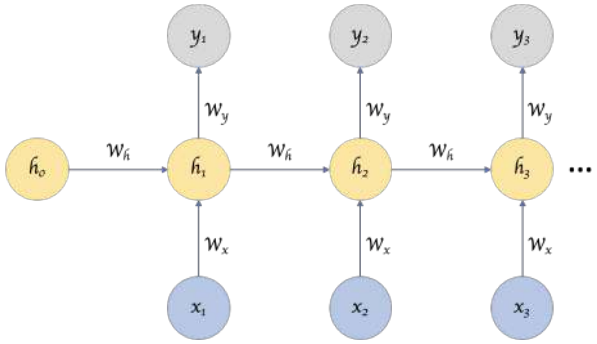

Fig. 2: A Recurrent Neural Network, with a hidden state that is meant to carry pertinent information from one input item in the series to others

comparing actual vs predicted results [24]. MAE calculates the averages of the absolute differences between prediction and actual observation where all individual differences have equal weight [24]. MAE is a good measure of error that can serve as a loss function to minimize. R^2 is used to measure how close the data are to the fitted regression line. It explains how much variability of one factor can be caused by its relationship to another factor (co-linearity between the observed and predicted data) [25].

G. Ethics Clearance

No ethics considerations were required for this study. All data used in this study was obtained freely.

In the next section we will discuss the results obtained from the study.

IV. Results and Discussion

This section presents the results obtained for each case scenario and the MI results. In section IV-A we discuss the results obtained from feature analysis and section IV-B presents the regression results.

A. Feature ranking

There were 4 features used in this paper. Using MI we deduced the contribution of each feature to classify the features as a value from the target variables. Table II shows the results of applying MI to the feature set for each target variable.

Table II illustrates the scores of the contribution of each feature to each target variable. The first column indicates the borehole site ID (BH site), the remaining 4 columns indicate feature names and the corresponding scores to each target variable.

Table II shows that on average regional abstraction correlates with water levels the strongest in each borehole with an average entropy of 0.63. Correlation does not imply causality, but these results essentially show that the method detects a correlation between the curve of increasing groundwater use over time with the groundwater levels at each borehole. It should be noted that the results obtained are quite surprising given that the groundwater level dataset is significantly noisier than that of groundwater abstraction which shows an increasing curve

TABLE II: Mutual Information results summary

BH Site	Temperature	Precipitation	Discharge	Abstraction
D4N0037	0.01	0.36	0.45	0.61
D4N0127	0.01	0.32	0.35	0.69
D4N0110	0.05	0.39	0.43	0.58
D4N0142	0.03	0.35	0.32	0.62
Average	0.03	0.36	0.39	0.63

over time. However, the results also support the assertion that the compartment is highly impacted by regional abstraction as recorded in previous studies.

The second most correlating feature with groundwater levels is discharge with an entropy average of 0.39. A strong relationship is expected, given that the hydraulic gradient between the surrounding aquifer and the spring is what drives discharge hence changes in groundwater level will directly translate to changes in discharge rate.

The rainfall dataset is the feature with 3rd strongest correlation with average entropy value of 0.36. A high correlation was expected as groundwater levels respond to rainfall events. Temperature has the lowest correlation (and therefore least influence in predicting water levels) with an average entropy average of 0.03.

It should be noted that MI only measures the mutual dependence between two random variables by identifying how much information of one of the features can be obtained from the other features, but it does not tell us what drives the groundwater levels. However, MI gain provides a useful framework for feature selection by indicating the contribution of each feature relative to all the other features.

B. Scenario testing results

Table III shows the results obtained for the base case by training and testing the LSTM model with actual input values.

As can be seen by the results obtained the LSTM model performed quite well in the prediction of all four monitoring stations using precipitation discharge and groundwater abstraction as model inputs. On this basis the predictive capabilities of the LSTM model was considered adequate for the main objectives of this study.

In the next section we discuss results obtained through each scenario test.

1) Scenario 1: Subtracting 100mm from rainfall events that had peaks higher than 100mm resulted in a drop of groundwater levels at the specific month were precipitation was reduced. It is important to note that precipitation peaks above the 100mm threshold were not abundant in the testing phase but instead only a few high rainfall events occurred during 2000 – 2004 (duration of test data for most boreholes) that passed the threshold. For this reason, the drop in groundwater levels is only seen at the particular months were recharge was reduced. For borehole D4N0142, the decrease in water levels between year 0 to year 2 is clearly observed as recharge events were reduced during this period. For borehole D4N0037, a decline in water levels is observed during year 2 to 3 as compared to the base case the model had over-predicted value of groundwater levels in 2002. As for borehole D4N0127 there

TABLE III: Performance of LSTM model on the test data set for 4 boreholes in the Grootfontein aquifer.

BH Site	R^2	RMSE	MAE
D4N0037	0.87	0.09	0.06
D4N0127	0.81	0.57	0.36
D4N0110	0.77	0.13	0.10
D4N0142	0.85	0.18	0.13

was only a single rainfall event that was above the threshold during the testing phase hence only one negative change was observed with a drop of 0.2m at the beginning of year 3. The general trend for the rest of the years remained similar to that shown in the base case. For borehole D4N0110 a decline in water levels (0.2 to roughly 0.4m) can be observed from year 0.

2) Scenario 2: Doubling the regional abstraction rates in the compartment resulted in a the highest decrease of groundwater levels for all boreholes (ranging between 0.5 to 1.7m) in the compartment when compared to the base case. Although the doubled abstraction rates seemed to have a higher effect on boreholes D4N0110 and D4N0142, the magnitude for boreholes D4N0127 and D4N0037 was much smaller.

3) Scenario 3a: The highest negative change was observed from the third scenario were regional abstraction was doubled and recharge was reduced by 100mm for high precipitation events. Groundwater levels for borehole D4N0142 dropped by almost 1m. For boreholes D4N0037, D4N0127 and D4N0110 groundwater levels dropped by at least 0.5m. All selected boreholes showed a decline in groundwater levels. This indicates that the models are able to generate a change in groundwater level that would be expected if abstraction rates increase. This could be useful for assessing the impact of future changes in groundwater abstraction.

4) Scenario 3b: By halving all precipitation values in the test set, groundwater levels declined considerably when compared to the base case. The decline in groundwater levels is consistent throughout the years since all precipitation values were halved unlike in scenario 1a where specific events decreased (providing it was above 100m threshold). The LSTM model is clearly able to predict the influence of precipitation on groundwater levels in the compartment evidenced by the constant drop in water levels for all boreholes.

5) Scenario 3c: Similar to scenario 3a boreholes in this scenario showed an increase in groundwater levels in particular months were the rainfall event meet the required threshold for increase. The increase in precipitation increased groundwater levels for boreholes D4N0037 and D4N0110. In each of these boreholes an increase in recharge increased groundwater levels a lot higher than compared to borehole D4N0142. For borehole D4N0127 an increase in water levels was seen for year 3 while groundwater levels in the rest of the years remained almost stable. Generally, in this scenario the groundwater levels increased by 0.6 to 1.3m.

6) Scenario 4: For the final scenario, precipitation, abstraction and discharge data were formulated by averaging the 30

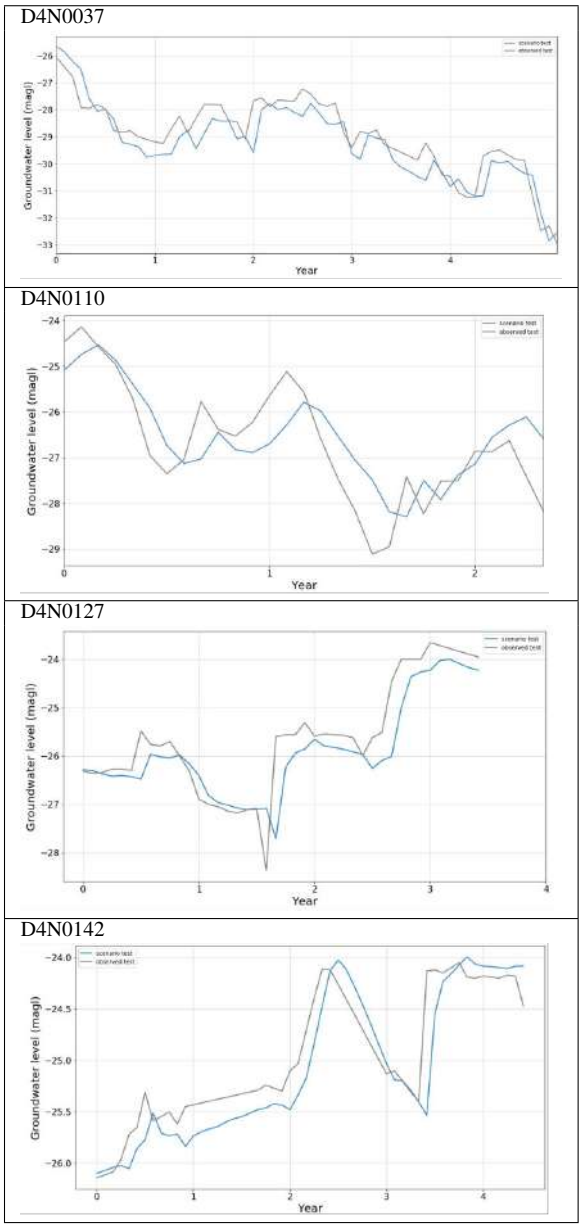

TABLE IV: Model prediction for scenario 1 - decrease rainfall peaks

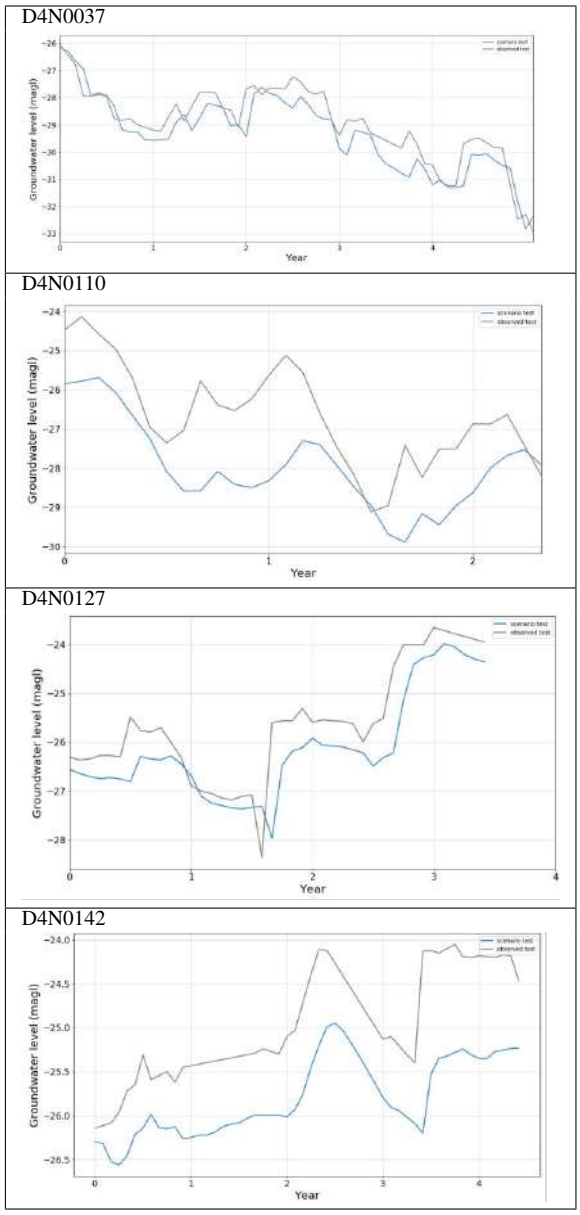

TABLE V: Model prediction for scenario 2 - double abstraction

years of data for each variable and predicting 15 years into the future for borehole D4N0037. The graph showed a reasonable prediction of groundwater levels by simply feeding the model averaged values of precipitation, discharge and abstraction. Due to fact that the model performed adequately for the base case were the model had actual data for each variable, it is not a far-fetched assumption to imply that the LSTM model would be able to predict long term trends up to 15 years given sufficient training data.

V. Conclusion

The purpose of this study was to simulate the effects of adjusted groundwater abstraction and precipitation on groundwater levels in the Grootfontein aquifer. The aim was to test the applicability of recurrent neural network models in

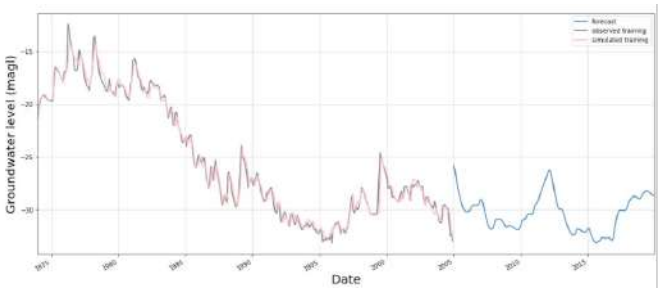

Fig. 3: Model prediction for scenario 4 - long term prediction for borehole D4N0037

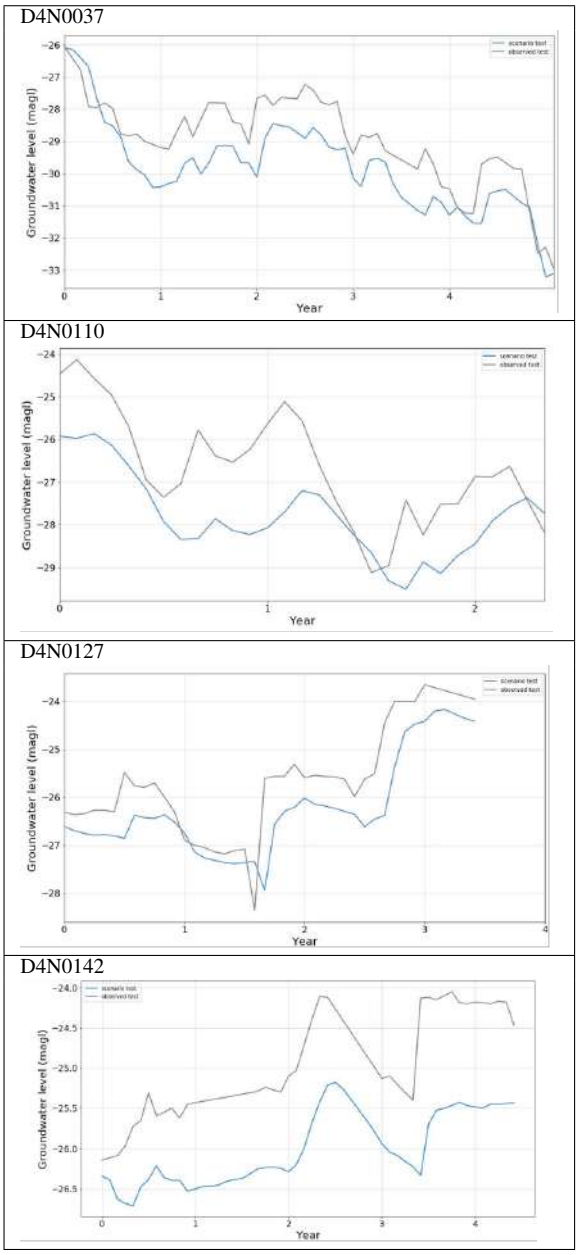

TABLE VI: Model prediction for scenario 3a - double abstraction + decrease rainfall peaks

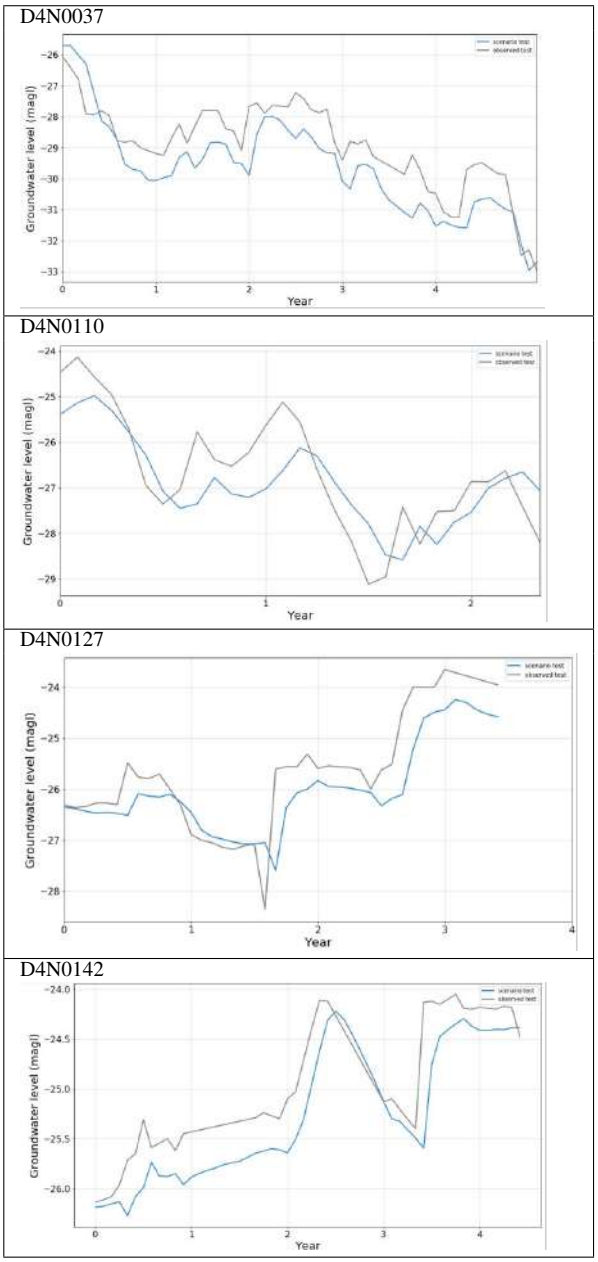

TABLE VII: Model prediction for scenario 3b - half all rainfall values

the estimation of groundwater levels under adjusted parameters. As highlighted previously, South Africa is expected to experience more low rainfall days and high water demand hence groundwater availability becomes a concern for water managers and water service authorities including those in the North West. Groundwater is an essential resource in the North West providing water to a significant part of the population. Four case scenarios were considered to investigate the effects of spatial and temporal variability of precipitation and groundwater abstraction on groundwater levels in the compartment using the LSTM model.

Although the RNN model was unable to predict the sporadic peaks and troughs which could be due to lurking variables such as daily pumping records from high-capacity irrigation wells or measurement errors, the model still performed quite well. The LSTM model was first tested to predict groundwater levels using actual input values obtained (considered as the base case). The model performed quite well with the modelled water levels matching the observed reasonably well. On this basis the predictive capabilities of the LSTM model was considered adequate for the main objectives of this study.

Scenario testing results showed a decline in groundwater levels when abstraction amounts were doubled and a more subtle decline when rainfall peaks amounts were reduced. Moreover, during what can be conspired as drought years the groundwater levels in the compartment decreased by almost 2

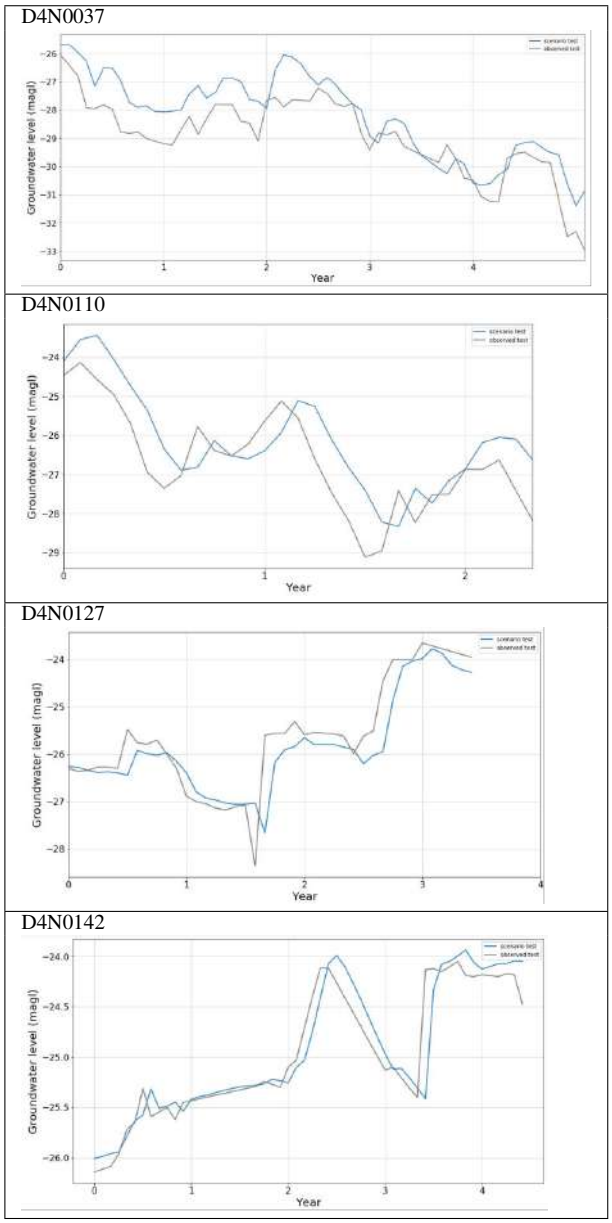

TABLE VIII: Model prediction for scenario 3c - increase rainfall peaks

m. These results indicated the importance the chosen variables had on groundwater levels in the region further strengthening our entropy results. The framework used in this study could be used by water managers and municipalities to manage water resources more effectively during drier years while ensuring that groundwater levels do not deplete.

This study only considered a handful of wells at a regional scale thereby potentially restricting large scale applicability of the model and results. Further investigation is therefore needed at a larger-scale. This study only tested a single model, further investigation could test applicability of different models in the prediction of groundwater levels. Lastly, testing with actual groundwater abstraction could further strengthen results.

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On-Policy Deep Reinforcement Learning Approach to Multi Agent Problems

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***Abstract*— Reinforcement learning approach has been preferred by researchers and scientists in recent years, especially due to its superior performance in robot studies. While smart systems are becoming widespread in technology that develops and changes day by day, communication problems between these systems and the environment are still among the issues that are being studied with great importance. Reinforcement learning determines what action to take in the next step by rewarding the experiences gained from the environment it is in. The most important difference from other machine learning approaches is that it does not need any preliminary data during the training phase.**

In this study, a deep reinforcement learning method that regulates the movements of three different robots used in limited areas is presented. The performance of the robots has been tested by training this problem with the Policy Gradient algorithm. With the presented method, it was ensured that the robots learn how to act both in the area they are in and in the collision problems against each other with the deep reinforcement learning method. Robots in this kind of mission do not only have a duty, but also need to be trained in terms of safety. In order to solve this problem, training was carried out by positioning fixed obstacles in the training environment. In this way, it performs its duty without hitting the fixed or mobile obstacles in the closed environment.

This study was trained in a simulation environment. It is addressed using a concurrent learning approach without any communication between agents. A multi-agent approach based on policy gradient, temporal difference error and actor-critic methods is used. The performance of robots is reported especially by supporting the reinforcement learning approach with deep learning algorithms.

Looking at the simulation results, it is seen that robots trained with the Policy Gradient algorithm are successful in cleaning the whole area. In addition, the rewards obtained by the robots at the end of the training are given in detail in section 4.

Keywords—deep reinforcement learning, multi agent, deep learning

I. INTRODUCTION

When we examine a single ant, we cannot say that it is very intelligent and saw very well. But for colonial ants, it is a well-known fact that they do extraordinary things like acting as a team, minimizing the distance to food, finding the most suitable nesting environment, or their impressive behavior in defense. Like ants, many creatures consist of simple individuals when considered individually but exhibit collectively intelligent behavior. Behind and the basis of these intelligent behaviors are the experiences gained individually and "knowledge" shared with the swarm in different social ways. Therefore, smart solutions to the problems they face emerge with the organization and communication between these simple individuals. In detail, it should not be overlooked that a leader is not needed for this magnificent coordination [1].

Despite many swarm algorithms, studies especially for industrial applications have not been successfully completed yet. When the current industry-related studies and research are examined, it is seen that although they use the term "swarm" in theory, swarm algorithms are not used in practice [2].

In swarm systems, they interact with each other for a common purpose with many agents of the same properties. Generally, every agent in a swarm has limited abilities in terms of perception and direction. Therefore, more than one agent must act together in complex tasks.

Swarms consist of more than one individual, homogeneous or heterogeneous agent [3]. Often they cooperate without any central control and act according to the local actions of the environment. It can be considered as an artificial organism that can adapt to changes in the environment in line with these actions. Some of the main advantages of moving in a swarm are:

- Following a predetermined goal
- Gathering or dispersing at a certain point
- Indirect or direct communication
- Memorization

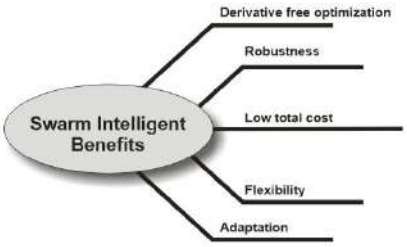

Fig. 1. Benefits of swarm intelligence

Fig. 1 shows the benefits of swarm intelligence.

Recently, deep reinforcement learning (DRL) approaches are frequently used in solving multi-agent coordination problems [4]. In DRL, tasks are determined indirectly by a cost function. This situation is generally easier to complete the defined task than other classical methods. DRL algorithms aim to determine a policy to minimize the expected cost after the cost function is defined. Implementing DRL's in swarm environments is difficult due to the complexity of the processing of varying datasets and the action to be taken together. If we list these main difficulties:

- High situation and observation dimension caused by large environments

- Change in the size of the existing information set in cases where the number of agents varies

If we list some of the studies in the literature; The computational algorithm in which biological swarm behaviors are developed [5], a study discussing autonomous guidance in general biological systems [6], a study discussing swarm intelligence using artificial neural networks and bio-robotics [7], studies investigating swarm intelligence for optimization [8, 9, 10, 11] a study comparing autonomous movement and optimization algorithms [12], a new state representation study for the multi-agent DRL approach [13], a study of swarm behavior [14], a multi-agent reinforcement to solve a partially observable multi-agent problem in disaster response. a study proposing a learning algorithm [15], a study by a robot team to improve the convergence speed of multi-agent Q-learning for collaborative task planning [16], a study investigating how agents affect the determination of physical position in a game setting [17], a study developed for tools [18] the most suitable broadcast band that can communicate from one vehicle to another Deep reinforcement learning is offered to find the power and power level, a solution is sought for the transportation and traffic problem with the "stochastic shortest path finding method" with the Q-learning algorithm [19].

In recent years, deep reinforcement learning method has attracted a lot of attention with solutions to problems in multiple agents and herd systems. Successful work is being carried out especially in unmanned aerial vehicles. However, this study presents a study that adopts parameter sharing that can be adapted to land vehicles. A convolutional artificial neural network is used by strengthening the deep reinforcement learning approach with its actor-critic structure.

The rest of the work is organized as follows. In the second part, theoretical information about the deep reinforcement learning approach is given. In section 3, the simulated robot herd application is explained. The experimental results are given in graphs in the 4th section and the results are discussed in the last section.

II. DEEP REINFORCEMENT LEARNING

Machine learning is a sub-branch of artificial intelligence developed for numerical learning and model identification studies in the 1950s [20]. Machine learning is basically a system that can learn and make predictions over existing data. Actions taken according to these estimates can be such as deciding whether a data sample belongs to a class or another class, detecting speech or faces from any image. While categorizing these tasks, we can categorize the way the computer learns patterns in the data. If the data in the training set is tagged, it is called supervised learning, if not, it is called unsupervised learning [21]. Reinforcement learning, on the other hand, is the state of educating himself by receiving punishment or reward according to his actions in the environment through an agent.

In this study, a deep reinforced learning approach that combines deep learning and reinforcement learning techniques is presented. In this section, after the basic structures and algorithms of deep learning and reinforcement learning are explained, deep reinforcement learning algorithms are introduced.

The contribution of this study to the literature; To apply a new machine learning approach to multi-agent robot problems, combining techniques from deep learning and reinforced learning that have become popular in recent years. Considering that deep reinforcement learning algorithms are generally used in single robot training, the contribution of this study is in the field. This chapter first introduces the main ideas of reinforcement learning and deep learning and basic algorithms from these areas. Then, the deep reinforcement algorithms on which the algorithm in this study is based are shown. Fig. 2 shows the basic structure of reinforcement learning.

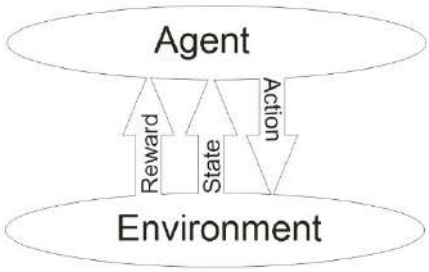

Fig. 2. Basic RL architecture

A. Reinforcement Learning

The main purpose of an agent in reinforcement learning is to learn how to maximize its target performance or minimize the cost of punishment by interacting through an environment. In addition to agentic and environment, reinforced learning is included in 4 different concepts [12]. Policy; defines how the agent reacts to the current situation in his environment, reward; defines the good or bad value of the agent as a result of an action, value functions; defines and model the long-term expectation for reward determined under the current policy from a predefined situation; define the transition dynamics of the environment. The agent determines a state from the current state (St) of environment E from all the set of possible states at each step (S) and selects an action from all the set of possible actions (a) depending on this state.

For variables that will occur at different steps during training, in general, a probability distribution where the next state s_{t+1} depends on all previous situations and actions,

$$P_r\{s_{t+1} = s' | \, s_0, a_0, s_{t-1}, \dots, a_{t-1}, s_t, a_t\} \qquad (1)$$

it is expressed as in the equation(1).

If the next state is completed using only the current state and current action, then the environment can be said to be Markovian and the environment variables

$$p(s'|s,a) \coloneqq P_r\{s_{t+1} = s' | \, s_t = s, a_t = a\} \qquad (2)$$

are determined as equation (2).

B. Q-Learning

Q-learning is one of the most popular reinforcement learning algorithms. Q-Learning is a reinforcement learning algorithm that tells an agent under what conditions to perform which action and does not include a model to learn the accuracy of actions [22]. The main purpose of Q-learning is to direct the agent by choosing the best from the experience. It adopts a off-policy during the training phase and action is

determined by the behavior policy β(α|s) to explore the environment. According to this situation, s_t states are symbolized with rewards r_t, actions taken as α_t and for the next state with s_{t+1} . According to these:

$$\delta_t = r_t + \gamma \max_{\alpha} Q_t(s_{t+1}, \alpha) - Q_t(s_t, \alpha_t), \qquad (3)$$

The estimated value of the function in equation (3) is updated iteratively as $Q_t(s,a)$ [23].With the renewal of the initial value of $Q_0(s,a)$ in each step, α is updated by the number of steps as in equation (4).

$$Q_{t+1}(s_t, \alpha_t) \leftarrow\cdots Q_t(s_t, \alpha_t) + \alpha\delta_t \qquad (4)$$

C. Policy Gradient

The Policy Gradient (PG) algorithm [24] is a model-free, non-policy reinforcement learning method. PG agent is a policy-based reinforcement learning agent that directly calculates the most appropriate algorithm that maximizes long-term reward. PG agents can be trained for discrete and continuous environments.

During the training phase, an agent with an agent estimates the probabilities of execution for each action and chooses a random action based on these probabilities. It completes a training episode using the instant policy before gaining experience from existing experiences and updating policy parameters. Table 1. also PG training algorithm is shown.

TABLE I. LEARNING ALGORITHM OF PG

No	Meaning
1	Critic is started with θ_Q with random parameter values of $V(S)$.
2	The actor is started with θ_μ with random parameter values $\mu(S)$
3	For each training episode, experience is generated based on the $\mu(S)$ actor policy. Experience series: $S_0, A_0, R_1, S_1, \ldots., S_{T-1}, A_{T-1}, R_T, S_T$
4	For t = 1,2,…, T • The $\boldsymbol{G_t}$ feedback with reduced future reward is calculated. $G_t = \sum_{k=t}^{T} \gamma^{k-t} R_k$ • Using the value estimate from critic, the advantage function δ_t is calculated. $\delta_t = G_t - V(S_t\|\theta_v)$
5	Gradient values are summed for the critic network $d\theta_v = \sum_{t=1}^{T-1} \delta_t \nabla_{\theta_V} V(S_t\|\theta_V)$
6	Gradient values are summed for the actor network. $d\theta_\mu = \sum_{t=1}^{T-1} \delta_t \nabla_{\theta_\mu} \ln \mu(S_t\|\theta_\mu)$
7	The critic parameter θ_V is updated. $\theta_V = \theta_V + \beta d\theta_V$ β — learning rate
8	θ_μ actor parameter is updated. $\boldsymbol{\theta_\mu = \theta_\mu + \propto d\theta_\mu}$
9	During the training, steps 3 to 8 are repeated.

D. Aktor-Critic

Reinforcement learning policy is a mapping that chooses the action the agent will take based on observations in the environment. The agent adjusts the parameters of policy representation to maximize the accumulated long-term reward expected during training [25].

Reinforcement learning agents predict policies and value functions using value approaches called actor and critic representations, respectively. The actor represents the policy that chooses the best action to take based on existing observations. Critic represents the value function that predicts the expected accumulated long-term reward for the current policy.

Before constructing deep neural networks with an agent, the necessary actor and critic representations must be created using linear basic functions or lookup tables. Fig. 3 shows the basic structure of Actor-critic.

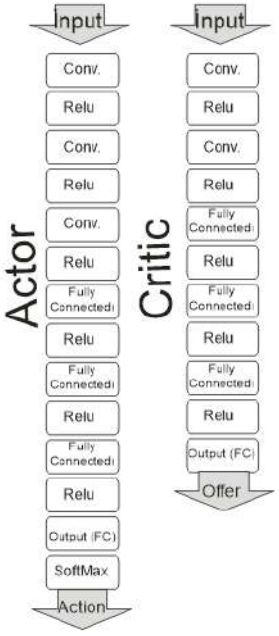

Fig. 3. Structure of Actor-Critic

E. Deep Learning

In classical machine learning methods, manually processed data was used to extract a feature map from the information considered to be important, and an algorithm was created in which this data was used as a source. The main purpose of deep learning is to produce a result based on raw data of an algorithm instead of this method. Deep learning is a machine learning method that learns features and tasks directly from data [26]. Deep learning algorithms use the

pixels of the tagged images as input to the system during the learning process. Fig. 4 shows a fully connected feed forward artificial neural network diagram. Circular shapes represent the neurons in each layer. Generally, artificial neural networks consist of input layer, hidden layer and output layer as shown in Fig. 4.

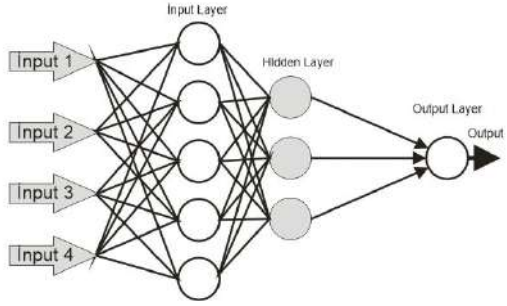

Fig. 4. Model of artificial neural network

In deep learning algorithms, different output layers and cost functions are used to measure the performance of an artificial neural network depending on the task given during the training phase. In classification methods, softmax layer is generally used, which compresses all output value ranges between 0 and 1 and can produce probability values for each class. After the last layer, the cross-entropy loss function is used to determine the accuracy of the prediction. The main purpose of the training is to minimize the loss function by optimizing each parameter set in a n-layer network [27].

F. Deep Reinforcement Learning

Deep Reinforcement Learning (DRL) is a method developed to solve the problems that arise in reinforcement learning. Since the performance of the Q-table in limited environments cannot be shown in unlimited environments, artificial neural networks have been used. Generally, DRL constructs use a deep neural network to calculate a nonlinear value from perceptual inputs to action values [28]or ability to move [29]. This used deep neural network updates the weights in the network used to maximize reward values from the environment, usually by back propagation. Fig. 5 shows the structure of DRL.

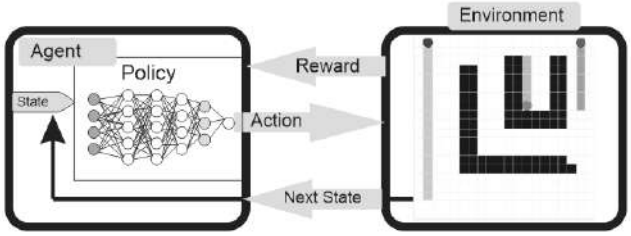

Fig. 5. Structure of DRL

DRL has two basic building blocks: deep learning and reinforcement learning. A large amount of memory is needed to store and manage Q functions in reinforcement learning. In problems with real environments, it is often impossible to keep Q functions in tables because the sets of states are large or infinite. Deep learning comes into play in exactly these situations and training is concluded with smaller parameter sets.

III. Simulated Robot Swarm Application

Deep reinforcement learning has produced successful results in environments where an agent can learn to act on their own. Successes in single-agent problems are now also achieved in multi-agent approaches. The success of education increases especially with the right policy choices.

This study focuses on three different agents cleaning at the same time and in the same environment. The simulation environment demonstrates the competitive mission based on a collaborative and concurrent learning approach in which three different agents are trained to explore all areas. During the training phase, they will try to clean up places that have never been visited as much as possible. This problem has been simulated and trained by using Matlab2020b software development program and Simulink library. Fig. 6 shows a moment from the training environment.

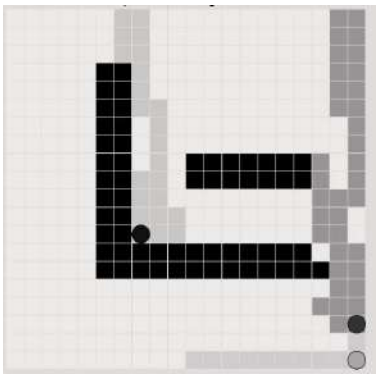

Fig. 6. Training environment

Policy-based agents rely on the outcome of their actor-critic network to learn the most appropriate action. In this tutorial, agents use deep neural network-based action estimators for actor-critic. Both actor and critic have similar network structures. Returns a scalar value representing the critic state value V (s). The actor gives the probability of performing one of the five specified actions π (a | s)

Agents move to their respective robots by selecting one of five possible motion actions (wait, up, down, left, right). Robots decide whether an action is legal or illegal. For example, it is considered illegal to move upward when the robot is at its upper limit. The same happens when hitting obstacles and other robots in the environment and they must be punished. The main purpose of robots is to discover all cells as quickly as possible.

In each time step, an agent observes the state of the environment through four different images shown in Fig. 7 that describe the disabled cells, the current position of the controlled robot, the location of other robots, and the cells discovered during the segment.

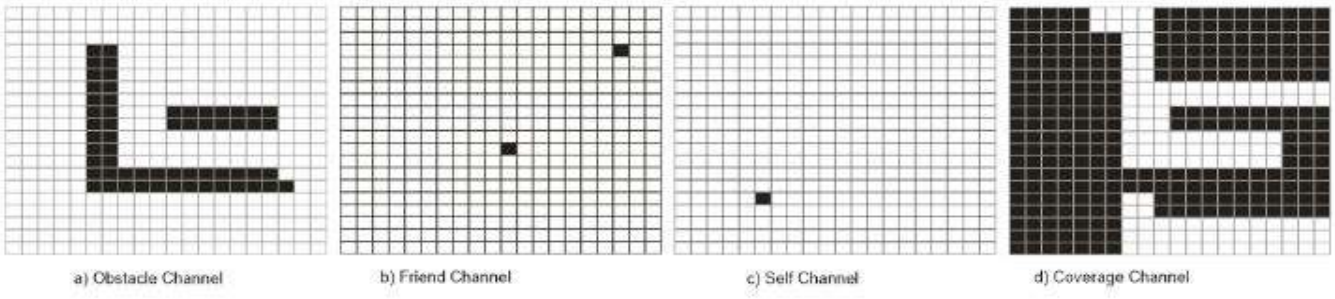

Fig. 7. A sample of what the agent controlling a robot is observing at a particular time step. a) the location where the obstacles are in the initial state of the environment, b) The location of the other robots, c) Its own location, d) The location of the areas scanned by three robots

The characteristics of the environment are as follows:

- The scanning area is an area of 20 x 20 including obstacles.

- For each agent, the observation is a 20x20x4 view.

- Discrete action set consists of five different actions. (Wait = 0, up = 1, down = 2, left = 3, right = 4)

- The training step ends when the grid is fully explored or the maximum number of steps is reached.

A. Experimental Adjustments

Deep learning algorithms need to be trained with the correct parameters to give successful results. Necessary adjustments should be made in the artificial neural network according to the complexity of the problem and the size of the environment. In this context, in a 20x20 environment, the deep learning algorithm has been optimized so that the robots in which 3 different agents give action capability can learn better. Table 2 shows the rewards an agent can receive during the training phase.

TABLE II. REWARD OPTIONS

Agents receive the following rewards and penalties at each training step.
+1 point for scanning a previously undiscovered cell,
-0.5 points for each illegal action (attempting to go out of bounds or hit other robots and obstacles),
-0.05 points for each action that results in a move,
-0.1 point for each action that does not result in a movement,
+200 points for each robot during the episode if the training area is fully scanned

IV. EXPERIMENTAL RESULTS

The training phase was completed after 1500 episodes. At the end of the training, the scores of each agent at the beginning of the episode were displayed in graphics and interpreted. In addition, a graphic showing how much of the training area all three agents scanned in each episode at the end of the training is shown. Table 3 shows the actions an agent can take during the training phase.

TABLE III. ACTIONS

No	Action
0	Wait
1	Up
2	Down
3	Left
4	Right

During the training phase, each episode consists of 500 steps. In total, 1500 episodes are continuing education. An agent's training is stopped when his average reward for 100 consecutive episodes is 80 or more. Table 4 shows the parameter values used in education.

TABLE IV. USED PARAMETERS

Parameter	Value
Max Episodes	1500
Max Steps Per Episode	500
Score Averaging Window Length	100
Stop Training Value	80

PG parameters used in the training phase Table 5. is also given. According to the parameters given in this table, the learning-based parameter is a logical parameter. Since neural network is used in the application, this parameter is set to 1 (True). The sampling time parameter takes a positive scalar value. It tells you how many seconds the agent should perform an action in the simulation environment. The entropy loss range is a scalar value in the range [0-1]. The value of 1 encourages the agent to take discovery by imposing a penalty to be completely sure of what action to take.

TABLE V. PARAMETERS OF PG

Parameter	Value
Use Baseline	True
Sample Time	1
Entropy Loss Weight	0
Discount Factor	0,99

Fig. 8 shows the rewards that robot A received in each episode during the 1500-episode training. When the graph is examined, it is seen that he completed the training in two different stages. While the average reward was at +50 in the first half, it was stably approximately -220 after the 800th step in the half. This situation has a direct link with the learning situation of other agents. At the end of the training, robot A received an average reward of -212.43.

Fig. 9 shows the graph of the reward-episode number of robot B after 1500 episodes of training. When the graph is examined, a generally regular reward line appears. He ended the training with a fixed average reward score, especially after the 800th episode. Robot B received +91.94 average reward during the training.

Fig. 10 shows the reward graph that robot C received during its 1500-episode training. When the graph is examined, it is seen that the reward points he received in the last 400 parts are in an increasing trend. The reward-episode graphic fluctuating in a narrow range from start to finish has steadily completed his education. The average reward score he received during the training was recorded as 97.31.

In Fig. 11, the graph of how much of the existing environment was scanned by three robots during the training. When the graph is examined, it is seen that the environment is scanned more between 60-80% in the first half of the training, and in the second half of the training, scanning intensified between 40-50%. This number is directly related to the step number parameter in each episode being 500. Increasing this parameter may increase the scanned area surface, but the total rewards robots receive will decrease.

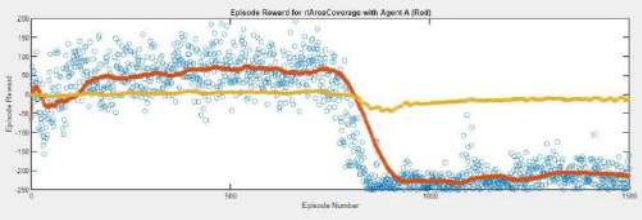

Fig. 8. Training graph of Agent A (red line is average reward)

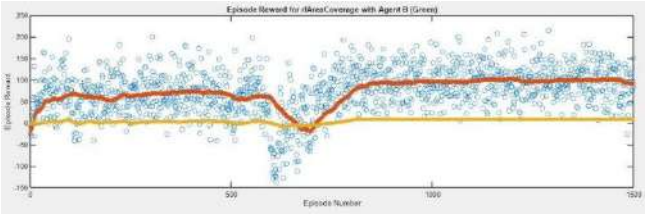

Fig. 9. Training graph of Agent B (red line is average reward)

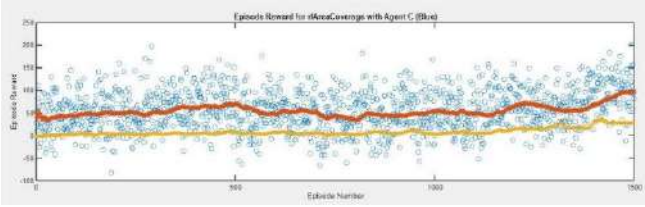

Fig. 10. Training graph of Agent C (red line is average reward)

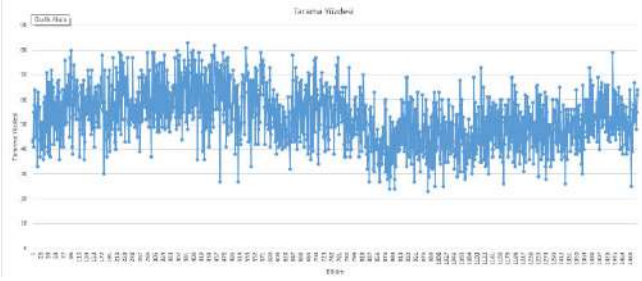

Fig. 11. Coverage percentage for per episode

V. Conclusion

In this study, parameter sharing learning approach was combined with deep reinforcement learning to improve performance.

It has been shown in the studies to date that the methods generally used in deep reinforced learning areas where single-agent method is trained, can be used in multi-agent methods.

Agents are trained in the Q function of situations and the actions of homogeneous agents within the framework of the Policy Gradient, which is stochastic policy.

During the training phase, because the actions of the robots in the previous episode were not the same in the next actions, it was difficult to minimize the penalty points brought by the action of navigating the areas scanned by each other. However, since the penalty points for hitting the fixed obstacle are learned by the robots, the minus points are minimized during the training phase due to the obstacle.

In the policy used, it is obvious that an agent has not seen an excessive success or failure compared to others. This showed that the application presented can be successful in multi-agent problems with the proposed approach.

The results of this study also show that the hidden layers of deep reinforcement learning models are useful in solving complex problems.

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Artificial Intelligence based modelling and multi-objective optimization of commercial Ethylene Oxide reactor

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Abstract—

In this work, a commercial ethylene oxide reactor was modelled by Artificial Neural Network algorithm with actual plant data as no reliable first principle based phenomenological model is available. In commercial plant, ethylene oxide is produced by reacting ethylene and oxygen at high temperature (225-275°C) and pressure (19-21 bar) with silver catalyst. The function of catalyst is to promote the desired ethylene oxide reaction (Ethylene + oxygen = ethylene oxide) and suppress the undesired reaction which produces CO_2 (Ethylene + oxygen = CO_2 + H_2O). A promoter is also added in small quantity (2-10 ppm) to enhance the catalyst selectivity. In commercial plant maintaining the optimum concentration of promoter is very crucial as it has large impact on selectivity. Our developed ANN model finds a relation of catalyst selectivity and catalyst temperature with other reactor operating parameters like promoter concentration, raw material concentration, CO_2 concentration etc. in reactor inlet gas. A multi-objective genetic algorithm (MOGA) is used to find the optimum reactor conditions to simultaneously maximize the catalyst selectivity and minimize the temperature. Pareto optimal solutions are generated to represent the trade-off between two contradictory objectives. Our developed modelling and optimization framework is deployed in running commercial plant for real time optimization of reactor conditions.

Keywords—

Ethylene oxide reactor; Multi-objective Genetic Algorithm; Artificial Neural Network; optimization; Pareto; selectivity.

1. Introduction

In commercial chemical plants, a reactor is considered as the power-horse which converts raw material to a value-added product. In that context, the reactor can be seen as equipment of significant value addition, and downstream separation equipment can be considered as energy and money user where product purity enrichment is done. Hence in any chemical plant, there is a huge impact of reactor optimization in overall plant profitability. To optimize the industrial reactor, the first step is to build a credible mathematical model that connects reactor output concentration with input concentration and other process parameters. For poorly understood industrial reactors, this is considered a tedious task. Industrial chemical reactions usually involve complex stoichiometry, kinetics, and thermodynamics. Most of the industrial reactions are multiphase catalytic reactions, involve complex unknown kinetics and phenomenological mechanisms of catalyst activity, selectivity is poorly understood. Due to this poor understanding of inherent phenomenology, the development of the credible phenomenological model of the industrial reactors remains a distant dream. Due to the short market for chemical products, it is usually not worthwhile for producers and owners of chemical plants to spend a lot of time, effort, and money studying the detailed mechanism of the complex reaction. In most chemical plants, the reactors remain as a black box, and operation engineers do not attempt to carry out many experiments on it in a running plant. Usually, operation engineers prefer to run the reactor within the prescribed limit of temperature, pressure, and concentration advised by the licenser. In most cases, this leads to the non-optimum operation of an industrial reactor. Hence, most complex industrial reactors remain an unexplored area of process industries. The non-optimum operation of industrial reactors has a huge negative effect on the overall profit of the plant. However, a little increase in catalyst selectivity or yield has a noticeably big impact on raw material consumption i.e., on production cost due to multiplicative effects of scale-up. Since the optimization of industrial reactors represents a lot of potential opportunities, it is worthwhile to explore alternative computational techniques to model complex industrial reactors. Since a huge amount of reactor input and output process-parameter data are available in any modern chemical plant data-driven modelling technique can be a viable alternative. In the last decade, Artificial Neural Networking (ANN) has

proved itself as an effective modelling technique to model industrial reactors.

Once a model is developed, the next vital step is to optimize the process parameters so that reactor performance in terms of selectivity can be maximized. In the present study, a multi-objective genetic algorithm is used to find optimum process parameters so that selectivity is maximized.

In this work, an industrial ethylene oxide reactor is modelled and optimized so that profit generated from the reactor is maximized. This paper deals with running commercial ethylene oxide (EO) plant and explore how a practical balance between profit and environmental impact can be made so that plant can implement it in their day to day operations. A step by step procedure to implement a multi-objective optimization strategy in running a commercial EO plant has been represented in this paper. EO is considered to be the second most demanding petrochemical product which is used to make polyester. Following two reactions simultaneously take place in commercial EO reactor:

$$C_2H_4 + \frac{1}{2}O_2 \rightarrow CH_2O$$

Desired reaction (1)

Ethylene + oxygen = ethylene oxide

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

Undesired side reaction (2)

Ethylene + oxygen = carbon-di-oxide + water

The first reaction produces the desired product EO, and the second reaction produces undesired CO_2, which subsequently separated and vents into the atmosphere. In petrochemical industries, a shell and tube reactor is used for the production of EO where the reactions take place in the tube side filled-up with silver-based catalyst, and in the shell side, boiler feed water is circulated to recover the heat generated due to the exothermic reactions. The schematic diagram of the EO plant has been depicted in Figure 1. Ethylene oxide plant is very attractive from a profit point of view as there is a huge never-ending demand for polyester used for making clothes and PET bottles worldwide [4]. On the other hand, the ethylene oxide plant has an extremely high negative impact on the environment as it consumes oxygen from the air and, in return, discharges harmful carbon-di-oxide into the atmosphere. The economics of the process is driven by the selectivity of the catalyst, which can be defined as a mole of EO produced per unit mole of ethylene. Higher selectivity means lesser ethylene consumption and lesser production cost since the cost of ethylene takes 90% share of the total production cost. Therefore, it is very crucial to find out optimum process conditions at which the selectivity of the catalyst can be maximized, which will lead to maximization of the production of ethylene oxide, minimization of the production of carbon-di-oxide, and minimization of the consumption of oxygen. Another operational feature of a commercial EO reactor is that with the age of the catalyst, the selectivity decreases gradually due to various factors such as sintering effect, catalyst poisoning, etc. The selectivity of the present generation catalyst is 91% at the starting of operation and it gradually decreases and reaches 85% at end of the run. As the trial and approach are used by operators, the catalyst selectivity does not remain up to the mark and that is why to overcome the decrease of reaction rate and enhance the selectivity of the catalyst, there remains no other option but to increase the reactor temperature. Catalyst temperatures need to increase over the life of the catalyst to increase the reaction rate to maintain production target to compensate for selectivity loss [4]. Increasing temperature more than what is required means lower catalyst life and lower profitability. Looking at the contradictory nature of selectivity and temperature with each other, it is the need of the hour to optimize the process conditions in such a way so that selectivity is maximized and the temperature is minimized, simultaneously while maintaining the production target.

This paper tries to explore that delicate balance between the two contradictory objectives as follows:

(i) Maximize profit generation, which essentially means maximization of selectivity.

(ii) Minimization of catalyst temperature which will extend the catalyst life.

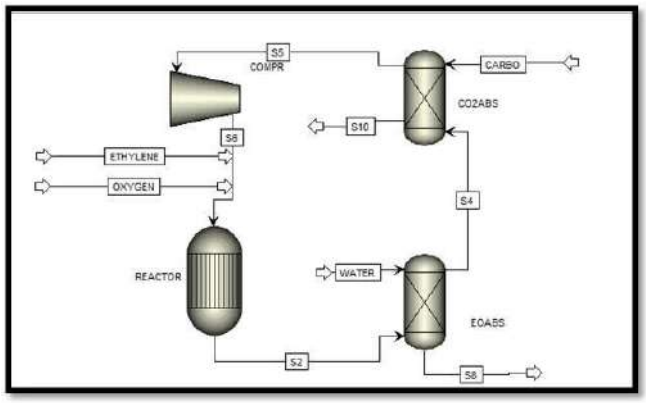

Figure 1: Schematic diagram of EO plant

As maximization of catalyst selectivity and minimization of catalyst temperature are

contradictory to each other and it is always the case for any major ethylene oxide plant, this paper addresses the issue. Firstly, a data-driven ANN-based model was built up for the EO reactor as there is a lot of operating data available in commercial EO plants. ANN modelling technique is used in the present study as no credible phenomenological model of EO reactor has been reported in the literature.

Furthermore, it is an exceedingly difficult task to develop a credible phenomenological model as the EO reaction process is a multiphase catalytic reaction, and reaction rates depend on various parameters. ANN has become very popular for its wide range of applications for modelling industrial processes. One of the major advantages of ANN is it can capture the non-linearity of the underlying relationship between predictor and response variable from the data and it can predict with high accuracy. The purpose of the model is to know the relationship between catalyst selectivity and temperature with reactor process parameters quantitatively [6, 7, 8, 9]. Once a reliable ANN model was built up, a metaheuristic multi-objective genetic algorithm optimization technique was applied to find out the optimal operating condition to balance the selectivity and catalyst temperature.

In this research work, there are two primary objectives as follows:

- Develop a data driven credible ANN model from actual industrial plant data which relates catalyst selectivity and reactor temperature with reactor operating parameters.
- Once a credible model is developed, utilize this model to evaluate the model for optimum reactor parameters which maximizes the selectivity and minimize reactor temperature. This will ensure maximization of plant profitability. Since selectivity and temperature are contradictory and both objectives cannot be achieved simultaneously, Multi-objective Genetic Algorithm is applied to find out the Pareto optimal solutions. If plant is run with these optimum reactor parameters, it will maximize the profit from reactor.

The first data was accessed from industry followed by cleaning of noise by applying principle component analysis (PCA) method. Development of a mathematical model was performed employing ANN with a suitable algorithm, activation function, and several hidden nodes. GA was applied to the developed model to obtain optimal parameters aiming at the maximization of the selectivity of the catalyst and minimization of the reactor temperature.

2. Development of ANN models for EO reactor

Artificial Neural Networks (ANN) are biologically inspired computer programs designed to simulate the way in which the human brain processes information. ANNs gather their knowledge by detecting the patterns and relationships in data and are trained through experience, not from programming (black box). ANN is formed from hundreds of single units, artificial neurons or processing elements (PE), connected with coefficients (weights), which constitute the neural structure and are organized in layers [10]. As of now, no mathematical model of an industrial ethylene oxide plant is available. It is not possible to deploy a first principle based model as a real-time application with varying industrial conditions as it is time-consuming. However, a black box model is dependent on the quality of data. Only accurate measurements will ensure effective model. ANN has successfully been applied in variety of applications in diverse engineering field. ANN is also applied to model industrial reactors from actual plant data [6, 7].

Identification of input/output parameters is the first step to develop ANN model. Since selectivity and reactor temperature has a profound effect on plant profitability and production cost. These are two parameters are kept as output parameters of the model. Now the plant production engineers and domain experts are consulted to identify the reactor operating parameters which can influence selectivity and temperature and those parameters are included in the wish list of model input parameters. The cross relation coefficient method is applied to shortlist the input parameters. Higher the cross relation coefficient more is the chance of getting selected as final input parameters. The final input and output parameters are shown in Table 1 and Table 2 respectively:-

Variable Name	ANN Input		
	Input Parameters	*Units*	*Range*
x1	Ethylene Concemntration	mole%	30.01-31.01
x2	Oxygen Concentration	mole%	6.65-7.44
x3	CO_2 Concentration	mole%	0.91-1.46
x4	Cycle gas Flow	MT/hr	320.27-356.18
x5	Cycle gas Pressure	bar	18.86-19.82
x6	Promoter Concentration	ppm	2.9-9.02
x7	Work Rate	kg hr^{-1} m^{-3}	163.22-178.43
x8	Cumulative hours	hour	24-12264

Table 1: Input dataset fed to ANN

Variable Name	ANN Output		
	Output Parameters	*Units*	*Range*
y1	Temperature	C	243.56-273.8
y2	Catalyst Selectivity	mole%	84.68-89.741

Table 2: Output dataset fed to ANN

So, here we have used the data collected from a commercial EO plant to develop our model. Using the application tool of Artificial Neural Networking in MATLAB software, a model is developed which consists of eight input layers, ten hidden nodes and three output layers. The input matrix consists of ethylene concentration, oxygen concentration, carbon dioxide concentration, cycle gas flow, cycle gas pressure, promoter concentration, work rate, cumulative hours. The output layer consists of our target variables namely catalyst selectivity and temperature as shown in Figure 2.

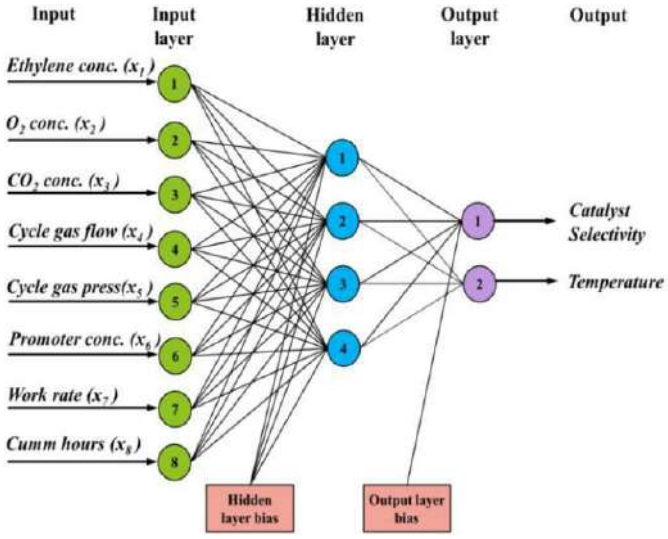

Figure 2: Artificial Neural Network architecture

The developed calculation model will be used in real time plant control. The advantages of ANN models are:

(i) They can be built from available input-output data, which is abundantly available in commercial EO plant

(ii) The ANN models usually have very high prediction accuracy as it learns the relationship from the actual operation data of plant

(iii) ANN consists of several easy to use built-in algorithms and activity functions, employing of which a high accuracy predictive model can be successfully developed.

(iv) ANN algorithm is also capable to handle a substantiate amount of noise in the data, which generally remains in the actual industrial dataset. However, a proper cleaning method should be applied to remove outliers as too much noise in data imposes more complexity in the ANN model.

From the graphs of actual vs predicted values (Figure 5, 6), we can see that ANN has accurately predicted the value of the objective variables.

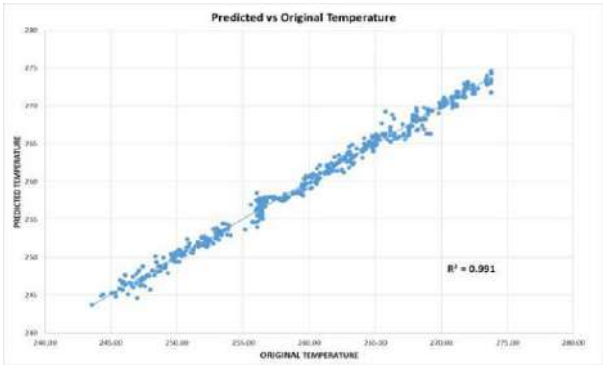

Figure 3: The regression coefficient of the developed ANN model for reactor temperature

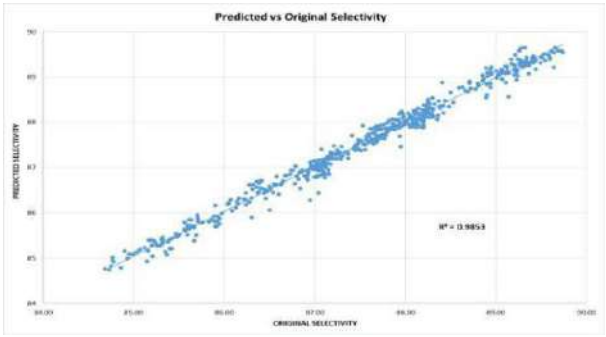

Figure 4: The regression coefficient of the developed ANN model for catalyst selectivity

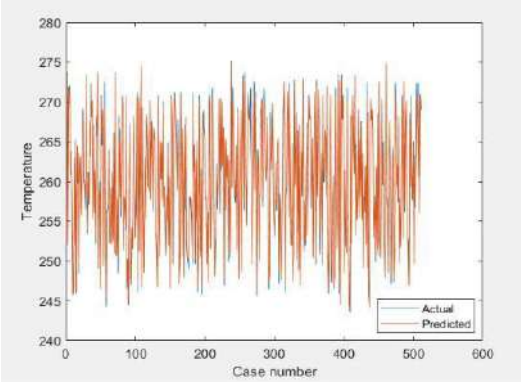

Figure 5: Validation of ANN model's predicted temperature

The mean square error percentage obtained for each of the objective variable is less than 0.1%. The R squared value obtained for each of the objective function is above 99% as shown in Figure 3, 4 . Thus, the model developed is highly accurate and reliable.

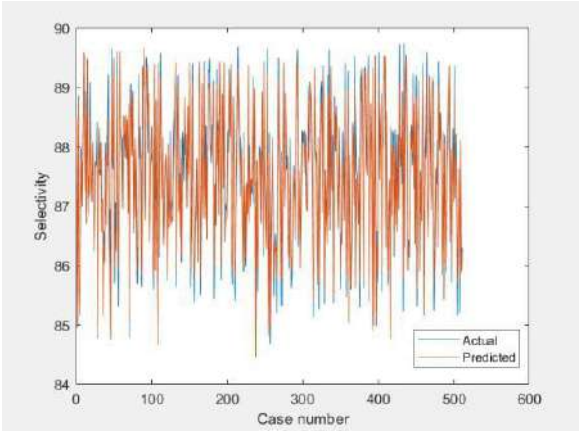

Figure 6: Validation of ANN model's predicted selectivity

3. Multi-objective Genetic Algorithm Optimization

In computer science and operations research, a genetic algorithm is a metaheuristic inspired by the process of natural selection, which belongs to the larger class of evolutionary algorithm. **Multi-objective Genetic Algorithm** (MOGA) is a guided random search method. It is suitable for solving multi-objective optimization related problems with the capability to explore the diverse regions of the solution space. MOGA is based on the law of natural evolution 'survival of the fittest'. It involves a robust search technique to find out the optimum one. Here, MOGA tool of the MATLAB software is used to optimize the EO plant operation, which is modelled by using ANN, where the objective function is to increase the selectivity if the catalyst and simultaneously decrease the temperature [1, 2]. As in this study, two objective functions with contradictory nature were taken into consideration, a multi-objective genetic algorithm (MOGA) was employed. The objective functions were taken as follows:

$F_1(x) = net_1$ (Temperature) (3)

$F_2(x) = 1/(1 + net_2$ (Selectivity)) (4)

Where net_1 (Temperature) and net_2(Selectivity) are the models developed through ANN. So, both the objective functions $F_1(x)$ and $F_2(x)$ were minimized through MOGA. Thus, we aim to find out the optimum operating conditions that will simultaneously meet both the contradictory objectives. The upper and lower limit of each target objective was set to the minimum and maximum value of the variable in the dataset generated. Through the conflicting objective functions a set of optimal solutions can be produced, and they are known as Pareto-Optimal solutions. These optimal solutions can't say which one is better than the other with respect to all objective functions and the reason is that there are many optimality solutions. Also Pareto optimal set known as solution to multi objective optimization represent a collection of points. These solutions are also termed as non-inferior, admissible, or efficient solutions [3, 5]. There is no single optimum solution as the objectives are contradictory. This gives rise to multiple optimum solutions for simultaneously maximizing catalyst selectivity and minimizing reactor temperature. It can be left to the operator's discretion on which operating variable should be given more preference. The trade-off between three contradictory objectives is depicted in the Pareto diagram (Figure 7).

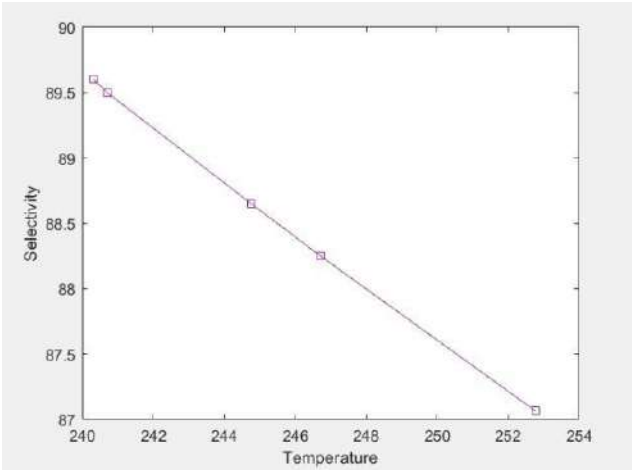

Figure 7: Pareto optimal solution graph

The modelling and optimization framework developed can be deployed in a real time commercial plant to optimize the process parameters.

Cum hours	Conc. of oxygen	Conc. of ethylene	Cycle gas flowrate	Cycle gas pressure	Carbon-di-oxide conc.	Conc. of promoter	Work rate	Reactor Temp	Catalyst selectivity
3607.94	6.71	30.36	353.51	19.82	1.34	3.34	171.22	240.32	89.60
3611.95	6.72	30.36	353.41	19.80	1.42	3.43	173.42	240.70	89.50
3618.59	6.72	30.36	353.03	19.51	1.39	4.51	172.38	244.75	88.65
4656.76	6.73	30.32	351.72	19.46	1.43	4.96	173.65	246.71	88.25
4946.79	6.72	30.32	351.54	19.23	1.45	5.91	175.36	252.77	87.06

Table 3: Pareto optimal solution

The optimum operating conditions obtained by the multi- objective Genetic algorithm optimization are depicted in Table 3.

4. Conclusion

The present study explains an innovative approach of modelling and optimization of commercial EO plant which can result in a reduction of operating cost, the increment of profitability of the plant, and an environmental solution with lesser consumption of O_2 and lesser emission of CO_2. An artificial neural network was applied on the industrial EO reactor data to obtain accurate models which are successful to establish a relationship between catalyst selectivity and reactor process parameters as well as between reactor temperature and reactor process parameters. An exhaustive search algorithm is developed to automatically select a proper ANN training algorithm, suitable activation function, and to fix the optimum number of nodes in the hidden layer, and thus relieves the user to undergo painstaking time consuming trial and error approach. A very high value of R^2 (close to 1) and very low prediction error indicates the developed EO reactor model is very accurate. After that, a multi-objective genetic algorithm was applied to the developed models to find out a set of Pareto optimal solutions with the help of which plant operator can optimize process parameters so that the plant runs in the best efficient way. Application of this hybrid ANN-MOGA technique in real commercial plant can bring substantial economic benefit and reduce environmental impact simultaneously. The developed hybrid ANN-MOGA strategy is generic and can be extended to optimize any other process plant also.

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A Predictive Model Anticipating Consumer Behavior in Online Purchasing in an E-Commerce Environment in the COVID-19 Era: A Study on Dhaka, Bangladesh

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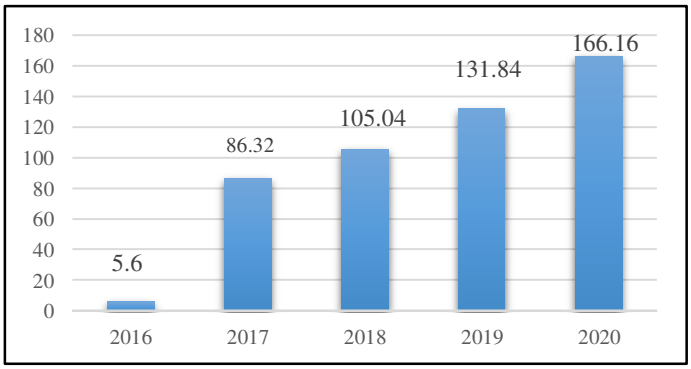
***Abstract*—The COVID-19 pandemic brought a paradigm shift in trade and business in both national and international context. Precautionary measures to avoid the disease; like lockdowns, social distancing, and prohibition on cross border trade caused significant damage to most of the businesses. However, the global E-commerce industry is one of the few for which this pandemic has acted as a boon. As for Bangladesh by mid-2020 the size of the E-commerce industry reached Taka 166 billion-an astonishing 30 times that of 2016. This study aims to construct a predictive model to analyse and predict consumer behaviour of online purchasing in Dhaka city of Bangladesh in this COVID-19 era. For the data set, interview on 200 participants were conducted to understand their approach to e-commerce businesses. To build the predictive model, binary outcome models like Probit and Logit models were selected to identify whether consumers will prefer to shop online after COVID-19 or not. The percentage of female consumers are 20% higher than male in overall online purchasing. Education level and income also indicate the same group. People with some specific health concerns like Diabetes, Respiratory Disease, MD, and Cancer are at higher risk and they have a higher chance to take precaution by staying at home more. As more of the participated interviewees fall in to age group of 25-31 years, limited number of them contained such disease. Both the models predicted that the participants are not willing to reduce online shopping in the future, which supports the argument that the pandemic substantially increased online shopping.**

Key words: COVID-19; Online, shopping; Consumer, Behavior; E-Commerce; Dhaka, Bangladesh)

I. INTRODUCTION

COVID-19 is an infectious disease which is caused by a newly discovered species of coronavirus. Till February, 2021 the total number of globally reported cases of COVID-19 are over 107 million; causing over 2.34 million deaths (WHO Coronavirus Disease (COVID-19) Dashboard, 2021). Countries around the world have been taking actions by initiating lockdowns, shutting their borders down and enabling mandatory social distancing. The ramifications of these caused severe impacts on multiple facets of global business, travel, E-commerce, employment, technology, and the economy as a whole. However, lack of demand has not been a concern for all industries; one of them being the global E-commerce industry. E-commerce is defined as buying and selling of products or services via any electronic medium. People being locked down at home, fear of getting in contact with other people and the tendency to avoid crowded places have caused a remarkable upsurge in online purchasing across the world. In relation with that, the size of the E-commerce industry in Bangladesh has risen to Tk 166.16 billion until August, 2020- approximately 29.67 times of the amount in 2016 (Bangladesh Competition Commission, 2020).



Source: Bangladesh Competition Commission (Figures in billion Taka)

Fig. 1. Growth of the E-Commerce Sector of Bangladesh

Acknowledging the expansion of E-commerce after COVID-19, it's crucial to conduct an in-depth analysis of primary consumers and understand the economy better. This study aims to identify the characteristics of primary consumers of E-commerce and how the factors are affecting consumers' preference to shop online.

In the next section, we provide a brief review of existing literature followed by a discussion about the methodology we used in the study. After that we elaborate our result and finally, draw a conclusion in the last section.

II. LITERATURE REVIEW

E-commerce revolutionized how business are conducted in the emerging economics such as: Bangladesh, India, China, Taiwan, Indonesia etc. Majority of the studies conducted with regards to E-commerce adaptation to SME (Kurnia et al., 2015, Rahayu and Day, 2017), where they empirically suggested the benefit of E-commerce technology adaptation and how different factors such as: environmental, organizational and national readiness impact E-commerce technology.

The primary driving force of E-commerce is how consumer behavior changed over the decade. Demographic

variables such as: gender, age, level of income, education level and marital status influences the consumer behavior and preference (Kim et al., 2008, Gong et al., 2013, and Rahman et al., 2018). Dennis et al., (2009) developed a dynamic model to rationalize the consumer's decision making process. By incorporating psychological and social factors, they emphasized on interactivity and emotional state which leads to the actual purchase. Bucko et al. (2018) determined 7 factors (price, availability, social proof, scarcity, product details and condition social media activity) by using Principle Component Analysis. Rahman et al. (2018) conducted an empirical study of consumer behavior for online shopping in pre-COVID-19 era Dhaka, Bangladesh and found that online shoppers are mostly below 24 years old and, demand for clothing and accessories is the highest.

Due to COVID-19, the world experienced a paradigm shift and it severely affected economy especially developing countries' economy for substantially low unemployment and limited business opportunities. Along with social constraints, mass quarantine induced changes in eating habits, anxiety, stress, stigma, and xenophobia (Javed et al., 2020). For such drastic changes, consumer behavior and preferences changes especially for essential goods and healthcare services (Change, 2020). The pandemic created high demand, which triggered consumers to stockpiling the basic commodities (Handfield et al., 2020, Wang et al., 2020). This stockpiling behavior shifted consumers' preference to shop online especially in lockdown. While physical stores faced the detrimental effect of lockdown, online shopping increased significantly.

To understand how the consumer behavior was affected by COVID-19, very few researchers focused on building a predicting model based on different experiments and surveys. Safara (2020) built a computational model by using machine learning techniques such as decision trees, along with Bagging and Boosting on the data set from a leading online site of Middle East. The researcher used five individual classifiers to establish the predictive model and the results suggest that the model which is similar to Bagging provides the highest accuracy (95.3%) among all other decision trees. Qiu, Lin and Li (2015) built a predictive model to understand customer purchasing behavior by using two staged COREL (Consumer Purchase Prediction Model), and suggested that customer preference relies on product's features. COREL provided a better prediction compared to the baseline methods. Yang et al. (2013) analyzed the online shopping pattern and developed a method by using Discrete Choice Model. Yang and Allenby (2003) implemented a Bayesian Autoregressive discrete choice model to analyze the presence of interdependency between customers.

From the past literature, we observe a growing importance of consumers' behavior in E-commerce context, implementing machine learning to expand the perspective and increasing the validity of the predictive model.

III. Methodology

Witnessing the overwhelming upsurge in E-commerce due to the pandemic, this study aims to construct a predictive model to analyze and predict consumer behavior, which is the foundation for the businesses. By anticipating consumer behavior and preferences, companies can align their strategies to increase sales and consumer purchasing rate.

For the data set, we conducted interview of 200 participants to understand their approach to E-commerce. These participants were selected randomly.

To build a predictive model, we selected binary outcome models such as: Probit and Logit model to identify whether consumers will prefer to shop online after COVID-19 or not.

A. *Probit Model*

Using the cumulative distribution function (cdf) of standard normal distribution $F(x'\beta)$, the generalized equation for Probit model is:

$$F(x'\beta) = \Phi(x'\beta) = \int_{-\infty}^{x'\beta} \phi(z)dz \quad (1)$$

The predicted probability ranges between zero (0) to one (1).

B. *Logit Model*

Logit model uses cumulative distribution function (cdf) of logistical distribution$F(x'\beta)$, the generalized equation is:

$$F(x'\beta) = \Lambda(x'\beta) = \frac{e^{x'\beta}}{1+e^{x'\beta}} = \frac{\exp(x'\beta)}{1+\exp(x'\beta)} \quad (2)$$

Similar to the Probit model, the predicted probability for Logit is also between zero (0) to one (1).

IV. Findings

The first part of this section is to provide the dataset and after that, the study explores the result of descriptive statistics and predictive model using Probit and Logit regression. The criteria is selected based on the previous literature where, Rahman et al., (2018) investigated the factors affecting consumer behavior online and Safara (2020) built a predictive model using Bagging and Boosting method.

TABLE I. DESCRIPTION OF THE DATASET

No.	Name	Description
1	Gender	Female or Male
2	Age	18-52
3	Occupation	Housewife/Student/Employee/Self-employment/Teacher/Manager/Academic/ Others
4	Education	Class 8/ SSC/ HSC / Graduation / Post-graduation / PhD
5	Diabetes	labelled with Yes/No
6	Respiratory Disease	labelled with Yes/No
7	Cancer	labelled with Yes/No
8	MD	labelled with Yes/No
9	Number of purchase (BP)	Number of online purchase in 2 months before pandemic (January 2020 – February 2020)
10	Number of purchase (AP)	Number of online purchase in 2 months after pandemic (March 2020 – April 2020)
11	Purchasing online (Recent times)	labelled with Yes/No
12	Frequency	If the frequency of online shopping reduced, labelled with Yes/No
13	Preference	If online shopping is preferred and they will continue to shop online, labelled with Yes/No

To identify the target consumer for online shopping, we looked at three measures: demographic, health issues, habit of online purchasing.

A. *Demographic*

Based on our survey, females around the age of 25-31 years tend to prefer online shopping. Although the age group for both male and female who tends to shop online is similar, but female had a higher percentage overall. Education level and income also indicate the same group, as graduate level education and student had higher number compared to the other groups. The second highest consumer for online shopping comes from postgraduate level education and those who have a stable income. As online shopping tends to save time and provides a large range of variety, it is convenient for the people who work full time. The following figures (Fig. 2, 3, and 4) show the demographic of the participants.

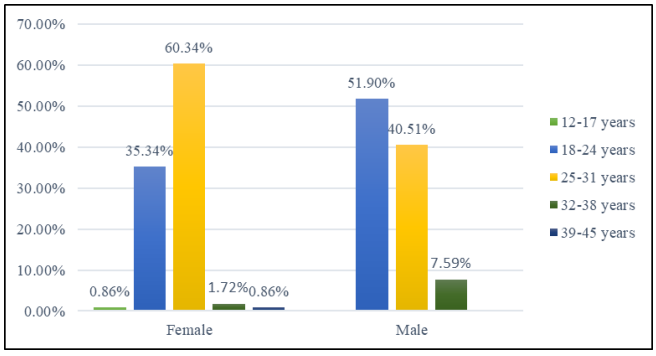


Fig. 2. Demography of Gender and Age

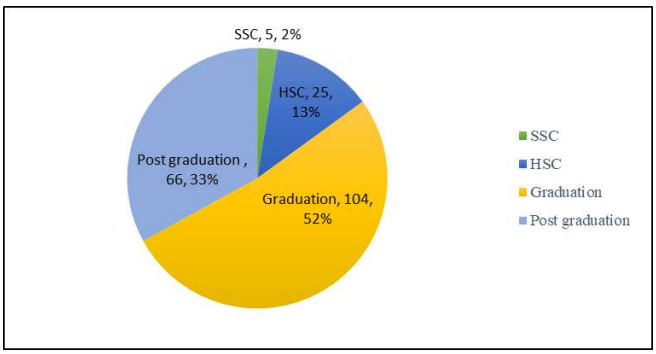


Fig. 3. Level of Education of the Respondents

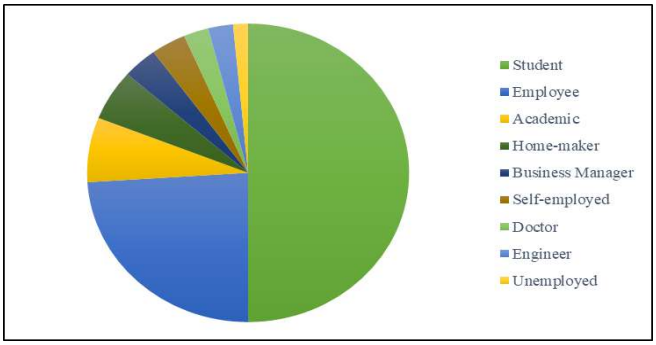


Fig. 4. Occupation of the Respondents

B. *Health issues*

The health concerns we considered are: Diabetes, Respiratory Disease, MD and Cancer. According to WHO (2020), people with such diseases are at high risk and they have a higher chance to take precaution by staying at home. As a majority of the participated interviewees fall into the age group of 25-31 years, a very limited number of them contained such diseases.

C. *Habit of online purchasing*

In order to understand the habit of online shopping, we looked into the frequency of online shopping right before the pandemic started worldwide (January, 2020- February, 2020) and right after the pandemic started (March, 2020 and April, 2020). Furthermore, we also observed whether the habit of online purchasing sustained by observing the trend in September, 2020 and October, 2020; when the pandemic was somewhat stabilized. From these variables, we clearly see that people shopped more from online stores compared to the physical ones. It is also supported by the questions where their preferences and desirability of online shopping were asked. The following figures (Fig. 5 and 6) show the results mentioned above.

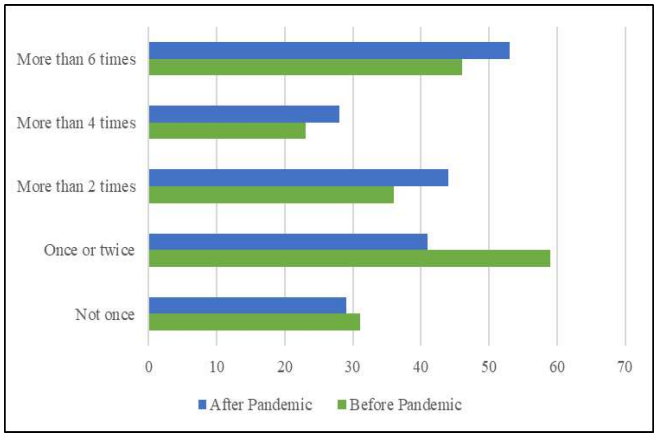


Fig. 5. Frequency of Online Shopping (before and after pandemic)

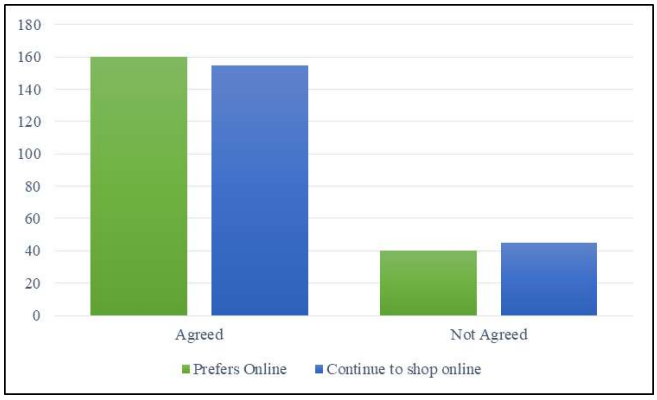


Fig. 6. Willingness to Shop Online after the Pandemic Ceases

D. *Predictive modelling*

In this study, we implemented the Probit and Logit models to identify a better way to distinguish and predict consumers' shopping preferences. Table II shows the results of the models.

TABLE II. RESULTS OF PROBIT AND LOGIT MODEL

Variables	Probit Model	Logit Model
Constant	-0.0660	-0.4150301
Female	0.4149	0.73425
Age	0.0109	0.1823
Education	-0.0034	0.1338
Experience	0.0866	-0.1676
Diabetes	0	0
Respiratory Disease	0.1825	0.2047
Cancer	0	0
MD	0.7202	1.3299
Number of purchase (BP)	0.0790	0.1460
Frequency to reduce	-0.1472	-0.2862
Continuity	0.3642	0.6613
Prob >chi2	0.0345	0.0269
Pseudo R2	0.0921	0.0959

Probit and Logit model provided almost similar results. The gender female, age, respiratory diseases, number of purchase before pandemic and willingness to continue shop online has a positive effect on preference of online shopping. Along with that, both models predicted that the participants are not willing to reduce online shopping in the future which supports the argument that the pandemic substantially increased online shopping. However, the Probit model predicted that education will have a negative effect and increasing experience will have a positive effect on the growing E-commerce industry, which was inversely predicted by the Logit model. It appears that there is a trade-off between these two variables and further investigation is necessary to understand the dynamics of it.

V. CONCLUSION

Due to the COVID-19 pandemic, the world economy altered its course overnight. Each country experienced a shift in the traditional methods of how businesses are conducted worldwide. Under these circumstances, with the increasing popularity, E-commerce experienced a significant boom in Bangladesh which paved the way to expand our knowledge of the market. In this study, we identified the primary consumers of the E-commerce industry and built a predictive model using the Probit and Logit Models. Female respondents aging around 25-31 years with no pre-existing health conditions are more prone to shop online. Moreover, due to the pandemic people are willing to shop online more, in overall. Both the Probit and Logit models indicate a growing E-commerce industry in Bangladesh.

As a future extension of the study, a larger sample size, including factors such as: psychological effect, income effect and demand of products will help us understand the pattern of consumer preference after COVID-19 era even better. Similar studies can be conducted on other big cities in Banlgadesh such as Chittagong, Rajshahi or, Sylhet. A majority of the respondents of this study belonged to the age range of 25 to 31 years old as this particular demography is more accustomed with the usage of technology of online shopping but a broader future scope of the study can test any potential inclination of other demography too.

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IT governance adoption and use by state-owned entities in South Africa: *a public administration perspective*

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***Abstract*—IT governance adoption and use in the South African public sector is deemed critical to good public administration and is regulated by government through the Corporate Governance of ICT Policy Framework (CGICTPF). The CGICTPF was published in 2012 and is based on COBIT5, ISO38500 and the King IV Report. However, compliance with the CGICTPF has been poor; the Auditor General of South Africa (AGSA) noted that a significant number of its auditees in the 2018–19 financial year had weak IT governance controls. The study shows that management factors such as top management support and IT governance competencies at the level of the board of directors positively influence the adoption and use of the CGICTPF by improving accountability and oversight. A compliance framework is proposed which is based on the TOE framework and the DeLone and McLean IS Success Model, which highlights management competencies as a crucial element.**

Keywords—IT governance, CGICTPF, IT governance adoption, public administration, state-owned entities, compliance, management competencies

I. INTRODUCTION

State-owned entities in South Africa are becoming increasingly dependent on information technology (IT) resources to improve efficiencies when delivering services to the public. This increased dependency on IT is demonstrated by: (1) the recognition of IT as a strategic tool for public sector organizations to increase the productivity of public servants and lower the costs of providing services [2], and (2) the related substantial and increasing IT-related financial investment [8].

State-owned entities are those organizations that depend on state budget allocation to provide public services [13]. There are more than 300 such state entities in South Africa [22]. State-owned entities are distinct from state-owned enterprises in purpose and operation. The key distinctions being that state-owned entities fall under Schedule 3 Part A of the Public Finance Management Act of 1996 (PFMA), do not sell products and services, and are non-profit making. State-owned enterprises, on the other hand, fall under Schedule 2 of the PFMA and are mandated to generate profit by selling products and services [22].

The Auditor-General of South Africa (AGSA) has noted that IT governance controls in the public sector have not been implemented effectively [8]. The AGSA reported that 63% of its auditees in the 2018–19 financial year had weak IT governance controls which demonstrated "a lack of accountability and oversight" [8]. The lack of accountability and oversight can be attributed to poor IT governance competencies among members of the board of directors [30]. In organizations where there is limited "IT governance knowledge, skills and experience" among members of the board of directors, the board cannot challenge or "ask the right questions of management and advisors" [30]. Previous surveys of senior executives revealed that "less than 20 percent identify as having [Enterprise Business Technology Governance] EBTG competent directors" in their organizations [30]. Further, when senior management understand the business-related benefits of IT governance and set the appropriate tone, IT governance implementation becomes a success [4].

The impact of the poor implementation of IT governance controls is that IT investments are not always maximised as a result of excessive levels of irregular, fruitless and wasteful expenditure [8]. Further, compliance with legislation, standards and the Corporate Governance of ICT Policy Framework (CGICTPF) has not been achieved as state-owned entities have "not implemented all the elements of the [CGICTPF] framework" [8]. This poor IT governance implementation is consistent with trends noted in other developing countries [24][28][10].

We are not aware of a compliance framework that has been developed in the South African context to theorise the adoption and use of the CGICTPF. We are also not aware of any studies that have explored the implications of mandated adoption and use of IT governance in public administration. Finally, one of the constructs of the preliminary compliance framework in this study is information quality, which is a novel addition to IT governance research in the public sector context in South Africa.

II. THE CORPORATE GOVERNANCE OF ICT POLICY FRAMEWORK (CGICTPF)

A. Public sector characteristics

The CGICTPF was published by the Department of Public Service and Administration (DPSA) in 2012 to improve IT governance in South African state-owned entities. Subsequently, all public organizations were mandated to implement it from 2014 onwards [2]. The CGICTPF is comprised of elements of Control Objectives

for Information and Technologies (COBIT5), the ISO38500:2015 standard and the King IV Report. The integration of these frameworks is intended to improve compliance.

IT governance is a key component of corporate governance [18]. There are many definitions of IT governance, including the following: (1) "Specifying the decision rights and accountability framework to encourage desirable behavior in the use of IT" [35]; (2) "IT governance is the process by which decisions are made around IT investments" [11]; and (3) "the organizational capacity exercised by the board, executive management and IT management to control the formulation and implementation of IT strategy and in this way ensure the fusion of business and IT" [7]. It is further defined as consisting of the "leadership and organizational structures and processes [to] ensure that the organization's IT sustains and extends the organization's strategies and objectives" [12].

These definitions are convergent. Therefore, this study adopted the following definition as it best fits the public sector context: *IT governance is the organizational capacity exercised by the board, executive management and IT management to make and monitor IT-related business decisions and investments to sustain and extend the organization's strategic objectives*. There are key differences that distinguish between public and private sector contexts, and these are most evident in the following areas:

TABLE I. PUBLIC SECTOR CHARACTERISTICS (ADAPTED FROM [37][14])

No.	Private vs public sector characteristics		
	Attribute	***Private sector***	***Public sector***
1	Goals	Shareholder value	Public value
2	Stakeholders	Few	Many
3	Environment	Less regulated	Legal and formal constraints
4	Incentives	High/market-related	Low
5	Risks	Lower aversion	High aversion
6	Competition	High	Low
7	IT innovation	Competitive advantage	Treated as necessity
8	IT sourcing	Flexible contracting	Complex tendering process
9	IT resources	Proprietary IT	Shared IT resources

These differences have been noted mainly in the US, Australia and Germany. Nevertheless, they are material enough in the South African context to necessitate an idiosyncratic approach to IT governance research. This will lead to a richer grasp of the IT governance mechanisms and practices that are best suited to the public sector context [37].

B. Mandated adoption and use of IT governance

The motivation to adopt new processes in public organizations needs to be clarified as this has a bearing on the success of the adoption [33]. In this study it is important to consider this because it also reveals the nomothetic nature of CGICTPF adoption. In the South African public sector context, the adoption of the CGICTPF is mandatory and all public sector organizations must implement it [2]. The CGICTPF was published following a recommendation from the AGSA that the state should implement a framework for IT governance [2]. The AGSA recommended that: (1) "a government-wide Governance of ICT Framework should be put in place to implement a national ICT strategy to address ICT risks based on defined processes and standards", and (2) "the Governance of ICT roles and responsibilities should be defined and implemented to ensure adequate Public Service ICT enablement" [2]. In addition, the stated purpose of implementing the CGICTPF is to embed IT governance "as an integral part of corporate governance" [2]. However, a key barrier to the adoption of the CGICTPF relates to management aspects such as a lack of requisite IT governance competencies among board members and poor support from top management [8][30].

The use of IT governance in most organizations is based on two imperatives: regulatory compliance and strategic alignment [26]. Although they may enjoy different levels of prominence, depending on the nature of adoption exercised, these imperatives are complementary. Based on the nomothetic nature of the CGICTPF adoption, the regulation-intensive environment and the public value goal of the public sector [37], the regulatory compliance imperative assumes emphasis in the public sector. However, it should be noted that one of the key components of IT governance is strategic alignment [4]. Organizations that meet compliance requirements by using the CGICTPF are able to use IT efficiently to meet organizational strategic objectives [4]. Therefore, compliance is a critical performance indicator and strategic differentiator in an environment where adoption is mandated, as is the case with the CGICTPF in the public sector.

IT enhances organizational performance and creates value in public sector organizations through five key organizational capabilities [19]. It has been observed that in the South African public sector, IT also enables these organizational capabilities, namely: (1) a digitized administrative process, (2) public intelligence analytics, (3) inter-organizational system integration, (4) online public interactive interfaces and (5) public information dissemination.

III. THEORETICAL FOUNDATION

Much of the literature on IT governance does not address the subject of IT adoption and use in state-owned entities as intended in this study. Rather, the literature focuses on the IT governance areas shown in Table II below.

TABLE II. IT GOVERNANCE FOCUS AREAS

No.	IT governance focus areas in literature		
	Focus area	***Sector***	***Reference***
1	Success factors	Public/private	[24][11]
2	Mechanisms	Private	[17]
3	Practices	Public	[36]
4	Awareness	Private	[23]
5	IT spending and efficiency	Public	[29]
6	Disclosures	Private	[6]
7	Barriers	Private	[28]

Several Information Systems (IS) researchers have considered the subject of IT governance adoption and implementation by extending to IT governance research the work conducted by other IS researchers on IT innovation and adoption [31]. The theoretical lenses applied in such studies include the: (1) Technology Acceptance Model (TAM) [5], (2) Unified Theory of Acceptance and Use of Technology (UTAUT) [32], (3) Theory of Planned Behavior (TBP) [9], (4) Agency Theory [14], (5) Technology Organization Environment (TOE) framework [27], (6) Diffusion of Innovation (DOI) [34], (7) Absorptive Capacity [20], and (8) the DeLone and McLean IS Success Model [25]. Some IS researchers have used a combination of theories in their studies so as to improve their understanding of the adoption and implementation decisions made by organizations [34][3].

This study builds on the work done by [31] through an in-depth multi-case inquiry that is exclusively focused on the public sector in the South African context. The unit of analysis for this study is the organization. A combination of theories is utilised to better account for the adoption and use of IT governance in state-owned entities. Accordingly, the TOE framework and the DeLone and McLean IS Success Model (D&M IS Success Model) are deemed suitable for this purpose.

A. *The Technology-Organization-Environment (TOE) framework*

The TOE framework is suited for this study because it is widely used in the IS literature, was conceptualised in a study of organizational analysis in the public sector and covers a broad spectrum of organizational characteristics that advance the depth of analysis [3]. It is organised by technological, organizational and environmental factors that affect organizational adoption [1]. The developers of the TOE framework asserted that its technological context "includes current practices and equipment internal to the firm" [1]. This quality makes the TOE framework suitable for a process-related inquiry such as that of IT governance adoption and use. Reference [3] note that the key limitations of the TOE framework are that it is too generic and its constructs can be vague. They further suggest that these limitations could be remedied in research by integrating the TOE framework with other theoretical models [3].

B. *The DeLone and McLean IS Success Model*

The D&M IS Success Model is also widely cited and considered to be among "the most influential theories in contemporary IS research" [25]. Its creation was driven by "a process understanding of IS" [15]. This makes it compatible with an inquiry into IT governance adoption and use. The D&M IS Success Model is also appropriate for this study because IT governance adoption and use is contingent on the "effective creation, distribution and use of information via technology" for IT-related decision-making [16]. In addition, the compatibility of the D&M IS Success Model with IT governance research is strengthened because concepts from an IT governance framework, namely: the Information Technology Infrastructure Library (ITIL), have directly influenced the choice of constructs of the D&M IS Success Model [16]. Criticism of the D&M IS Success Model includes dependence on system use as a success measure, the role of context, independent versus dependent variables, and process versus causal models [15]. In their ten-year review, DeLone and McLean [15][16] responded extensively to these criticisms and modified the D&M IS Success Model where they deemed it necessary.

IV. PRELIMINARY CONCEPTUAL FRAMEWORK

The main contribution of this study is to enhance corporate governance and public administration in state-owned entities. This is achieved by developing a compliance framework for enhancing the adoption and use of IT governance as shown in Fig. 1 below. Reference [16] caution that all D&M IS Success Model constructs must be accounted for if complete and clear research results are to be attained. In the preliminary framework for this study all D&M IS Success Model constructs are directly and indirectly accounted for. This novel approach will further enhance the validity of the TOE framework and the D&M IS Success Model as theoretical lenses for IT governance research. The preliminary conceptual framework and its constructs are presented below:

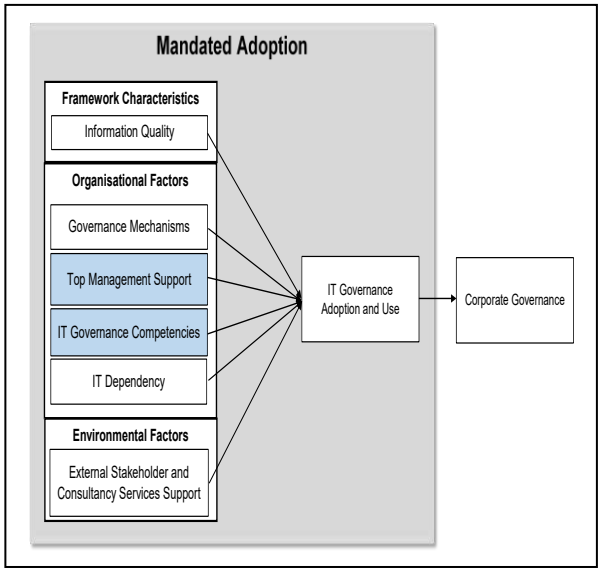

Fig. 1. A framework for IT governance adoption and use in state-owned entities

This paper focuses on IT governance competencies at the board level and top management support as key factors that influence the adoption and use of IT governance. The organizational resources and management involvement that is required to drive a successful implementation are easier to access when top management understand the "business-related benefits of" adopting IT governance [3]. Further, due to the reliance on IT as a strategic tool, board members of state-owned entities must acquire the skills and competencies necessary to provide accountability and oversight of IT strategy, investments and risks [30]. The six constructs of the preliminary conceptual framework and related propositions are presented in Table III below:

TABLE III. PRELIMINARY FRAMEWORK CONSTRUCTS AND PROPOSITIONS

No.	Constructs and propositions		
	Construct	***Proposition***	***Literature (adopted from)***

No.	Constructs and propositions		
	Construct	***Proposition***	***Literature (adopted from)***
1	Information quality	P1: The quality of management information is positively related to IT governance use.	[25]
2	Govenance mechanisms	P2: Formalised governance mechanisms in the organization positively influence IT governance use.	[38]
3	Top management support	P3: Top management support is positively related to IT governance use.	[3]
4	IT governance competencies	P4: Board-level IT governance competencies are positively related to IT governance adoption and use.	[30]
5	IT dependency	P5: The organization's mode of IT dependence is positively related to IT governance use.	[21]
6	External stakeholder and consultancy services support	P6: Support from external stakeholders and consultants is positively related to IT governance use.	[20]

V. FINDINGS

The overview of initial findings affirm the propositions of the study.

a) P1: The quality of information in management reports, on which key decisions are based, is influenced by implementing policies and standard operational procedures (SOPs) that are aligned to the IT governance framework. This, in turn, enhances the accuracy and relevance of reporting on targets defined in the annual and divisional performance plans.

b) P2: The role of the Chief Information Officer (CIO) is integral to the adoption and use of IT governance. However, relevant IT governance-related key performance indicators (KPIs) need to be clearly defined, formalised and incorporated into performance contracts of: (1) all senior and executive management, and (2) service level agreements (SLAs) with suppliers. IT governance must be on the agenda of organizational structures such as the management committee, enterprise architecture committee and IT steering committee. IT governance-related information and policies must be communicated effectively throughout all levels of the organization.

c) P3: IT sourcing decisions are effective when there is collaboration between business and IT. Business management ownership of relevant IT governance processes is critical to avoiding corruption related to IT investment and sourcing decisions.

d) P4: Competent board-level committees (i.e. Operations and IT committee, Risk and Audit committee) provide an accountability and oversight mechanism for such IT investments and sourcing decisions. Therefore, the board of directors and management must invest in ongoing and formal IT governance training for IT and business personnel; and must support the IT governance awareness initiatives. Support for periodic IT governance self-assessments must also come from the top management structures.

e) P5: It was found that the more the organization considers IT to be a strategic partner to business objectives, the more they are inclined to comply to the IT governance framework.

f) P6: Intergovernmental collaboration by public organizations was considered to be critical. This was achieved through peer review, benchmarking against local and international organizations, and memoranda of understanding (MOU) with other organizations in the public sector. A mature implementation of IT governance facilitated the collaboration efforts through clearly defined roles and responsibilities.

VI. CONCLUSION

This study proposed a compliance framework for IT governance adoption and use in public sector organizations in South Africa. This framework is necessary due to the significant number of state-owned entities who are poorly implementing IT governance controls. The framework is based on the TOE framework and the D&M IS Success Model. Its objective is to improve corporate governance, public administration and compliance with the CGICTPF. The framework considered internal and external factors that influence the successful adoption and use of the CGICTPF. The study concluded that management factors such as top management support and IT governance competencies at the level of the board of directors have a significant impact on the adoption and use of IT governance. Other related factors include information quality, governance mechanisms, IT dependency, as well as stakeholder and consultancy services support.

VII. LIMITATIONS AND FUTURE RESEARCH

This study is focused on public sector organizations that form part of Schedule 3 Part A of the PFMA (i.e. non-profit making agencies, board(s), commission(s), authorities, fund(s) etc.). In future, it would be worth investigating the adoption and use of the CGICTPF across government departments and state-owned enterprises. In addition, the conceptual framework presented here is still in the process of being empirically evaluated; therefore, only initial findings have been presented herein.

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Tourists' Information Sharing Intention in Social Media: An Empirical Study in Bangladesh

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***Abstract*— This study investigates tourists' information sharing intention in social media in the context of Bangladesh, and the Elaboration Likelihood Model (ELM), and Uses and Gratifications Theory (UGT) were used as the theoretical foundation. Data were collected from 301 tourists who use social media through an online survey and analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The estimation revealed that argument quality has a strong influence on information-seeking motive, entertainment motive, and relationship maintenance motive, and information-seeking motive also influenced by source credibility. At the same time, source credibility does not influence entertainment motive and relationship maintenance motive. Furthermore, tourists' information sharing intention is greatly influenced by all these three motives. The findings will expand the current knowledge of similar studies, and policy-makers can use it in practice. The implications, limitations, and future research directions are also discussed.**

Keywords*— *Tourists, social media, information sharing intention, Bangladesh.

I. INTRODUCTION

The use of social media broadly inclines the tourism industry. Social media is considered one of the essential weapons of the tourism industry; it becomes a common platform to the mass people over the decade [35]. Social media is an internet-based media where people can create a personal account, engage in social communication and share their wisdom and experience among people having a similar interest [7]. Tourism destination providers now realize that social media platform is more useful for the tourists than the products [13]. Moreover, information shared by tourists in social media has a significant impact in stimulating others to visit the destination as social media enables customers to find information and interact with each other that also mobilizes the growth of tourism [3,33,17].

Furthermore, the rise of social media leads to a decrease in the power of marketers and institutions, while it increases the strength of its users. It indicates that tourists' information in social media is more trustworthy and dependable than the information provided by travel-related organizations [24]. Also, numerous empirical studies on social media applications have been found in tourism research [20,9,8,4]. However, theoretically, more empirical studies on how to increase consumer participation and intention to share their experiences in social media have colossal need [24,1]. Therefore, this study investigates tourists' information sharing intention in social media in the context of Bangladesh.

II. RSEARCH BACKGROUND

This study applies ELM and UGT as the theoretical foundation. ELM refers to argument quality and source credibility as a means of persuasive processing routes [23], while UGM was used to understand various needs of social media users such as- information, entertainment, and social interaction [10]. Argument quality deals with the real strength of information that measures how strongly a piece of received information can convince a person to behave for making high involvement decisions [16,5]. This indicates that tourists seek complete and satisfactory information regarding the products and services from quality online reviews [15]. Source credibility deals with the precise and honest data as message source is more important than what is written in the message [18,2]. Tourists mostly rely on online reviews to collect hints about the delivery system and handle the services of a hotel, restaurant, or airline [15]. They are encouraged to seek information about the destination services through a credible source that stimulates tourists to leave comments, enjoy photos, videos, and information, and pass their time [15].

The information-seeking motive refers to find out relevant information through using social media [34]. It is argued that information seeking motive poses the most prominent motivation among others through using the internet [26]. Social media users can share information with identical interests, which helps to seek useful travel information to fulfill individuals' future needs [25,15]. However, entertainment motive can be defined as how social networking site provides entertainment that relief from mental stress [22]. Social media users can be entertained, which is transformed from individuals to regular users [21]. The users' primary aims are to seek satisfaction, enjoyment, time passing, refreshment, and collect social news [15,11].

Relationship maintenance motive stated to stay in touch with friends and other parties to pay a visit with new people [31]. It argued that people communicate with each other to get a sense of living [30]. In recent years, interpersonal communication takes place through the internet instead of direct contact [28]. For example, writing birthday wishes in friends' timeline is one of the standard practices to maintain social media relationships [32]. Previous studies acknowledge that both argument quality and source credibility have a more significant role in influencing users'

information-seeking motives, entertainment motives, and relationship maintenance motives [15,8].

Information sharing intention in social media refers to a wish to share users' views, opinions, and travel experiences in social media in personal accounts and organizations' official pages [27]. It creates an opportunity for social interaction between information providers and receivers [19]. It is a crucial aspect for both the customers and the travel enterprises [17]. This trend indicates that destination marketing's success depends on the users' intention to share information on a social networking site and their willingness to create a social association in social media [33]. Studies also acknowledged that social media users' different motives (information-seeking motive, entertainment motive, and relationship maintenance motive) have a significant influence on tourists' information sharing intention [15,8,27].

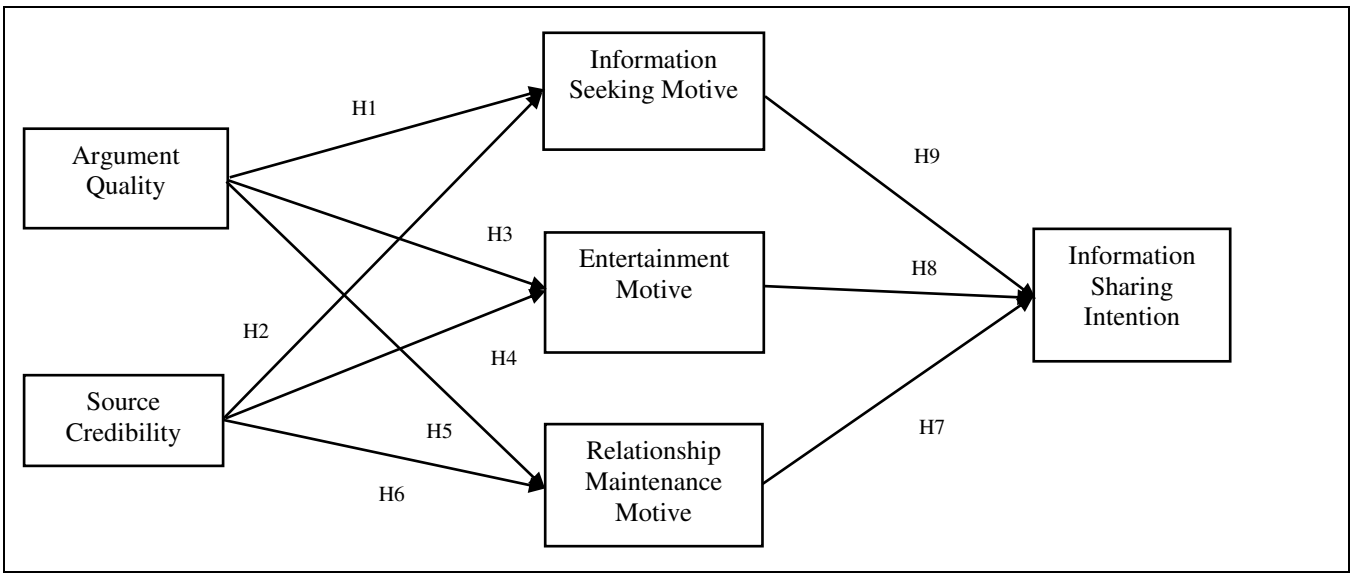

Figure 1: Conceptual Framework

With this, the above discussions and arguments lead to the following hypotheses:

H1: Argument quality has a significant positive relation on information seeking motive.

H2: Source credibility has a significant positive relation on information seeking motive.

H3: Argument quality has a significant positive relation to entertainment motive.

H4: Source credibility has a significant positive relation to entertainment motive.

H5: Argument quality has a significant positive relation to relationship maintenance motive.

H6: Source credibility has a significant positive relation to relationship maintenance motive.

H7: Information seeking motive has a significant positive relation on information sharing intention.

H8: Entertainment motive has a significant positive relation to information sharing intention.

H9: Relationship maintenance motive has a positive relation to information sharing intention

III. Research Methods

A quantitative survey was carried out by collecting data to test the significance of the proposed relations in the conceptual framework. The measurement items on the used constructs were adopted from previous related studies [15,33,27]. A six-point Likert type scale ranging from strongly disagree (1) to strongly agree (6) is used to analyze each measurement item. The data collection was carried out from tourists of the social media users online and received 301 usable responses, and performed Partial Least Squares-Structural Equation Modeling (PLS-SEM). This was done by performing factor leading, composite reliability, average variance extracted, and Fornell and Larcker's (1981) and Heterotrait-Monotrait (HTMT) criterion using different suggested cut-off points. The bootstrapping and blindfolding procedures were further performed to test the significance of the model. The effect size of the estimated relation and the structural model's predictive relevance was also performed in this study [14,29].

IV. Findings And Discussions

A. Measurement Model

The factor loading, composite reliability (CR), and average variance extracted (AVE) were performed to establish the convergent validity [12] (also see Table I). The test results exceeded different threshold values; thus, the convergent validity met all three requisites.

Table I: Assessment of Item Reliability

Construct	Item	Factor loading	CR	AVE
Argument Quality (AQ)	AQ1	0.73	0.81	0.59
	AQ3	0.79		
	AQ4	0.78		
Source Credibility (SC)	SC1	0.72	0.80	0.57
	SC2	0.79		
	SC3	0.76		
Entertainment Motive (EM)	EM2	0.70	0.82	0.54
	EM3	0.79		
	EM4	0.75		
	EM5	0.69		
Information Seeking Motive (ISM)	ISM1	0.81	0.84	0.58
	ISM2	0.77		
	ISM3	0.79		
	ISM4	0.66		
Relationship Maintenance Motive (RMM)	RMM1	0.55	0.74	0.61
	RMM4	0.96		
Information Sharing Intention (ISI)	ISI1	0.80	0.85	0.66
	ISI2	0.84		
	ISI3	0.80		

Item AQ2, EM1, RMM2, and RMM3 were deleted due to the low loading score.

Discriminant validity was further assessed using the test suggested by Fornell and Larcker's (1981) and HTMT criterion (see Table II and III). The HTMT method indicates that the threshold value of below 0.90 between two study constructs is acceptable to establish discriminant validity. The HTMT.90 means that the result is below the recommended critical value of 0.90 for each group-specific model estimation. Thus, it also met the tests of discriminant validity.

Table II: Square Root of the AVE and Correlation of Coefficient

Fornell and Larcker Criterion						
	AQ	EM	ISI	ISM	RMM	SC
AQ	**0.77**					
EM	0.30	**0.73**				
ISI	0.34	0.32	**0.81**			
ISM	0.28	0.14	0.27	**0.76**		
RMM	0.26	0.29	0.34	0.25	**0.78**	
SC	0.56	0.22	0.32	0.27	0.21	**0.76**

Note: Bold diagonal values represent the square root of the AVE, and the off-diagonal value represents the correlation of coefficient.

Table III: HTMT Results

	AQ	EM	ISI	ISM	RMM	SC
AQ						
EM	0.442					
ISI	0.492	0.432				
ISM	0.398	0.192	0.360			
RMM	0.390	0.529	0.547	0.516		
SC	0.877	0.335	0.460	0.387	0.329	

Note: Discriminant validity is established at HTMT 0.90

B. Structural Model

The bootstrapping procedure was used to test the path relations in the structural model utilizing 5000 subsamples that ensure the significance of the path relations between the used constructs [14]. The results (Table 4) illustrate that the direct effects of AQ on ISM, EM, and RMM, SC on ISM, and RMM, EM, and ISM on ISI have a significant positive relation, while SC on EM and RMM does not have. Therefore, hypotheses H1, H2, H3, H5, H7, H8, and H9 were supported, whereas the relationships of the hypotheses H4 and H6 were negative insignificant.

Next, the structural model's predictive relevance was further evaluated by using the blindfolding procedure [14,29]. The proportion of variance in the endogenous construct was assessed using the coefficient of determination (R2), which was predicted from the independent variables. The structural model also evaluated the cross-validated predictive relevance by using the criterion of Stone-Geisser's (Q2). Besides, the effect sizes (f2) that specified the extent of the relative effect of a particular independent variable on a dependent variable was substantial [6] (also see detail in Table IV).

Table IV: Results of the Structural Model

Direct Effect	Beta	S.E.	t-value	p-value	5.00%	95.00%	Decision	f^2	R^2	VIF	Q^2
H1: AQ -> ISM	0.19	0.07	2.73	0.07	0.05	0.31	Supported	0.03	0.10	1.45	0.05
H2: SC -> ISM	0.17	0.07	2.40	0.02	0.02	0.28	Supported	0.02		1.45	
H3: AQ -> EM	0.26	0.07	3.93	0.00	0.12	0.38	Supported	0.05	0.10	1.45	0.05
H4: SC -> EM	0.08	0.07	1.18	0.24	-0.05	0.20	Rejected	0.01		1.45	
H5: AQ -> RMM	0.20	0.06	3.12	0.00	0.07	0.31	Supported	0.03	0.07	1.45	0.03
H6: SC -> RMM	0.10	0.06	1.58	0.12	-0.02	0.22	Rejected	0.01		1.45	
H7: RMM -> ISI	0.23	0.05	4.38	0.00	0.13	0.34	Supported	0.06	0.20	1.15	0.12
H8: EM -> ISI	0.23	0.06	3.92	0.00	0.12	0.34	Supported	0.06		1.10	
H9: ISM -> ISI	0.18	0.06	3.08	0.00	0.06	0.28	Supported	0.04		1.07	

**p < 0.01, *p < 0.05, S.E. = Standard error.

The findings explain that the argument quality of the media broadly influences social media users' information seeking motive, entertainment motive, and relationship maintenance motive, and these motives significantly influence information sharing intention. On the other hand, source credibility plays a significant role in rising users' information-seeking motives, while this does not have such influence in increasing users' entertainment and relationship maintenance motives.

V. Conclusions, Implications And Suggestions

The current study investigates tourists' information sharing intention in social media in Bangladesh, and mixed insights found. The findings can provide benefits to the tourism destination providers, policy-makers, and other related stakeholders. The study has two fundamental limitations that might provide opportunities for future research. Firstly, the study was carried out in Bangladesh, while a cross-national study would be more suitable to generalize the findings. Secondly, the study considered a limited number of constructs. In contrast, the additional constructs such as users' trust and outcome expectations have a significant role in information sharing intention that might useful in future studies.

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Technology Adoption and Students' Satisfaction in Online Learning: A Study of INDIAN Experience During the Time of COVID-19

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***Abstract*— Online learning has become a buzzword in the wake of Covid-19 pandemic. All the educational institutions from primary school to the higher education have shifted to online teaching and learning pedagogy with the announcement of the lockdown. Though online learning and teaching were there on the education scene of many countries in various forms, it has got the legitimacy by its wide use during the pandemic period. The educational institutions have experimented with several online platforms for meeting the academic requirements of students. Not only classes, but the examinations, both internal and external are also conducted online. It has also given us an impression that even after this pandemic, online learning shall continue. In this context, the present paper analyses the experiences of the students from various institutions about their online learning lessons. Data collected from across the country from various institutions brought to the limelight the need for mainstreaming the practices of online classes. In fact, the education experience during Covid-19 made it clear that the use of ICTs in education can play a critical role in extending innovative forms of technology support to the stakeholders of education.**

Keywords— Online education, Students' satisfaction, Technology adoption, Teacher Preparedness, Quality of Content

I. INTRODUCTION

The Covid-19 has unleashed new possibilities and avenues for the education sector world-wide. In fact, the pandemic is not a mere health issue. It has gone beyond the health malady. It has impacted the education sector, business sector, and even the livelihoods of millions. The education sector has viewed it as an opportunity to experiment on many new possibilities for continuing the instruction without losing any academic session. The rapid development of internet, web resources and technology has made it easy to the educationists to embark on an immediate shift over from offline to online. Though in the beginning, there was confusion among the educationists, it slowly disappeared and the institutions started working with online mode. Starting with asynchronous teaching, now almost all the educational institutions join with the synchronous method of teaching. Thanks to the innovation in technology and its diffusion. In whatever mode the teachers follow their online classes, the ultimate objective is to make their students learn the content. However, learning in classroom and online is never the same for students. So, the students' needs and their satisfaction should be addressed in a proper way.

One of the interesting dimensions of Covid-19 pandemic is the widespread use of digital technology diffusion in the sphere of education from primary to higher education. Even though, technology and internet were readily available even before the pandemic, its uses were confined to some sections of the student population only. Due to massive and unexpected closures, affected countries and communities have been forced to seek quick fixes in different digital learning platforms [1]. However, it has become pervasive in the wake of the pandemic, even though the stakeholders were not fully prepared for it. For example, many of the products of Google like Google class room, Google Drive, Google forms, Google Calendar, Google Jam Board etc., are widely used in conducting online classes.

Despite the advent of technology to the rescue of educational planners and administrators, it is beset with several problems as well. Parkes et al., [2] identified the major challenges faced by the teachers while delivering classes online. While, Song et al., [3] in their paper views that online classes cannot teach practical lessons and also even in theory, the contents delivered are only mediocre. Similarly, the low level preparedness of the learners and the technical and other related problems makes online learning less effective. There are several studies [4][5][6] discussing the low levels of teacher preparedness in online classes. Lichoro found that faculty members do not feel adequately prepared to teach online [7]. It is interesting to note that only around 50 per cent of the educational institutions are having educators with prior knowledge of online teaching [8][9].

All these have clear effect on the students' satisfaction with technology mediated online education. The satisfaction level of students is core factor of the success and failure of digital technology based education. The American Distance Education Consortium (ADEC) believes that student satisfaction is inevitable to retain learners. Satisfaction can be interpreted as "a concept that reflects outcomes and reciprocity that occur between students and an instructor" [10]. The students' perceived value of his/her educational experience from an educational establishment can be considered as student satisfaction according to Austin [11]. Anyhow, perception is an individual feeling or mental experience. So, it varies from person to person. That is why scholars like Muilenburg & Berge [12] pointed out that significant differences exist in the perception of students towards their online learning experience. However, the retention of the students in online learning is conditioned on the perceptions of the students [13][14]. It is also to be noted

that e-learning is a multi-dimensional activity including well organised content, high quality design and the like. So, the learners' requirements should be kept in mind while offering online education [15].

In the background of these developments, this paper addresses the level of students' perceptions on the use of digital technologies while undergoing online education.

II. Review of Earlier Studies

Several studies have been conducted in the area of online learning, distance learning, blended learning etc., in the past years. However, in the Indian context, online education has become an accepted pedagogy in the wake of the pandemic. Hence, a look at those attempts in learning the different satisfaction dimensions of students is helpful in developing a suitable methodology for the current study.

Students' satisfaction in online platform is influenced by several factors. The instructor, the technology used interactivity between the teacher and students, management of courses are of prime importance [12]. While, one study identified constructs like quality of the system, multi-media adoption and social ability as highly important [16][17]. Levy [18] argued that students' satisfaction is an indicator of retention and dropout rates in e-Learning courses.

One of the most important aspect in online education is the entry barrier. This may be of different kinds like, administrative issues, skill set of the learner, motivation, economic problems [12]. While, Navarro [19] and Simonson et al, [20] had identified the hitherto unfamiliar roles and responsibilities of the learner, insufficient feedback mechanism, relatively low performance of students etc., as barriers.

Research studies by various scholars looked at the satisfaction level of students in online education [21][22][23]. They were of the view that providing supplemental materials after an online lecture is highly useful to guide the students well. For example, customised or personalised video or audio lectures can reinforce what is learned in the online platform.

The findings one [24] study emphasised factors like student-teacher interaction, student engagement and the appropriate use of technology as cardinal constructs of satisfaction of learners. Moreover, the findings showed that gender moderates the relationship between the use of technology and student satisfaction. The path coefficient of technology for female students contributed less to student satisfaction. It was concluded that the level of anxiety was higher among female students concerning the use of technology.

The study Zeqiri, Jusuf and Baker Ahmad Alserhan [25], through a comparative study of blended learners from North Macedonia and Jordan. A comparative study of the Google Classroom used at the South Eastern European University (SEEU) and Moodle used at Princess Sumaya University for Technology (PSUT) were analysed. Despite the preference to blended learning, the study found some differences in satisfaction between the two samples. The digital divide, poor resources of the institutions have blocked the delivery of good quality online education in many of the institutions [26][27]. The lack of continuity of student engagement, despite the use of available technology is a matter of concern for many of the instructors [28].

The above studies have shown that technology adoption in online learning has been beset many challenges which has bearing on the students' satisfaction and quality of studies. The perception of the learners also differs considerably from country to country. There are many studies focusing on these aspects at the international level, but scanty as far as Indian scenario is concerned. It is this realisation that made us to conduct a fresh study in the context of Covid-19.

III. Research Methodology

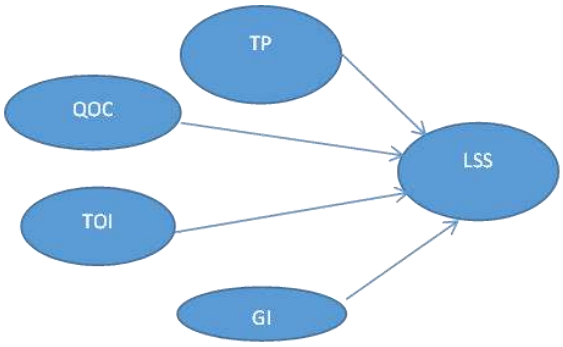
Objectives of the Study

The general objective of this study is to explore the satisfaction levels of students who are undergoing courses through online in the Indian environment. The specific objectives are the following:

1. To examine the level of satisfaction about online education among the higher education students.

2. To understand impact of teacher preparedness (TP), Quality of online content (QOC), Technology Interactions (TOI) and General issues (GI) in online teaching on level of students' satisfaction (LSS).

Proposed Model



Hypotheses

We hypotheses that:

H0 (1): There is no significant impact of Teacher Preparedness on student satisfaction during online education.

H0 (2): There is no significant impact of Quality of online content on student satisfaction during online education.

H0 (3): There is no significant impact of Technology Interaction on student satisfaction during online education.

H0 (4): There is no significant impact of General issues on student satisfaction during online education.

Description of Survey Instrument

We have used Google Forms to collect information from the sample respondents. These forms were distributed through various social media platforms like WhatsApp and Twitter, and also through emails. The data collection tool has three sections, General Information, availability of technological support, and perceptions of the learners on adoption of technology and the satisfaction level. In perception part four constructs as subsection namely Teacher Preparedness, Quality of online content, Technology Interaction and General Issues are measured using 4, 3, 4 and 6 statements respectively. We have used a five-point Likert scale ranging from five points for strongly agree to one point for strongly disagree.

Method and Data Source

The study makes use of primary data from the students who have undergone online learning at least for one semester during the Covid-19 lockdown period. The survey was conducted during January 2021. The study covers institutions throughout the country. A sample of 597 online learners was included after removing outliers from total sample of 650 in the study. As per 5 per cent error 385 sample is required. In addition 1:20 respond is required 19 item * 20 = 380 sample size. Hence, sample is more than required to conclude the study.

Sample Descriptive

Total sample of 597 is tried to justify demographic mix. 65 per cent female (388) responses are received. Out of 597, 374 responses are from non-professional education. 385 (64.5 per cent) arts students are followed by 200 (33.5 per cent) commerce students. Very few science students have participated, for them practical and physical training is really very crucial. 436 are UG students and 161 are PG students. 338 students from government institute with 259 private institute students have participated. Out of 597, mostly (555) students have preferred to attend session through their smart phones. Only, 42.4 per cent students are able to attend sessions for more than 3 hours online. More than 60 per cent of syllabus delivered with more than 60 per cent attendance for most of the students. Total 451 (75.5 per cent) students are taught using Google meet platform followed by 58 (10 per cent) students are using zoom. Other platforms are yet very less popular. With this data sample further analysis is done.

Tools and Technique

Teacher Preparedness, Quality of online content, Technology Interaction and General Issues are measured using 4, 3, 4 and 6 statements respectively using likert scale. Overall satisfaction is measure on 3 point scale. Impact of these independent variables Teacher Preparedness, Quality of online content, Technology Interaction and General Issues on Level of satisfaction are checked using regression analysis in next section.

IV. Data Analysis and Interpretation

As shown in table 1, model is fit at 5 per cent significant level. It indicates that Teacher Preparedness, Quality of online content, Technology Interaction and General Issues together explains Satisfaction level of students for online teaching significantly.

Table 1: Model Fit

Model		Sum of Squares	Degree of Freedom	Mean Square	F	Sig.
1	Regression	43.36	4	10.8400	33.886	.0000[a]
	Residual	108.03	592	0.1820		
	Total	151.39	596			

Note: Significant at 5%
a. Predictors: (Constant), Teacher Preparedness, Quality of online content, Technology Interaction and General Issues
b. Dependent Variable: Students' Satisfaction

In fact, as shown in table 2 these all independent variables together explain 82.2 per cent of variation in level of satisfaction. Only, 17.8 per cent variation is unexplained. This unexplained variation may be due to missing independent variables those are yet to explore.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.93	0.8620	0.8220	0.43

Now, as indicated in table 3, Teacher Preparedness and Quality of online content are the two significant variables that impacts on Level of satisfaction. Of course, other variables are important as supported by literature. But Teacher Preparedness and Quality of online content are significant at 5 per cent and can use for improvement in satisfaction level.

Table 3: Coefficients Summary

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	0.9210	0.1380		6.6780	0.0000*
	Teacher Preparedness	0.0690	0.0290	0.0970	2.4070	0.0160*
	Quality of online content	0.2800	0.0230	0.4850	12.2070	0.0000*
	Technology Interaction	0.0050	0.0310	0.0060	0.1480	0.8820
	General Issues	0.0160	0.0310	0.0200	0.5080	0.6120

*Note: Significant at 5 per cent

Mathematically,

Level of Satisfaction = 0.9210 + 0.0690 * Teachers Preparedness + 0.2800 * Quality of online contents + 0.0050 * Technology Interaction + 0.0160 * General Issues

As one can depicts from table and equation, with on an average increase of Teacher Preparedness by faculties to 1 unit leads to improve satisfaction level by 0.069 units on an average keeping all other thing constant. In addition to this, on an average increase of and Quality of online content by

faculties to 1 unit leads to improve satisfaction level by 0.28 units on an average keeping all other thing constant.

So, as conclusion to improve students' interest in online learning process it is very critical that how you are designing content of delivery.

V. Discussion and Conclusion

After COVID19, the world is change very rapidly. Here this study is try to explore variables that are affecting level of students satisfaction during their online study. This study found that similarly to normal class room learning Teachers' preparedness and Quality of online content are very important in online also for keeping students' interest and satisfaction. This study clearly reflects how even online class with help of technology can be satisfactory to the students by just focusing on quality of content of delivery.

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Obtaining Quantum Gate Models from Known Input and Output Values

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***Abstract*— Studies in the field of quantum computing have gained momentum with the emergence of quantum computers in recent years. Quantum computing, which is based on quantum principles, uses different techniques from known computational methods. The large size of quantum circuits causes noise in computers in the NISQ era. Optimizing quantum circuits and completing a job with a minimum of gates is important for the algorithms to work properly. In this study, the modelling of a quantum system with known input and output is investigated. By transferring the developed method to the programming environment, it is calculated whether the desired gate can be obtained and what form it should be. The created gate models are tested, and the results produced by the gates compared with the expected values.**

Keywords—quantum computing, quantum gates, quantum circuits, quantum circuit optimization

I. INTRODUCTION

Interest in quantum computing has been increasing in recent years with the advent of quantum computers, however, quantum computers are still live their infancy age [1]. Beside the advantages, there are challenging problems in developing quantum computers [2]. One of them is lack of hardware for storing the qubits in super position state. So, the era of quantum computers called NISQ (Noisy Intermediate-Scale Quantum) [3].

Quantum computing is the computation method which uses the quantum mechanics. Super position is the term which represent the situation that the position of subatomic particle is not known until it is observed. It is assumed in quantum world that a particle is 0 and 1 at the same time. The qubits can be implemented in different ways [4]. Super conductor based quantum computers utilizes the electron spin directions. Such qubits can be represented by Bloch Sphere or Bloch circle which is simplified version of Bloch Sphere. Visualization of Bloch Sphere is given by Fig. 1 [5].

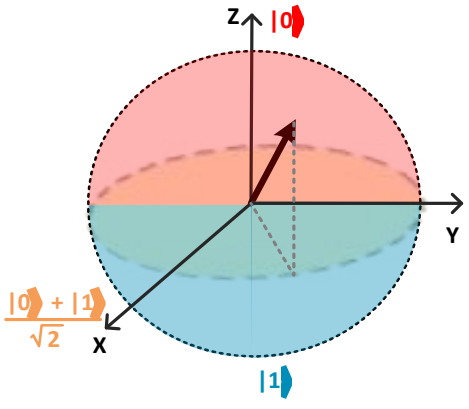


Figure 1. Bloch Sphere visualization [5].

Interest in studies on quantum computing started in the 1980s [6], [7]. Shor, Grover and Deutsch-Jotza quantum algorithms were developed in the 1990's. Shor's algorithm performs prime factorization of a number, Grover's algorithm performs searching in an unordered array and Deutsch-Jotza algorithm determines whether a function produces the same output for each input [8]. Today, with the emergence of quantum computers such as IBM-Q and D-Vawe, quantum computing gain popularity [9]. Quantum computers have been proven to be superior for some problems thanks to their different computational approach. However, their limitations are still an obstacle to using them more efficiently. In the NISQ era, keeping a subatomic particle in superposition form is a challenging problem. The longer the quantum circuit, the more difficult it will be to keep the particles in superposition form, so the formation of long circuits causes noise on the results [3]. For this reason, there are studies on optimizing the circuits [10], [11]. The fact that today's quantum computers allow the use of certain quantum gates makes it necessary to have quantum gates that correspond to the matrices used in quantum computing. In addition, quantum computers such as IBM-Q run transpiled versions that they adapt to the processor structure before running the generated quantum circuits [12].

Today, many studies have been carried out on quantum circuits which directly performed on quantum computers and quantum-inspired algorithms based on quantum computing [13]–[15]. There are relevant quantum circuits for many operations that can be applied on classical computers. For example, there are quantum circuits that will perform basic level mathematical operations like in classical processors [16]. Moreover, there are quantum circuit designs that will perform the multiplication of matrixes, which are frequently used in discrete mathematical methods [17]. Quantum circuits have been developed for the Fast Fourier transform, which is frequently used for frequency domain transform [18]. In addition to basic operations, quantum computing is used to solve special problems. In a study, quantum circuits based on quantum computing is proposed to solve the N-queen problem [19]. One of the studies on quantum computing and computers is done on bomb detection [20].

Quantum computing is also used for many issues related to artificial intelligence. For example, modelling perceptron, known as the simplest applications of artificial neural networks, is carried out with quantum circuits [21]–[24]. In one of them, 2x2 sized binary images are classified according to form of patterns (line form or not) [21]. In another study, the training process is carried out through simulation with the quantum neural network model and the two classes are successfully distinguished [25]. With the samples, it is seen that there is various studies on quantum computing. In this paper, we aim to produce simpler quantum circuits to help running the algorithms with lower noise.

II. Quantum Gates

The qubits are mathematically expressed in vector form with the Dirac notation [26]. The vector representation of single-qubit inputs is shown in (2) where $|0\rangle$ is being 0 state, and $|1\rangle$ is being 1 state.

$$|0\rangle = \begin{bmatrix}1\\0\end{bmatrix}, \quad |1\rangle = \begin{bmatrix}0\\1\end{bmatrix} \tag{1}$$

Matrix-format equivalents of terms with two qubits are calculated with the help of tensor product as in (2). In this case, the vector representation of $|00\rangle, |01\rangle, |10\rangle, |11\rangle$ are like given (3-6).

$$|\mathbf{ab}\rangle = |\mathrm{a}\rangle \otimes |\mathrm{b}\rangle = \begin{bmatrix}a_0\\a_1\end{bmatrix} \otimes \begin{bmatrix}b_0\\b_1\end{bmatrix} = \begin{bmatrix}a_0.b_0\\a_0.b_1\\a_1.b_0\\a_1.b_1\end{bmatrix} \tag{2}$$

$$|\mathbf{00}\rangle = |0\rangle \otimes |0\rangle = \begin{bmatrix}1\\0\end{bmatrix} \otimes \begin{bmatrix}1\\0\end{bmatrix} = \begin{bmatrix}1.1\\1.0\\0.1\\0.0\end{bmatrix} = \begin{bmatrix}\mathbf{1}\\\mathbf{0}\\\mathbf{0}\\\mathbf{0}\end{bmatrix} \tag{3}$$

$$|\mathbf{01}\rangle = |0\rangle \otimes |1\rangle = \begin{bmatrix}1\\0\end{bmatrix} \otimes \begin{bmatrix}0\\1\end{bmatrix} = \begin{bmatrix}1.0\\1.1\\0.0\\0.1\end{bmatrix} = \begin{bmatrix}\mathbf{0}\\\mathbf{1}\\\mathbf{0}\\\mathbf{0}\end{bmatrix} \tag{4}$$

$$|\mathbf{10}\rangle = |1\rangle \otimes |0\rangle = \begin{bmatrix}0\\1\end{bmatrix} \otimes \begin{bmatrix}1\\0\end{bmatrix} = \begin{bmatrix}0.1\\0.0\\1.1\\1.0\end{bmatrix} = \begin{bmatrix}\mathbf{0}\\\mathbf{0}\\\mathbf{1}\\\mathbf{0}\end{bmatrix} \tag{5}$$

$$|\mathbf{11}\rangle = |1\rangle \otimes |1\rangle = \begin{bmatrix}0\\1\end{bmatrix} \otimes \begin{bmatrix}0\\1\end{bmatrix} = \begin{bmatrix}0.0\\0.1\\1.0\\1.1\end{bmatrix} = \begin{bmatrix}\mathbf{0}\\\mathbf{0}\\\mathbf{0}\\\mathbf{1}\end{bmatrix} \tag{6}$$

Quantum gates are used for obtaining output values by manipulate the input qubits. Quantum gates are represented in matrix form in quantum computing. A quantum gate example for one qubit system is given by (7).

$$\boldsymbol{G} * \boldsymbol{I} = \begin{bmatrix}G_{00} & G_{01}\\G_{10} & G_{11}\end{bmatrix} * \begin{bmatrix}I_0\\I_1\end{bmatrix} = \begin{bmatrix}G_{00} * I_0 + G_{01} * I_1\\G_{10} * I_0 + G_{11} * I_1\end{bmatrix} \tag{7}$$

Where G is quantum gate and I is input. There are one-qubit and multi-qubit gates in the literature. The gates for one, two and three qubits are given by Table 1-3 [27].

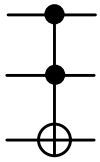
TABLE I. The Quantum Gates With 1 Qubit

Gate Name	Symbol	Matrix Form
Hadamard	H	$\frac{1}{\sqrt{2}}\begin{bmatrix}1 & 1\\1 & -1\end{bmatrix}$
Pauli-X	X	$\begin{bmatrix}0 & 1\\1 & 0\end{bmatrix}$
Pauli-Y	Y	$\begin{bmatrix}0 & -i\\i & 0\end{bmatrix}$
Pauli-Z	Z	$\begin{bmatrix}1 & 0\\0 & -1\end{bmatrix}$
Phase	S	$\begin{bmatrix}1 & 0\\0 & i\end{bmatrix}$
$\pi/8$	T	$\begin{bmatrix}1 & 0\\0 & e^{i\pi/4}\end{bmatrix}$

TABLE II. The Quantum Gates With 2 Qubits

Gate Name	Symbol	Matrix Form
C-NOT (controlled-NOT) (2 qubits)		$\begin{bmatrix}1 & 0 & 0 & 0\\0 & 1 & 0 & 0\\0 & 0 & 0 & 1\\0 & 0 & 1 & 0\end{bmatrix}$
Swap (2 qubits)		$\begin{bmatrix}1 & 0 & 0 & 0\\0 & 0 & 1 & 0\\0 & 1 & 0 & 0\\0 & 0 & 0 & 1\end{bmatrix}$

TABLE III. The Quantum Gates With 3 Qubits

Toffoli (3 qubits)		$\begin{bmatrix}1 & 0 & 0 & 0 & 0 & 0 & 0 & 0\\0 & 1 & 0 & 0 & 0 & 0 & 0 & 0\\0 & 0 & 1 & 0 & 0 & 0 & 0 & 0\\0 & 0 & 0 & 1 & 0 & 0 & 0 & 0\\0 & 0 & 0 & 0 & 1 & 0 & 0 & 0\\0 & 0 & 0 & 0 & 0 & 1 & 0 & 0\\0 & 0 & 0 & 0 & 0 & 0 & 0 & 1\\0 & 0 & 0 & 0 & 0 & 0 & 1 & 0\end{bmatrix}$

Each of the basic quantum gates has specific tasks. The Hadamard gate is used to transform input values into superposition. The Hadamard gate allows giving all the input values to the algorithm at the same time. Pauli gates are used to take inverse of an input. Considering the Bloch Sphere, the Pauli-X gate rotates the electron position 180 degrees in the X-axis. Pauli-Y and Pauli-Z are similar. The formula in (8) can be used when you want to change the spin direction in a certain degree.

$$U(\theta) = \begin{bmatrix}\cos(\theta) & -\sin(\theta)\\\sin(\theta) & \cos(\theta)\end{bmatrix} \tag{8}$$

III. Obtaining The Quantum Gates

Quantum gates are used for obtaining output values by manipulate the input qubits [28]. Obtaining quantum gates which rotates the qubit with θ angle is given by (8). In this paper, obtaining of the gates with known input and outputs is examined. To find the appropriate quantum gate model, matrix equation can be used. Matrix equation with known A, C and unknown X matrices is given in (9).

$$\begin{gathered} X * A = C \\ X * A * A^{-1} = C * A^{-1} \\ X = C * A^{-1} \end{gathered} \tag{9}$$

When considering the quantum gates, an output for each input must be valid. So the A input matrix in (9) will be a diagonal one matrix. Because inverse of diagonal one matrix is diagonal one matrix, the equation simplified as $X = C$.
So, the following algorithm is proposed to obtain the quantum gate models in practical way:

1- Determine all$|\mathrm{ab}\rangle * QGate = |\mathrm{xy}\rangle$ equations.
2- Sum the $|\mathrm{ab}\rangle$ vectors for the same $|\mathrm{xy}\rangle$ values.
3- Write transpose of $|\mathrm{ab}\rangle$ vector to $|\mathrm{xy}\rangle$ indices.
4- Decompose the matrix if possible.

where $|\mathrm{ab}\rangle$ is input, and $|\mathrm{xy}\rangle$ is output vectors.

For an example system with two qubits is like given in Table 4, where a, b are inputs; and x, y are outputs.

TABLE IV. AN EXAMPLE INPUTS AND OUTPUTS FOR QUANTUM GATE

a	b	|ab⟩		|xy⟩	
0	0	|00⟩	$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}$	|01⟩	$\begin{bmatrix}0\\1\\0\\0\end{bmatrix}$
0	1	|01⟩	$\begin{bmatrix}0\\1\\0\\0\end{bmatrix}$	|00⟩	$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}$
1	0	|10⟩	$\begin{bmatrix}0\\0\\1\\0\end{bmatrix}$	|11⟩	$\begin{bmatrix}0\\0\\0\\1\end{bmatrix}$
1	1	|11⟩	$\begin{bmatrix}0\\0\\0\\1\end{bmatrix}$	|10⟩	$\begin{bmatrix}0\\0\\1\\0\end{bmatrix}$

In here, because there is no the same |xy⟩ outputs, step 2 is passed. According to step 3, the obtained gate model for the example given in table 4 is like given in (10).

$$QGate = \begin{bmatrix}0 & 1 & 0 & 0\\1 & 0 & 0 & 0\\0 & 0 & 0 & 1\\0 & 0 & 1 & 0\end{bmatrix} \quad (10)$$

After obtaining the quantum gate model, we investigate if the quantum gate is entangled or decomposable. For this purpose, recall the tensor product given in Fig 2.

$$\begin{bmatrix}a & b\\c & d\end{bmatrix} \otimes \begin{bmatrix}x & y\\z & t\end{bmatrix} = \begin{bmatrix}ax & ay & bx & by\\az & at & bz & bt\\cx & cy & dx & dy\\cz & ct & dz & dt\end{bmatrix}$$

Figure 2. Tensor product of 2x2 matrices.

We need to correlate the dotted group and the color group which colored with the same color. In our example, the products of a*y, a*z, d*y and d*z are 1, and the others are 0. So when a, d, y, z are 1, the matrix in Fig. 2 becomes equal to the equation (10). So we can decompose the quantum gate as in equation (11).

$$\begin{bmatrix}0 & 1 & 0 & 0\\1 & 0 & 0 & 0\\0 & 0 & 0 & 1\\0 & 0 & 1 & 0\end{bmatrix} = \begin{bmatrix}1 & 0\\0 & 1\end{bmatrix} \otimes \begin{bmatrix}0 & 1\\1 & 0\end{bmatrix} \quad (11)$$

The matrix can be written by known basic quantum gates which are Identity gate and Pauli-X (Not) gate.

For another example we consider the sum operation. The sum operation takes two separate qubits, so the binary output should be with max 2 qubits. The input output pair are like given in Table 5.

TABLE V. INPUTS AND OUTPUTS FOR SUM OPERATION

a	b	|ab⟩		|xy⟩	
0	0	|00⟩	$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}$	|00⟩	$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}$
0	1	|01⟩	$\begin{bmatrix}0\\1\\0\\0\end{bmatrix}$	|01⟩	$\begin{bmatrix}0\\1\\0\\0\end{bmatrix}$
1	0	|10⟩	$\begin{bmatrix}0\\0\\1\\0\end{bmatrix}$	|01⟩	$\begin{bmatrix}0\\1\\0\\0\end{bmatrix}$
1	1	|11⟩	$\begin{bmatrix}0\\0\\0\\1\end{bmatrix}$	|10⟩	$\begin{bmatrix}0\\0\\1\\0\end{bmatrix}$

In this example, for the same outputs (|01⟩ and |11⟩), the inputs are aggregate as shown by Table 6.

TABLE VI. OUTPUT- INPUT PAIRS FOR SUM OPERATION

|xy⟩		|ab⟩
$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}$	→	$\begin{bmatrix}1\\0\\0\\0\end{bmatrix}$
$\begin{bmatrix}0\\1\\0\\0\end{bmatrix}$	→	$\begin{bmatrix}0\\1\\0\\0\end{bmatrix} + \begin{bmatrix}0\\0\\1\\0\end{bmatrix} = \begin{bmatrix}0\\1\\1\\0\end{bmatrix}$
$\begin{bmatrix}0\\0\\1\\0\end{bmatrix}$	→	$\begin{bmatrix}0\\0\\0\\1\end{bmatrix}$

In the sum example, we obtain the matrix given in equation (11). When we look the Fig. 2, we see only a*x, a*t, b*z, and d*y should be 1. This is impossible because when d and z are 1 the production of d*z is also 1. So this model is entangled and cannot be decomposed. So, the sum operation needs more complex structure to be implemented.

$$QGate_{sum} = \begin{bmatrix}1 & 0 & 0 & 0\\0 & 1 & 1 & 0\\0 & 0 & 0 & 1\\0 & 0 & 0 & 0\end{bmatrix} \quad (11)$$

IV. EXPERIMENTAL RESULTS

The proposed algorithm has been applied in MATLAB environment. First, the number of qubits to be used should be given to the algorithm. The operations described in the previous section can be carried out with the help of 2^n size vectors, where n is the number of qubits entered. Then the inputs and corresponding expected outputs are requested from the user. An output value must be given for each different input value. Otherwise, the gate cannot be fully modelled and the result of the gate will be uncertain for not given outputs. After checking that output values are given for all inputs, the inputs giving the same output are summed together. Then the transposition of the input vector is written in the row to which the output corresponds. In this way, the matrix that produces the desired outputs against the inputs determined, that is, the quantum gate, is obtained.

After the quantum gates are obtained, the transforming to known quantum gates is carried out. The resulting quantum gate is divided into 2x2 compartments, which are the size of single-qubit gates. Then it is determined which of the letters corresponding to the parameter values for each region would be 1. If there is no contradiction in value of parameters, the circuit is considered decomposable and written as the tensor products of the relevant 2x2 matrices. Then, it is checked whether the produced gates correspond to the one-qubit known gates given in Table 1. If there are matrices corresponding to the known gates, a circuit for output is given by converting the matrix into unit gates. It can be said that the matrix to be created is entangled in case there is a contradiction in the parameters in Figure 2 while assigning the values.

With this study, it is investigated whether matrices expressed mathematically can be transformed into known single-qubit gates for use in quantum circuits. This process is automated with the developed software.

V. CONCLUSIONS

Interest in the field of quantum computing has increased with quantum computers, for which important steps have been taken for its development and are still being implemented in a laboratory environment. Today, there are studies to use quantum algorithms in different areas. However, it is very difficult to provide reliability for quantum computers that are still in their infancy. This era of quantum computers is called NISQ. In quantum computers in the NISQ era, the loss and deterioration that will occur in the system increase according to the circuit size. Therefore, quantum algorithms must be optimized first and then operated. On the other hand, existing quantum computers allow the use of basic gates due to their structures. Mathematically, a large gate model must be transformed into unit gates to be used in quantum circuits.

There are formulas to create basic gates which rotates a particle in superposition at a certain angle. In this study, a mathematical model of a gate with known input values and corresponding expected output values is created. Then it is investigated whether the model created can be obtained with unit gates. To perform this algorithm necessary coding is done. The study aims to create the desired matrix by using unit gates at the same T time. However, it is not possible to model many matrices with the gates used at the same T time. However, it is known that the sum operation can be performed with gates applied at different times of T1, T2 and etc.

In this study, the transformation of matrices used in quantum computing into one-qubit gates is investigated. In future studies, it is planned to work on the automatic creation of circuits that will fulfil the task of the desired matrix by using combinational circuits for different T times.

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Assessing the impact of Employee attitudes on TQM Diffusion and Climate for Continuous Improvement

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***Abstract*—While there are various facets to TQM diffusion, many organizations have not been able to reap the benefits from a TQM Philosophy. Many organizations have also have not paved the path to using TQM and Supervisory reinforcement for creating a culture of continuous orientation in their firms. This study aims at assessing the impact of Top management support and commitment on Employee involvement and perceived benefits from TQM Interventions, as well as the role of Employee involvement and supervisory reinforcement on a climate for continuous improvement orientation. The study was conducted in Manufacturing companies in an industrial hub in west Tamilnadu region. The results of the study indicate that the model is fit and employee involvement can greatly support not only TQM implementation, but also help build a climate of continuous improvement.**

***Keywords*—** *Total Quality management; Climate Continuous Improvement; Manufacturing Companies*

I. INTRODUCTION

For organisations to be successful, it is important that they are highly quality focussed and consistent in improving their products services and processes. Top management and managers in the organisation should define the quality policy and goals of the company and give utmost importance to the same. Unless a company sets quality as a priority and builds a climate of quality consciousness, it will only remain ritualistic and a principle that is never put into practice. Managers have to understand the significance and allocate adequate resources and strive to bring in quality improvement, institutionalising these systems into the employee performance systems help a great deal (Minjoon et al. 2006). There are also businesses that have struggled to spread TQM, as well as success stories, due to the inability of top management to assign appropriate authorities and inspire people in organizations (Minjoon et al. 2006).

II. TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) is defined by the Deming prize committee as a systematic activity that contributes to achieving corporate purposes by running all corporate units effectively and efficiently to provide products and services with a quality that satisfies customers in a timely fashion and at an appropriate prices. It is an organized and systematic approach, as the concept goes, in which the culture of organizations guides and encourages the consistent achievement of customer satisfaction. This customer focus also inculcates instruments, procedures and training to continuously enhance the processes of the business, resulting in high-quality goods and services.. The above definition and meaning of TQM though encompasses all the aspects, there are several practices put forth by researchers across organisations and industries and across situations that supports / aids in diffusion of TQM..

A. Top Management Support on TQM Interventions implementation

While there exist a world of literature that talks about the reasons for the success of TQM initiatives, there is one aspect that is recommended and suggested by all researchers across geographies and industries which is the involvement and the commitment from Top Management for the implementation of TQM. This is an indication that for any initiative to be successful in an organisation Top Management Support is of pivotal importance. Dubey, Rameshwar (2017) argue that top management support plays a dominant role with respect to TQM implementation in an organisation. Top management support is an important mediator of the relationship between institutional pressures and diffusion of TQM according to their study. Top management commitment usually takes the form of management belief' and participation (Liang et al., 2017). Further the paper cites that the vision and strategies put forth, help managers and division heads about the opportunities as well as pitfalls in implementation of systems like TQM and ERP. Likewise, the opinion of top managers regarding usefulness of TQM result in managerial decisions and actions directed towards the successful implementation of TQM. The behaviour, actions and the opinion of top management regarding the potential of TQM usually have a major role to play in the diffusion of TQM practices (Ahire and Ravichandran, 2001). Hazen et al. (2012) also suggest that the extent to which the organisational constituents agree to the adoption of quality consciousness philosophy, the more likely is the chance of such interventions being initiated and diffused in organisations. Hence the first hypothesis

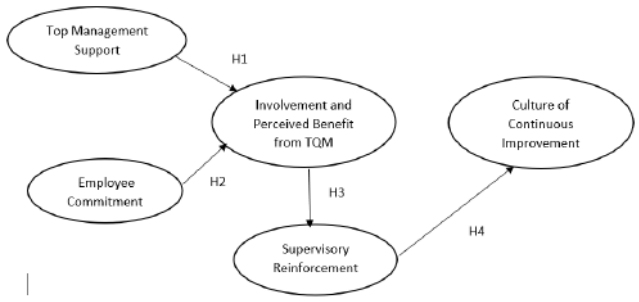
H1: Top management support positively affects the employee involvement and perceived benefits from TQM Interventions

B. Impact of Commitment on Involvement and Perceived benefits from TQM Interventions

The extent of a TQM diffusion achievement depends on the degree of top management engagement (Olorunniwo and Udo, 2002). Rejections, approval, opposition and variance of projects are directly proportional to the dedication of workers and management in the theory of TQM. It is of utmost importance to the degree of top management engagement at all stages or levels, motivating workers where possible and managing capital (Beck, 1983; Manley, 1975). Ndiritu (2015) clearly emphasizes the significance of commitment in their research by the statement "quality is "a boardroom affair". It simply means that the initiative is directly proportional to the extent of commitment from the top management. Top management commitment helps to create

trust with the workforce. In their day-to-day working within the organization, they are able to buy the concept of quality knowledge and follow quality conscious activities. The mentality of following such a philosophy requires enormous dedication from the workers. Top managers, by focussing on developing skills and competencies of their team members through learning and development programs that are specially designed to improve quality and productivity (Jones & Grimshaw ,2012). When employees understand that the organisation invests in their individual development, their willingness to contribute to TQM diffusion is higher due to higher involvement and perceived benefits from TQM.

H2: Employee commitment positively impacts the level of involvement and perceived benefits from TQM interventions



C. *Impact of TQM Interventions on Supervisory Support*

With the increased willingness of employees to take part in TQM diffusion in companies, comes increased responsibility for supervisors and managers to channelize the efforts of their subordinates in the right direction. According to Olorunniwo and Udo (2002) there are main factors that contribute to TQM success namely a. taking interest and getting involved in team meetings, spending time with people to get their feedback and being a part in resolving issues with people, allocating and supporting employees by providing them the required resources, c. embedding the right kind of leadership to translate attainment of goals through regular and periodic project review, as well as official commissioning of project leads and team leads. With improved participation and involvement from employees, also comes the need for higher supervisory reinforcement of quality centric approach. It is a fact that top management is expected to set the overall directions for TQM diffusion, by formally forming an executive steering committee to track, review and monitor the project progress through proper supervisory reinforcement. This leads us to the hypothesis

H3: Involvement and Perceived Benefits from TQM interventions improve the supervisory reinforcement on quality conscious practices

D. *Impact of Supervisory Reinforcement on Continuous Improvement Orientation*

Focus on continuous improvement in product innovation and expanded market share results in cost savings and, in turn, improvement of the organization's financial performance (York & miree 2004). According to Schultz (2003) the quality of leaders to a large measure influences the success or failure of any organization. There must be an efficient leader who is able to coordinate all the resources in the organization to accomplish its goals in order for any organization to be successful. Firms which have supervisors who create teams that are committed to organisational goals (Leithwood and Jantzi, 2000). Such supervisors and leaders also eventually become exemplary role models for their teams, they motivate their subordinates to be committed to the vision of the firm. This once again reiterates that TQM is not only about quality of product, but also has its emphasis on efficient leadership and updated standards and processes within the organization. Efficient Supervisors who have a mindset for quality are needed to lead the procedure at work, this in a big way helps achieve the strategic principle of continual improvement. This also ensures that all efforts are directed towards quality orientation and customer orientation (Mohammadi 2014). When such supervisors, build a clan of their own, they have followers who emulate the behaviours which leads to creating a culture of quality consciousness. Knab (2009) reinforces that such leaders build trust at the workplace through doing what they do, set an example by being committed to quality consciousness and through their working style ensure progress. By setting the examples, the managers are able to demonstrate their commitment to continuous improvement orientation and thereby to organization and its people. For creating a culture of continuous improvement orientation, it is important that people know what tasks to do at a given time and how to do it. The four governing principles that is considered important being a. people centric management b. consistently exceeding customer expectation, continuous improvement orientation and d. fact-based management. This gives rise to the fourth hypothesis

H4: Supervisory reinforcement positively impacts the climate for continuous improvement orientation

III. METHODOLOGY

This research aims at assessing the effect of employee attitudes towards TQM diffusion and climate of continuous improvement. The study tests the assumption that with higher employee involvement and supervisory empowerment can create a climate for continuous improvement. The research followed a descriptive approach as it focuses on employee attitudes. The constructs used in the study include Top management Support (5 items), Organisational Commitment (developed by Cook and Wall (1980) and Allen and Meyer, Supervisory Reinforcement (6 items), Employee Involvement and Perceived benefits from TQM Intervention Diffusion (7 items) . All the other constructs were adopted from Coyle-Shapiro, Jacqueline. (2002).Primary Data was collected through a structured questionnaire from employees working in mid-size manufacturing companies in west tamilnadu region which is the hub for industrial and engineering companies. The data collected from 139 manufacturing companies from Manchester of south India, Coimbatore and neighbouring region. For all the four constructs in the study data was collected using a structured instrument with scales (5-point, Likert type) ranging from strongly agree (5) to strongly disagree (1).

IV. RESULTS AND DISCUSSIONS

The Correlation between the Continuous improvement orientation, Top management support, Supervisory reinforcement, Organisational Commitment, Participation and Perceived benefit from TQM intervention was analysed by means of a correlation matrix and is shown in Table 1. Top management support is significantly correlated with

Supervisory reinforcement (r = 0.477), Organisational Commitment (r = 0.538), and Participation and Perceived benefit from TQM intervention(r = 0.423). Supervisory reinforcement seems to be significantly correlated Participation and Perceived Benefit from TQM intervention(0.451).Organisational Commitment has significant correlation with Involvement and Perceived Benefit from TQM intervention (r = 0.533).

TABLE I. CORRELATION

Constructs	CI	TMS	SR	OC	TQM
Climate of continuous improvement (CI)	1				
Top management support (TMS)	.112	1			
Supervisory reinforcement (SR)	.320**	.477**	1		
Organisational commitment (OC)	.139	.538**	.498**	1	
Involvement and perceived benefit from TQM intervention	.165	.423**	.451**	.533**	1
**. Correlation is significant at the 0.01 level (2-tailed).					

A. Assessment on the Measurement Model

The measurement model refers to the relationship between the study variables / survey items / indicators and the measurements underlying each construct. The data shows that the indicators are stable as indexed by the composite reliability and they exhibit a good degree of internal consistency. The composite reliability of the various measures varied between 0.80 and 0.85, above the suggested threshold value of 0.70. Cronbach's alpha reliability test is used in order to assess the reliability of the various constructs / measurement scales used in the study. Scales have been tested by means of internal consistency in terms of their reliability.

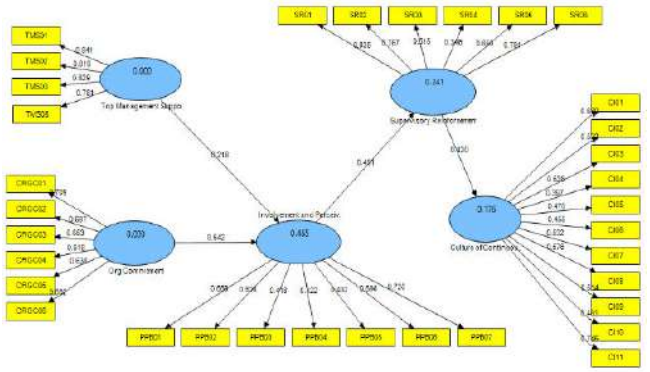


Fig. 1. Results of Path Modelling

According to Nunnally (1978), reliability less than 0.6 considered low is considered unacceptable, reliability score in the range between 0.7 and 0.8 is considered acceptable, those Cronbach alpha values above 0.8 and below 0.9 are considered very good. Therefore, closer the alpha of Cronbach is to 1, the better is the reliability. The alpha values for all the study constructs are above 0.7, as per the results in the table, the reliability hence is in the acceptable range. The determination coefficient which is the R^2 value is a statistical indicator of the nearness of the data, to the regression line fitted. In other words, the square of the correlation between the response values and the response value expected is R-square. The R^2 value ranges between 0 and 1. The greater the value, or in other words, closer the value is to to 1, better is the proximity of the regression line to the data values and higher is the accuracy of prediction of the developed model. R^2 values of 0.75 are substantial, 0.50 is moderate and 0.25 is small, according to rule of thumb by Hair et al. (2013).

TABLE II. RELIABILITY ANALYSIS RESULTS AVE, CR AND

Constructs	AVE	CR	R Square	Cronbachs Alpha
Involvement and Perceived Benefit from TQM Implementation	0.38	0.80	0.47	0.73
Climate of Continuous Improvement	0.30	0.82	0.18	0.77
Org Commitment	0.44	0.83		0.76
Supervisory Reinforcement	0.45	0.82	0.24	0.73
Top Management Support	0.60	0.85		0.77

From the above table, it is inferred that the Involvement and Perceived Benefit from TQM Implementation is influenced positively by Top Management Support with a path coefficient of 0.218 and Org Commitment with the path coefficient of 0.542. The R-square value of Involvement and Perceived Benefit from TQM Implementation is 0.47 it can be concluded that 47% of variation in Involvement and Perceived Benefit from TQM Implementation is of the sample as explained by the Top Management Support and Org Commitment.

TABLE III. PATH ANALYSIS RESULTS

Path Analysis Results	Beta	Standard Error	T Statistics	Sig
Involvement and Perceived Benefit from TQM Implementation -> Supervisory Reinforcement	0.491	0.16	2.93	0.00
Org Commitment -> Level of Involvement and Perceived Benefit from TQM Implementation	0.541	0.09	5.79	0.00
Supervisory Reinforcement -> Climate of Continuous Improvement	0.42	0.07	5.30	0.00
Top Management Support -> Involvement and Perceived Benefit from TQM Implementation	0.21	0.09	2.18	0.00

This empirical investigation supports the Top Management Support and Organisation Commitment supports the fact that Involvement and Perceived Benefit from TQM Implementation. From the above table, it is inferred that the Supervisory Reinforcement is influenced positively by Involvement and Perceived Benefit from TQM Implementation with a path coefficient of 0.419. The R-square value of Supervisory Reinforcement is 0.24 it can be concluded that 24% of variation in Supervisory Reinforcement is explained by the Involvement and Perceived Benefit from TQM Implementation. And the

Climate of Continuous Improvement is influenced positively by Supervisory Reinforcement with a path coefficient of 0.420. The R-square value of Climate of

Continuous Improvement is 0.18 it can be concluded that 18% of variation in Climate of Continuous Improvement is of the sample is explained by the Supervisory Reinforcement.

B. Assessment of Hypothesis Results

H1: Top Management Support has a significant effect on Involvement and Perceived Benefit from TQM Implementation. This is confirmed by the results where β = 0.218 and its respective t-value = 2.188. Since the t-value is greater than 2, the null hypothesis is rejected and Hypothesis (H1) is accepted, the findings of this research confirm the outcomes of the empirical study performed by Dubey, Rameshwar (2017) and Liang et al (2017). With an increased involvement from the top management for TQM related practices, greater will be employee's involvement in such initiatives and they will perceive a higher benefit due to TQM implementation in the organisation. Thus, top management support plays a dominant role with respect to TQM implementation in an organisation

H2: Organisation's Commitment has a significant effect on Level of Involvement and Perceived Benefit from TQM Implementation The results of the hypothesis establish (β = 0.5419, t-value = 5.7984), that higher the organisation's commitment , higher the employee involvement as well as perceived benefit. The t-value is greater than 2, the findings of this research endorse the results of the empirical study carried out by Ndiritu (2015) that emphasizes the significance of commitment by the statement "quality is a boardroom affair". It simply means that the initiative is directly proportional to the extent of commitment from the top management. It also help build trust with the employees.

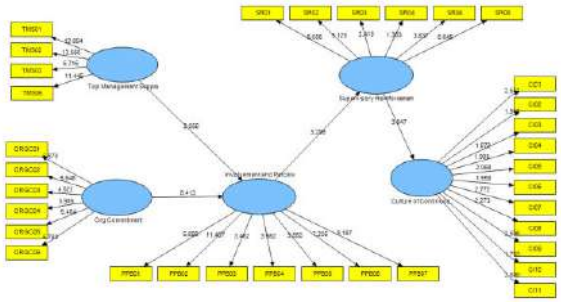


Fig. 2. Bootstrapping results for the Path Model

H3: The relationship between Involvement and Perceived Benefit from TQM Implementation and Supervisory Reinforcement supported, this is established as the β = 0.49 and t-value = 2.93, since the t-value is greater than 1.96 , the Hypothesis (H3) is accepted. The results of this study match with the research conducted by Olorunniwo and Udo (2002), With the increased willingness of employees to take part in TQM diffusion in companies, comes increased responsibility for supervisors and managers to channelize the efforts of their subordinates in the right direction.

H4: The relationship between Supervisory Reinforcement and Climate of Continuous Improvement supported, this is evidenced by the value of the (β = 0.42, t-value = 5.3039), since the t-value is greater than 2, the Hypothesis (H3) is accepted. The results of this study match with the research conducted by Mohammedi (2014), supervisors and leaders also eventually become exemplary role models for their subordinates, they motivate them to be more committed to the vision of the company. This once again reiterates that TQM is not only about quality of product, but also has its emphasis on efficient leadership and updated standards and processes within the organization

V. IMPLICATIONS

The results of the study clearly indicate that empowering employees and creating a sense of belongingness to the supervisors coupled with the strong sense of purpose and commitment by the management towards quality orientation and quality consciousness practices can help in diffusion of TQM across the organisations. The enabler for TQM intervention, shall definitely be the management, however it has to be backed by, the buy in from employees in the organisation and should have the urge from middle level manager or supervisors who will push for the same. Unless all three levels – the top, the middle and the bottom level persist creating a climate of Quality consciousness shall remain only on papers. Many organisations today have benefitted from the quality conscious processes which has eventually made them more customer centric.

Practical Implications for management from this research shall include the extent of direct intervention by the members of top level – the higher they discuss, deliberate, institutionalise the tqm diffusion better it is. In many cases, their presence in TQM related meetings, making employee champions who drive the process, instituting recognition programs for quality improvement, designing and implementing performance practices that have quality components helps. It also reiterates to the employees and other stakeholders - the seriousness the management has in quality practices.

Implications to Managers and supervisors shall be to regularly discuss about TQM in their weekly meetings, creating awareness of best practices with respect to quality, employee knowledge sharing session regarding quality improvement initiatives, openness to explore and experiment process improvement suggestions given by employees, a policy for eliciting , deploying and sustaining employee suggestions and process improvements can help in building a climate that is responsive to customers' expectations on quality.

VI. CONCLUSION

The study aimed firstly at identifying which factors contribute to creating a climate for continuous orientation through diffusion of TQM. Study constructs used were Top Management Support, Organisation's commitment, employee involvement and perceived benefit from TQM practices, and Supervisory Reinforcement for the same. Top management's support and commitment towards such quality enhancement initiatives are the precursors to employee involvement and trust. Eventually, the reinforcement from superviors and manager do the magic in creating a climate that fosters quality centric workplace. It helps build and

sustain a climate that is quality focused and incidentally customer centric. When organisations imbibe and apply this model for their TQM interventions, success cannot be far away.

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A Comprehensive Analytical Study of the Walmart-Flipkart Deal - Mergers & Acquisitions

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I. ***Abstract*— Walmart is following the digital transformation trend with acquisitions all around the globe. Before the Flipkart deal, the company owned seven e-commerce sites along with its vast physical retail network. Flipkart, on the other hand, was an India-based start-up, which had been able to grow its marketplace operations into a multi-billion-dollar business in less than a decade. Flipkart's penetration into the Indian market, which offered huge potential to Walmart with its 1.3 billion population and constantly growing economy, served as one of the main reasons for the deal. The deal was completed in May 2019, in which Walmart acquired 77% of Flipkart's shares for 16 billion USD, along with a promise to inject 2 billion USD to further promote the growth of the business.**

Keywords—mergers, acquisitions, Walmart, Flipkart, e-commerce

II. INTRODUCTION (*EXECUTIVE SUMMARY*)

Walmart has relied its global growth on acquisitions. The Flipkart acquisition is another step for Walmart to both grow its presence in the online business and to enter the Indian market, which is has a promising growth in the coming years ahead, since its spending is growing more than that of the US. According to the eMarketer, India was ranked 10th biggest e-commerce market in the world, as of 2017. From the Flipkart side, which has grown its business with constant R&D and acquisition, this deal has been the ultimate target. It can also be said that this deal will create its own market and the growth. It is expected that the deal will give the Indian e-commerce market a strong boost. According to Kalyani, Walmart's ambition in its investments in online, especially the Flipkart acquisition is because of the inconsistency between high revenue and relatively lower valuation than Amazon. One of Walmart's objective with the deal is to direct the company towards the more promising online business rather than the old-school retail-based model. This paper evaluates the pre- and post-deal structures as well as the financial side of the deal. [1]

III. COMPANY, SECTOR AND PRE-DEAL RELATED INFORMATION

A. WALMART *Company Information*

Walmart, the retail giant headquartered in the US had a revenue of $500 Billion in 2018 and $28.3 Billion in its operating cash flow. It has over 11,700 stores in 28 different countries around the globe. Given its vast reach, Walmart served 270 Million customers a week in 2018. Walmart is aiming to grow its presence in the online channels. The sales revenue from this channel in the US was $11.5 Billion in 2018, which only represents 2% of Walmart's total sales.[2]

The Walmart Company owned seven different e-commerce sites before the acquisition and these sites are planned to be integrated with their physical stores. For instance, they have been successful in the installation of online grocery pick-up points in 1000 stores and more 1000 is planned for 2019. Walmart, with its ambition in the online market and strong presence in the physical retailing in considered the biggest competitor for Amazon in the US. In the meantime, operating in 27 different countries, Walmart is expected to take the competition in the e-commerce outside of the US. [3]

B. FLIPKART *Company Information*

Flipkart, the Indian e-commerce platform, started its business life as a start-up back in 2007. It was until 2010 that the company would receive its first order. Despite being a start-up itself, Flipkart has relied its growth on successful acquisitions of prospective start-ups. Sites, such as weRead.com, Letsbuy.com and the digital music store Mallers Inc. were bought by Flipkart, during 2010-2012. The launch of its Android App has resulted in an investment of $160 Million to the company. Following that, in 2014, it has received a $ 1 Billion investment from GIC, the Singaporean wealth fund, which listed Flipkart as the receiver of the biggest single found in the Indian e-commerce market. In the same year, Flipkart has acquired the online retailer Myntra.com for $300 Million. The constant inflow of investments to Flipkart and its investments in the e-commerce market secured a $ 2 Billion valuation for Flipkart in 2014. Just in one year, with the successful launch of the "The Big Billion Day" and additional investments from existing investors such as Tiger Global, DST and GIC, as

1 Kalyani, 2018

2 Walmart Annual report, 2018

3 Kalyani, 2018

well as new investors like Qatar Investment Authority the valuation of the company jumped to $15 Billion.[4] 2016 was a crucial year for Flipkart as the valuation has decreased to $11 Billion. Despite that, company continued to invest in the industry and raised an additional $1.4 Billion in 2017 from companies like, Tencent, eBay and Microsoft.[5] One of the biggest investments of the company was the acquisition of eBay India in 2017, which still operates independently. Softbank Group was the biggest shareholder in the company, as Walmart acquired the 77% shares of Flipkart for $16 Billion in April/May 2018.[6]

IV. Key Synergies and Expected Benefits Of The M&A Deal

A. *Walmart's justification for the relatively high price*

Walmart justified the value derived from the deal through two main scopes; India and Flipkart.

Firstly, Walmart's President C. Douglas McMillon stressed the attractiveness of the Indian market which is characterized not only by a huge population of 1.3 billion people but also strong GDP growth, a growing middle class (as shown in **Figure 1:** Annual Growth in Household Spending & **Figure 2:** E-Commerce Spend per Capita projections in India) and significant runway for smartphone, internet and e-commerce penetration where $21 billion were spent in 2017 alone, making India the 10th-biggest e-commerce market in the world, which is expected to grow to $200 billion by 2027, shifting India's position up to the 5th biggest e-commerce market in the world . Estimations are based on comparison with similar models in China which proved to be very positive. Considering the growth opportunities, this transaction is a long-term strategy for Walmart, which could justify for the expected low returns in the couple of years ahead. This deal is also crucial for Walmart, since it is the initiation of its competition with Amazon in the emerging markets. Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

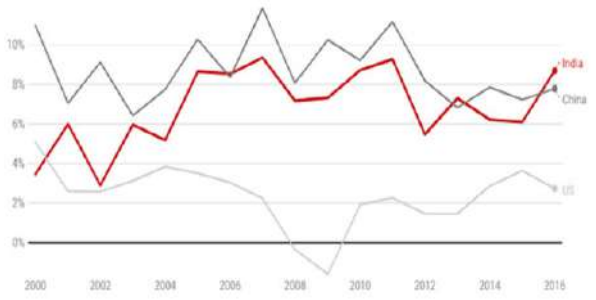

***Figure 1**: Annual Growth in Household Spending* [7]

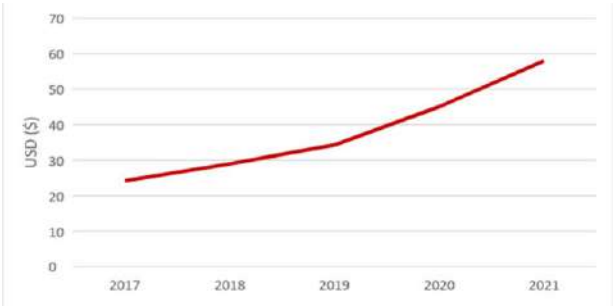

***Figure 2**: E-Commerce Spend per Capita projections in India* [8]

Secondly, Flipkart has been a major player in India's e-commerce market with a major market share of 34.3%, followed by Amazon 26.6%. Moreover, Flipkart's growth figures were impressive as shown in **Figure 3**: Financials of Flipkart for the Fiscal Year Ending March 2017.

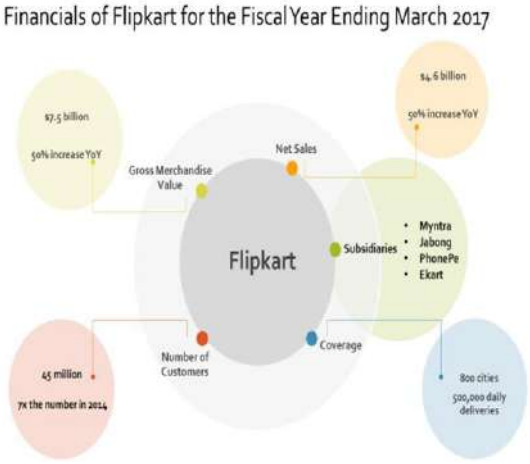

***Figure 3:** Financials of Flipkart for the Fiscal Year Ending March 2017*

Most importantly, Walmart will benefit from the comprehensive ecosystem that Flipkart has built. This includes its fashion e-commerce platforms Myntra and Jabong. In addition to its payment business, PhonePe, as well as its logistics arm, Ekart; both of which support the e-commerce transformation in the Indian market.

Walmart will profit from this infrastructure in several ways. First, the fashion business gives it higher margins and profits compared to other undifferentiated products. Flipkart's fashion business currently has 35% share of the online fashion market and has plans to grow to 50% by 2023 by adding more tier 2 and tier 3 cities, according to Rishi Vasudev, Head of Flipkart Fashion.

Secondly, PhonePe is now being used by Walmart to hook its customers even in the wholesale market. While Ekart logistics network is used to serve Walmart's Best Price stores.[9] From a more strategic point of view, Walmart intends to use India's ecosystem as a learning model to be applied elsewhere in the world. This would support Walmart's objective to direct the company towards the more

4 Paul, 2018

5 Kalyani, 2018

6 Russel, 2018

7 Molla and Del Rey, 2018

8 Mintel, 2016

9 Livemint, 2018

promising online business rather than the old-school retail-based model.

Furthermore, being on board with technology leaders from Tencent, Tiger Global and Microsoft would absolutely enhance the learning experience of Walmart. Walmart stresses their confidence in the management and leadership team in Flipkart, describing them as innovators and problem-solvers that will be up to any upcoming challenges. It is quite obvious that starting from scratch would have cost Walmart a whole lot of investment, in addition to it running the risk of competing with a homegrown giant backed by Softbank, and local regulations. These unfavourable circumstances for Walmart contributed to the high valuation for Flipkart.

From a competitive perspective, Flipkart has an advantage in terms of how well they understand the Indian market, the comprehensive ecosystem they have, in addition to the different business lines they operate. Even when compared to competitors like Amazon they have a stronger bargaining power with local suppliers, and this can be leveraged with Walmart to include better deals from foreign suppliers as well.

V. THE DEAL, STRUCTURE AND INTEGRATION PLANS

A. *The Deal*

Walmart acquired the 77% of Flipkart for $16 Billion in May 2019. With this deal, Walmart owned a controlling share of Flipkart.

As stated above, Flipkart, throughout its growth and maturity stages have received several investments from big corporations. The deal also means that some of these investors exit and some stay and enjoy the growth sustained by Walmart. Flipkart, after the deal will continue to run the company with Tencent and Tiger Global still in the business. The deal also promises a $ 2 Billion injection to the company, which is to be used for supporting the growth of the company. [10]

Walmart and Flipkart have been "competitors" in the following areas:

1. Offline B2B (Wholesale)
2. Walmart's Online B2B (Wholesale) vs Flipkart's Offline B2B (Wholesale)

These areas, after the deal, would merge into a horizontal combination, whereas the new areas that the two companies present to each other would stay on the vertical side. Below is a graph by Competition Commission of India to lay out the relations between business units after the deal. [11]

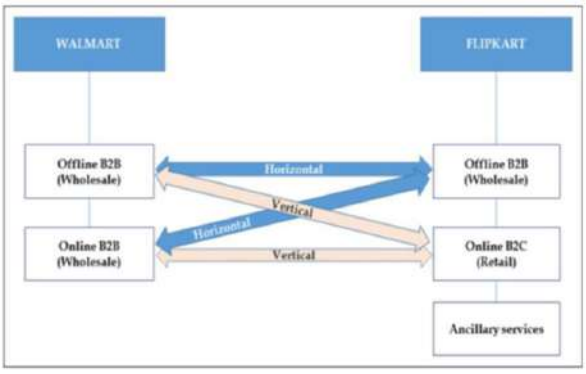

Figure 4: *Product Profile of Walmart and Flipkart India*

B. *Pre & Post-Integration Plans*

Walmart and Flipkart deal are of great importance not only for its financial size, but also for the significance of the two companies in global and national landscape. Flipkart is a blueprint for start-ups on how to grow fast and big, being the major player in Indian e-commerce market, whereas Walmart has already presence in the country with its twenty-three Best Price Wholesale Stores they own.

One of the most important challenges – if not the most important- of any merger is the process of integration. That is why we will observe the plans for this deal on a pre and post-integration basis.

Flipkart was in a bad situation financially after a ''discount war'' with Amazon in India. Amazon's business worldwide allow them to take on new markets but Flipkart needed a strong partner in order to support them on winning the Indian market and not run out of cash.[12] Additionally, in terms of evaluation, the deal is a definite success for Flipkart with the staggering of $16 Billion, making the deal world's largest e-commerce acquisition.

With this deal, Walmart adds a new front in company's battle with Amazon and enters a market with great growth potential. Currently estimated at $38 Billion, the projection for the Indian e-commerce market is to reach $200 Billion by 2027. Once the two companies manage to integrate, they will have different challenges and targets with the cultural fit being the common denominator in all of them. Flipkart can give a sprinkle of innovation and entrepreneurial thinking while Walmart will help them with process orientation. [13] Walmart though is notorious for trying to impose policies in its acquisitions with unpleasant results for the employees. Binny Bansal, CEO of Flipkart Group said that there won't be firings, instead the group will need to hire more people for the new initiatives. [14]

Besides, deal will aid Flipkart's target to transform commerce in India and highlight Walmart's commitment for expanding their presence in India, one of biggest emerging markets worldwide.[15] Finally, Walmart stated that there will be no integration with Flipkart and the current Cash & Carry

10 Loizos, 2018

11 Competition Commission of India, 2018

12 Prasanto, 2018

13 Athira, 2018

14 Athira, 2018

15 Saraswathy, 2019

stores of them in India. Instead, they plan to set up 50 more of these stores in the next four to five years with the total amount of this investment to be around $500 million.

VI. POST-DEAL INFORMATION

A. The Marketwise Reasoning of the Deal

With the Digital and Telecommunication Revolution tapping into India post 2015, according to the reports of Internet and Mobile Association of India (IAMAI),[16] there are about 500 million internet users as of June 2018. With an aspirational goal of a fully connected India, internet perforations into the deeper rural areas only reaffirms why investing in India is a profitable proposition for major e-commerce companies. According to the predictions of Morgan Stanley International, [17] the domestic Indian e-commerce market is expected to witness compounded annual growth of 30% to an evaluation of $200 billion by 2026. This was one of the prime reasons why Walmart, the world's largest brick-and-mortar retailer shifted its complete focus to the second biggest emerging market in the world i.e. India post its exit from China in 2016, to witness a long-term and strong edge over its fierce rivals Amazon and Alibaba for worldwide market share and dominance.

The race towards an ambitious consolidation of online and offline market has convincingly driven Walmart, the world's largest company by revenue to completely pivot to cement itself as a major share leader in the Indian e-commerce market post a dismal decade in establishing itself as an offline wholesale retailer.

Tipped to become 5th largest economy of the world in 2019, a huge retail market size worth $670 billion, varied cultural diversity, second largest population in the world, a strong spending middle class and a shifting trend in consumer purchasing behaviour, allows India to become the most favoured and only major e-commerce market for Walmart to capitalise on to have a considerable lead over Flipkart and it's common rival Amazon.

Walmart's Flipkart acquisition has led to an impressive and major mix of online and offline retail giants efficiently collaborating for a consolidated e-market portal with varied specifics catering to over a billion people in India alone.

With strong financial backing from major tech giants like Softbank, Microsoft, Tencent, e-Bay, Tiger Global, etc. Flipkart has taken the correct call at the right time to pivot more into the offline domain to explore and exploit a stronger market standing, through this symbiotic collaboration with Walmart; where the latter too aims to have a stronger online initiation in the Indian market. [18]

B. Critical Success Factors (The Policy Dilemma)

Even though the deal was approved by the Competition Commission of India, there have been a robust bias from small and middle-sized retailers and traders claiming that such a big entrance to the market would damage the competition. Walmart's strategy of promoting its entrance to the Indian market as an opportunity for India in terms of job creation and growth in the start-up sector may have been effective in the first stages, but later a new regulation was introduced, which would jeopardize Walmart's returns. [19]

For Walmart, the changes in the foreign direct investment (FDI) policy were unexpected. On February 1, 2019, India implemented the new FDI policy in the online retail markets, which aims to safe brick-and-mortar stores in India. The new policy could heavily impact the sales of Flipkart.

The new rules intend to provide a level-playing field to Indian physical stores. It restricts foreign e-commerce from selling products purchased from firms they own stakes, creating a more competitive market for multiple vendors. Online retailers also are not allowed to sell exclusive products on their sites. Online giants are restricted from buying more than 25% of their inventory from a single seller, which effectively prevents these companies from manipulating the price or providing huge discounts. [20]

Since 2016, when India determined that foreign-owned e-commerce platforms could operate as a marketplace rather than sellers who sell directly to consumers, Flipkart generated wholesale distributors in order to reach out to their consumer effectively. However, the new FDI policy forces the company to restructure its supply chains, which means established wholesale distributors cannot be the suppliers any longer. The major money spinner for the e-commerce platforms is to offer exclusive products on their sites, but the Flipkart is projected to stop selling 25 % of the products listed on its portal to meet the new regulations by February 2019.

Although all the facts mentioned above show negative future expectation of the development of Flipkart, it is crucial to mention that the common rival of Walmart and Flipkart, Amazon, is restricted by the FDI policy in India as well. This means that under the same circumstances, Walmart could gain more market share in India by investing more in Flipkart.

16 Mathur,2019

17 Desai, 2019

18 Kalwani, 2019

19 Saraswathy, 2019

20 Delhi, 2019

VII. FINANCIAL PERSPECTIVE

A. *Financial Drivers for Flipkart's Acquisition*

Although Walmart has shown strong performance in the United States since its establishment with revenues growing up to $500 billion in 2018, the year-on-year quarterly growth was slowing down as shown in **Figure 4**: Walmart's YoY Quarterly Growth. [21]

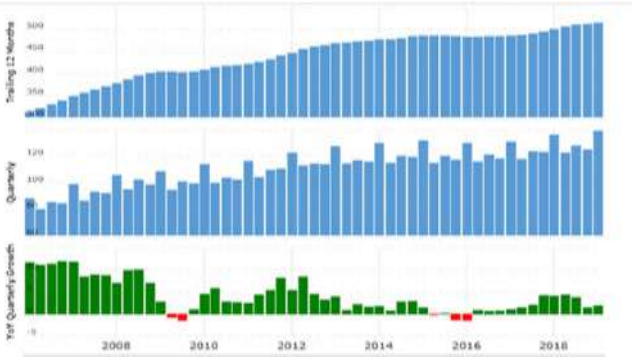

***Figure 5**: Walmart's YoY Quarterly Growth*

A main reason for this is the change in the retail market introduced by the now the main competitor for Walmart, Amazon. Amazon has revolutionized the retail business and based on PwC industry trend report, all the inflation-adjusted gains in retailer revenue in the last several years have been driven by online channels; which are seven times faster in growth than the overall sector as shown in **Figure 5**: Sales Growth Online vs. Total Retail. [22]

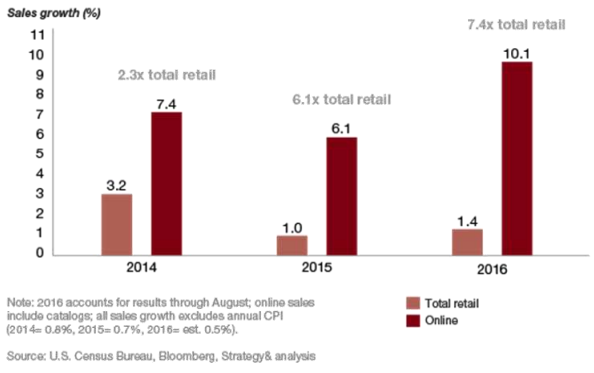

***Figure 6**: Sales Growth Online vs. Total Retail*

In the U.S. Amazon accounted to about 70% of the online retail growth and that put store-based retailer such as Walmart, Costco and Target in a difficult position causing the likes of Amazon with much lower revenues ($177.9 billion in 2017) to have a much higher market capitalization, which was around $600 billion by the end of 2017. In addition to restructuring its sales channels in the U.S., Walmart was carefully shaping its portfolio of businesses and geographies to secure its position as a retail leader. This vision was enhanced by the 77% stake it acquired in Flipkart.

B. *The Valuation of Flipkart*

Walmart's assigned value to Flipkart was based on asset valuation as well as expected future value as follows:

Assets of $24.1 billion:
- $2.2 billion in cash and cash equivalents
- $2.8 billion in other current assets
- $5.0 billion in intangible assets
· $4.7 billion represents the fair value of trade names, each with an indefinite life
· $0.3 billion of intangible assets primarily relate to acquired technology with a life of 3 years.
- $13.6 billion in goodwill; consists largely of anticipated synergies and economies of scale primarily related to procurement
Liabilities of $3.7 billion
- $1.8 billion of current liabilities
- $1.8 billion of deferred income taxes
Noncontrolling interest of $4.3 billion, for which the fair value was estimated using the income approach

This valuation is three times the estimated Gross Merchandise Value (GMV) and approximately seven times the 2017-2018 revenues. While Flipkart's value based on raised capital did not exceed $12 billion a year ago.

The transaction was financed with the combination of newly issued debt and cash on hand. The debt was part of a $15.9 billion net proceeds from long-term debt issued by Walmart in part to finance the acquisition as well as other general corporate purposes. Walmart's board also explained the short- to mid-term effects on the company's EPS; which will go down due to the company having higher interest expenses, more amortization and depreciation to account for. However, Walmart is focusing on the long-term benefits the deal would bring.

On the other hand, shareholders seemed concerned about the deal as the announcement of the acquisition led to a drop in the share prices by 4% reducing Walmart's market cap by $10 billion. Analysts thought Walmart has overpaid for its stake in Flipkart.

This is mainly due to the expected short-term effect on the EPS as well as the fact that Flipkart has been burning cash with losses mounting up to $3.6 billion by March 2017. However, Flipkart is still seen as a start-up with huge future potential due to its stabilized share in the market and profits are yet to come and as Kalyan Krishnamurthy, chief executive officer at Flipkart said "(Cash) burn is not a metric that anybody worries about any more", referring to Walmart's board position.

21 Macrotrends, 2019

22 U.S. Census Bureau, 2018

C. Post-Acquisition Effect on the Financial Statements

Analysing the 10-K report of Walmart, Walmart indicates that it consolidated the operations of Flipkart in the third quarter of the forward-looking statements of fiscal 2019. The consolidation is reported to have negative effect on the net income of 2019 and this effect will continue until fiscal 2020.

However, Flipkart's sales will drive the overall sales of Walmart International, which is likely to increase by $2.8 billion in 2019. Moreover, Walmart reported forward-looking 3% growth in consolidated net sales for the fiscal year 2020 due mainly to positive impact from Flipkart sales.

VIII. CONCLUSION

In conclusion, given the high consistency between two company's future expansion strategies with the two greatly complementing each other's business capabilities, the deal is expected to bring tremendous synergies and added value for the collaboration. However, the deal was done under the assumption of no material policy change in the Indian retail market. With radical changes in the regulatory environment, the value of the deal in the short term may shrink. Nevertheless, as Walmart eyes the long term in the deal and is positive about the ultimate lessening of related regulations, the ultimate value of the deal need time to be seen and materialised.

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Multivariate Missing Value Imputation Using Weighted Cluster Softmax Technique

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***Abstract*— Missing Data is a common phenomenon in many research areas and can have significant impact on the conclusions that can be drawn from such data. Existing missing data imputation techniques replace the missing entries by some plausible values either using deterministic or random methods. In this work, we propose a new approach, weighted cluster softmax technique, which is a generalization of K-Means clustering for handling multivariate missing value imputation. We have considered multiple open source data set from UCI libraries to test the algorithm and it is observed that our proposed method performs better than existing simple mean imputation and K-Means clustering based method.**

Keywords— K-Means Clustering, Missing Data, Multivariate, Missing value imputation, softmax

I. INTRODUCTION

Statistically, data is said to be missing when no data value is stored in one or more attributes in an observation. Since most of the real-world data contain missing values so it is required to handle missing values efficiently otherwise, we will end up with an unreliable estimate of the parameters. According to Little and Rubin [1] missing value can appear in a data set in three ways, which are missing completely at random (MCAR), missing at random (MAR), and not missing at random (NMAR). In this paper we work on data sets where missing values depend on the observed data i.e., MAR. In the last few decades, researchers have investigated different techniques for dealing with missing data. Method of handling missing data can be classified into different categories. The first approach is discarding the missing data using list-wise or pairwise deletion. Strike et al. (2001) [2] and Raymond and Roberts (1987) [3] mentioned that when missing rate is small i.e., less than 10%, we can simply remove them from dataset. However, problem arises when missing rate is higher or the data set itself is small as in such cases, we may lose critical information. The second approach is imputation technique, which replaces the missing values with substituted values based on information available in the dataset. In practice, imputation include different techniques like mean or median imputation [4], [5], [6], missing value imputation with forward and backward fill, hot deck and cold deck imputation [7], [8]. The mean median imputation is simple to impute but their performance is poor in terms of RMSE or other performance measure. Another approach is Expectation-Maximization (EM) [9], [10] based missing value imputation, where the missing values are estimated iteratively by following two steps (E-M steps). In E- step of the EM algorithm involves expectation of complete likelihood and in the M-step the likelihood to be maximized. Machine learning based approaches, such as simple regression [11], KNN [12], Decision Tree [13], neural network [14] etc. are also widely explored for handling multi variate missing values. Another popular approach comprises of unsupervised techniques such as clustering [15], [16] and [17], where clusters are formed using complete data and then missing values are filled with the centroid of the nearest cluster. In this work we have proposed weighted cluster softmax technique (WCST), which is a generalization of K-means clustering for handling multivariate missing value imputation. We evaluate the performance of our proposed methodology on five open source data set taken from UCI Machine Learning repository. It is note that we have taken mean imputation as reference metric and our results are compared with the simple mean imputation method and K-Means Clustering based imputation method. We have observed that our proposed methodology performs better than other two state of the art methodologies, where the performance is based on Root mean square error (RMSE) and Mean absolute error (MAE) metric.

The rest of the paper is organized as follows. In Section II, we have described different methodologies related to missing value imputation, also this section contains proposed algorithm. In Section III, experiment and results are described and finally in Conclusion Section, we have summarized our work and discuss the potential future direction.

II. METHODOLOGY FOR IMPUTATION OF MISSING VALUES

Suppose, X is a dataset with n observations and each observation contains p dimensional vector of variables, namely $(x_1, x_2, ..., x_p)$. An observation is considered as complete if all the attributes are non-null i.e., $\{x_j \neq \phi\}$ for ∀j, j = 1, 2, …, p, where ϕ denotes the null value. A partial observation is defined as $\{x_j = \phi\}$ for any j, j = 1, 2, …, p. The whole multivariate data set can be segmented into two parts. The complete and partial information of a multivariate data X, can be abbreviated respectively as X_{CI} and X_{PI} and they are defined as follows:

$$\left.\begin{aligned} X_{CI} &: \{x_{ij} \neq \phi, \forall i, j : 1 \leq i \leq n, 1 \leq j \leq p\} \\ X_{PI} &: \{x_{ij} = \phi, \textit{for at least one } j : 1 \leq i \leq n, 1 \leq j \leq p\} \end{aligned}\right\} (1)$$

Here our aim is to impute the missing values for an incomplete case, using the statistics of X_{CI}. Suppose in X_{PI}, we have m number of observe data and (p-m) number of missing data, then X_{PI} can also be written as $X_{PI} = (X_{\_observe}, X_{\_missing})$, where, $X_{\_observe} = (x_1, x_2, ..., x_m)$ and $X_{\_missing} = (x_{m+1}, ..., x_{p-m})$.

A. Missing value imputation using K-Means Clustering:

A basic approach for handling missing values is to impute the missing data based on the information of complete data, which has similar behavior to the partial information dataset (i.e. the dataset which has observations with some missing values). Therefore K-Means clustering is widely used for grouping similar types of observations. The algorithm works iteratively to assign each data point to one of the nearest cluster by initialized number of required clusters and its centroid randomly. Here the points are assigned to the nearest cluster based on Euclidean distance similarity measure. The Euclidean distance between two point $x = (x_1, x_2, ..., x_n)$ and $y = (y_1, y_2, ..., y_n)$ are given by:

$$d_{Euc} = \sum_{i=1}^{n} |x_i - y_i|^2 \quad (2)$$

Here the Complete Information data X_{CI} is divided into K cluster $(K \le n')$ by K-Means clustering method, where n' is the number of observations in the complete information data. Let $\mu = \{\mu_1, \mu_2, ..., \mu_k\}$ be the set of centroids of K clusters where each μ_i is a p dimensional vector. The optimum choice of K can be obtained by minimizing the within cluster sum of square distance and maximizing the between clusters distance. The loss function is defined by:

$$argmin \sum_{k=1}^{K} \sum_{x \in \mu_k} \|X - \mu_k\|^2 \quad (3)$$

And the algorithm will converge if it reaches to a predefined iteration or predefined threshold value. After getting the optimum cluster K in the complete dataset X_{CI}, we get the centroid for each cluster. For imputing the missing values of each incomplete observations, first we calculate the Euclidean distance between the observed information of an incomplete data and all the centroids of k clusters. Then in the second step, the missing values of the attributes are imputed using the centroid of the nearest cluster. Let j-th attribute is missing in i-th incomplete observation for $1 \le j \le p$ and if i-th observations is nearest to the k-th cluster then the j-th missing attribute is imputed by $x_{ij} = \mu_k^*$, where μ_k^* is the centroid of the k th cluster. The algorithm is given by Forgy and Edward [18], and the application can be seen in [19].

Algorithm-1: Missing values imputation based on K-Means clustering

Input:

Receive a dataset

$X = \{X_1, X_2, ..., X_n\} where\ each\ X_i = (x_1, x_2, ..., x_p)$

Divided the dataset into two parts: X_{CI} and X_{PI}

Output:

Imputed data X^{imp}

Step 1: Clustering

1. Apply K-Means clustering on X_{CI} data
2. Draw the scree plot (it is given in the Appendix)
3. Choose an appropriate K
4. Store the centroid's information for all the K cluster

Step 2: Missing value imputation procedure

for i-th incomplete observation do

for k= 1, 2, . . . , K

$$d_k = \sum_{j=1}^{p} \delta_j \left\| x_{ij} - \mu_{kj} \right\|^2;$$

$$where\ \delta_j = 0, if\ x_j = \phi,\ else\ \delta_j = 1$$

return d_k

end for

$\mu_k^* = argmin_{k \in K} \{d_k\}_{k=1}^{K}$

$x_{ij} = \mu_{kj}^*, where\ x_j = \phi$

Repeat the above step for all missing observation i.

B. Missing values imputation based on weighted Cluster Softmax Technique (WCST):

In the previous subsection, in **Algorithm-1**, the missing values are imputed by nearest cluster centroid. However, with such choice there is always some level of uncertainty associated with the decision as two clusters may overlap with each other. To deal with such problem, here we generalize **Algorithm-1**, by taking weighted cluster information technique using softmax function. In this approach, we impute the missing values by aggregating all the weighted clusters centroids, instead of looking only into the nearest cluster information. For getting the weights, first we calculate the Euclidean distance, d_k between the observed information of incomplete data and all the clusters centroid. Then the clusters with higher distance are penalized exponentially using negative exponential function, e^{-d_k}. Thus, the weights w_{ik} are defined by using softmax function, which is given as follows

$$w_k = \frac{e^{-d_k}}{\sum_{k=1}^{k} e^{-d_k}} \quad (4)$$

The proposed WCST algorithm is described in **Algorithm- 2.**

III. Experiment and Results

To evaluate the performance of our algorithm we have considered five data sets from UCI Machine Learning Repository [20]. Since the dataset doesn't contain any missing values so it is generated by MAR procedure mentioned above i.e., missing values are generated by randomly deleting some values from the datasets with different missing rates. It is to be noted that in this study we are only considering continuous attributes. We have used the metrics RMSE (Root Mean Square Error) and MAE (Mean Absolute Error) for the purpose of comparison and evaluation of the proposed algorithm. RMSE and MAE are defined by:

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}\left\| x_t - \hat{x}_t \right\|^2} \quad (5)$$

$$MAE = \frac{1}{n}\sum_{t=1}^{n}\left| x_t - \hat{x}_t \right| \quad (6)$$

where x_t is the actual value and $\hat{x}_t$ is the predicted impute value.

Algorithm-2: Missing values imputation based on WCST

Input:

Receive a dataset

$X = \{X_1, X_2, ..., X_n\} where\ each\ X_i = (x_1, x_2, ..., x_p)$

Divided the dataset into two parts: X_{CI} and X_{PI}

Output:

Imputed data X^{imp}

Step 1: Clustering

1. Apply K-Means clustering on X_{CI} data
2. Draw the scree plot (it is given in the Appendix)
3. Choose an appropriate K
4. Store the centroid's information for all the K cluster

Step 2: Missing value imputation procedure

$for\ i = 1, 2, \ldots..., n'$ do

$for\ k = 1, 2, \ldots, K$ do

$$d_{ik} = \sum_{j=1}^{p} \delta_j \left\| x_{ij} - \mu_{kj} \right\|^2;$$

$$where\ \delta_j = 0, if\ x_j = \phi,\ else\ \delta_j = 1$$

end for

$$w_{ik} = \frac{e^{-d_k}}{\sum_{k=1}^{K} e^{-d_k}}$$

Return w_{ik}

$$x_{ij}^{imp} = \sum_{k=1}^{K} w_{ik} * \mu_{kj}, where\ x_{ij} = \phi$$

A. Description and Experiment Result:

To evaluate the performance, we use two varying parameters as percentage of missing data (10%, 30%) and the number of clusters (k = 6, 12). For the computational simplicity, we have reported our results by taking only two values. **TABLE-I to TABLE-V** summarize the performance of the two algorithms by taking mean imputation as benchmark. From **TABLE-I to TABLE-V**, we have observed that the performance of both algorithms depend on percentage of rate of missing value and the number of cluster. From the tables, it is observed that our algorithm performs better than simple mean imputation and K-Means

TABLE-I. ANALYSIS OF DIABETES DATA

Data Set	% of missing values	No of Cluster	Method	Performance measure	
				RMSE	MAE
Diabetes Data	10		Mean Imputation	58.19	40.1
		6	Algo -1	72.6	33.6
			Algo -2	40.0	24.3
		12	Algo -1	52.8	23.2
			Algo -2	43.9	22.8
	30		Mean Imputation	63.1	42.7
		6	Algo -1	65.0	31.6
			Algo -2	46.0	25.3
		12	Algo -1	68.0	35.7
			Algo -2	45.0	25.0

TABLE-II. ANALYSIS OF IRIS DATA

Data Set	% of missing values	No of Cluster	Method	Performance measure	
				RMSE	MAE
Iris Data	10		Mean Imputation	0.928	0.703
		6	Algo -1	0.391	0.289
			Algo -2	0.44	0.370
		12	Algo -1	0.258	0.219
			Algo -2	0.477	0.383
	30		Mean Imputation	0.865	0.660
		6	Algo -1	0.568	0.333
			Algo -2	0.470	0.345
		12	Algo -1	0.521	0.338
			Algo -2	0.459	0.334

TABLE-III. ANALYSIS OF ABALONE DATA

Data Set	% of missing values	No of Cluster	Method	Performance measure	
				RMSE	MAE
Abalone Data	10		Mean Imputation	1.11	0.41
		6	Algo -1	1.48	0.45
			Algo -2	1.04	0.39
		12	Algo -1	1.82	0.51
			Algo -2	1.07	0.41
	30		Mean Imputation	1.30	0.47
		6	Algo -1	1.66	0.53
			Algo -2	1.23	0.47
		12	Algo -1	1.65	0.51
			Algo -2	1.12	0.43

TABLE-IV. ANALYSIS OF SKIN SEGMENT

Data Set	% of missing values	No of Cluster	Method	Performance measure	
				RMSE	MAE
Skin Segment	10		Mean Imputation	64.82	53.68
		6	Algo -1	46.05	27.35
			Algo -2	45.30	27.08
		12	Algo -1	44.50	22.38
			Algo -2	43.56	21.98
	30		Mean Imputation	65.11	53.95
		6	Algo -1	48.62	29.22
			Algo -2	46.90	28.54
		12	Algo -1	50.66	26.67
			Algo -2	49.42	26.26

TABLE-V. ANALYSIS OF SONAR DATA

Data Set	% of missing values	No of Cluster	Method	Performance measure	
				RMSE	MAE
Sonar Data	10		Mean Imputation	0.183	0.135
		6	Algo -1	0.126	0.104
			Algo -2	0.164	0.121
		12	Algo -1	0.123	0.101
			Algo -2	0.162	0.119
	30		Mean Imputation	0.173	0.123
		6	Algo -1	0.142	0.901
			Algo -2	0.152	0.109
		12	Algo -1	0.126	0.085
			Algo -2	0.152	0.109

clustering, based on RMSE and MAE measures. It is also observed that when the number of clusters increases RMSE and MAE decrease but opposite phenomena observed with the increase of missing rates as expected.

IV. CONCLUSION AND FUTURE WORKS

In this work, we have proposed an approach WCST, for handling multivariate missing values. We have taken five open source data set. From the results it is observed that the proposed method WCST performs better than the simple mean imputation and K-means clustering based missing value imputation techniques for all five data sets. For choosing the appropriate number of clusters, we have taken the decision based on the information of scree plots and evaluate the performance at the point where the gradient of the plot is almost constant and the curve converges almost to a straight line. It is observed from the tables that when percentage of missing data increases, performance of the algorithm decreases as expected. Future scope includes to handle categorical or mixed type of data using our proposed method WCST and it will be reported in the future work.

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Appendix

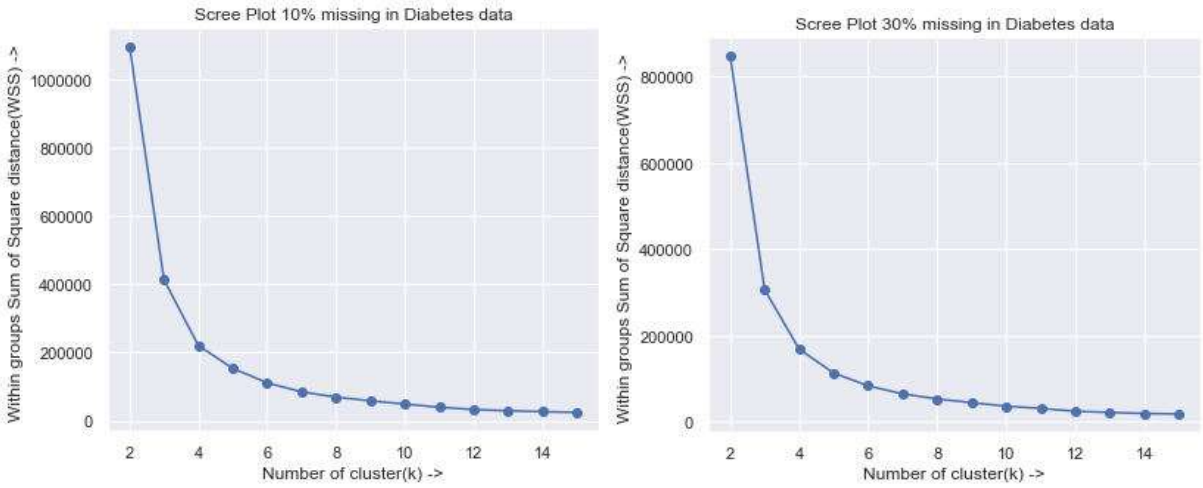

Fig -1: Scree plot for the Diabetes data set.

It is to be noted that, though we have drawn the scree plots for all the data sets but for the sake of simplicity we are only reporting the scree plot of Diabetes data set.

Sentiment Analysis of Student Textual Feedback to Improve Teaching

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***Abstract*—Instructor evaluation based on student feedback is essential in education, it allows instructors to see if their teaching has been effective. But, it is very challenging for an instructor who teaches numerous students to analyse feedback provided by all the students. To solve this problem, this paper develops a sentiment analysis model to analyse students' feedback to assess the effectiveness of teaching and learning. In this paper, machine learning models like, Support Vector Machines, Multinomial Naïve Bayes, Random Forests, K-Nearest Neighbours and Neural Networks are trained on feature engineering and re-sampling techniques to classify student feedback into three sentiment classes: negative, positive or neutral, using student dataset collected from Kaggle. From the analysis before the re-sampling of the data, K-Nearest Neighbours model is found to be more efficient in predicting student sentiment towards teaching practices than the other models with good accuracy of 81%. After the re-sampling of the data, Neural Networks performed better than the other models with good accuracy of 84%. The model will help institutions make effective decisions towards teaching and learning strategies.**

***Index Terms*—Sentiment analysis, Student feedback, Feature engineering, Machine learning models, Re-sampling**

I. Introduction

It has become common practice for educational institutions to collect student textual feedback on teaching and learning practices and use it as an improvement tool and performance measure. Student feedback can help instructors learn of their strengths and weaknesses and this will motivate them to perform better, thus improve their teaching. However, due to the unavailability of automated text analytic tools, the student feedback cannot be really used to their full advantage. Instructors cannot really derive useful information from the feedback to make effective decisions and improve their teaching [2].

Taking into consideration this issue, there has been determined attempts to address it. Prior research has shown that sentiment analysis is the best automated process that can be used by educational institutions to collect and analyse student feedback to evaluate the performance of instructors and highlight their strength and weaknesses in teaching.

Previous studies have used real student feedback from educational institutions as datasets from different sources like Learning Management System, Kaggle website, etc. They used uni-grams, bi-grams, tri-grams, word length, etc. as features. Among all the features, uni-grams is widely used because of its better performance with classifiers. They considered models like Support Vector Machines, Naive Bayes and Complement Naive Bayes, Multinomial Naive Bayes, random Forest, Maximum Entropy, Decision Trees and K Nearest Neighbours. Among the different models, Support Vector Machine is found as the best classifier followed by Multinomial Naive Bayes classifier [2], [6], [12], [14], [16].

Sentiment analysis is an automated process that collects, analyse and classify text data into different sentiments such as positive, negative, or neutral especially to understand the attitudes, opinions and emotions expressed towards a particular topic, product and or service [4]. In a similar way, this paper aims to analyse student textual feedback and track positive, negative or neutral sentiment from it by developing a sentiment analysis system that can help in assessing instructors' performance and highlighting major areas of the instructors' strength and weaknesses.

To ensure that the developed system provides best results, five models such as Support Vector Machines (SVM), Multinomial Naïve Bayes (MNB), Random Forest, K Nearest Neighbours (K-NN) and Neural Networks (NN) are trained with real students' feedback on pre-processing and feature engineering techniques. A comparative analysis is conducted among the first three models that are informed by the literature and the last two models that this paper claims will outperform the informed models. In light of the aim of this paper, the following questions are set out for the paper to answer: What are students' attitudes about teaching performance of the instructor? How does analysing student feedback improve instructor performance?

In addition, this paper suggests interpreting students' feedback by generating a word cloud for visualisation. A Word Cloud is a visual representation of the words used in a particular piece of text, with the size of each word indicating its relative frequency [3]. The more frequent the word is in a text, the larger it is in the visual. This paper contributes to the current body of literature by providing a predictive model to classify student textual responses using sentiment analysis and by providing possible strategies to use the comments provided by the predictive model to improve one's teaching

and learning.

The rest of the paper is structured as follows: Section II discusses the related work that highlights work done by other authors. Section III discusses the proposed methodology which comprises of data, features, models and evaluation. Section IV presents the results and discussion of the findings. Finally, section V concludes the paper and provides future work recommendations.

II. Related Work

This section explains some of the various research studies related to sentiment analysis of student feedback to improve teaching and learning approaches and limitations met by these research studies. There have been many attempts to deduce the sentiment of the responses in student forums.

A. Data

Different authors have used real students' feedback from different sources for instructor assessment. In this paper [6], the authors collected students' feedback using google forms. This paper [12] used student feedback gathered at the end of 63 courses. In this paper [14] students' feedback are collected from Kaggle website. This paper [9] used data from Learning Management System from computer science students.

On the other side, this paper [2] collected students' feedback from an institution and labelled data source by 3 experts, these includes; End of Unit Other Institutes, End of Unit University of Portsmouth and Real-time feedback University of Portsmouth, for these experts they considered 768, 117 and 190 instances respectively. The author in this paper [16] collected feedback from an institution, the data has 1036 records of students' feedback with 641 positive sentiments, 292 negative sentiments and 103 neutral sentiments.

B. Features

Several studies have used different features like uni-grams, bi-grams, tri-grams, word length, etc. Uni-grams is widely used. Paper [6] found that machine learning algorithms with uni-grams are better in performance than bi-grams. This paper [2] got the highest performance with the use of uni-grams. On the other hand, the authors in this paper [12] used uni-grams and found that the feedbacks are incorrectly classified.

C. Models

Many different classifiers are considered like Support Vector Machines, Naive Bayes and Complement Naive Bayes, Multinomial Naive Bayes, random Forest, Maximum Entropy, Decision Trees and K-Nearest Neighbours. Among these classifiers, Support Vector Machines classifier is found to be the best by [2], [9], [16]. On the other hand, this paper [6] found that Multinomial Naïve Bayes is better in performance.

D. Accuracy

Some of the authors concluded that support vector machine classifier performs better in predicting whether the opinion expressed by students towards teaching performance is positive, negative or neutral, with accuracy of 94%, 97% and 85% respectively [2], [9], [16]. On the other hand, this paper [6] compared Multinomial Naive Bayes, Support Vector Machines, etc. and concluded that Multinomial Naive Bayes classifier is more accurate with accuracy of 80%.

The various research studies related to sentiment analysis of student feedback to improve teaching and learning approaches are also presented in TABLE I.

III. Research Methodology

This section provides the proposed methodology. In more details, this section outlines the methods of data collection, the features used, models, and the type of data evaluation functions.

A. Data

In this subsection, data collection methods are discussed, followed by two sub processes such as data pre-processing and word cloud visualization which are essential to extract meaningful insights from the students' feedback.

1) Data Collection: Data consisting of students' feedback is collected from Kaggle. This is an existing dataset that is collected from a prominent university in India and it is used to create an overall institutional report. It consists of 185 records with 12 columns of which 6 columns are features like teaching, course content, examination, etc. with students' feedback and 6 columns are ratings of the students' feedback [1]. In this paper, only the teaching feature with student feedback about how they feel towards the teaching practices and its corresponding ratings column are considered.

2) Data Pre-processing: The following pre-processing phases are performed in Python Jupyter Notebook:

a) Basic Data Cleaning: The first step in cleaning the data is to remove stop words, words that do not add much meaning to the students' feedback, words like, have, the, etc. in order to improve classification accuracy. Punctuation are removed and the data is converted into lowercases. The feedbacks are then split into individual tokens such as words, this is because much processing of raw text is done at token level.

b) Vocabulary: The tokens are then used to prepare a vocabulary. Vocabulary refers to the set of unique words in the corpus (collection of text data) [5]. Vocabulary is used to create the tokenized input sentences. Each word in the vocabulary is treated as a unique feature.

c) Conversion of text into numeric: Texts are converted into numeric, this is because some machine learning libraries do not take categorical variables as input. The conversion of text into the corresponding numerical form can be achieved in various approaches. In this paper, we used the bag of words model to convert text to numbers.

d) Feature Engineering: In this phase, raw text feedback is transformed into feature vectors and new features are generated using the existing dataset. The following approaches are implemented in order to obtain relevant features from our

TABLE I: This table showcases work done by other authors on sentiment analysis of student feedback.

Authors	Data	Features	Models	Evaluation
[Nabeela Altrabsheh, Cocea, and Fallahkhair 2014]	Labelled by 3 experts: End of Unit Other Institutes, 768 instances. End of Unit University of Portsmouth, 117 instances. Real-time feedback University of Portsmouth, 190.	Unigrams	Naive Bayes, Complement Naive Bayes (CNB), Maximum Entropy and Support Vector Machine (SVM) were trained using real students' feedback. 10-fold cross-validation was used to test learning performance.	Accuracy: SVM is of 94% and CNB is 84%.
[Ullah 2016]	Institution data, 1036 data with 641 positive sentiments, 292 negative sentiments and 103 neutral sentiments.	Uni-gram, Bi-gram, Tri-gram and Opinion words	Support Vector machines, Naïve Bayes and complement Naïve Bayes and Maximum Entropy and apply of neutral class.	Accuracy: 97%, 89%, 84% and 87%.
[Rajput 2016]	1748 students' feedback provided at the end of 63 courses conducted during 2010 and 2014.	Type, length of word and part of speech of the word	Sentiment analysis was performed using Knime workflow	To measure its performance, accuracy, recall, precision, and F-measure were computed and the results were found to be very positive.
[Shinde 2019]	kaggle website, 186 records.	Student Response System	For analysis, Microsoft Excel tool was used. With R programming.	Neutral reviews(105) surpass those of positive(8) and negative(8).
[Adesh 2019]	Google forms	ngram method	Support Vector Machine (SVM), Naïve Bayes (NB), Random Forests	Accuracy: NB is 80%.
[Kavitha 2019]	Learning Management System (LMS), 200 samples from computer science students.	Performance in statistical learning, Chi-square, IG, Mutual Information and Symmetric Uncertainty.	Naïve Bayes, Support Vector machine, Decision Tree and K-Nearest Neighbour. NLTK and Valence Aware Dictionary and sentiment reasoner for analysis.	Accuracy: 85% for SVM and Information Gain performed better.

dataset: Count Vectorizer and TF-IDF. They use vocabulary as features.

- Count Vectors as features – used to get the texts' bag-of-words counts as a vector.
- TF-IDF Vectors as features - Bag of words approach has a drawback because it assigns a score to a word based on its occurrence in a particular document. It doesn't take into account the fact that the word might also be having a high frequency of occurrence in other documents as well. TFIDF feature resolves this issue by multiplying the term frequency of a word by the inverse document frequency. The TF stands for "Term Frequency" while IDF stands for "Inverse Document Frequency". TF-IDF is a numerical statistic that reflects how important a word is to a document in a collection [13].

e) Train Test Split: To overcome overfitting, the dataset is divided into training and testing splits, this allows us to see how the algorithms performed during the testing phase. The split ratio is 80:20.

3) Word Cloud Visualization: A word cloud is generated from the words in the students' feedback in Python. The more frequent the word is in the students' feedback, the larger it is in the word cloud visual.

IV. Features

Features like, CountVectorizer, TFIDF and SMOTE are implemented in this paper. The CountVectorizer is used to create a bag of words for the conversion of student feedback into numerical form while the TFIDF is used to show the importance of each word in the vocabulary. Resampling technique, such as, SMOTE technique is applied in this paper because the distribution of the sentiment classes is not balanced, so this technique is used to balance the distribution of the classes to enhance the performance of the classification models.

V. Models

Three machine learning classifiers, Support Vector Machines (SVM), Multinomial Naïve Bayes (MNB) and Random Forests (RF) informed by the literature are used in this paper due to their better performance with good accuracy in earlier research. A comparative analysis is conducted between these three classifiers and other two machine learning classifiers, such as Neural Networks and K-Nearest Neighbours that we think will outperform the literature and give good results based on the data. Therefore this paper uses five classifiers. The classifiers are trained using the training dataset on TF-IDF vectors and tested with the testing dataset. These models are briefly described in the following subsections.

Support Vector Machines

Support Vector Machine (SVM) is a supervised machine learning algorithm which can be used for both classification and regression challenges. The model extracts a best possible hyperplane line that separates two classes [10].

Multinomial Naïve Bayes

Multinomial Naïve Bayes (MNB) has been widely used in text classification. Given a set of labelled data, MNB often uses a parameter learning method called Frequency Estimate (FE), which estimates word probabilities by computing appropriate frequencies from data [15].

Random Forests

Random forest algorithm is a supervised classification model. This model creates the forest with number of trees [7]. Random forest classifier works well with missing values. It does not overfit the model when there are more trees in the forest.

K-Nearest Neighbours

K-Nearest Neighbour is a non-parametric classification algorithm. This algorithm works by finding the distances between a new data point and all the labelled datasets in the data, it reads through the whole dataset to find out the k nearest neighbours closest to the new data point, then the votes for the most frequent label in classification will be the class for the new data point [11].

Neural Networks

Neural Network is a complex model which tries to imitate the way the human brain develops classification rules. A neural net consists of different layers of neurons. Each layer receives inputs from previous layers and pass outputs to further layers. Its advantage is the ability to create complex prediction functions and emulate human thinking in a way that no other algorithm can [17].

A. Evaluation

Confusion matrix is used for evaluation, accuracy is calculated from the confusion matrices for both classifiers. The accuracy of all the classifiers is evaluated using 5-fold cross validation method on the training dataset. The goal for cross validation is to test the model in the training phase and then provide insight on how the specific model adapts. Cross validation is very efficient in mitigating overfitting. Overfitting refers to a model that performs too well on the training dataset but underperforms on new data (test dataset).

The interpretation in the Confusion Matrix is as follows:

- True Positive (TP), when both the actual and predicted values are positive.
- True Neutral (TNeu), when both the actual and predicted values are neutral.
- True Negative (TNeg), when both the actual and predicted values are negative.
- False Positive (FP), when the actual value is either negative or neutral and the predicted value is positive.
- False Neutral (FNeu), when the actual value is either positive or negative and the predicted value is neutral.
- False Negative (FNeg), when the actual value is either positive or neutral and the predicted value is negative.

TABLE II: A confusion matrix to describe the performance of a classification model on a set of test data for which the true values are known.

Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	TNeg	FNeu	FP
Neutral (0)	FNeg	TNeu	FP
Positive (1)	FNeg	FNeu	TP

The accuracy is computed as:

$$Accuracy = \frac{TP + TNeu + TNeg}{TP + TNeu + TNeg + FP + FNeu + FNeg} * 100$$

VI. Results and Discussion

This section presents in details the experimental results of predicting the sentiment of students using existing dataset that is designed based on students' feedback acquired from a prominent university in India. The dataset comprises of 185 records of students'feedback about how good they find their instructors' teaching practices. Sentiment analysis is performed using Python programming language. 5-fold cross validation method is used to evaluate the accuracy of all the five classifiers in the training dataset. Experiments are conducted in two ways: Firstly, the training dataset is split into 5 parts, this is known as 5-fold cross validation. The models are trained on the five parts on TF-IDF vectors before and after SMOTE. Secondly, after cross validation on training dataset, the analysis is validated on the testing dataset on TF-IDF vectors before and after SMOTE technique to see if the models are able to create accurate predictions on data they haven't been trained on.

A. Word cloud visualization

A word cloud from the complete 185 students' feedback is shown in Fig. 1. The larger the word is in the visual the more frequent it appears in the students' feedback. The most frequent words are good, lecture, delivery, and so forth. Word clouds can help in identifying patterns that are difficult to identify from reading the students' feedback [8].

VII. Class distribution before and after SMOTE

This section shows how the data is distributed before and after applying SMOTE technique to balance the class distribution from the dataset. Fig. 2 shows the class distribution before applying SMOTE technique, it can be seen that data is mostly distributed to the positive class 1. On the other hand, Fig. 3 shows the class distribution after applying SMOTE technique, it is clear now that the classes are equally distributed.

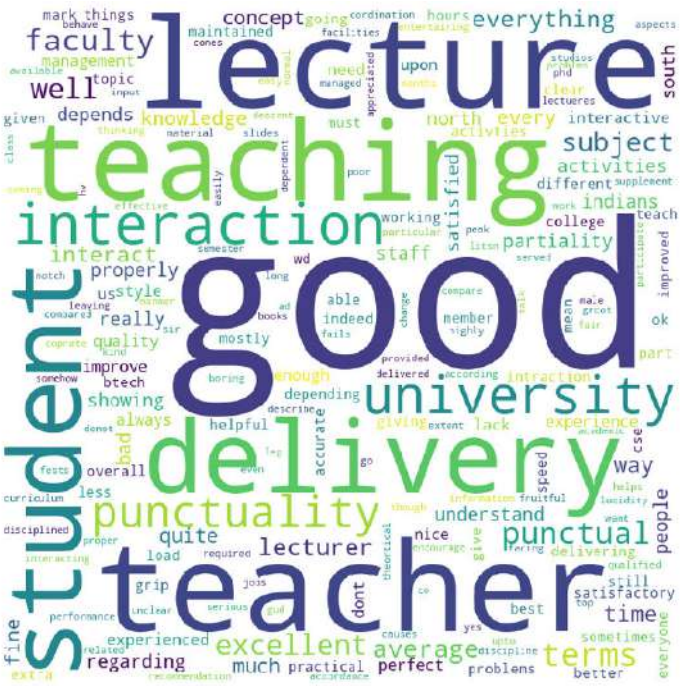

Fig. 1: Word Cloud of student feedback about teaching.

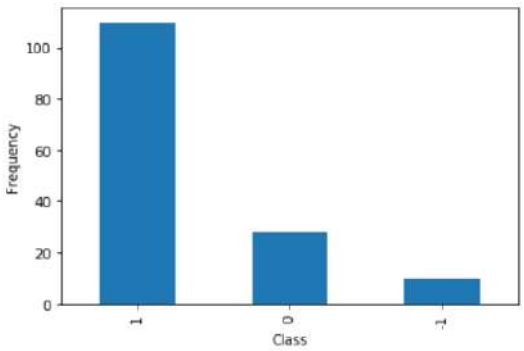

Fig. 2: This figure shows the distribution of each sentiment (positive, negative or neutral) on the students' feedback before the data was balanced using SMOTE technique.

A. 5-Fold Cross Validation before and after SMOTE

Training dataset is split into 5-folds cross-validation and then an average of the results are taken for each model. TABLE III shows the accuracy of the analysis done on each fold and the average (mean) accuracy before and after SMOTE technique is applied. It can be seen that SVM and RF performed better than the other classifiers with mean accuracies of 80% in the training dataset before the class distribution is balanced. After balancing the class distribution, the NN performed better with mean accuracy of 80% and SVM mean accuracy remained constant, this is because of the smaller dataset used in this work.

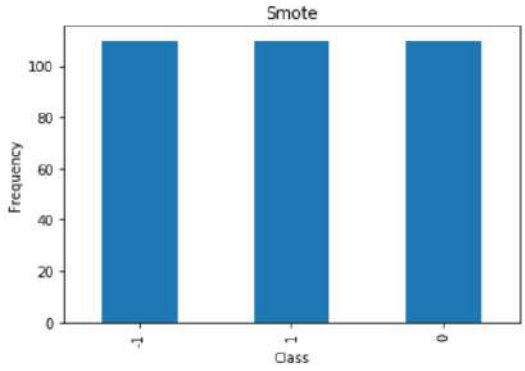

Fig. 3: This figure shows the distribution of each sentiment (positive, negative or neutral) on the students' feedback after the data was balanced using SMOTE technique.

B. Analysis on test dataset before and after SMOTE

In the experiments, the five models are used to analyse the students' feedback to predict the sentiment of students towards teaching. Therefore, TABLE IV depicts the confusion matrices of all the models before balancing the class distribution using SMOTE technique. It can be seen from these matrices that there are 3 students' feedback in the negative class for SVM, MNB, RF and NN, then the models were successful in predicting 0 of those correctly in the negative class, but 3 were classified as positive. In contrast, there are 3 students' feedback in the negative class in K-NN, 0 of them was classified correctly, but 1 of them was classified in the neutral class and 2 were classified in the positive class.

In contrast, there are 7 students' feedback in the neutral class for all the classifiers, but 1 of them was classified correctly by SVM and NN. These two classifiers predicted 6 in the positive class. On the other hand, MNB and RF classified 0 of these 7 feedback correctly, but 7 were classified on the positive class. However, K-NN classified 5 of these students' feedback correctly, but 2 were classified as positive.

There are 27 students' feedback in the positive class for all the classifiers and all of them are classified correctly by SVM and MBN. However, RF and NN classified 26 of the 27 students' feedback correctly, but RF classified 1 of them in the negative class and NN classified 1 of them in the neutral class. On the other hand, K-NN classified 25 of them correctly, but 2 of them were classified in the neutral class.

Therefore the confusion matrices shows that the best performance was for positive class. The lower number of records in the dataset affected the performance of the negative and neutral classes.

TABLE V depicts the confusion matrices of all the models after balancing the class distribution using SMOTE technique. It can be observed from the confusion matrices

TABLE III: The accuracy of each model for each part in 5-fold cross validation on training dataset before and after the class distribution was balanced and the average accuracy.

K-Fold	SVM		MNB		RF		K-NN		NN	
	Before	After	Before	After	Before	After	Before	After	Before	After
1-fold	83%	80%	73%	76%	83%	80%	90%	88%	73%	78%
2-fold	83%	83%	73%	76%	83%	80%	70%	80%	73%	76%
3-fold	80%	79%	73%	76%	77%	78%	70%	79%	77%	79%
4-fold	76%	76%	76%	80%	76%	76%	72%	70%	76%	87%
5-fold	79%	80%	76%	79%	83%	79%	79%	70%	76%	80%
Mean	80%	80%	74%	77%	80%	79%	76%	77%	75%	80%

after SMOTE that the performance on negative and neutral classes improved. SVM, MNB, K-NN and NN improved significantly in classifying all the students' feedback correctly for the negative class. But, for the neutral class, only the RF improved in classifying the feedback correctly. However, the best performance is still for the positive class like before SMOTE technique was applied, this is because of the smaller number of records from the dataset.

TABLE VI shows the prediction accuracy of the five models before and after balancing the class distribution, from the analysis before SMOTE technique is applied, K-Nearest Neighbors model is found to be more efficient in predicting student sentiment towards teaching practices than the other models with good accuracy of 81%. After SMOTE technique was applied, Neural Networks performed better than the other models with good accuracy of 84%.

VIII. Discussion

The five models performed well when classifying the sentiment of students towards teaching practices, because their properties match with the properties of the dataset. This means they are able to accurately classify small amount of data. Amongst these models, two of them, the K-NN and NN were hypothesised to work better than the other three models (MNB, SVM and RF) informed by the literature. This hypothesis was made because the models informed by the literature are mostly considered in text classification as they are proven to be best by many studies, therefore, this research wants to see how other models perform in predicting sentiment from text data.

Both the K-NN and NN were chosen because they were not mostly used in prior research and they can be trained on small dataset. As hypothesised by this research, the K-NN performed better than the other models before the class distribution could be balanced. On the other hand, the NN model performed better than the other models after the class distribution was balanced.

IX. Conclusion anf Future Work

This section presents the conclusion of this paper and suggestions for future work in sentiment analysis.

TABLE IV: This table shows the confusion matrices that describe the performance of the classification models before SMOTE technique was applied to balance the class distribution. The diagonal numbers are correctly classified students' feedback.

SVM			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	0	0	3
Neutral (0)	0	1	6
Positive (1)	0	0	27
MNB			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	0	0	3
Neutral (0)	0	0	7
Positive (1)	0	0	27
RF			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	0	0	3
Neutral (0)	0	0	7
Positive (1)	1	0	26
K-NN			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	0	1	2
Neutral (0)	0	5	2
Positive (1)	0	2	25
NN			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	0	0	3
Neutral (0)	0	1	6
Positive (1)	0	1	26

A. Conclusion

In this paper, a combination of pre-processing phases with different feature engineering techniques, re-sampling technique and machine learning classification models is applied to analyse students' textual feedback. It is found that, using pre-processing methods, feature engineering techniques and machine learning models properly increased accuracy when predicting sentiment of students' feedback towards teaching practices. It is also observed that, analysis on text dataset with an unbalanced class distribution affects the accuracy of some classes. The use of re-sampling techniques to balance class distribution shows an improved performance of mod-

TABLE V: This table shows the confusion matrices that describe the performance of the classification models after SMOTE technique was applied to balance the class distribution.

SVM			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	3	0	0
Neutral (0)	3	3	1
Positive(1)	2	1	24
MNB			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative(-1)	3	0	0
Neutral(0)	4	3	0
Positive(1)	1	2	24
RF			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	1	1	1
Neutral (0)	1	2	4
Positive (1)	0	0	27
K-NN			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	3	0	0
Neutral (0)	1	2	4
Positive (1)	1	2	24
NN			
Actual Values	**Predicted Values**		
	Negative (-1)	Neutral (0)	Positive (1)
Negative (-1)	3	0	0
Neutral (0)	2	3	2
Positive (1)	1	1	25

TABLE VI: Prediction accuracy of the models before and after the class distribution was balanced

Models	**Accuracy before SMOTE**	**Accuracy after SMOTE**
Support Vector Machine	76%	81%
Multinomial Naïve Bayes	73%	81%
Random Forest	70%	81%
K-Nearest Neighbors	81%	78%
Neural Network	73%	84%

els in sentiment analysis. From the results after resampling technique, SMOTE, it can be seen that as a result of the smaller dataset used in this paper, the accuracy of the negative and neutral classes are still affected. Therefore, from this paper, it is suggested that large datasets be used for significant learning like sentiment analysis. The results proves true the hypothesis proposed by this paper that K-NN and Neural Networks models will out perform the models informed by the literature, Neural Networks performed better than the other models. This paper indicates that Neural Network model gives very good results; therefore, it could be used for real-time students' feedback analysis. From the analysis, it can be observed that the accuracy measured against the 5-fold cross validation of the training dataset is very good and accuracy measured against a test dataset is also good, therefore, this paper concludes that the models generalize well from the training dataset to unseen data(test dataset). The sentiment analysis model built by this paper is able to analyse and classify students' feedback' into positive, negative or neutral. Educational institutions can utilize this model to analyse and understand how students feel about teaching practices. From the analysis, effective decisions can be made to improve teaching.

B. Future Work

For experimental purposes, this paper used small dataset of 185 records, however, the five models are bias towards the negative and neutral classes in terms of accuracy. Therefore, from this paper, it is suggested that large datasets be used for significant learning like sentiment analysis to avoid biasness. This paper also suggests that Neural Networks be used for further studies because it gives efficient accuracy in prediction.

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Different Models Relating Prior Computer Experience with Performance in First Year Computer Science

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***Abstract*—According to a South African university, the current minimum admission requirements to study a degree in computer science is 70 percent or above in pure mathematics and 60 percent and above in English. This shows that students are not evaluated based on their computer skills. The evaluation of a student's computer skills could provide one with information on whether or not the student is comfortable with using a computer. This may have an impact on whether a student passes or fails first year computer science. In order to investigate this further, two groups of students were considered. The first group had no prior computer experience while the second group had prior computer experience. Based on the accuracies of three classification models, we were able to determine group 2 as a better predictor of performance in first year computer science with accuracies of more than 60 percent for each model. Furthermore, a hypothesis test and confidence interval test was conducted. This was used to establish whether or not the final computer science results of the second group were greater than or equal to the first group. The hypothesis test and confidence interval test resulted in students in the second group performing better as compared to students in the first group at a significant level of 5 percent (95 percent level of confidence).**

KEY WORDS

***Index Terms*—Prior computer experience, Pearson correlation coefficient, Linear regression, Logistic regression, Naïve Bayes model, Decision tree classifier, Performance in first year computer science, Secondary school results**

INTRODUCTION

To enter the computer science programme in South African universities, potential students are required to have performed well in both pure mathematics and English as confirmed by [10] and [12]. The aim of this investigation is to determine whether or not the evaluation of a student's past computer experience along with their results in both mathematics and English is a better predictor of performance in first year computer science as compared to only evaluating their mathematics and English results.

This study will compare the performance of first year computer science students with prior computer experience to students without prior computer experience. Four machine learning models will be used. The linear regression model will allow us to predict the actual results of students. The outcome produced from the model is a real number [9]. The classification models which include: the logistic regression model; the decision tree classifier and the naïve Bayes model will allow us to predict a student's results as either a *PASS* or *FAIL*.

Similar studies have been done in finding effective predictors for performance in first year computer science. Language performance as a predictor was studied by [10]. The study used the Pearson product-moment correlation to establish language performance as a better predictor as compared to mathematics.

Similar to [10], [12] used the Pearson product-moment correlation to establish the strength between mathematics results and performance in computer science. [5] also investigated mathematics results as a predictor and was confirmed as a good predictor for performance in computer science.

A past study that investigated past computer experience as a predictor was by [7]. The study could not establish any significant relationship between computer-related subjects and performance in computer science [10]. For the purpose of our study, we consider past computer experience prior to entering first year as our predictor and not first year computer-related subjects.

The predictors of concern in this investigation are grade 12 results in pure mathematics; English first language and computer studies. We will be applying our different models to our chosen predictors. We do this to evaluate the strength of past computer experience as a predictor in comparison to the known predictors, namely, mathematics and English. We will evaluate the accuracy of each chosen model on the predictors. More on the methodology will be discussed in section 3.

Students are evaluated on the basis of their results in both grade 12 pure mathematics and English, however, they are not evaluated based on their computer skills. The contribution made by this study will be to show whether or not the

combination of a students' results in mathematics; English and prior computer experience is an effective way to evaluate a potential student to study first year computer science as compared to only evaluating their results in mathematics and English.

In section 2, we will be elaborating on the past research studies that have done similar work in using past results as a predictor of performance in computer science. We will evaluate the different features and models used as well as results from the respective past research studies. In section 3, we will provide a detailed outline of the methodology used in conducting our investigation. Section 4 will provide results from our investigation. Finally, we end with a conclusion and recommendations for future work based on this investigation.

Related Work

There has been several past research studies that have studied potential predictors of performance in first year computer science. Some studies even went as far to study the perception that students have towards studying computer science [13]. For the purpose of our investigation, we will only be studying grade 12 results in pure mathematics, English first language and computer-related subjects as potential predictors. For each related work that we discuss, we will be concerned with the features; the models used as well as the accuracy of the models from each investigation.

Table 1 is displaying information pertaining to the features, models and accuracies for previous research studies that have investigated at least one of the features: mathematics; English and past computer experience as predictors of performance in first year computer science. The logistic regression model, used by [2], produced the highest accuracy (80 percent) out of all the research studies listed in *Table 1*.

TABLE I
Table displaying a summary of previous research studies that have investigated past computer experience; mathematics and English as predictors of performance in computer science

Authors	Features	Models	Accuracy
[2]	MATH12	LogR	80 %
[4]	MATH12	LinR; PPMC	< 0.3
[4]	COMS12	LinR; PPMC	> 0.04
[4]	ENGFL12	LinR; PPMC	< 0.3
[5]	MATH12; ENGFL12	PPMC; DA; WL	68.4 %
[8]	COMS12	Regression	Between 45% and 65 %
[10]	MATH12; ENGFL12	PPMC	Refer to Table II
[1]	MATH12; COMS12; ENGFL12	LogR: SVM: NB: KC: MP:	59 % 59 % 58 % 57 % 62 %

Key for *Table I*
MATH12: *Grade 12 pure mathematics results*
ENGFL12: *Grade 12 English first language results*
COMS12: *Prior Computer experience*
PPMC: *Pearson product-moment correlation*
LogR: *Logistic Regression model*
LinR: *Linear Regression model*
SVM: *Supprort Vector Machine model*
NB: *Naïve Bayes model*
KC: *K* Classification*
MP: *Multilayer Perceptron*
DA: *Discriminant Analysis*
WL: *Wilks' Lambda*

Mathematics as a predictor

The first predictor that we concern ourselves with is mathematics. This is a known predictor of performance for computer science as confirmed by [12]. This investigation studied several features that may have an impact on results for computer science [12]. One of the features was the final secondary school results in mathematics [12]. The Pearson product-moment correlation was used to establish a relationship between results in mathematics and computer science. Results showed that a significant relationship existed between performance in mathematics and computer science [12].

Results from [5] were similar to that of [12]. Amongst the features studied included: background in high school mathematics and science; SAT scores as well as gender [5]. The study used the discriminant analysis; Multivariate t-test as well as the Wilk's Lambda and correlation coefficient to conduct the investigation [5]. Results from this investigation confirmed the findings of [12].

Past computer experience as a predictor

One would expect past computer experience to be the best predictor of performance in computer science. A study by [4] produced results contradictory to what many would expect. The study investigated several predictors including mathematics and prior computer experience [4]. Mathematics did not disappoint as a predictor. However, prior computer experience was found to have no impact to the performance in computer science [4]. The study tested using the Pearson product-moment correlation; ANOVA and regression. The Statistical Analysis System (SAS) was used to perform all the statistical analysis [4].

Other studies which investigated prior computer experience as a predictor was by [7] and [8]. [7] used the multiple regression analysis to confirm performance in computer related modules as a weak predictor of performance in computer science. However, [8] found prior computer experience to have a significant relationship with overall performance in computer science when using a regression model.

Language performance as a predictor

Another useful predictor is language performance. English is known as one of the admission requirements to study

computer science and this was verified by [10]. The results produced from this investigation were really interesting. It showed language performance as a better predictor of performance in computer science as compared to mathematics [10]. Similarly to the study by [12], [10] used the Pearson product-moment correlation to establish a relationship between its chosen predictors and performance in computer science modules. It was successful in realising language performance as a better predictor as compared to mathematics as shown in *Table II*.

TABLE II
Table sourced from [10] that shows the results from using Pearson's correlation. The independent variables are: mathematics; English first language; English second language and all other first languages. The dependent variables are: BCO and FAC

Category	BCO to FAC	Category to FAC	Category to BCO	n
Mathematics	0.7607	0.2664	0.2782	90
English first language	0.7667	0.4571	0.4063	48
English second language	0.7755	0.2343	0.1232	46
All first language	0.7651	0.3213	0.2440	96

Key for *Table II*
BCO: *Basic Computer Organisation*
FAC: *Fundamental Algorithmic Concepts*

Moving on to section 3, we will be discussing the methodology used to conduct our investigation. This will include the information about the data collection process; the features to be used; the models that will be employed as well as the measures of accuracy for each of our models.

METHODOLOGY

In this section, we will be discussing the methodology used to conduct our investigation. We will be including the data collection process; the features used; the models used as well as the measures of accuracy. Four different machine learning models were used in this investigation to make our predictions. These included: the linear regression model; the logistic regression model; the decision tree classifier and the the naïve Bayes model. We used confusion matrices; F1 score; recall; precision and the Pearson correlation coefficient to measure the accuracy of our models. We also used a hypothesis test and confidence interval test to confirm our findings.

We divided the features into two groups *(Table III)*. Group 1 consisted of students with mathematics and English first language but with no prior computer experience. Group 2 consisted of students with mathematics, English first language and prior computer experience.

We used the hypothesis test and confidence interval test to test whether or not the students in group 2 outperformed the students in group 1.

TABLE III
Table displaying the groups considered for this investigation. We have divided the data into two groups namely: Group 1 and Group 2

Group number	Group Description
Group 1	Group consists of students with no prior computer experience. (We consider only the results for pure mathematics and English first language)
Group 2	Group consists of students with prior computer experience. (We consider the results for pure mathematics; computer studies and English First language)

The structure of the methodology process is as follows: firstly, we introduce our data collection process. Secondly, we discuss the features that we used in the investigation. Thirdly, we introduce the machine learning models that we used along with their respective measures of accuracy. Next, we discuss the hypothesis test and confidence interval test that we conducted. Lastly, we include information about the ethics clearance certificate that was obtained for this research.

Data collection and pre-processing

The data consisted of high school results; biographical information; university results and registration information of students from a South African university. The data had 14326 samples.

The focus of this study was on computer science majors, therefore, data pertaining to computer science majors were extracted from the original 14326 samples. This decreased the number of samples to 428. The new sample consisted of students who either had prior computer experience or did not have prior computer experience.

Features and target value

Table IV shows the features used in the investigation. We used the final aggregate first year computer science results as our target value (the variable we are aiming to predict).

TABLE IV
Table displaying the features used in this investigation

Features
English first language grade 12 results
Pure mathematics grade 12 results
Computer studies grade 12 results

Past studies by [12], [5] and [10], suggested mathematics and English were good predictors so we used our own data to confirm this.

Linear Regression Model

$$Y = B_0 + B_1 X \tag{1}$$

We used this model to predict the aggregate of a student's final results using testing data. *Equation 1* shows the linear

equation used in the linear regression model to predict the final aggregate results (Y) of students given their feature results (X). B_0 represents the y intercept while B_1 represents the gradient. *Equation 1* resulted in predicted values (final aggregate results) given a feature in *Table IV*. The accuracy of our model was calculated using the Pearson correlation coefficient similar to what was done in past studies, [10], [12] and [4] to analyse the strength of the correlation between each feature in *Table IV* and final aggregate results in first year computer science.

Logistic Regression Model

This classification model was used to predict whether a student had passed or failed based on the results of the chosen predictors as shown in *Table IV*. For the purpose of this investigation, an aggregate score of 50 percent and above was considered a *PASS*. Furthermore, an aggregate score of less than 50 percent was considered a *FAIL*. A confusion matrix was constructed and displayed for the group (*Table III*) which produced the highest accuracy. From the confusion matrix, we were able to evaluate the F1 score; recall; accuracy and precision of the logistic regression model.

Naïve Bayes Model

This classification model was used to classify a student as having passed or failed based on the results of each chosen feature. To use this model, the features needed to be independent of each other and the data needed to be normally distributed [11]. A confusion matrix was constructed and displayed for the group (*Table III*) which produced the highest accuracy. From the confusion matrix, we were able to evaluate the F1 score; recall; accuracy and precision of the naïve Bayes model.

Decision Tree Classifier

The decision tree classifier was used to classify a student as having passed or failed based on the results of each chosen feature. We constructed a decision tree using the gini index as well as using entropy. Based on the results of the students from the chosen features (depending on the group), a decision was made on whether a student had passed or failed. A confusion matrix was constructed and displayed for the group (*Table III*) which produced the highest accuracy. From the confusion matrix, we were able to evaluate the F1 score; recall; accuracy and precision of the decision tree classifier model.

Hypothesis Test and Confidence Interval Test

We constructed a hypothesis test at a significant level of 5 percent to test whether or not the students in group 2 outperformed the students in group 1. Our null hypothesis was that the aggregate results of the two groups were equal. The alternative hypothesis was that the aggregate results of students in group 2 were greater as compared to students in group 1. A 95 percent confidence interval was constructed alongside the hypothesis test to validate our results.

Ethics Clearance

The study participants were learners who studied at a South African Higher-Education Institution. The study ethics application has been approved by the University's Human Research Ethics Committee (Non-Medical). The ethics application addresses key ethical issues of protecting the identity of the learners involved in the study and ensuring the security of data. The clearance certificate protocol number is H19=03=02.

RESULTS AND DISCUSSION

We have used four different machine learning models in this investigation. We also constructed a hypothesis test and confidence interval test which gave us interesting results. Results from the hypothesis test showed that students with prior computer experience performed better as compared to students without prior computer experience using a significant level of 5 percent. The confidence interval test produced similar results to the hypothesis test at a 95 percent level of confidence.

Linear Regression Model

The results in *Table V* shows the correlation between each feature with the final first year computer science results as was done in studies by [12], [10], [5] and [4]. Grade 12 pure mathematics produced the greatest correlation with a value of 0.35. It was followed by computer studies with 0.32 and finally English first language with 0.16. Mathematics and computer studies proved to be the best predictors as compared to English first language.

TABLE V
Table displaying the Pearson correlation coefficient for pure mathematics, English first language and computer studies with the final first year computer science results

Modules (features)	**Pearson Correlation Coefficient**	**n (sample size)**
Pure mathematics grade 12 results	0.346117	214
Computer studies grade 12 results	0.320650	119
English First Language grade 12 results	0.164604	214

Logistic Regression Model

We constructed a logistic regression model and applied it to the two groups in *Table III*. Results in *Table VI* indicate that group 2 produced the highest accuracy by correctly classifying 62.5 percent of students' results as either a *PASS* or *FAIL*. A confusion matrix was constructed for group 2, as seen in *Figure 1*, as it was the group which produced the highest accuracy when using the logistic regression model.

TABLE VI
Precision, recall, F1 score and accuracy from the logistic regression model

Group	Precision	Recall	F1 score	Accuracy
Group 1	58.71 %	66.42 %	62.33 %	59.85 %
Group 2	62.33 %	63.21 %	62.76 %	62.5%

		Predicted Outcome	
		Pass	Fail
Actual Outcome	Pass	134	81
	Fail	78	131

Fig. 1. Confusion matrix for the logistic regression model classifying students' results in group 2 as either a *PASS* or *FAIL*.

Naïve Bayes Model

We constructed a naïve Bayes model and applied it to the two groups in *Table III*. Results in *Table VII* indicate that group 2 produced the highest accuracy by correctly classifying 61.32 percent of students' results as either a *PASS* or *FAIL*. *Figure 2* shows a confusion matrix generated for group 2.

TABLE VII
Precision, recall, F1 score and accuracy from the naïve Bayes model

Group	Precision	Recall	F1 score	Accuracy
Group 1	68.29 %	40.88 %	51.14 %	60.95 %
Group 2	61.54 %	60.38 %	60.95 %	61.32 %

		Predicted Outcome	
		Pass	Fail
Actual Outcome	Pass	128	80
	Fail	84	132

Fig. 2. Confusion matrix for the naïve Bayes model classifying students' results in group 2 as either a *PASS* or *FAIL*.

Decision Tree Classifier

Table VIII is displaying the precision; recall; F1 score and accuracy for each group when using the decision tree classifier. We produced results using both the gini index and entropy. Group 2 produced the highest accuracy by correctly classifying 68.75 percent of students' results as either a *PASS* or *FAIL* when using the gini index and 73.44 percent of students' results as either a *PASS* or *FAIL* when using entropy. Confusion matrices for both the gini index and entropy are shown in *Figure 3* and *Figure 4* respectively for group 2.

TABLE VIII
Precision, recall, F1 score and accuracy from the decision tree classifier model

Group	Precision	Recall	F1 score	Accuracy
Group 1 using the gini index	62 %	60 %	56 %	60.24 %
Group 1 using entropy	62 %	60 %	56 %	60.24 %
Group 2 using the gini index	81 %	69 %	66 %	68.75 %
Group 2 using entropy	74 %	73 %	73 %	73.44 %

		Predicted Outcome	
		Pass	Fail
Actual Outcome	Pass	26	0
	Fail	40	62

Fig. 3. Confusion matrix for the decision tree classifier classifying students' results in group 2 as either a *PASS* or *FAIL* using the gini index.

		Predicted Outcome	
		Pass	Fail
Actual Outcome	Pass	44	12
	Fail	22	50

Fig. 4. Confusion matrix for the decision tree classifier classifying students' results in group 2 as either a *PASS* or *FAIL* using entropy.

Hypothesis Test and Confidence Interval Test

A hypothesis test and confidence interval test was conducted to test whether or not there was a difference in average aggregate final first year computer science results between students with prior computer experience (group 2) and students without prior computer experience (group 1).

Table IX is displaying results from the hypothesis test and confidence interval test. We represented the average aggregate final first year computer science results for group 1 as μ_1 whereas μ_2 represented the average aggregate final first year computer science results for group 2.

Based on the results from *Table IX*, the null hypothesis was rejected at a 5 percent level of confidence. The confidence interval test results showed that the first year computer science results of students with prior computer experience was greater as compared to students without prior computer experience at a 95 percent level of confidence.

Based on the hypothesis test and the confidence interval test, we can conclude that Students with prior computer experience outperformed students without prior computer experience in first year computer science.

TABLE IX
Table displaying information and results from the hypothesis test and confidence interval test.

Section	Content / Value
Null hypothesis (H_0)	μ_2 - $\mu_1 = 0$
Alternative hypothesis (H_A)	μ_2 - $\mu_1 > 0$
Z score	1.645
The calculated Z statistic	6.034
Confidence interval test lower bound	6.137
Confidence interval test upper bound	10.737
Hypothesis test decision	Reject null hypothesis at a 5 percent level of significance
Confidence interval test result	First year computer science results of students in group 2 was greater as compared to students in group 1 at a 95 percent level of confidence.

CONCLUSION AND RECOMMENDATIONS

Two group were considered when investigating the effect that prior computer experience had on the final first year computer science results. Students in group 1 had no prior computer experience. Students in group 2 had prior computer experience. The final grade 12 results for pure mathematics; English first language and computer studies were used to predict the final aggregate first year computer science results. We used three classification models, namely: the logistic regression model; the naïve Bayes model and the decision tree classifier model. Another model used was the linear regression model.

The three classification models resulted in group 2 with the highest accuracy. However, the difference in accuracies between group 1 and group 2 was not great when using the logistic regression model and naïve Bayes model. The difference in accuracies observed in the decision tree classifier model was greater between the two groups as compared to using the logistic regression model and naïve Bayes model. The difference in accuracies between the two groups using the logistic regression model was 2.65 percent. Furthermore, The difference in accuracy between the two groups when using the naïve Bayes model was 0.37 percent. The difference in accuracy between the two groups when using The decision tree classifier was 8.51 percent when using the gini index and 13.2 percent when using entropy.

Results from the hypothesis test and confidence interval test showed that the students in group 2 outperformed the students in group 1. Based on these results, it is worth considering past computer experience as an additional criterion to studying computer science. However, we should not ignore students without prior computer experience considering the fact that the accuracies produced from both group 1 and group 2 differed by a small percentage when using both the logistic regression model (difference of 2.65 percent) and naïve Bayes model (difference of 0.37 percent).

For future work, we can consider a student's self-efficacy towards programming which is based on the mind set of the student towards programming. This was done in the study by [13].Further additional work that can be done is investigating the first year performance in computer science as a predictor of performance on the final year results in computer science. First year computer science modules will be considered as the features while performance in final year computer science is what we will be predicting. With this additional work; we will be able to get an idea as to which modules in first year computer science are good predictors of performance for final year computer science.

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Factors influencing customer satisfaction of wireless mobile services during the Covid-19 pandemic led lockdown

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***Abstract*— The telecommunication industry in India is rapidly growing and witnessing many developments. 85% of respondents reported increased usage of mobile services during the Covid 19 lock-down in 2020 on activities such as work-from-home, entertainment, learn from home, etc. The objective of this research was to identify factors influencing customer satisfaction of wireless mobile services in the Covid-19 led lockdown and formulate a framework for the same. The study identified six factors that influence customer satisfaction, viz, customer convenience, billing-payments, problem resolution, data speed, tariff-offers, and network strength. Using partial least squares structural equation modelling, a model for evaluating customer satisfaction was built. The study also identified factors that had significant impact on customer satisfaction.**

Keywords—customer satisfaction, mobile services, services satisfaction, service quality

I. INTRODUCTION

Telecommunication has become an inseparable part of everyday life. India is the world's second-largest telecommunications market. The telecom market can be split into three segments – wireless, wireline and internet services. According to TRAI, the wireless mobile services market is 98.21 per cent of the total subscriber base as of December 2019. Mobile phones have grown beyond its earlier purpose of enabling voice calls and text messages from anywhere to anywhere. Whatever service beyond voice and messaging used to be classified as value-added services. Indian Mobile Value-Added Services (MVAS) industry is expected to grow at a CAGR of 18.3 per cent during 2015– 2020 and expected to reach US$ 23.8 billion by 2020 (IBEF 2020). Now value-added services have become mainstream in mobile industry. This has been amply demonstrated by Reliance Jio, which charges the company only for data (which was earlier defined as VAS) and calls are free. Today smartphone serves as a platform for video conferencing, accessing social media, learning, banking, ordering food and accessing scores of other services. The players in the telecom industry seek the most profitable markets throughout the world (Hossain and Suchy, 2013). Due to increased competition in the sector, companies search for various ways to attract and retain customers (Vranakis et al. 2012).

In recent times, Telcos have reduced the number of plans on offer, and now offer a limited number of simple tariff plans along with marquee plans. This has simplified choosing plans for customers as they can choose the best deals for themselves (IBEF 2020).

With increased use of telecom services during lockdown due to work from home, learn from home, consuming entertainment through OTT platforms and availing other remote services, Telcos have benefited from the surge in demand for voice and data.

In spite of the remarkable improvements and measures taken up in the troubling times of lockdown by the industry, there were complaints of interrupted voice signals, network congestion and reduced data speed. There is, therefore, the need for Telcos to evaluate what factors influence customer satisfaction in the unique circumstances of lockdown where telecom is proving to be the backbone of service industry. This study is initiated to investigate respondents across the demography and identify the factors (service reliability, service consistency, operator's network/signal coverage, pricing, value added services, data services, fulfilment of customer demand, problem resolution and operators contribution for society) responsible for customer satisfaction in mobile telecommunication industry in India during the COVID-19 led lockdown and provide some managerial implications on the basis of findings of the study.

To identify the factors that are expected to influence the satisfaction of the customers, we have used exploratory factor analysis (EFA). In the second stage, we have used Partial Least Squares Structural Equation Modeling (PLS-SEM) to build the model that links the factors identified and the satisfaction of the customers.

II. LITERATURE REVIEW

Customer satisfaction is defined as "the consumer's fulfilment response. It is a judgment that a product or service feature, or the product or service itself, provides a pleasurable level of consumption related fulfilment" (Mattsson, 2009). Ashim (2009), asserts that business runs because of customers; they are the kings. Customer Satisfaction is a measure of ascertaining the happiness customers associate with the product, its quality and overall experience.

Hasemark and Albinsson (2004) stated that customer satisfaction in essence is the emotional reaction to the two different states; what they really want and what customers actually get. Their research further clarified that satisfaction is an overall attitude towards a product provider. Hoyer and MacInnis also agree with this statement and clarify that customer satisfaction refers to how a person is happy with the service or with the product. Additionally, they also stated that satisfied customers recommend their friends and relatives to buy that product or service. A strong relationship is seen between customer satisfaction, customers; delight and customers' dissatisfaction (Souca, 2014).

It has also been proven that decline in product quality results in lower customer satisfaction which in turn will lower the brand equity of the company (Taylor and Baker, 1994). Kano et al. (1984) developed a two-way model that distinguishes between different quality attributes. This model divides product or service quality attributes into five distinct categories- Attractive quality, One-dimensional quality, Must-be quality, Indifferent quality, and Reverse quality, each of which influences customer satisfaction differently.

Two of the very well-known scales for measuring service quality are (a) SERVQUAL scale (Parasuraman et al., 1985, 1988) and (b) SERVPREF scale (Cronin & Taylor, 1992, 1994). The SERVQUAL scale is built on the basis of customer expectations and customer perceptions. It has two identical scales – one measuring expectations and the other perceptions of customers. SERVQUAL has five dimensions – "tangibility, reliability, responsiveness, assurance and empathy" and the scale has 22 items grouped under these five dimensions.

Lata and Narta (2020) found that in the present era of competition, one of the most important issues for a telecom industry is know the satisfaction level of customers, their behaviour and their switching intentions with respect to the service providers. When it comes to customer satisfaction of mobile network services, the factors that need to be considered are different. According to Kalita and Bikash (2019), network quality is found to be the best predictor of customer satisfaction. Other than network quality, the role of front-line staff and value added services offered by the provider are also important. Yadav and Rai (2019) found that customer satisfaction mediates the relationship between service quality and customer loyalty in mobile service.

Ta and Yang (2018) provides a unique view of service innovation by categorizing service innovation into two forms, interactive and supportive service innovations, and exploring their effects on customer satisfaction and retention in the context of telecommunication services. Their study suggests that service firms should differentiate themselves by investing in supportive service innovations.

Rao and Subbarao (2018) say that customer satisfaction is about providing customers required support and service to meet their needs.

Anjum, et al (2016) opines that customer satisfaction for telecom service can be built when brand satisfies the requirements and cravings of clients. The study uses the SEVQUAL scale where it was proven that three out of five predictor variables i.e. assurance, responsiveness and reliability have positive impact on customer satisfaction while empathy and tangibility have no significant influence on customer satisfaction.

Qi, et al (2015) says that the telecommunications service providers should develop appropriate strategies based on their strengths in satisfying their customers as well as overcoming their weaknesses by learning from each other. With network quality and customer service identified as the major factors influencing customer satisfaction, strategies should be formulated along these two areas. Also telecommunications service providers cannot ignore the importance of product diversity and pricing as these factors are shown to have strong correlation with customer satisfaction.

Wang and Li (2011) indicate that the mobile service attributes of personalization, identifiability, and perceived enjoyment have significant positive influences on the key brand equity factors, including brand loyalty, perceived quality, brand awareness, and brand associations. Their research also provides insights into how mobile value-added services (M-VAS) may be better designed and delivered to enhance brand equity and, in turn, profits.

As the telecom industry sees a rapid decline in voice tariffs, it is looking at services beyond standard voice calls, or MVAS to propel it to the next level of growth. With mobile penetration expected to go up, and the advent of 4G, the industry is looking at various means to use MVAS as a growth driver and simultaneously as a key differentiator. While today, non-voice revenues in India only account for about 10% of an operator's revenues, the global average for leading MVAS countries is far higher, pegged at approximately 23%. The focus of the industry, so far, has been infotainment MVAS, but there is much discussion around other services which have a greater growth potential such as Governance and Commerce, and currently may not even exist (Deloitte 2011).

The COVID-19 pandemic has propelled the growth of telecommunication sector aided by high dependence on digital tools for entertainment, business and education. Cellular Operators Association of India (COAI) reported a 30% jump in traffic during the initial period of lockdown ie. In April 2020. High traffic also came with attendant problems like poor connectivity and call drops. COAI has indicated that the average net addition of subscribers is expected to come down from 3 million/ month to below 1 million during the phase 1 of lockdown in April 2020.

On review of several research papers as above, it was found that network quality is the key determinant of customer satisfaction. However in the context of increasing data usage, it is required to identify other factors that influence customer satisfaction and hence this research.

III. RESEARCH DESIGN

A. Statement of Problem

There are no specific studies, especially in the Indian context on customer satisfaction of wireless mobile network services especially during the pandemic-led lockdown in 2020. This research study aims to bridge this gap. The study at the basic level will identify and evaluate different variables that a consumer will consider towards customer satisfaction. Further, based on these variables, the study aims to build a customer satisfaction framework. The variables will lead to the factors, which in turn will constitute different dimensions of customer satisfaction.

The customer satisfaction framework thus formed will enable wireless mobile service providers to assess the perceived customer satisfaction of their customers. The study will also help the service providers in understanding the relative importance of different factors and dimensions of customer satisfaction.

B. Type of study

We have used a descriptive research design to achieve the objectives of the study. The respondents for the survey constituted the existing wireless mobile service consumers

across India experiencing the lockdown. Responses were collected from the customers using a structured online questionnaire. The same were used to build the framework for assessing customer satisfaction of wireless mobile service providers.

C. Research Objectives

The research aims at developing a model for assessing customer satisfaction with wireless mobile services. Specifically, the objectives of this research are:

- To identify the constructs and factors/dimensions that contribute to customer satisfaction of wireless mobile services
- To assess the relationship between the factors/dimensions of customer satisfaction
- To create a model for customer satisfaction of wireless mobile services

D. Sampling and data collection

Non-probability convenient sampling technique was used in this study. The targeted respondents were from across India and were approached through social media platforms. The sample size was considered according to Marcoulides and Saunders (2006), which depends on the number of factors considered. Accordingly, for this study with six factors, the sample size should be a minimum of 75 respondents. Research by Hoyle (1995) suggests that the sample size of 100 to 200 is usually a good starting point in carrying out path modeling. For this study, data was collected from 318 responses, with a 5% margin of error for a 95% confidence interval.

The questionnaire had questions to ascertain the overall customer satisfaction and influence of various factors on customer satisfaction in addition to respondent demographics and nature of consumption of wireless mobile network services (increased/decreased consumption, service providers, prepaid/post-paid plans, etc). A five-point Likert scale and a 95% confidence interval were considered for this research study.

E. Hypotheses

The following hypotheses which relate the different factors to customer satisfaction were tested for significance in the study:

H1: Network strength has a significant impact on customer satisfaction of wireless mobile services
H2: Customer convenience has a significant impact on customer satisfaction of wireless mobile services
H3: Problem resolution has a significant impact on customer satisfaction of wireless mobile services
H4: Tariff and offers has a significant impact on customer satisfaction of wireless mobile services
H5: Account and payments have a significant impact on customer satisfaction of wireless mobile services
H6: Data speed has a significant impact on customer satisfaction of wireless mobile services

F. Exploratory Factor Analysis (EFA) and PLS-SEM

EFA was used to extract the factors that were used to build the model to explain the satisfaction level of the cutomers. The data collected on items or variables was used to build the factors using EFA. Kaiser-Meyer-Olkin (KMO) index was to measure the sampling adequacy and Bartlett test was used to test the significance of the correlation matrix built using the data collected on the items. The cut-off point for the KMO index was 0.5 or more and the Bartlett test should result in the rejection of the null hypothesis (correlation matrix is insignificant). The communalities indicate the percent of variation in the items explained by the factors and the cut-off is 0.5 or more. Using the factors extracted, one should be able to explain at least 60% of the total variance explained by all the items put together. Finally, the items under each factor were identified using the factor loadings. Items that were having loadings with 0.5 or more will be considered under a factor. To avoid the cross loadings, we used vari-max factor rotation. Principal component analysis was used to extract the factors. One can refer to Hair et.al. (2006) for further details on EFA.

A model was built using PLS-SEM, which was used to connect the factors extracted. The reliability of the factors was checked using Cronbach alpha and the Composite reliability (Jöreskog's rho (ρc)), the cut-off points are 0.7 or more. To check the convergent validiy of the factors, we used average variance extracted (AVE) and the cut-off point was 0.5 or more. To check the divergent validity of the factors we used Fornell-Lacker criterion and the Heterotrait-Monotrait (HTMT) ratio. According to the Fornell-Lacker criterion, the Squared correlations should be less than the AVE in the diagonal and, the HTMT ratio should be less than 0.85. To test the significance of the path coefficients, we use t-test and based on the results of the same, we identify the significant factors that explain the satisfaction of the customers towards the mobile services. One can refer to Hair et.al. (2014) for further details on PLS-SEM. We present the results of the data analysis in the next section.

IV. DATA ANALYSIS

A. Common method bias

Common method variance can occur if one collects all the variables in the study from the same source by adopting the same method. In this study, we use Harman's single factor test (Podsakoff and Organ, 1986) to check the common method bias. After examining the unrotated factor structure of the variables, we found that no single factor accounted for the majority of the variance. The total variance for a single factor in the study was found to be 45.367%, which is less than 50%. Hence, we conclude that the issue of common method variance is not present.

B. Exploratory Factor Analysis using Principal Component Analysis

The principal component analysis (PCA) was used to extract the factors using the items considered in the study, with a varimax rotation. Table 1 gives the factors and items under each of the factors along with the loadings.

TABLE 1 FACTORS AND LOADINGS

Factors	Variables	Loadings
Billing and Payments	Access_to_information	0.804
	Accurate_billing	0.777
	Easy_safepayments	0.715
	Roaming_services	0.755
	Uninterrupted_services	0.856
Convenience	M_Commerce_services	0.883
	M_Entertainment	0.893
	M_Governance_services	0.884
	Videostreaming	0.816
Data Speed	Data_speed	0.906
	Download_speed	0.951
	Upload_speed	0.933
Network Strength	Audio_video_calls	0.875
	Audio_voice_calls	0.844
	Call_drops	0.710
	Video_video_calls	0.882
Problem Resolution	Easy _to_use	0.875
	Prompt_response	0.896
	Prompt_solution	0.919
Tariff and Others	Data_Plans	0.884
	Promotional_offers	0.730
	TopUps_other_offers	0.836
	Voice_Call_Plans	0.869

Source: From the researchers data analysis

The six factors extracted explained 71.421% of the total variance and all the items under each of the factors have loadings more than 0.5. An item with less than 0.5 loadings has been deleted from the analysis. Also, variables that cross load on two are more factors have been excluded from the analysis. The overall KMO index value is 0.932 and the KMO index value for each of the items is more than 0.5, which satisfies the criterion for sampling adequacy. Bartlett's test of sphericity has resulted in a Chi-square value of 5336.832 with d.f. 300, with the corresponding p-value <0.05 (0.0001). This indicates that the correlation matrix of all the items is significantly different from the identity matrix. All the items have communalities more than 0.5 and this indicates that at least 50% of the variance in each of the items is explained by the factors extracted. Using the results of EFA, we build a model that explains the satisfaction of the customers towards the mobile service provider. The model is presented Fig 1.

C. Reliability, Convergent and Discriminant Validity

To check the convergent validity, the Average variance extracted (AVE) was calculated. Cronbach alpha and composite reliability (CR) are used for checking the reliability of the questionnaire. To check the discriminant validity, we used the Fornell and Larcker (1981) criterion and the Heterotrait-Monotrait criterion. The results are given in Tables 2 to 5. As shown in Table 2, a high level of internal consistency reliability has been demonstrated, as values are above 0.7. This is used to measure Outer Loading. The questionnaire has high reliability since the value of Cronbach's alpha for each factor is more than 0.7

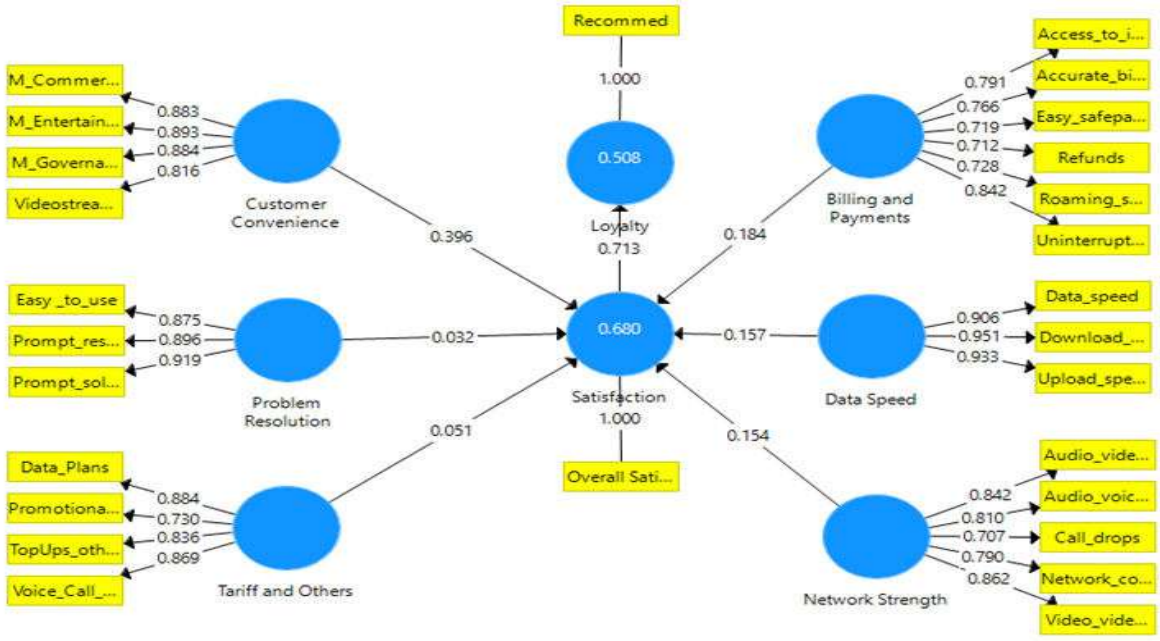

Fig. 1 Customer Satisfaction Model (Source: Model built by the researcher from the data analysis)

TABLE 2 RELIABILITY

Construct	Dijkstra-Henseler's rho (ρA)	Jöreskog's rho (ρc) Composite Reliability	Cronbach's alpha(α)
Customer Convenience	0.8930	0.9254	0.8922
Problem Resolution	0.8812	0.9249	0.8782
Tariff and Offers	0.8624	0.8995	0.8499
Billing and Payments	0.8674	0.8918	0.8545
Data Speed	0.9220	0.9507	0.9220
Network Strength	0.8701	0.9010	0.8623

Source: From the researchers data analysis

TABLE 3 CONVERGENT VALIDITY

Construct	Average variance extracted (AVE)
Customer Convenience	0.7565
Problem Resolution	0.8043
Tariff and Offers	0.6922
Billing and Payments	0.5796
Data Speed	0.8654
Network Strength	0.6465

Source: From the researchers data analysis

Heterotrait-Monotrait Ratio (HTMT): This ratio helps to measure discriminant validity in a more precise way. The cut off value should not exceed 0.85. All the values are within the cut-off value and hence the discriminant validity is established

D. Assessment of the Structural Model

The coefficient of determination R-Square is 0.6799 for the satisfaction factor. This means that six factors that contribute to overall satisfaction (customer Convenience, problem resolution, tariff and offers, billing and payments, data speed, and network strength) R-Square explains the degree to which the input variables explain the variation of the output / predicted variable. So, here the R-Square is 0.6799, which means 67.99% of the variation in the output variable is explained by the input variables as shown in Table 6. Besides evaluating the magnitude of the R^2 values as a criterion of predictive accuracy, we also examined Stone-Geisser's Q^2 value as a criterion of predictive relevance. The Q^2 value of latent variables in the PLS path model is obtained by using the blindfolding procedure. Since the value of Q^2 is more than zero, the predictive relevance for the model is verified.

TABLE 4 HETEROTRAIT-MONOTRAIT RATIO

Construct	Customer Convenience	Problem Resolution	Tariff and Offers	Billing and Payments	Data Speed	Network Strength	Satisfaction
Customer Convenience							
Problem Resolution	0.6558						
Tariff and Offers	0.6661	0.5983					
Billing and Payments	0.7235	0.7597	0.6765				
Data Speed	0.6941	0.6556	0.6254	0.6567			
Network Strength	0.7261	0.6246	0.6784	0.6581	0.7129		
Satisfaction	0.8041	0.6273	0.6274	0.7138	0.6900	0.7061	
Loyalty	0.6611	0.5266	0.5795	0.6106	0.6712	0.6847	0.7128

Source: From the researchers data analysis

TABLE 5 DIVERGENT VALIDITY- FORNELL AND LARCKER CRITERION

Construct	Customer Convenience	Problem Resolution	Tariff and Offers	Billing and Payments	Data Speed	Network Strength	Satisfaction	Loyalty
Customer Convenience	0.7565							
Problem Resolution	0.3386	0.8043						
Tariff and Offers	0.3364	0.2664	0.6922					
Billing and Payments	0.4035	0.4351	0.3365	0.5796				
Data Speed	0.3952	0.3492	0.3090	0.3499	0.8654			
Network Strength	0.4106	0.2994	0.3418	0.3305	0.4145	0.6465		
Satisfaction	0.5772	0.3464	0.3393	0.4476	0.4390	0.4399	1.0000	
Squared correlations; AVE in the diagonal.								

Source: From the researchers data analysis

TABLE 6 R-SQUARE, ADJUSTED R-SQUARE AND Q-SQUARE

Construct	Coefficient of determination (R^2)	Adjusted R^2	Q-Square
Satisfaction	0.6799	0.6738	0.639

Source: From the researchers data analysis

TABLE 7 DIRECT EFFECTS – PATH COEFFICIENTS

Effect	Original coefficient	Standard bootstrap results				
		Mean value	Standard error	t-value	p-value (2-sided)	p-value (1-sided)
Customer Convenience -> Satisfaction	0.3961	0.3903	0.0634	6.2502	0.0000	0.0000
Problem Resolution -> Satisfaction	0.0325	0.0353	0.0599	0.5428	0.5873	0.2937
Tariff and Offers -> Satisfaction	0.0512	0.0550	0.0480	1.0663	0.2864	0.1432
Billing and Payments -> Satisfaction	0.1844	0.1831	0.0616	2.9923	0.0028	0.0014
Data Speed -> Satisfaction	0.1575	0.1554	0.0479	3.2888	0.0010	0.0005
Network Strength -> Satisfaction	0.1543	0.1574	0.0495	3.1187	0.0018	0.0009

Source: From the researchers data analysis

E. Size and significance of path coefficients

A path coefficient indicates the direct effect of a variable assumed to be a cause on another variable assumed to be an effect. The P-values of the path coefficient of PLS-SEM as shown in Table 7, indicate the relationship between customer satisfaction and the factors that make up the model of customer satisfaction. For two factors - problem resolution and tariff & offers, the P-value is greater than the desired cut off of 0.05, and hence null hypotheses for these two factors are not rejected. It can thus be concluded that the factors of convenience, data speed, billing and payments, and network Strength have a significant impact on customer satisfaction with wireless mobile services.

V. DISCUSSION AND CONCLUSION

This research was taken up to examine and identify the constructs/ factors that contribute to customer satisfaction of wireless mobile services in the Covid-19 led lockdown. The study confirmed six such factors, viz., Billing-Payments, Convenience, Data Speed, Network Strength, Problem Resolution, and Tariff-Offers that contributed to the customer satisfaction of wireless mobile services in Indian context. The study also identified the variables/ constructs that constitute the six factors.

As shown in the final model of PLS-SEM, Billing-Payments factor is constituted by variables, viz., ease and safety, Roaming services, Accurately billing, Uninterrupted services, and Access to information, Convenience factor by variables, viz., Uninterrupted video streaming, M-Entertainment services, M-Governance services, and M-Commerce services, Data Speed factor by variables, viz., data speed as per plan, Download speed, and Upload speed, Network Strength factor by variables, viz., voice quality in voice calls and video and voice quality in video calls, and Tariff-Offers factor by variables, viz., Unlimited Calling Plans, Data Plans, Top-Ups and other Off-Net Tariff Plans, and promotional offers.

The study also showed that the factors of convenience, data speed, billing and payments and network strength have a significant impact on customer satisfaction of wireless mobile services, while problem resolution and tariff & offers do not have much impact on customer satisfaction.

Further research can be taken up to understand the importance of problem resolution and network strength to understand whether these factors are key determinants of customer satisfaction or play the role of hygiene factors as the study indicates. This will help the wireless mobile network service providers in the telecom industry to understand and address the areas that are perceived as important by customers in ensuring customer satisfaction.

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'Nurses' Perception as a Behavioral Factor Reveals Efficiency in Documentation as a Health Care Parameter In Selected Government Hospitals of Goa

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Abstract— **Documentation is a basic nursing service leading to transparency and efficiency in implementation in the health care sector and hospitals, especially in these uncertain times. The standard of nursing care provided to clients in hospitals is linked to the quality of documentation followed in the hospitals. It forms the basis on which to audit and improve medical care. The purpose of this paper is to identify socio-demographic characteristics of nurses at government hospitals and to assess nurses' perception regarding documentation based on five selected components. For this, a cross-sectional, descriptive study was conducted between May 2017 and May 2018. Primary data was collected from nurses of two district and two sub-district hospitals to assess nurses' perception towards documentation carried out at select government hospitals of North and South District of Goa. A total of 114 nurses participated in the study. It was found 52% of the nurses were satisfied with the maintenance of records, 30% were very satisfied, 14% remained neutral. While 4% were dissatisfied, none were very dissatisfied.**

Keywords— Electronic Health Records, Documentation, Nurses' perception, Web services, E-health introduction

Documentation (American Nurses Association, 2010) which is clear, concise, and timely written, plays an important role in providing quality health care to clients in hospitals. Written and electronic health records (EHR) last longer and can be recovered easily (1). Silfen (2006) viewed that no data should be abandoned in spite of a data element being recognized as purposeless (2). A study by Benyamin Mohseni Saravi et al. (2016) indicated that 62 percent of admission (registration sheet) were evaluated and found to be in the "poor" category (3). Karami and Shokrizadeh (2009) highlighted that evidence of records and the spread of information are the basis of the programming and decision-making processes in health, education, and research. Incomplete records (Tavakoli, 2006) are due to the belief by hospital staff that medical care required for clients are essential vis-à-vis documentation of the data (5). Rashida's (2013) study explains that no records were maintained in admission notes with regards to the final diagnoses and procedures that were performed on clients (6). Marie et al. (2011) observe that the monitoring of the administration of prescribed medications for clients and their adverse effects remains an issue of concern in health institutions. The same could be monitored by the health team to minimize drug-related adverse reactions among clients (7). Zurita-Garaicoechea et al. (2015) remarked that although in Navarra (2011) a total of 781 adverse drug reaction (ADR) cases were reported, only 7.33% were reported by nurses (8). Hospital records can be monitored in terms of quality via an (electronic tools) auditing instrument to facilitate the importance of documentation (9). The term audit is often linked to finance however medical /nursing audit tools can be developed to evaluate documentation that can indicate the quality of retrospective and concurrent client care practices (10, 11). In 2002-2004 the Copenhagen University Hospital, Rigshospitalet (2002-2004) announced the Swedish VIPS model for documentation of nursing care. VIPS is an acronym for well-being, integrity, prevention, and safety. The model assists in organizing nursing data as per keywords. This facilitates the storage and retrieval of data whenever needed (12). Clinical records permit hospitals to have an accurate view of their clients. The law requires that all actions related to medical services such as tests, diagnoses, treatments, and nursing care be recorded completely and accurately (13). Health care records promote client safety, facilitate continuity of care across time and care settings, support the transfer of information when clients are at a site, during shift handovers, or for a deteriorating client(14). Hospital healthcare stakeholders need to be acquainted with institutional documentation standards at the induction stage or during their medical training (15). A study by Olfat et al. (2015) showed that medical records can be deficient (range from missing data to data being incompletely recorded). Well-maintained hospital records promote safety, help in coordination and communication of care. Quality use of data in the medical record leads to productive medical and nursing care (16). To Wookjin et al. (20013) the evolution of mobile devices opens up new eventualities for integrating mobile services in healthcare institutions. This helps healthcare providers to view clients' medical records and information on the go, without a workstation (17). Ehrler et al. (2013) state that healthcare professionals require free mobility and usability to provide client care in hospital situations (18). Nolan (2011) finds that smartphones have become an indispensable part of doctors' lives. Improving digital health applications can go a long way in enhancing the quality of care and in ensuring that protocols and policies for safety measures become the norm for all clients in hospitals. (19).

E-Health is bringing discipline in the network of medical informatics and public health. It relates to health services and

information provided through the internet and related technologies (20). Web services provide easy access to health-related information and care particulars /awareness and health services to clients and hospital staff (21). The status and /role of a client (Nagel, 2005) has changed to an 'informed' one, who can be counted on to be an independent, accountable, and accomplished associate in his/her care (22). Bourgeois (2009) explained that electronic client portals, which comprise provider-tethered applications, have permitted clients to electronically access health information that is documented and managed by hospital stakeholders (23). As per Ross et al., several studies showed an improvement of doctor-client communication by client-accessible medical records. There were, however, conflicting findings on improvements in treatment adherence, client education, and client empowerment; some controlled studies showed an improvement, while others did not (24).

DATA AND METHODOLOGY

Goa was selected because of a perceived good quality health output. Quality of documentation as input in health services will require the output to be studied to assess the scope for improvement. Government hospitals were selected as they were looked upon as role models in providing low-cost health care. A cross-sectional, descriptive study was conducted between May 2017 and May 2018. The validity and reliability of the present study were based on five dimensions. Primary data was collected from nurses attached to two districts and two sub-district hospitals to assess the nurses' perception towards the quality of documentation being carried out at their workplace. A five-point Likert scale included: Strongly Agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly Disagree (1). Only nurses willing to participate in the study and who were available at the time of data collection were included. Nursing staff included in the study were 04 matrons, 16 head nurses, and 94 staff nurses. Ethical clearance was obtained from each of the respective institutions. Initially, a sampling frame of nurses available in each hospital was prepared. A simple random technique was used to obtain a sample of 150 nurses. However, a total of 114 nurses participated in the study. A structured questionnaire was designed in English. The content of the questionnaire was divided into two sections. Section - I consisted of socio-demographic variables and Section - II consisted of questions on the perception of nurses towards documentation in their hospitals. Five dimensions were scored, these included: legible and adequate medication orders written legibly and adequately (name of the client, route, dose, time, technique), hospital accessibility to electronic medical record (web portal or mobile app), the conduct of the regular medical audit, conduct of regular nursing audit, medical and nursing staff's alertness with regards to side effects of drugs. A feasible slot during the non-busy shift time was provided by the nursing staff for responding to the questions. Each nurse spent 10 to 15 minutes filling up the questionnaire.

RESULTS

As shown in Table No. 1 – Sample consisted of 114 nurses. The data analysis revealed that 11 (9.65%) were in the age group of > 50 years and 18 (15.79%) were in the age group of >41-50years. 32 (28.07%) were in >31-40 years age group, with a maximum number of nurses 53(46.49%) in 21-30 years age group. A majority of the nurses were females 107 (93.86), 65 (57.02 %) were diploma holders. Graduates were 22 (19.30%), and post-graduates were 27 (23.68%). An equal number of nurses, 34 (29.82%), had hospital work experience between 1-5yrs and >5-10. Only 16 (14.04%) nurses had >10-15years of working experience. While 04 (3.51%) had >15-20 yrs experience, 26 (22.81%) nurses had working experience of >20yrs. 3 (2.63%) were working in the OPD. A majority of the nurses, 47 (41.23%) were found to be working in the Casualty. While 33 (28.95%) nurses were working in the wards, 31 (27.19%) of the nurses indicated that they had to manage OPD, Indoor & Casualty.

TABLE I. ANALYSIS OF DEMOGRAPHIC CHARACTERISTICS OF NURSES WORKING AT GOVERNMENT HOSPITALS, GOA.

S.NO	CHARACTERISTICS OF SAMPLE	FREQUENCY	PERCENTAGE
1	***AGE***		
	21-30	53	46.49
	>31-40	32	28.07
	>41-50	18	15.79
	>50-	11	9.65
2	**GENDER**		
	Male	7	6.14
	Female	107	93.86
3	**EDUCATION**		
	Diploma	**65**	**57.02**
	Graduate	22	19.30
	Post-graduate	27	23.68
4	**YEARS OF EXPERIENCE**		
	1-5	34	29.82
	>5-10	34	29.82
	>10-15	16	14.04
	>15-20	04	3.51
	>20	26	22.81
5	**AREA OF POSTING**		
	Only OPD	3	2.63
	Only Indoor	33	28.95
	Only Casualty	47	41.23
	OPD, Indoor & Casualty	31	27.19

[a] Source: Health care provider's perception database collected by the authors

I. ANALYSIS ON PERCEPTION OF NURSES TOWARDS QUALITY DOCUMENTATION IN HOSPITALS: FIVE DIMENSIONS

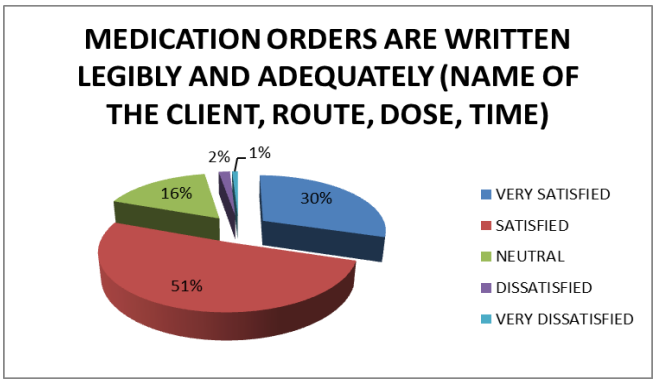

Figure I: Medication order are written legibly and adequately

With regards to written medication order, 51% of nurses were satisfied, 30% were very satisfied, 16% remained neutral, 2% were dissatisfied, whereas only 1% was very dissatisfied.

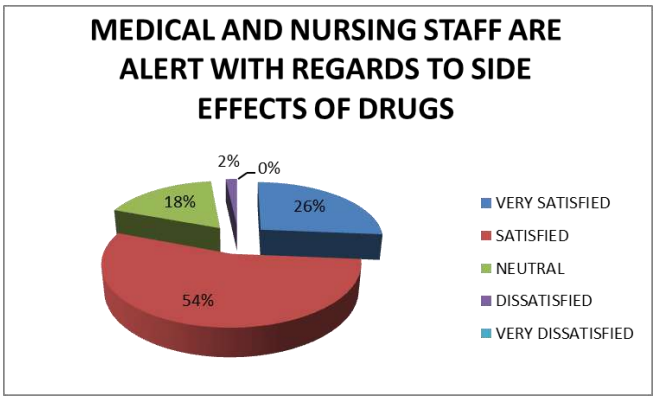

Figure II: Medical and nursing staff are alert with regards to side effect of drugs

The majority, 54%, of nurses were satisfied and perceived that medical and nursing staff were alert regarding the side effects of drugs and their documentation. While 26% were very satisfied, 18% remained neutral, and only a negligible 2% remained dissatisfied, with zero percent remaining very dissatisfied.

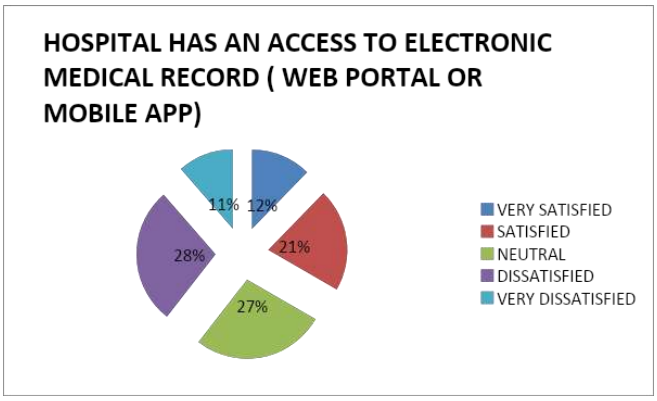

Figure III: Hospitals has access to electronic record

Nurses perception in view of access to electronic medical record revealed that 21% of nurses were satisfied, 12% were very satisfied, 27% remained neutral, 28% were dissatisfied and the remaining 12% were very dissatisfied.

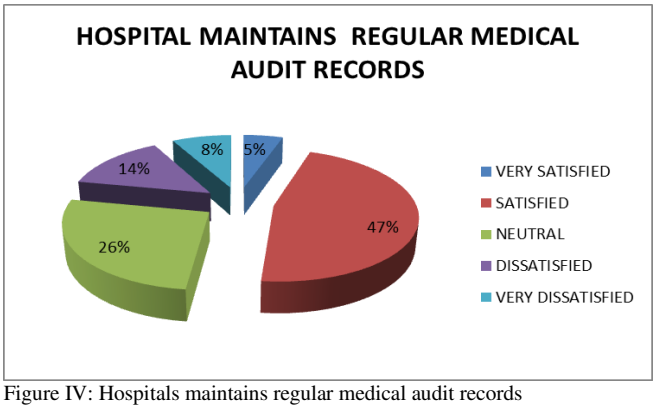

Figure IV: Hospitals maintains regular medical audit records

Study showed that 47% of nurses were satisfied with regards to hospital maintaining regular medical audit records, 5% very satisfied, 26% were neutral, 14% dissatisfied other 8% remained very dissatisfied.

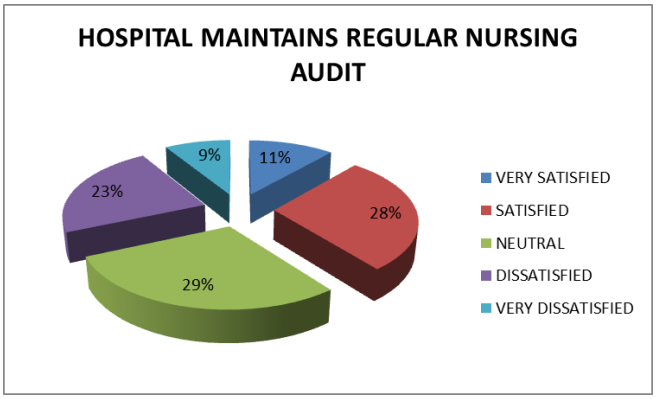

Figure V: Hospitals maintains regular nursing audit records

Perception regarding hospital maintaining regular audit showed 28% of nurses were satisfied, 11% were very satisfied, 29% remained neutral.While 23% were dissatisfied only 9% were very dissatisfied.

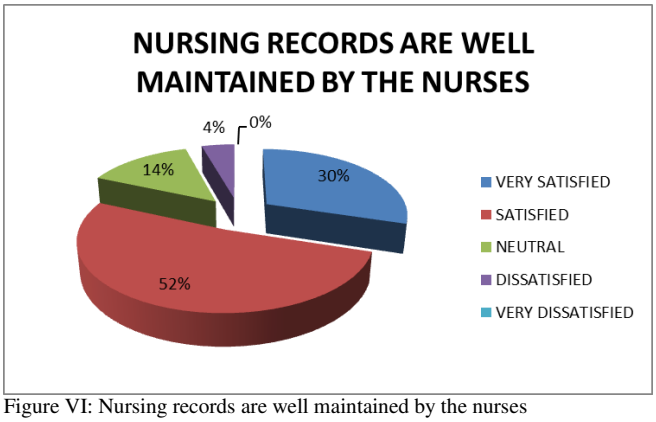

Figure VI: Nursing records are well maintained by the nurses

The study explained that overall nurses' perception in relation to documentation highlighted that 52% of nurses were satisfied with the maintenance of records, 30% were very satisfied while 14% remained neutral. Only 4% were dissatisfied but none very dissatisfied.

CONCLUSION

Documentation is a vital component of quality care which is a shared responsibility among all members of the health care team. Nurses play an important role in terms of defining and measuring quality of documentation practised in their work place. Although documentation systems have been used extensively in daily client care, not much attention has been given with regards to the designing of client care plan and this affects the documentation process. Use of well written legible orders for medications by doctors and legible recording by nurses, recording the adverse effects of administered medications to clients, use of web portal/ mobile app, and regular medical and nursing audit would improve quality care to clients seeking hospital services. Nursing heads need to be alert to include documentation (process, standards and barriers) when planning continuing in-service education.

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Shared Mobility in India-Bus and Share-rickshaw Combined System

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***Abstract*— Resource sharing has been a common feature in shared economies where customers in general are motivated by economic, environmental, and social considerations. In developing countries like India, loosely-organized sharing of transportation resources is quite common; shared mobility systems, such as "share auto", represent a convenient and cost-effective transportation option for low- to middle-income customers. We have specifically studied the performance characteristics of a system of shared taxi/rickshaws operating alongside public transport. In our study, we analyze arrivals occurring singly whereas service is delivered in bulk. Due to the complexities of analyzing bulk queues mathematically and numerically, we have run the analysis with simulation software. Based on simulation runs with Extend v6 software, we observe that in many situations, public bus transport is not able to cater to the needs of the travelling public and sharing arrangements introduced by private taxi/rickshaw operators take away the customers. Municipal authorities will do well to consider the bus-taxi/rickshaw combination by legalizing routes as being done already in some places like Mumbai.**

Keywords*— *Bulk Queues, Share-taxi, Sharing Economy, Simulation Modeling, Simulation Software.

I. INTRODUCTION

Resource sharing as a business model has been around for a long time. Sharing of library resources was attempted as far back as 1876 [1]. Today, library resources are readily available on the cloud via sophisticated networks (e.g. OCLC Research). Car sharing was practiced in Zurich as early as 1948 and became popular in Northern Europe in the 1980s through various schemes operated by small, not-for-profit cooperatives [2]. However, since information costs were high during the analogue age, such sharing efforts remained confined to small communities of users. Today, of course, ridesharing has formally developed and matured through digital platforms like those of Uber, Lyft, Ola etc. Customers in general are motivated by economic, environmental, and social considerations and sharing arrangements almost always result in lower cost to the consumer than the direct acquisition of a product or service. In developing countries like India, loosely-organized sharing of transportation resources is quite common; for example, some private auto-rickshaw ("rickshaw") drivers pick up multiple, unrelated passengers on the same trip, and also frequently compete with public transport (buses) in the process. Such "shared rickshaw" systems represent a convenient and cost-effective transportation option for low- to middle-income customers. The rickshaw driver, in turn, also gains by avoiding long trips outside his local area and the corresponding uncertainty that a return fare might not materialize. A report in [3] states that, out of around 1000 routes in Mumbai, only 295 are authorized; the other 70 % are illegal! While this loose practice is quite common in developing countries, it can even be found in the developed world (as observed by the first author) in taxi services in the New York City borough of Staten Island as well as in to-and-fro airport transfers in large cities like Houston). Our interest in this paper is to study the operational characteristics of a combined bus and taxi/rickshaw transportation system featuring implicit resource sharing between a private and a public transportation option.

II. LITERATURE REVIEW

We are specifically interested in studying the performance characteristics of a system of shared taxi/rickshaw operating alongside public transport. An appropriate methodology to analyze this system will be the "bulk service" queueing process. Bulk service queues have been studied over the past several decades and we describe some of those studies briefly. Bailey [4] introduced bulk service queueing models by considering fixed-size batches and derived the equilibrium distribution of queue length. Downton [5] obtained the waiting time distribution. Jaiswal [6] confirmed the result of Downton (ibid.) by deriving waiting time distribution using the embedded Markov-chain technique. He assumed that the batches were either of fixed length or whole queue, whichever was lower. Arora [7] analyzed the two-server bulk service queueing model. Ghare [8] generalized Arora's result to more than two servers. Cosmetatos [9] and Sim and Templeton [10, 11] considered the queueing system. Chaudhry and Templeton's book [12] provides a backdrop of bulk service queues, and Neuts [13] discusses a general class of bulk queues. Medhi [14] provides an analytical solution for the waiting time distribution.

III. RESEARCH METHODOLOGY

Due to the complexity encountered with queueing models in general and specifically bulk service queues, we observe a dearth of models that apply to our problem. In our study, we are dealing with arrivals occurring singly but service is delivered in bulk. Many transport services involving airplanes, trains, buses etc. have this common feature of bulk service. Also, the server (carrier, in our case) has a fixed maximum capacity B. We analyze bulk service queues with independent arrivals and FCFS queue discipline. In a single-arrival, single service situation, we normally study the distribution of number in the system. However, in a bulk service $\mathbf{M/G^b/1}$ system, it is more convenient to obtain the distribution of number in the queue which leads to the imbedded Markov chain and the waiting time distribution.

Generally, buses arrive at fixed intervals and pick up as many passengers as are waiting at that time or up to some maximum capacity. We are considering a situation where a bus and shared taxis/rickshaws operate in parallel and the queue is longer than the maximum capacity of the server (bus). When the queue forms for the bus, impatient customers will display reneging /balking behavior and join the queue for the taxi/rickshaw where the service is quicker with less waiting time. Based on a study of bulk service models available in the literature, we identified Medhi's paper [14] and Krishnamoorthy and Usha Kumari [16] as suitable models fitting to our problem. Queueing systems are complex as such and bulk service problems are more so. After considering theoretical solutions for basic models, we recognize the complexity and switch to simulation-based studies for bus-taxi/rickshaw combinations. In both the analyses, we calculate possible performance measures and discuss the results and conclusions.

IV. Analytical Modeling

Our case of bus and shared taxi/rickshaw system can be considered as an extension of a simple bus service operating with single arrivals and bulk service, a system described by Kendall's [15] notation $M/M^{a,b}/1$, $M/G^{a,b}/1$etc. and analyzed by Medhi [ibid.]. We initially discuss the operation of a bus within such a framework. The features of such a system are

- Server starts service only when a minimum number of units 'a' is present in the queue and the maximum service capacity is 'b'. In our case, we consider 'a' equal to 1 and 'b' is equal to the capacity of the bus/shared taxi/share-rickshaw – 50/8/3 respectively.
- If the server is free and if the number of units in the queue is 'a' or more but less than or equal to 'b', the entire queue is taken into service and if the queue length is greater than b, then 'b' units are taken into service while others wait in the queue. In our case, the server being free is indicated by being placed at the bus stop.
- Arrivals are Poisson and occur singly. Though the arrivals in our case are affected by bulk dispersal from an arriving train, we are initially assuming single arrivals as per Poisson as a simple approximation and exponential or general service times (system denoted by $M/M^{a,b}/1$).
- Arrivals are Poisson with parameter λ. Service time of a group of size (s| $a \leq s \leq b$) is assumed to have independent exponential distribution with mean $1/\mu$. Service time distribution is assumed to be independent of batch size.

V. Analytical Results

Following the model analyzed by Medhi [14], we represent our system as M/Ma, b/1, indicating – Poisson arrivals (exponential interarrival times), bulk service (following Neuts' general bulk service rule (GBSR) and number of servers one (bus, taxi, rickshaw as the case may be). In a bulk service system with arrival rate λ and mean service time $1/\mu$ and bulk capacity of say b, the occupation rate, ρ, is defined as $\lambda/b\mu$. To avoid queue eventually growing to infinity, ρ is generally required to be < 1. Queueing systems are analyzed with the help of a few performance measures, based on specific input parameters. Due to the complexity, a few measures are only considered after studying the inputs from various researches with bulk queues. Some of the relevant performance measures required for our models are - distribution of waiting time, distribution of number of customers in the queue, and distribution of busy period of server. We are interested in mean performance measures such as mean waiting time and mean number in queue, which represent the long run average waiting time, E (T) and long run average number of customers in the queue, E(W). One useful relationship between E (T) and E (W) is established by Little's formula. This formula has been verified by Medhi for bulk service situation also. The following discussion is based on Medhi [ibid.]. System in the state is designated as (0, q) which means the service channel is idle and that there are (q | $0 \leqslant q \leqslant$ a-1) units waiting in the queue. The system in the state (1, n) will mean that the service channel is busy and that there are n units waiting in the queue. We follow the results obtained by Medhi and work out a few performance measures in respect of distribution of waiting time, number of people in queue, and idle time.

An important particular case of the GBSR is obtained by taking a = 1. In this case the server operates as long as the number in the queue is more than 1, and takes in a batch b units or the number of units present in the queue whichever is less. As this is the rule usually considered for bulk service, this may be termed as usual bulk service rule (UBSR) and the system is denoted by M/M1, b/1. The steady –state probabilities for this case are obtained putting a=1 in relevant equations, derived by Medhi in the main model. Noting that does not occur, and substituting for P0, 0, we get the following results in the UBSR (a=1) case. Following the definition of p and solution of d, we derive the mean and variance of waiting time distribution.

$$E(T) = pd/\{\mu(pd + d - 1)(1 - d - b)\} \quad (1)$$

$$E(T^2) = 2pd/\{\mu^2(pd + d - 1)(1 - d - b)^2\} \quad (2)$$

It follows that

$$V(T) = pd(pd + 2fd - 2)/\{\mu(pd + d - 1)(1 - d - b)\}^2 \quad (3)$$

Further if b=1, we have d=1/p and from above we obtain the corresponding results for the simple queue M/M/1. Also as verified by Medhi, the relation $L = \lambda W$ holds even in this case of general bulk service rule. We then identify L_q, the number of persons in queue, as equal to λ *E (T).

VI. Specific Case Analysis

In crowded cities like Mumbai, public transport is found to be inadequate. Other private operators use these opportunities to operate their private vehicles for gain in such situations. This is a win-win situation for the private operators of Taxi/rickshaw as well as the customer who is looking for reasonably priced alternatives to public transport. For example, in Kharghar, a suburb of Navi

Mumbai, this situation is utilized by private taxi operators. The basic premise is that for the queue gathering at the bus stop (NMMT route 54) during peak hours, the bus transport organized by Navi Mumbai Municipal Transport undertaking (public transport) will not be able to service the crowd and some of the customers - who have lower waiting threshold and who can pay a little extra - will look for other transport arrangements. Here, we find share taxis (with capacity of 8) picking up the impatient passengers, charging Rs. 18($0.25) as against the bus fare of Rs.15 ($ 0.22). Currently, frequency of the bus (route no. 54) is one bus every 8 minutes and the bus gets filled in about 2 minutes and customer waiting time threshold is assumed to be 10 minutes. We first study the bus operation with the theoretical model of Medhi, as this will give us a good idea when we run the simulation model in ExtendSim v6 software [19]. ExtendSim software is from Imagine That Inc, of the USA.

Steady-state probabilities and waiting time estimates can be worked out properly only when $\lambda/b\mu < 1$. P1,n is the probability that the system is busy and there are n persons in the queue. This situation happens when the bus has arrived at the bus stop and people have started boarding the bus and is described as bus filling with passengers to capacity and n more persons waiting in the queue. From these P1, n, sum of probabilities of 1 to 10 persons waiting is calculated. On the other hand, is the probability that the bus service is idle and that there are no persons in the queue. These two probabilities indicate the state of the system regarding the number of persons waiting in the queue. These results are presented in table I.

From the above results, we observe that

- Theoretically, steady state is realized only if $\lambda/b\mu < 1$. However, d, an intermediate variable defined by Medhi, has been derived through application of Solver. Since optimal solution is not guaranteed in some non-linear problems, we applied the evolutionary solver approach available in Frontline Solver loaded in Excel. Due to this, we believe we are reporting suboptimal solutions arrived through evolutionary solver, in those cases also.
- We have been able to obtain the waiting time distributions from theoretical results which give us some idea of the real situation. From E (T), we observe that the mean waiting time is around 5 to 6 mins, well within the service time of 8 mins. However, the waiting times may vary from zero to 20, 22 mins, as indicated by the confidence limits (derived but not shown here).
- From $\sum$ P1, 1 to 10, we observe that number of persons waiting in the queue could be more than 50 (bus capacity) in 32 % to 50 % of the time. Average number of persons in queue (Lq) is also worked out with Little's formula and this ranges from 31 to 56 for different arrival rates ranging from 6 to 9 per minute.

Since higher arrival rates lead to violation of the steady-state conditions and any delay in bus arrivals can also lead to longer queues, we have considered alternative modeling with simulation.

TABLE I. EVALUATION OF KHARGHAR SITUATION AS PER MEDHI'S RESULTS

Parameters			
Bus capacity	50	50	50
λ-arrival rate/min.	6	8	9
$1/\mu$	8 mins.	8 mins.	8 mins.
$b\mu$-service rate/min	6.25	6.25	6.25
Steady-state($\lambda/b\mu < 1$)	Yes	No	No
$P_{0,0}$	0.347	0.255	0.222
$\sum P_{1,1 \text{ to } 10}$	0.320	0.417	0.457
E(T)/(exp w(t))	5.224	5.958	6.228
V(T)	56.293	59.829	60.859
σ (T)	7.503	7.735	7.801
$L_q = \lambda * E(T)$	31.343	47.661	56.049

We also consider reneging or balking in the queues when the waiting times for any impatient customer go beyond their threshold waiting time. Reneging and balking customers join a different queue to take the alternative service of share taxi or share rickshaw. Analysis of bulk service situations is very complex, as it is. A combination of bus and taxi/rickshaw makes the analysis more complicated. In this context, analysis through simulation modeling seems to be an appropriate alternative. We have used Extend simulation – academic edition v6, which is found suitable for our purposes.

Field trials were conducted in Kharghar, Navi Mumbai, where the passengers exiting from the railway station board the bus (No. 54) or take the shared taxi arrangement, if the bus is delayed for long or if the waiting time exceed their threshold. Due to almost similar costs of the bus trip and shared taxi trip, people exhibit reneging/balking behavior and switch from bus to shared taxi. Data were collected over four evenings during which the queue formation was studied and recorded for four 10-minute and two 20-minute slots. Based on the averages of these observations, average arrival rate/min and service times were calculated. For our analysis, we have simulated the model in Extend v6 software and simulated the system for 180 minutes and 1000 iterations and the results with different parameter inputs are tabulated in table II below.

We ran a similar analysis for a different location having a bus-rickshaw combination (Ghatkopar) leading to similar results - not presented here), Based on the above results at Kharghar (Navi Mumbai) and Ghatkopar (Mumbai), we conclude that the bus alone is not able to clear the passenger rush, if the arrival rate is higher, say 8 or 9 per minute.

The shared taxi/ rickshaw system operates well in such crowded but under-serviced situations. However, the sharing system is unregulated in many places. If the local municipal government is able to press more buses into service, the share taxi/rickshaw system may be curtailed by punitive action. But as long as the above does not happen, shared arrangements are likely to continue, albeit in an unauthorized fashion, and it will be better for local governments to regularize and control it from safety and security angles.

TABLE II. KHARGHAR SIMULATION RESULTS

Kharghar Simulation	Bus			Bus + Shared	
	1st Trial	*2nd Trial*	*3rd Trial*	*1st Trial*	*2nd Trial*
Arrival Rate (Poisson) λ/min =	5/	8/	9/	5/	8/
Bus Capacity	50	50	50	50	50
Bus Frequency	8 min.	8 min.	8 min.	8 min.	8 min.
Service Rate (fixed) μ/min =	6.25/	6.25/	6.25/	6.25/	6.25/
Reneging (type of stack)	10 min.	10 min.	10 min	10 min	10 min
Max. queue length	100	100	100	100	100
Results and Outputs (Stack 1)					
no. of items	938	1405	1639	921	1427
Reneging/balking (exit)	0	233	429/18	0	263
Utilisation	0.782	0.963	0.961	0.7699	0.955
Average queue length	16.27	53.51	68.18	16.03	54.25
Average wait (minutes)	3.09	6.99	7.7	3.15	6.97
Max. length	49	96	100	54	100
Max. wait	7.99 min	10 min.	10 min	8.51 min	10 min
Taxi					
Taxi capacity				10	10
Taxi Frequency				3 min	3 min
Service Rate (ST – fixed) μ/min =				3.33/	3.33/
Reneging (type of stack)				5 min	5 min
Max. queue length				50	50
Results and Outputs (Stack 2)					
No. of items				0	263
Reneges (exit)				0	13
Utilisation				0	0.351
Average queue length				0	2.66
Average wait				0	1.82
Max. length				0	27
Max. wait				0	5

VII. LIMITATION AND FUTURE SCOPE

Our study is just the first step in analyzing a complex phenomenon like the bus-taxi/rickshaw combination. While we face the problem of complexity in analytical modeling, we have been able to model the system with simulation modeling in Extend software. We can study different extensions following same methodology of analytical modeling (with possible models in literature) and if required with simulation modeling. We have done some preliminary analysis with the analytical model proposed by Krishnamoorthy and Ushakumari (2000) [16] and are hopeful of deriving useful results. Van Eenige (1996) [17] researched various solution techniques for obtaining solutions in case of queues with periodic service like fixed-cycle traffic lights. We feel that our bulk queue model can be approximated by a similar model. A possible extension is by considering bulk *arrivals*, e.g. when there is a sudden influx of passengers disembarking and emerging from a train station. A bulk arrival/bulk service model like the one studied by Kumar and Shinde (2018) [18] will be useful for such an extension. In all the above suggested extensions, we will be able to study the combined systems through simulation with Extend or any other simulation software.

VIII. CONCLUSION

In this paper we have proposed the application of the bulk service queueing methodology to study the share-taxi/rickshaw-Bus system encountered as part of the sharing economy in many developing countries. In view of the complexities involved in the analysis, we have used simulation modeling and derived the results. Local governments there are grappling with the question of whether to formalize the informal shared taxi/rickshaw system already operating alongside public transportation. We feel that our analysis and similar studies could provide the necessary analytical support to formulate appropriate government policies for social interventions. Preliminary results from our study indicate that the results could be reasonably interpreted and suitable models could be implemented for improving social policy measures.

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Predicting Telecommunication Customer Churn using Machine Learning Techniques

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***Abstract*—Customer churn is a major problem and one of the most important concerns for large businesses. Due to the direct effect on the profits of the companies, especially in the telecommunication area, companies are looking for ways to develop means to predict potential customers which may churn. Therefore, looking for factors that increase customer churn is important to take necessary actions to reduce this retention. The main contribution of our work is to develop a churn prediction model which assists telecommunication businesses to predict customers who are most to leave after a certain period of time. The model developed in this work uses machine learning techniques on big data platform and builds a new way of feature selection. In order to measure the performance of the model, the area under curve (AUC) standard measure is adopted, and the AUC value obtained is 84%. The model was prepared and tested through python environment by working on a large data-set that was found at www.kaggle.com. The model experimented four algorithms: logistic regression, random forest, support vector machines and extreme gradient boosting "XGBOOST". However, the best results were obtained by applying random forest algorithm at a 80% accuracy.**

I. Introduction

Customer churn is the percentages of customers that has stopped using a company's product during a certain period of time. It is calculated by dividing the number of customers a business loses at the end of the period by the number of customers a business had in the beginning of the time frame. Customer churn is one of the most important factors for a growing business to evaluate. This is the number that can give a company direction and insights [1].

Customer churn has always been a major problem and one of the biggest concerns for large businesses. Due to the direct effect it has on the profits of a company, more especially in a telecommunication area, companies have went out to look for ways to develop a system that would help to predict which customers were most likely to leave. Since the telecommunication field is a very competitive area, many competitors within the industries, have resorted in finding ways to keep clients. Studies have shown that it is more costly to get new clients that to keep the existing ones [1].

We proposed a predictive approached where a large telecommunication data is used to develop models which are capable of predicting, classifying and explaining the customer churn problem. We used telecommunication customer churn data from www.kaggle.com for this particular study. Machine learning techniques such as support vector machines, random forests and logistic regression and XGBoost classifier were used to give better results due to their strong classification nature. We used confusion matrix as well as the area under the curve to evaluate our results.

In this study, we would like to find out which customers are most likely to churn? Can we predict which factors affect the customer churn? Can we predict which customers should get automated renewals before their contracts expire? What impact does customer churn have on the business? Can we identify the features that has the greatest impact on the customer churn rate?

There has been several attempts to predict customer churn using large company data. Hung (2006), He (2009), Huang (2015) and Brandusoiu (2016) gave the best results with the highest accuracy showing that the four predictive models which are support vector machines , random forests and logistic regression and XGBoost classifier are the best to use in order to get the best results. Hung (2006) used data from a wireless company, meanwhile He (2009) used data of 5.23 Million customers. Huang (2015) used data from the operations support and business support department of a telecommunication company. Brandusoiu (2016) used data-sets for call details of 3333 customers from a company.

In this study we used the Cross Industry Standard Process for Data Mining which follows the following six-step process [17]:

- Understanding the domain and developing the goal for the research;
- Identifying, assessing and understanding the relevant data sources;
- Pre-processing, cleaning, and transforming relevant data;
- Developing methods using comparable analytic techniques;
- Evaluating and assessing the validity and the utility of the models against each other; and
- Deploying the models for use in decision making process.

This favoured methodology gives a systematic and structured way of conducting data mining studies and thus enlarge the possibility of acquiring accurate and authentic results.

This study will make contributions through the body of literature by:

- Identifying which customers are most likely to churn.
- Knowing which factors to look out for with regards to customer churn.
- Knowing which customers to give immediate attention to to avoid customer churn.
- Identifying which features has a great impact on the customer churn rate.

The rest of the report is arranged in this sequence. The next section is the related work which will be followed by the research methodology. Then in section 5, we have discussion and results. The last section will present the conclusion and future work.

II. Related Work

In this section, we see the work that the other authors have done which may give light to our study. Understanding predictor variables that affects customer churn is crucial. We will see the data that was used, the models which the authors opted for, the accuracy of those models and how the models were evaluated.

A. Features

Some of these authors have similarities in their studies. He (2009) and Zhang (2012) used a large and feature rich for their study. He (2009) considered 5.23 million customers of a large Chinese telecommunication company. Zhang (2012) used experimental data from a leading service provider and compromise more than 1 million customers. Huang (2012) considered data of 827 124 customers that were randomly selected from a real world database provided by the telecommunications in Ireland. Buckinx (2005) considered retailing data-sets of 158 884 customers.

Sharma (2011) and Brandusoiu (2016) used voice calls data. Sharma (2011) considered churn data-set from the UCI Repository of ML databases at the University of California Irvine. The churn data-set deals with cellular service providers and the data pertinent to voice calls they make. Brandusoiu (2016) considered the data-set for call details of 3333 customers with 21 features, and a dependent churn parameter with values: yes/no. Huang (2015) used departmental data. Huang (2015) considered the operation support department and business support department in China's largest telecommunication company.The rest of the other authors used data from institutional data bases. Hung (2006) considered data from a wireless telecommunication company and Coussement (2008) considered the subscriber data-set of an institution.

B. Models

There is a limited number of models that can be used in Machine Learning. Some of these models give the best results while some give poor results. We see that a lot of authors used the most popular models. Artificial neural networks were used by almost all the authors. Buckinx (2005), Coussement (2008), Huang (2012) and Huang (2015) used the random forests. Buckinx (2005) and Coussement (2008) also used the logistic regression.

Huang (2012) considered a number of predictive models including, Bayes Naves, decision trees, linear classifiers as well as support vector machines. Hung (2006), He (2009), Sharma (2011), Zhang (2012) and Brandusoiu (2016) used the artificial neural networks. Huang (2006) also used decision trees and K means clustering meanwhile Zhang (2012) considered logistic regression and decision trees. Brandusoiu (2016) also used the support vector machines and the Bayes network. We see that the artificial neural networks gave the best results.

C. Accuracy

The models that were used gave the results, from poor to rich results. We see that Hung (2006), He (2009), Sharma (2011), Huang (2015), and Brandusoiu (2016) gave the best results with the highest accuracy showing that the two predictive methods which are the artificial neural network random forests are the best to use in order to get best results. We see that the random forests and artificial neural networks have a tough competition. Sometimes the support vector machines give the highest accuracy followed by the decision trees and visa versa. We have also seen that the logistic regression are greatly used. The Bayes networks, clustering and Bayes Naive were overpowered by the other models.

The highest accuracy in the algorithm is the reason why we choose to work with random forests and artificial networks. Due to the logistic regression being the mostly used classification techniques, which has its roots in traditional statistics, we have decided to used this technique to see what results it will give.

D. Evaluation Functions

Taking the results of the data mining models without any evaluation processes can be risky and lead to wrong decision making [7]. Different authors use different evaluation for the performance of the model. We see that the confusion matrix was one of the most used evaluation tool. Huang (2012) used the confusion matrix, receiver operating characteristic curve (ROC) and the area under the ROC curve (AUC). Sharma (2011) and He (2009) only considered the confusion matrix. Brandusoiu (2016), Coussement (2008) and Huang (2015) considered AUC to measure the performance of the algorithm. Hung (2006) considered top-decile lift and hit ratio. Buckinx (2005) used the classification accuracy and the area under the curve (AUC). Zhang (2012) used top-decile lift, AUC and hit ratio.

III. Research Methodology

This study will be using the Cross Industry Standard Process for Data Mining (CRISP-DM) which follows the following six-step process [17]:

- Understanding the domain and developing the goal for the research;
- Identifying, assessing and understanding the relevant data sources;
- Pre-processing, cleaning, and transforming relevant data;
- Developing methods using comparable analytic techniques;
- Evaluating and assessing the validity and the utility of the models against each other; and
- Deploying the models for use in decision making process.

This favoured methodology gives a systematic and structured way of conducting data mining studies and thus enlarge the possibility of acquiring accurate and authentic results. The fact that we start by understanding the domain followed by understanding the data and preparing the data this positions the study to be a prosperous data mining study. In this study we will use the 10-fold cross-validation approach to estimate the performance of the prediction models. We set the k into 10 since studies show that 10 appears to be an optimal number of folds [11].

A. Step-by-step processes for the study

We started by getting the raw data from the IBM telecommunication data-set available from www.kaggle.com then processed the data to get pre-processed data. We then applied designs of experiment to get to the experimental design where we had 10-fold cross-validation. We did model testing by applying confusion matrix and the area under the curve (AUC). From the experimental design we had model building using our prediction models.

B. Data description

We used the IBM telecommunication data-set available from www.kaggle.com. The raw data contained 7043 rows (customers) and 21 columns (features) [10]. Each row represents a customer, each column contains customer's attributes described on the column Metadata.

The data-set was divided into the following categories:

- Customers who left within the last month – the column is called Churn.
- Services that each customer has signed up for – phone, multiple lines, internet, online security, online backup, device protection, tech support, and streaming TV and movies.
- Customer account information – how long they have been a customer, contract, payment method, paperless billing, monthly charges, and total charges.
- Demographic info about customers – gender, age range, and if they have partners and dependents.

The "churn" column was the target variable. The classification goal was to predict whether the customer will churn.

1) Attributes:

- customerID: Customer ID
- gender: Whether the customer is a male or a female
- SeniorCitizen: Whether the customer is a senior citizen or not (1, 0)
- Partner: Whether the customer has a partner or not (Yes, No)
- Dependents: Whether the customer has dependents or not (Yes, No)
- tenure: Number of months the customer has stayed with the company
- PhoneService: Whether the customer has a phone service or not (Yes, No)
- MultipleLines: Whether the customer has multiple lines or not (Yes, No, No phone service)
- InternetService: Customer's internet service provider (DSL, Fiber optic, No)
- OnlineSecurity: Whether the customer has online security or not (Yes, No, No internet service)
- OnlineBackup: Whether the customer has online backup or not (Yes, No, No internet service)
- DeviceProtection: Whether the customer has device protection or not (Yes, No, No internet service)
- TechSupport: Whether the customer has tech support or not (Yes, No, No internet service)
- StreamingTV: Whether the customer has streaming TV or not (Yes, No, No internet service)
- StreamingMovies: Whether the customer has streaming movies or not (Yes, No, No internet service)
- Contract: The contract term of the customer (Month-to-month, One year, Two year)
- PaperlessBilling: Whether the customer has paperless billing or not (Yes, No)
- PaymentMethod: The customer's payment method (Electronic check, Mailed check, Bank transfer (automatic), Credit card (automatic))
- MonthlyCharges: The amount charged to the customer monthly
- TotalCharges: The total amount charged to the customer
- Churn: Whether the customer churned or not (Yes or No)

C. Data Pre-processing

This section will diligently talk about the data pre-processing. Data pre-processing is the step before applying data mining algorithm where the original data is transformed into a suitable shape to be used by a particular mining algorithm. Data pre-processing includes different tasks as data cleaning, feature selection and data transformation. [16].

1) Data Cleaning: Data cleaning is one of the most important pre-processing tasks, which is applied on this data set to remove irrelevant items and missing values.

Firstly, we got rid of columns that are unnecessary. The customerID column was removed because it did not add any more value to the model or the analysis of the problem since it is just an ID for the customer. With the one column removed, we were left with 7,043 rows and 20 columns as the new data-set.

We then converted all non-numeric columns or categorical columns to numerical columns.

2) Feature Selection: Feature selection is a fundamental task in data pre-processing area. This is also an important task done under data pre-processing. The objective of feature selection process is to select an appropriate subset of features which can perfectly describe the input data, reduces the dimensionality of feature space, removes unnecessary and irrelevant data [9].

This process can play an important role in improving the data quality therefore the performance of the learning algorithm. Feature selection methods are categorized into wrapper-based and filter-based methods. Filter method is searching for the minimum set of relevant features while ignoring the rest. It uses variable ranking techniques to rank the features where the highly ranked features are selected and applied to the learning algorithm. Different feature ranking techniques have been proposed for feature evaluations such as information gain and gain ratio [9].

In this study, we applied filter-method using information gain based selection algorithm to evaluate the feature ranks, checking which features are most important to build customer churn model. During feature selection, each feature assigned a rank value according to their influence on data classification. The highly ranked features are selected while others are excluded. Total charge feature got the higher rank, then followed by tenure, monthly charges, contract (month-to-month) and online security features. As we can see the appropriate subset of features consist of five features while other ones are excluded. In summary, the features that are related customer account information have an greater impact on the customer churn.

D. Predictive Models

In this study, four popular classification methods— (support vector machines, random forests classifier, XGBoost classifier and logistic regression) are built and compared to each other making use of their predictive accuracy on the given data samples.

A sizeable number of studies compare predictive methods. Most of these previous studies found machine learning methods (i.e support vector machines and random forests) to be superior to their statistical equivalent (i.e logistic regression) in terms of both being less constrained by assumptions and producing better prediction results. From the literature that was reviewed, Hung (2006), He (2009), Sharma (2011), Huang (2015), and Brandusoiu (2016) gave the best results with the highest accuracy showing that the two predictive methods which are the artificial neural network and random forests are the best to use in order to get best results. We used logistic regression, random forests classifiers and the support vector machines as informed by the literature. We decided to add XGBoost classifier because it is an efficient and easy to use algorithm which delivers high performance and accuracy as compared to other algorithms.

1) Logistic Regression: Logistic regression is the mostly used classification techniques, which has its roots in traditional statistics. The concept of the logistic regression is to examine the linear relation between the dependent variable and the independent variable. The dependent variable may be binomial or multi-nomial [19]. Logistic regression is a predictive analysis.

Logistic regression is used to describe data. Some of the advantages of using this method include: logistic regression is one of the simplest machine learning algorithms and is very much easy to use and implement yet provides great training efficiency in some cases. This algorithm proves to be very efficient when the data-set has features that can be separated linearly. The algorithm allows models to easily update to reflect new data, unlike the decision trees or support vector machines. The logistic regression algorithm can easily be extended to multi-class classification using a soft max classifier [14].

Some of the disadvantages of using logistic regression includes: it is difficult to see complex relationships using logistic regression. Only important features should be used to build a model otherwise the probabilistic predictions made by the model may be incorrect and this may end in one getting incorrect predictive values. The algorithm is sensitive to outliers hence the presence of data values that deviate from the expected range in the data-set may lead to incorrect results. logistic regression requires a large data-set, it does not really work well with small data-sets [14].

2) Random Forests Classifier: Random forests are an ensemble learning method for classification, regression and other tasks that operate by constructing a multitude of decision trees at training time and outputting the class that is the mode of the classes or mean prediction of the individual trees [6]. Random forests correct for decision trees' habit of over-fitting to their training set [8] .

Some of the advantages of using this method include: random forest can automatically take care of missing values. The algorithm is powerful in handling outliers. A random forest algorithm is very stable. Non linear parameters don't affect how the a random forest performs unlike any other algorithms. Random forests works well with both categorical and continuous data. The algorithm also reduces over-fitting and the variance which therefore improves the accuracy of the model [12]. Some of the disadvantages of using this method include: random forests creates a lot of trees and combines their outputs. This algorithm requires much more computational power and resources. Random forest require a

lot of time to train and makes decision based on the majority [12].

3) Support Vector Machines: Support Vector Machines (SVM) are a technique which is good for both classification and regression problems but mainly preferred for classification problems. Inputs are evaluated according to where they sit in the hyper-plane in the feature space and projected to a (0,1) interval which can be interpreted as possibilities of class membership. The projection is a major component of the algorithm. SVM's represents the best line as the one which has the maximum margin. The maximum margin classification has an additional benefit. Only the closest data points to the line have to be remembered to be able to specify the model and be able to classify all points. These data points are called support vectors [5].

The advantages of support vector machines are: It is effective in high dimensional spaces. Still effective in cases where number of dimensions is greater than the number of samples. Uses a subset of training points in the decision function (called *support vectors*), so it is also memory efficient.

Versatile: different kernel functions can be specified for the decision function. Common kernels are provided, but it is also possible to specify custom kernels. The disadvantages of support vector machines include: If the number of features is much greater than the number of samples, avoid over-fitting in choosing kernel functions and regularization term is crucial. SVM's do not directly provide probability estimates, these are calculated using an expensive five-fold cross-validation.

4) XGBoost Classifier: XGBoost is an optimized disbursed gradient boosting library designed to be quite efficient, bendy and portable. It implements machine learning algorithms under the gradient boosting framework. XGBoost provides a parallel tree boosting which helps solve many data science problems very fast and in an accurate manner.

XGBoost is a good algorithm. It works well with most types of data. The algorithm works well on small data, data with subgroups, big data, and complicated data. It does not work so well on sparse data. However, it tends to do better than most supervised learning algorithms on those types of data problems. This algorithm is efficient in handling missing data. XGBoost is an easy to use algorithm which deliverers high performance and accuracy compared to other algorithms. The biggest limitation is probably it's black box nature. It does not give effect sizes. One would need to derive and program that part yourself.

E. Evaluation

When using machine learning algorithms we need to test to see if the identified models work. We propose to use the confusion matrix also known as an error matrix [18], which is a specific table layout that permits visualization of the performance of an algorithm, typically a supervised learning one. Each row of the matrix represents the instances in a predicted class while each column represents the instances in an actual class (or vice versa) [15].

IV. Results and Discussion

A. Interpretation of Results

In this section we show graphics of the data that was used. We see the results directly from the data and how it is affected from customer churn. About 5,174 customers did not churn and 1,869 customers left the company. We then showed this count visually.

The below visuals gave us an idea of which feature has an effect on customer churn and which one does not. They also show that customers who have not signed up for certain things are most likely to churn. Those that did not have an effect on the customer churn included: gender, dependents, partner, phone services, multiple lines, streaming TV, payment method and senior citizen.

Meanwhile the customers that did not sign up for the following: online security, online backup, device protection, tech support and paperless billing are most likely to churn. Customers who signed up for fibre optics are most likely to churn, about 50% have churned. Customers without internet service have a low rate of churn.

Contracts have a great impact on customer churn. The month-to-month contract had the most customer churn. Not churned customers have a longer average tenure of about 20 months than churned customers. Churned customers paid over 20% higher on average monthly fees than not churned. Churned customers paid more than not charged.

The following graphs are derived directly from the data.

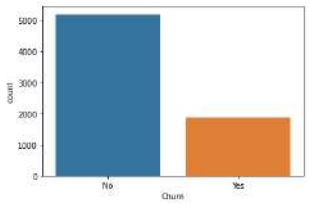

Figure 1: Visual count of customer churn

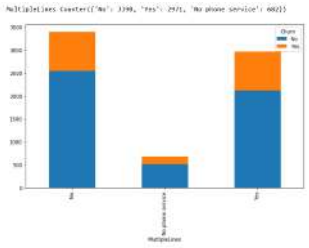

Figure 2: Plot for the Multiple Lines

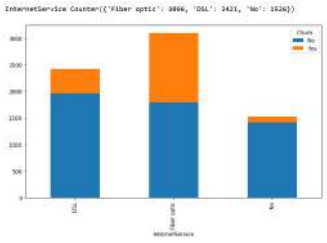

Figure 3: Plot for the Internet Service

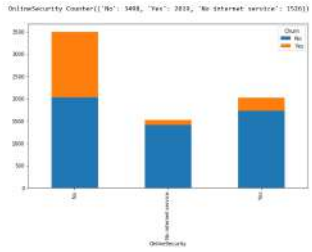

Figure 4: Plot for the Online Security

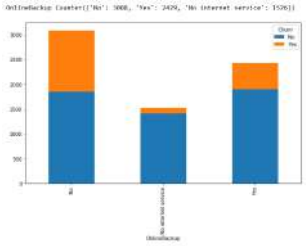

Figure 5: Plot for the Online Backup

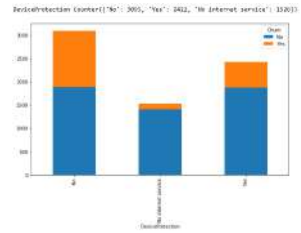

Figure 6: Plot for the Device Protection

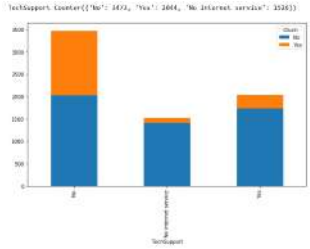

Figure 7: Plot for Tech Support

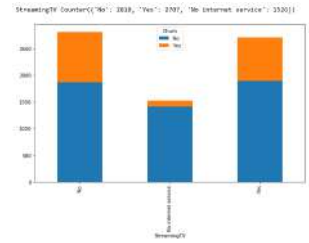

Figure 8: Plot for Streaming TV

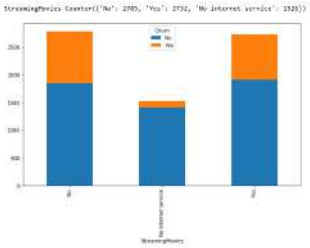

Figure 9: Plot for Streaming Movies

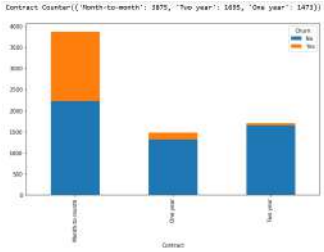

Figure 10: Plot for Contracts

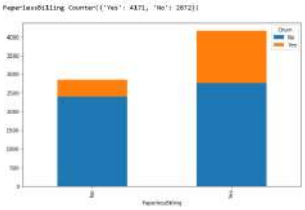

Figure 11: Plot for Paperless Billing

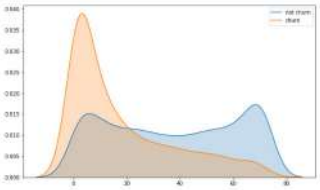

Figure 12: Plot for Tenure

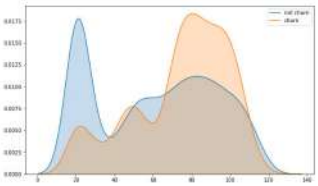

Figure 13: Plot for Monthly Charges

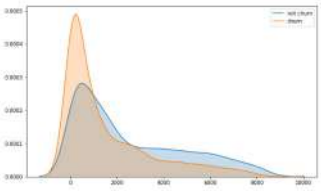

Figure 14: Plot for Total Charges

B. Evaluation Measures

In our study, we use four common different measures for the evaluation of the classification quality: Accuracy, Precision, Recall and F-Measure [15], [3]. We also used the AUC-ROC curve which is a performance measurement for classification

problem. ROC is a probability curve and AUC represents degree of disconnectedness. It tells how much model is capable of distinguishing between classes.

Accuracy is the proportion of the total number of predictions where correctly calculated.

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

Precision is the ratio of the correctly classified cases to the total number of misclassified cases and correctly classified cases.

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

Recall is the ratio of correctly classified cases to the total number of unclassified cases and correctly classified cases.

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

In addition, we used the F-measure to combine the recall and precision which is considered a good indicator of the relationship between them [3].

$$F - Measure = 2\frac{Precisionc * Recallc}{Precisionc + Recallc}$$

C. Evaluation Results

There are many features directly or indirectly affecting the effectiveness of the customer churn model. In this section, we evaluated the impact of customer churn using different classification techniques such as (logistic regression, random forests, support vector machines and XGBoost classifiers).

1.Logistic Regression

Accuracy:	73.80%
Precision Score:	49.94%
Recall Score:	74.33%
F1 score:	59.91%

Confusion Matrix: $\begin{bmatrix} 1146 & 400 \\ 142 & 419 \end{bmatrix}$

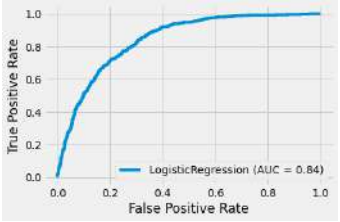

Figure 15: AUC for Logistic Regression Churn Customer.

2.Random Forests Classifier

Accuracy:	80.17%
Precision Score:	65.71%
Recall Score:	49.73%
F1 score:	56.81%

Confusion Matrix: $\begin{bmatrix} 1413 & 193 \\ 277 & 279 \end{bmatrix}$

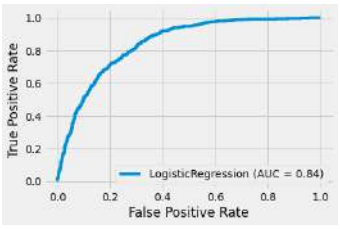

Figure 16: AUC for Random Forest Churn Customer.

3.Support Vector Machine

Accuracy:	79.82%
Precision Score:	67.89%
Recall Score:	45.11%
F1 score:	53.97%

Confusion Matrix: $\begin{bmatrix} 1436 & 130 \\ 308 & 288 \end{bmatrix}$

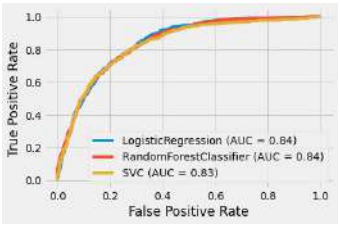

Figure 17: AUC For LR, RFC, and SVC.

4.XGBoost Classifier

Accuracy:	78.98%
Precision Score:	61.83%
Recall Score:	50.54%
F1 score:	55.63%

Confusion Matrix: $\begin{bmatrix} 1383 & 178 \\ 275 & 289 \end{bmatrix}$

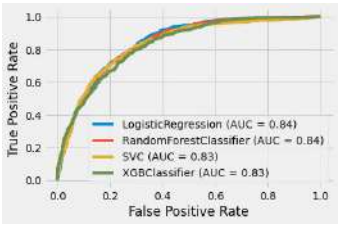

Figure 18: AUC For LR, RFC, SVC and XGBoost.

The table below gives an overview of how each model performed.

	Logistic Regression	Random Forests	Support Vector Machine	XGBoost
Accuracy	73.80%	80.17%	79.82%	78.98%
Precision	49.94%	65.71%	67.89%	61.83%
Recall	74.33%	49.73%	45.11%	50.54%
f1-score	59.91%	56.81%	53.97%	55.63%
AUC	0.84	0.84	0.83	0.83

Out of all the algorithm, the random forests gave out the more accurate results with an accuracy of 80.17%. This proves that for a classification problem, random forests is the best model to use. Seeing that the random forests gave the highest accuracy, this agrees with the literature that was reviewed.

V. Conclusion

Customer churn is a major problem and one of the most important concerns for large businesses. Due to the direct effect on the profits of the companies, especially in the telecommunication area, companies are looking for ways to develop means to predict potential customers which may churn. Therefore, looking for factors that increase customer churn is important to take necessary actions to reduce this retention.

In this study, we proposed a predictive approached where a large telecommunication data is used to develop models which are capable of predicting, classifying and explaining the customer churn problem. We used telecommunication customer churn data from www.kaggle.com for this particular study. Machine learning techniques such as support vector machines, random forests and logistic regression and XGBoost classifier were used.

In addition, we applied ensemble methods to improve the performance of these classifiers. The obtained results reveal which features to look out for when dealing with customer churn. The results gave the accuracy of 80.17% for random forests, 79.82% for support vector machines, 78.98% for XGBoost and 73.80% for the logistic regression with the AUC of 84%. As expected, the random forest outperformed the other predictive models.

The current methodology of the churn prediction can be tested for other sectors/fields like banking, airline, insurance through comparison for prediction accuracy. This customer churn model can be tested on a very large data, larger than the current.

Acknowledgment

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Implementation of Obstacle Avoidance-An Aspect of Automated Load Carrier for Industry 4.0 Plant

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***Abstract*—In modern day, it is of utmost importance to develop and build autonomous vehicles. Robotics offers a dependable and cost-effective solution supporting fast changing agile manufacturing. Their intelligent and fully autonomous, mixed fleet of AGVs reliably move materials between production cells, whether on the plant floor or warehouse. These processes are executed safely and with great precision including 24/7 IIoT monitoring. The roadmap to such autonomous vehicles, begins right from the development of an obstacle avoiding robot. Proximity sensors are used to sense obstacle distances without any physical contact. In our project, we have used an Ultrasonic Distance Sensor (HC SR04) to serve this purpose. The position of this sensor is controlled by a micro-servo motor. Arduino Uno R3 has been used as a microcontroller which serves as the brain of the entire circuit. According to the data received by the microcontroller from the sensor, a decision is taken accordingly, as programmed. After this, the motor driver receives signal and controls the motion of the DC gear motors. This is how the motion of this robot is controlled.**

An Obstacle Avoiding Robot finds its huge application in the modern-day industries, military vehicles, and many more. These types of robots have a built-in intelligence in it, which allows it to take decisions independently, according to the situation.

This report explains the designing, direction and speed control, various advantages and disadvantages, applications and the entire making of an Obstacle Avoiding Robot. The robot is also equipped with some unique features.

Keywords—Obstacle Avoiding Robot, Automated Load Carrier, Industry 4.0

I. INTRODUCTION

Automation is the present decade's revolution through which the modern industries are undergoing. It not only assures lean in production, but also agility. It gave rise to robotics. Robotics is a term which always comes to our mind whenever there is a need for a cost-effective solution with a high precision.

A Robot is a machine capable of carrying out a complex series of actions automatically; especially one programmable by a computer and Robotics is the branch of technology that deals with the design, construction, operation, and application of robots. Obstacle avoidance refers to the ability to detect obstacles along the way if there are any and thus make suitable adjustments and create an obstacle-free path. Understanding how this mechanism works is a step towards the development of autonomous vehicles, which is arguably the future of transport.

AGVs form the backbone of Industry 4.0 to facilitate easy and fast material transportation on the production floor to meet the daily fluctuating demands of the market. Also, smart-networking and smart-sensing makes the industries proactive.

The need for such a robot is immense. For example, it might not always be possible for humans to visit every place, especially places which possess health hazards to humans. We can deploy such a robot in these places and monitor the information that it sends back from a safe distance. As the robot is programmed to avoid obstacles and create its path around the obstruction, one does not need to worry about it getting stuck.

The goal of this project is to develop a robot that will move in a straight line, continuously looking for obstacles in its path and navigating away from them. This kind of obstacle avoidance is extremely useful in industries as well, where automated supervision is needed. This robot can also be equipped with other sensors, like light sensors or line sensors, depending on the need.

This project deals with the designing and making of an obstacle avoiding robot that can detect an obstacle and adjust its course automatically. This project helped us learn and understand in detail about the working principles of various hardware such as the Ultrasonic Distance Sensor, Arduino Uno, Motor Driver, etc.

II. LITERATURE REVIEW

The integration of three ultrasonic distance sensors provides higher accuracy in detecting surrounding obstacles [1]. IR transmitters can also be used as an obstacle distance sensor, since it continuously generates an Infrared signal of 38KHz, and when an obstacle comes in the path, the infrared signal gets reflected back [2]. One of the works also has a unique feature of dynamic steering algorithm in which the robot does not have to stop before any obstacle, as it diverts its direction without stopping itself [3]. In [4], the robot was made remote controlled using an IR receiver and a remote controller. Also, obstacle sensing was achieved by a combination of infrared and ultrasonic sensor modules which were placed at the front side of the robot.

We observe in [5] that in future, cameras can also be used to detect obstacles. Infrared (IR) and Passive Infrared (PIR) sensors sense a signal while avoiding obstacles in its path,

and thus can also be used [6]. A study in [7] tells that an ultrasonic sensor is most suitable for obstacle detection and it is of low cost with a capability of high range. Also, the robot can be made app controlled by connecting to a Bluetooth Module. An interesting research in [8] describes the working and making of an Autonomous Mobile Robot which moves to the north direction and keeps on avoiding the unexpected obstacles which come in its path. This is achieved by using a digital compass HMC5883L along with an Ultrasonic Sensor.

III. Familiarization with some basic components

A. Arduino

Arduino is a popular programmable board used to create projects. It consists of a simple hardware platform as well as a free source code editor, which makes coding very easy. Arduino was released in 2005 by students from the Interaction Design Institute Ivrea (IDII) as a modest tool for Mac OSX and Windows. Since then, Arduino has been able to initiate an international-do-it yourself revolution in the electronics industry. The open-source microcontroller hardware has been designed in a way that it can easily interface with various sensors (registering user inputs) and driving the behaviors and responses of the external components such as speakers, motors, and LED (responding to the user inputs). Due to its open-source environment, one can write and upload codes to the I/O board without any hassle. It is worth noting that Arduino can run on Linux, Mac OSX, as well as Windows, as the environment is based on Java.

In this project, we are going to use Arduino Uno R3. This model has 6 Analog Input pins, 14 Digital pins, out of which 6 are PWM pins.

Figure 1: Arduino UNO R3

B. Ultrasonic Sensor (HC-SR04)

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves and converts the reflected sound into an electrical signal. The very first technological application of ultrasound was an attempt to detect submarines by Paul Langevin in 1917. The piezoelectric effect, discovered by Jacques and Pierre Curie in 1880, was useful in transducers to generate and detect ultrasonic waves in air and water. Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has traveled to and from the target). This particular model of the ultrasonic sensor has a range of 2cm – 400 cm and emits sound waves of frequency 40 kHz.

For calculating the distance between the sensor and the obstacle, the sensor measures the time taken by the sound wave to travel from the transmitter to the obstacle, get reflected by the obstacle, and then return to the receiver. The formula for this calculation is **D = ½ T x C** (where D is the distance, T is the time taken for the sound to travel to and from, and C is the speed of sound ~ 343 meters/second). For example, if a scientist set up an ultrasonic sensor aimed at a box and it took 0.025 seconds for the sound to bounce back, the distance between the ultrasonic sensor and the box would be: **D = 0.5 x 0.025 x 343** *(in meters)*

Figure 2: Ultrasonic Sensor

C. Motor Driver (L298N)

The L298N is an integrated monolithic circuit. It is a high voltage, a high current dual full-bridge driver. It is designed in a way to accept standard TTL (Transistor-Transistor) logic levels and drive inductive loads such as relays, solenoids, DC motors, and stepping motors. The two enable inputs provided helps us to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected, and the corresponding external terminal is used for the connection of an external sensing resistor. An additional supply input is provided so that the logic can work at a lower voltage.

The L289N has a high operating voltage of about 5-35 Volts. It has an instantaneous peak current up to 2A with a 25W rated output power. It also comes with a high-capacity filter capacitor and a freewheeling diode that protects the devices in the circuit from being damaged by the reverse current of an inductive load, enhancing reliability.

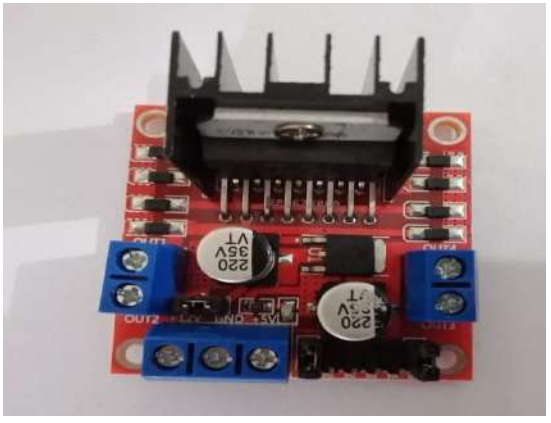

Figure 3: Motor Driver

D. Micro Servo Motor

A servo motor is a rotary actuator that allows for precise control in terms of the angular position, acceleration, and velocity. It makes use of a regular motor and pairs it with a sensor for position feedback. A Servo Motor is a closed-loop servomechanism. The input to its control is a signal (either analog or digital) representing the position commanded for the output shaft. These signals are then processed, and suitable adjustments are made according to the given instructions.

The very basic type of servo motors can correct its position by sensing via a potentiometer and bang-bang control of the motor. Further, the motor always rotates at full speed. Though this type of servomotor doesn't have many uses in industrial motion control, it, however, forms the basis of easy to use and cheap servos, used for radio control models.

Servo motors also find uses in optical rotary encoders to measure the speed of output shaft and a variable-speed drive to control the motor speed. Servos, when combined with a PID control algorithm, allows the servomotor to be in its command position more quickly and more precisely with less overshooting.

Figure 4: Servo Motor

E. DC Gear Motor

A DC motor is an electrical machine that converts electrical energy into mechanical energy. The working of a DC motor follows the principle of a current-carrying conductor placed in a magnetic field, experiences a mechanical force. The direction of this force is calculated using Fleming's Left-Hand Rule, and its magnitude is given by F = BIL (*in newton*).

DC motors are seldom used in ordinary applications because all-electric supply companies furnish alternating current. However, for special applications such as in steel mills, mines, and Electric Trains, it is advantageous to convert alternating current into direct current for using dc motors. The reason is that the speed/torque characteristics of DC motors are much more superior to that of AC motors.

Figure 5: DC Gear Motor

IV. Circuit Diagram

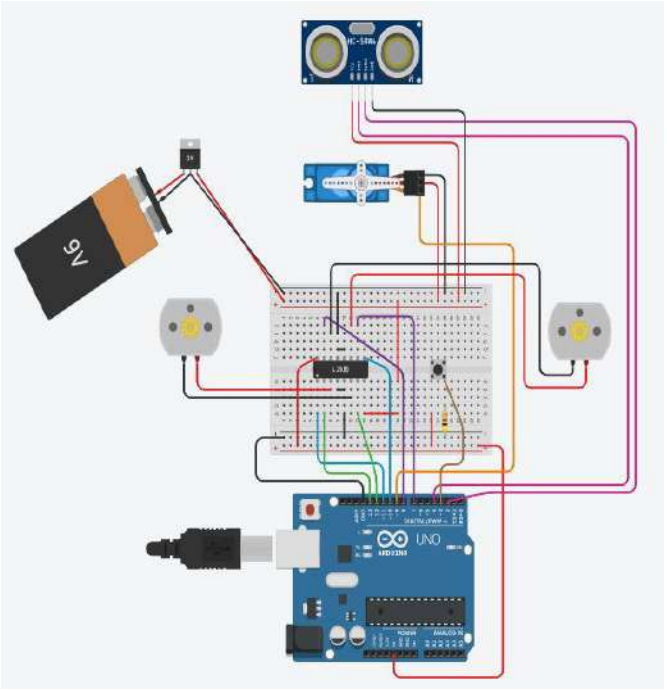

Figure 6: Circuit Diagram

v. Salient features

- It keeps on avoiding obstacles that may come in its path.
- An Ultrasonic Distance Sensor (HC SR04) is used to sense the obstacle distance.
- This sensor is attached to a servo motor. As a result of which, the sensor is capable of sensing the obstacle distance on the front, left and right as well.
- The robot has three wheels, two at the back and one at the front. The two at the back control the entire motion of the robot, whereas the front wheel is just for the sake of balancing.
- It turns only in that direction where the obstacle is at a larger distance.

- Our robot has a unique feature. If by chance, it enters some tunnel like a thing, which is blocked from inside and there is an inadequate space to take a turn, it will simply start moving in the reverse direction and come out of that tunnel without getting stuck.

VI. Working Principle

Our robot works on the principle of a closed loop control system. In this system, a feedback of the work done is taken through a sensor. The reading of the sensor is known as the **process variable (PV)**. The desired final output, which is initially set in the controller, is known as the **set-point (SP)**. The difference between the set-point and the process variable is known as **error**. According to this error, the **controller** gives a signal to the **actuator**. After receiving the signal, the actuator works accordingly to bring a change in the **plant** (i.e., system). Again, the sensor takes feedback and the entire process repeats until the desired final output is accomplished.

In our project, we have used an **ultrasonic distance sensor** (HC SR04). This sensor is used to sense the obstacle distance. It is capable of rotating about a mean position because of its attachment to a **servo motor**. The position of this servo motor is controlled according to the signal given by the microcontroller. The mean position of the servo motor is taken as 90 degree. At this position, the sensor faces in the front direction. To face towards left, the servo motor is rotated to 180 degree, and to face towards right, the servo motor is rotated to 0 degree.

Here, the microcontroller used is **Arduino Uno R3**. It can be programmed to serve our purpose. To drive the robot, two **DC Motors** are used. These DC motors are connected with the help of an **L298N DC Motor Driver**. This motor driver is used to facilitate the speed and direction control of both the DC motors simultaneously.

The entire circuit is turned on or off by a **pushbutton**.

The sensor triggers an ultrasonic wave. This wave is then received by it after getting reflected from an obstacle. With a particular set of algorithms, the total time taken by the wave to come back is calculated. This time is then further used to calculate the obstacle distance. If the obstacle distance is greater than 10 cm, the robot will keep on moving in forward direction. Otherwise, the robot will stop instantly to prevent any collision. Now, we all know that even if we turn off the motor, the inertia will cause it to move and collide with the obstacle. To prevent this, we came up with a solution. We created a reverse motion of the motor for a period of 1 second. Thereafter, the motor will turn off. At this moment, the servo motor turns at 180 degree. This causes the sensor to turn towards the left and likewise measures the obstacle distance. Then the servo motor turns at 0 degree to facilitate the sensor to turn towards right. In a similar fashion, the obstacle distance on the right side is measured. After this, a comparison work goes on in the microcontroller. If both the distances are less than 15 cm, there is a chance that the robot may get stuck while taking a turn. To prevent this, the robot will simply start moving backwards for 2 seconds. After this, the motor will turn off and once again it will measure the obstacle distance on the right and on the left. In the similar fashion, it will compare the value and check if it is suitable to take a turn. This continues unless and until there is a sufficient space to take a turn. In case the obstacle distance on the right side is more than 15 cm and greater than or equal to that on the left side, the robot will take a right turn. However, if the obstacle distance on the left side is more than 15 cm and greater than that on the right side, the robot takes a left turn.

To let the robot move in front direction, both the motors have to be kept in forward motion. For taking a right turn, the left motor needs to be in forward motion, whereas the right motor needs to be in reverse motion. Similarly, for taking a left turn, the right motor needs to be in forward motion, whereas the left motor has to be in reverse motion.

A forward motion of the motor is created when the **enable pin** is supplied high voltage, **input pin 1** is also supplied high voltage (i.e., 5V), and the **input pin 2** is supplied low voltage (i.e., 0V). For reverse motion, the only difference is that the **input pin 1** is supplied low voltage (i.e., 0V) and the **input pin 2** is supplied high voltage (i.e., 5V). To control the rotational speed, the enable pin has to be connected to one of the **PWM** (Pulse Width Modulation) pins of the Arduino. Then instead of supplying high voltage, we can supply an intermediate voltage to control the speed accordingly.

Figure 7: Final Prototype

VII. Procedure

The entire circuit is initially made and simulated in ***TINKERCAD***. Only for the simulation purpose, we have used **L293D DC Motor Driver** instead of L298N DC Motor Driver. The reason being that L298N DC Motor Driver is unavailable in TINKERCAD. The actual prototype has to be made after the simulation runs perfectly.

STEP 1: -

L293D DC Motor Driver is selected and placed on a breadboard, along with two DC motors. Then connections are made with Arduino Uno R3 as follows: -

i. Enable 1 & 2 → 11 (PWM pin)
ii. Input 1 → 13 (Digital pin)
iii. Input 2 → 12 (Digital pin)
iv. Output 1 → Goes to Motor A (Left Motor)
v. Output 2 → Goes to Motor A (Left Motor)
vi. Enable 3 & 4 → 10 (PWM pin)
vii. Input 3 → 7 (Digital pin)
viii. Input 4 → 8 (Digital pin)
ix. Output 3 → Goes to Motor B (Right Motor)
x. Output 4 → Goes to Motor B (Right Motor)
xi. Ground → Ground Connection (common ground)
xii. Power 1 → 5V supply
xiii. Power 2 → 9V/12V supply (regulated by a 5 Volt LM7805 Regulator)

STEP 2: -
A Pushbutton is selected and placed on the breadboard. Terminal 1a is connected to the 5V supply, whereas Terminal 2a is connected to pin 3 of Arduino. Terminal 2a is also connected to ground with a 1 kilo Ohm resistor.

STEP 3: -
A Micro Servo is selected. It has three pins: Signal, Power and Ground. Signal is connected to pin 9 (PWM pin), Power is connected to the 5 Volt supply, and Ground is connected to the ground terminal. Its position is dictated by the signal it receives from Arduino.

STEP 4: -
An Ultrasonic Distance Sensor (HC SR04) is selected. It has four pins: VCC, Trig, Echo and GND. The connections are made as follows: -

i. VCC → 5 Volt supply
ii. Trig → 4 (Digital pin)
iii. Echo → 2 (Digital pin)
iv. GND → Ground connection

STEP 5: -
The code is written in the Arduino Integrated Development Environment (IDE), and then uploaded to the microcontroller (i.e., Arduino Uno R3) through USB.

Now, on pressing the pushbutton, the robot turns on.

VIII. Conclusion

Obstacle avoidance is the very first step towards autonomous transportation. Automated Load Carriers navigate dynamic manufacturing environments and configurations, making it easy for the systems to be rerouted and to meet production coordination, material flow without added cost, disruption or safety concerns.

This type of robots can be implemented in the mining operations where humans can not enter in the small spacings. It can also facilitate the modernization of the military vehicles. Its unmanned feature also allows it to be inducted in the nuclear power plants to sense the level of radiation.

IX. Future Scope

This project can be further enhanced. One more sensor can be added at the back of the robot. This will cause the entire system to also keep in mind the obstacle distance at the rear side. So, if suddenly, an obstacle comes at the backside while the robot is already in reverse motion, then instead of colliding, it will stop right at that point unless and until there is a passage for it to come out.

Also, obstacle avoidance can be clubbed together with the line-following robotic system, for an improved industrial application.

The performance of this robot can be further improved by placing multiple ultrasonic distance sensors on the front side, which are at different orientations. An ultrasonic distance sensor provides a genuine reading only when the object is almost perpendicular to the sound waves emitted, but practically this condition is not achieved all the time. So multiple sensors placed at different orientations would provide more reliable reading.

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Performance Enhancement of Micro Channel Heat Sink Using Cu-Nanofluid-A Numerical Study

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***Abstract*— Recent advancement in the electronics and manufacturing technology make it possible to miniaturize the electronic components. In this progress one of the major challenges faced by the engineers is the effective cooling system design. In this research work, the performance of a combined microchannel heat sink with nanofluids as the next generation cooling devices for removing high heat flux has been studied. A numerical study by Finite Volume Method has been carried out for three cases having different geometry fluid flow and thermal boundary condition to compare the performance of liquid cooled microchannel heat sink with and without Cu nano particle in water as the base fluid. Friction factor and thermal resistance are considered as the performance parameters. It has been observed that Cu-nanofluid augmented the heat transfer and the performance of the water-cooled microchannel heat sink.**

Keywords— ***Microchannel, Heat Sink, Numerical study, Nanofluid***

I. INTRODUCTION

Among different types of thermal devices, microchannel heat sinks have received noticeable attention in the recent years [1]. Recently, microchannel heat sinks are employed in important industries such as microelectronics, aerospace, and so on. Based on the definition presented by Kandlikar and Grande [2], channels with hydraulic diameter between 10 μm and 200 μm can be called microchannel. Many scholars have carried out experimental, theoretical, and numerical studies on microchannel heat sinks by considering significant parameters such as heat transfer rate and pressure drop [3]. Tuckerman and Pease [4] were pioneers in the investigation of forced convection in microchannel heat sinks. There are two causes that limit the performance of micro heat sinks: fluid flow needs greater pressure drop across the channel, and the rate of heat transfer is limited by the heat transfer fluid employed. Therefore, applying innovative geometries and using fluids with excellent thermal features can improve efficiency of the micro heat sinks. Many efforts have been made for modifying configuration of microchannels in order to enhance the performance of these devices. Leela Vinodhan and Rajan [5] evaluated flow and heat transfer in four microchannel heat sink configurations. The microchannel heat sinks consisted of four compartments with separate coolant inlet and outlet ducts for each part. Nusselt number and heat transfer rates are greater as a result of large portion is of developing region. Moreover, at a constant pumping power, thermal resistance was examined for different designs. Ramos-Alvarado et al. [6] studied the thermal performance of liquid-cooled heat sinks with conventional and novel microchannel flow field configurations. Details of the thermal efficiency, particularly the uniformity of temperature distribution on the solid surface and pumping power for the relevant heat sinks were determined.

The heat transfer characteristics are limited by the flowing fluids that are employed in micro heat sinks. The recent development of nanotechnology has resulted in the concept of using solid nanoparticles in ordinary liquids to enhance the heat transfer attributes of the base fluids [7]. These suspensions are termed as nanofluids, which possess excellent thermal properties according to many studies carried out in this area [8]. Many researchers have investigated the performance of nanofluids in different devices, some of which have evaluated application of nanofluids in micro heat sinks [9]. Bahiraei and Heshmatian [10] examined hydrothermal attributes of a biological nanofluid in a liquid block heat sink for cooling of an electronic processor. The liquid block possessed 20 channels, and its bottom surface was attached with a processor. By increase of Reynolds number and particle concentration, temperature distribution became more uniform in processor surface and heat transfer coefficient enhanced also. Moreover, the surface temperature reduced with increase in the concentration and Reynolds number. Al-Rashed et al. [11] assessed the effect of nanofluids on the performance of a micro heat sink for CPU cooling experimentally and numerically. For the range of mass flow rate and heat load values under study (115 and 130 W), thermal enhancement was obtained up to 7.7% in the case of using nanofluids rather than water. Sarafraz et al. [12] investigated the heat transfer efficacy of a cooling liquid block heat sink operating with gallium. The CPU employed during this work was researched at three situations of standby, normal and overload working modes. The results revealed that gallium was the more efficient fluid than the nanofluid and water supported convective thermal efficiency, however, the many penalty for pressure drop and pumping power occurred with the utilization of gallium. The CuO water nanofluid, demonstrated a better thermal efficiency than the water, while had less pressure drop and pumping power compared with the gallium.

Though much work has been done on the study of water based nanofluids, the results are not consistent and rather highly conflicting in few cases. So, more research in this area is required. Therefore, in the present study a numerical simulation using Finite Volume Method has been done on

three different cases in terms of geometry, thermal and fluid flow boundary conditions on a microchannel fitted over a heat source. Performance of the heat sink in terms of thermal resistance and friction factor is compared for water-based Cu nanofluid and pure water in each of the three cases.

II. NUMERICAL ANALYSIS

A. Physical description of the model

The microchannel heat sink of rectangular cross section as shown in Fig 1 is of our interest of study for three different cases as mentioned in Table 1We have taken the dimensions according to the experimental conditions of Tuckerman [4].

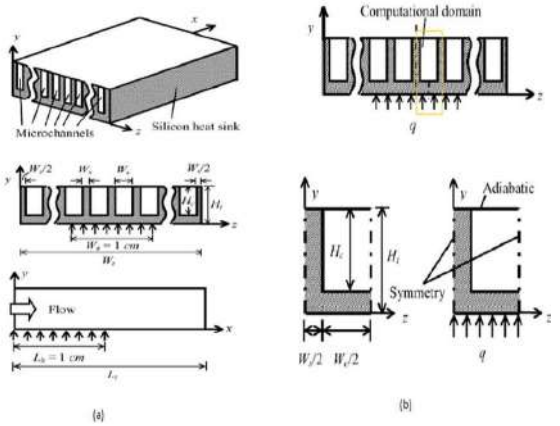

Fig 1. Geometry of microchannel heat sink (a) microchannels and flow direction (b) Computational domain

TABLE I. GEOMETRICAL, HEAT AND FLUID FLOW SPECIFICATIONS OF THREE MICROCHANNEL HEAT SINKS

Parameters	CASE I	CASE II	CASE III
$L_t(cm)$	2	2	1.4
$W_t(cm)$	1.5	1.5	2
$W_c(micron)$	64	64	56
$W_s(micron)$	36	36	44
$H_t(micron)$	489	489	533
$H_c(micron)$	280	280	320
$Q^a(cm^2/s)$	1.86	1.277	4.7
$Q(W/cm^2)$	34.6	34.6	181
Number of channels	150	150	200

The nanofluid under investigation is a water-based copper nanoparticle. The reason for using this nanofluid is that copper nanoparticles have excellent thermal conductivities, and the conducted studies have reported that nanofluids containing these nanoparticles result in superior thermal characteristics in comparison with other nanofluids. Indeed, it is possible to reach a high rate of cooling with low concentrations of nanoparticles. Low concentration does not increase viscosity of nanofluids so much and therefore, pumping power remains at a rational value.

B. Governing equations

We have used FLUENT 16 software to analyze the models. The governing equations to describe the fluid flow and heat transfer phenomena are continuity, momentum and energy equation. The mentioned equations are solved to get the velocity, pressure and temperature field. We have considered 3-D, laminar and steady flow models.

C. Thermophysical properties of nanofluid

By applying the principle of mass conservation to the two species in finite control volume of the nanofluids, the nanofluid density was obtained from the relation:

$$\rho_{nf=}\varphi\rho_{np} + (1-\varphi) \quad (1)$$

By applying the principle of calorimetry in the mixture the overall specific heat of the nanofluid was calculated from the relation:

$$C_{nf=}\frac{\varphi(\rho C)_{np} + (1-\varphi)(\rho C)_w}{\varphi(\rho)_{np} + (1-\varphi)(\rho)_w} \quad (2)$$

The equation of Sharma et al. was used for the estimation of viscosity and thermal conductivity for water based nanofluid. The following equations are applicable for spherical shaped particles of diameter 20-150nm, temperature between 20-70ºC and volume concentration less than 4.0%.

$$\mu_{nf} = \mu_w(1+\phi)^{11.3}\left(1+\frac{T_{nf}}{70}\right)^{-0.038} \times \left(1+\frac{d_{np}}{150}\right)^{-0.061} \quad (3)$$

$$k_{nf} = 0.8938k_w(1+\phi)^{1.37}\left(1+\frac{T_{nf}}{70}\right)^{0.2777} \times \left(1+\frac{d_{np}}{150}\right)^{-0.0336}\left(\frac{\alpha_{np}}{\alpha_w}\right)^{0.01737} \quad (4)$$

D. Boundary Conditions

At inlet, outlet and wall boundary conditions are chosen according to the information of Tuckerman Experiment [4] as follows.

TABLE II. INLET BOUNDARY CONDITIONS

Inlet	CASE I	CASE II	CASE III
Velocity inlet	0.069 m/s	0.475 m/s	1.371 m/s
Temperature of inlet liquid	293K	293K	293K

At outlet zero-gauge pressure is employed in all the cases.

TABLE III. WALL BOUNDARY CONDITIONS

Wall	CASE I	CASE II	CASE III
Side walls	Adiabatic	Adiabatic	Adiabatic
Top wall	Adiabatic	Adiabatic	Adiabatic
Bottom wall	34.6 W/cm2	34.6 W/cm2	181 W/cm2

E. Meshing and model setup

The mesh of the computational domain was generated using a triangular patch conforming method. This mesh contains mixed cells (Tetra and Hexahedral cells) having both triangular and quadrilateral faces at the boundaries. Care is taken to use structured hexahedral cells as much as possible. The generated mesh consisted of 13,975 elements and 33,672 nodes.

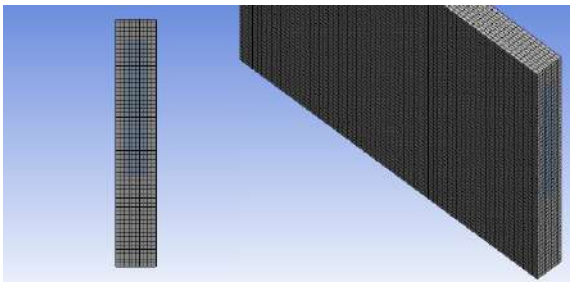

Fig 2: Model of meshed microchannel in ANSYS mesh modeler

A 3-D, incompressible and pressure-based solver was chosen for the computational domain. A 2nd order upwind interpolation formula was used for discretization of momentum and energy equation. The conventional SIMPLE (Semi-Implicit Method for Pressure-Linked Equations) algorithm was used to solve the pressure velocity coupled equations, where several iterations were performed to ensure convergence. Convergence of the numerical solution was assured by monitoring the scaled residuals to a constant level of 10-6 for each variable.

F. Convergence and Grid-independency

The solution obtained in this work is mesh independent. 4×10^{-5}.

III. RESULTS AND DISCUSSIONS

A. Simulation work

This is clear from the solution of the numerical analysis that addition of Cu nanofluid is definitely decreasing the thermal resistance in all three cases as shown in Fig 3a, 3b and 3c. Therefore, heat dissipation capacity of the heat sink would be enhanced.

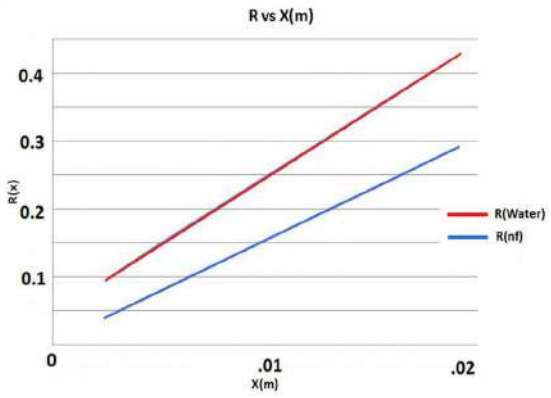

Fig 3a: Thermal resistance comparison of Case I

On the other hand, pressure drop characteristic measured in terms of friction factor has been increased in Cu nanofluid in comparison to pure water in all the cases observed as shown in Fig 4a, 4b and 4c. But the increase of pressure drop is not very significant.

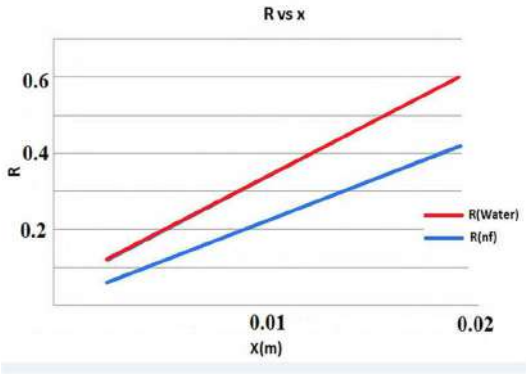

Fig 3b: Thermal resistance comparison of Case II

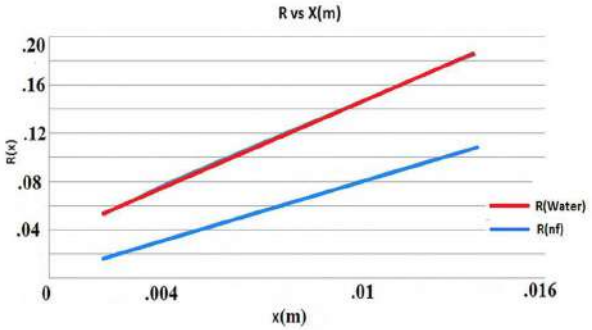

Fig 3c: Thermal resistance comparison of Case III

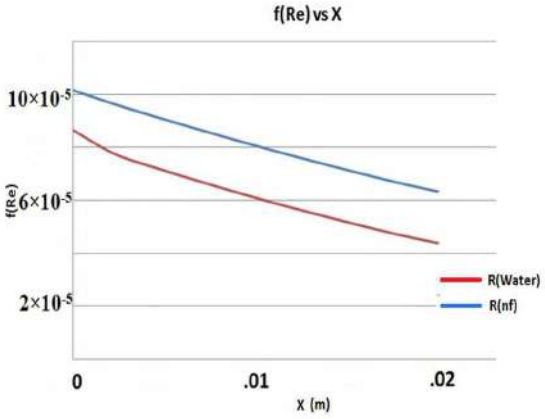

Fig 4a: Friction factor comparison of Case I

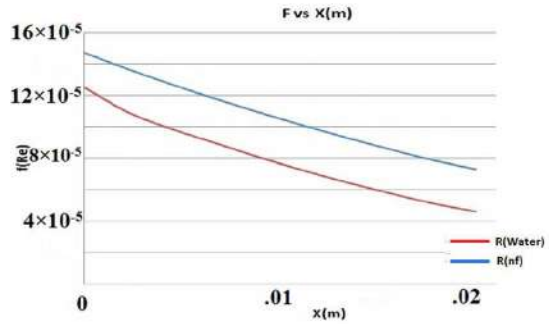

Fig 4b: Friction factor comparison of Case II

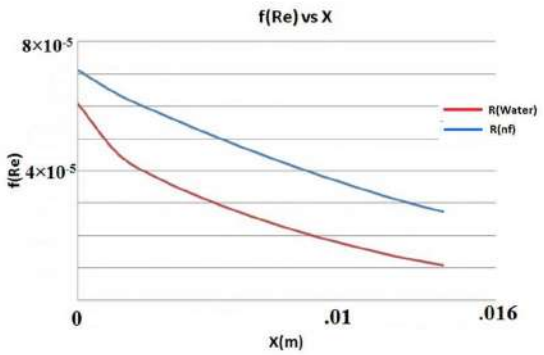

Fig 4c: Friction factor comparison of Case III

B. Experimental validation of the model

Validation is done to check the authenticity of the CFD tool that we are working on. We have validated the model by comparing the results of thermal resistance value with the available experiment done by Tuckerman [4].

Resistance R(x) is defined as R(x)=(Tmax-Tmin)/q

Resistance R(x=0.9cm)	**Case I**	**Case II**	**CaseIII**
Tuckeman's experiment	0.280	0.277	0.11
Our simulation result	0.23	0.31	0.13
Error	17%	12%	18%

IV. CONCLUSIONS

We can conclude that the thermal resistance of the liquid cooled microchannel heat sink is reduced by using Cu-H2O nanofluid with a very little sacrifice of increased pressure drop. In this analysis 4% Cu nanofluid is taken as stabilizing larger volume fraction of the nanofluid is very challenging and chances of pressure drop will also increase. Overall performance of the microchannel heat sink will be improved by employing Cu nanofluid as heat dissipating fluid.

ACKNOWLEDGMENT

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Optimization Of High Density Polyethylene (HDPE) Reactor Using Artificial Intelligence

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***Abstract*— In present study, specific artificial intelligence based modelling techniques, along with nature inspired optimisation algorithms are utilised to model and optimise commercial high density polyethylene (HDPE) plants. Polyethylene is considered the most versatile plastic product with diverse applications in manufacturing products like plastic bottles, milk packets, buckets, cars, suitcases, etc. Commercial HDPE plants need to produce different grades of plastic as per market demand and profit margin. During grade changeover, lots of polymer gets wasted as they don't conform to quality specs as they are produced during transition from one grade to another. Process parameters of HDPE reactors like temperature, pressure, ethylene flow, catalyst flow, ethylene to hydrogen ratio, etc. need to be adjusted to produce specific grade. As MFI is the most important quality parameter of the final polymer product, plant engineers target a particular MFI to produce a particular grade of polymer. In this study, two AI based modelling techniques, namely Artificial Neural Network (ANN) and Genetic Programming (GP) have been used to model MFI from reactor process parameter data. Historically, 3-years of commercial plant data has been used to develop MFI models. Two modifications were made to both ANN and GP on their basic algorithms to make them suitable to model complex chemical reactors. These modifications ensure that the developed model contains underlying physics and reaction kinetics and not only represents a data-driven blackbox. These modifications accomodate large amounts of industrial data along with their transmitter and process noise and inaccuracies. Commercial plant data and polymer plant operation experience has been utilised to identify the input parameters and train the models. The developed model was found to be very accurate (mean square error less than 1%) at coefficient of determination (R2 = 0.98). Once an adequate and reliable MFI equation is developed, in the next step, genetic algorithm was used to optimise reactor process parameters to achieve target MFI. Usually, MFI is measured by lab analysis which takes 4-6 hours, based on which, production engineers adjust the operating parameters to regulate the MFI. The current model helps the production engineer to get MFI value in real time without waiting for lab analysis. The second advantage of this model is that it recommends, in real-time basis, to the production engineer, the value of the process parameters to be kept in the reactor to achieve the target MFI. This model can be deployed in a plant control system (DCS) to indicate MFI of HDPE product in real-time basis. It also recommends the optimal reactor parameters which helps the production engineer to take corrective and preventive action to avoid losses from off-spec polymer products during grade changeover. This real-time application is an excellent example where artificial intelligence and metaheuristic optimisations are applied on commercial polymer plants to increase huge amounts of profit without any investment. The hybrid modelling and optimisation strategies developed in this work are generic and can be extended to any other chemical process and industry where first principle based models don't exist.**

Keywords — Optimization; Melt Flow Index; Artificial Intelligence; Artificial Neural Networks; Genetic Algorithm; High-density polyethylene, Soft Sensor

I. INTRODUCTION

In our daily life, the usage of plastic in its various shapes and sizes has become inevitable. The number of commercial plants for polymer production is increasing rapidly to meet the demand for plastic consumption. We start our day using plastics in the form of a toothbrush, water bottles, etc, and at the end of the day lose count of the number of diverse forms of polymer we come across.

Unfortunately, in most of the polymer industries around the globe, plants are run based on experience only due to the non-availability of a reliable phenomenological model. The plant operator changes the value of operating parameters based on experience which often doesn't lead to the most

optimum conditions for production. This results in the production of undesirable products, which eventually adds up to the waste generated resulting in huge losses for the industry.

The operators working in commercial High Density Polyethylene (HDPE) plants face one such major problem. In the process of producing HDPE polymer, Melt Flow Index (MFI) is the most important quality parameter of the final product. Usually, this is measured using a specially designed MFI apparatus in the laboratory. The lab analysis for calculating the MFI of a polymer takes 4-6 hours for a certain range of temperature. Based on the results, the production engineers change the operating parameters to regulate the MFI. The major drawbacks of the lab analysis are it is highly time-consuming and it only takes temperature as the variable eliminating the weightage of other variables that can be controlling the value of MFI.

Due to poor understanding of the polymer formation mechanism inside HDPE reactor, a credible first principle-based model that can be deployed in a commercial plant is not available in literature. Moreover, polymer formation, multiphase catalytic reaction kinetics are very complex and not fully understood. So first principle-based phenomenological model development of industrial HDPE reactors is considered a very time consuming and arduous task. However, HDPE reactor parameters have a great influence on the final MFI of the polymer product. So, in industry, it is necessary to develop a model that will relate the MFI of a product with HDPE reactor operating parameters. If this model is available, then the production engineer can accurately predict the MFI and quickly optimize the reactor parameters during grade changeover. There is a lot of reactor operating parameter data, MFI laboratory data available in the industry where developing a phenomenological model of a commercial HDPE reactor is difficult. In the present work, it is explored to develop a data-driven AI model from the actual data of industry. Artificial Neural Network (ANN) is a proven established data-driven model and applied in various engineering branches and applications successfully. ANN modeling has been known as "effortless computation" and is readily used extensively because of its model-free approximation capabilities of complex decision making processes [1]. For example, ANN is applied to model industrial ethylene oxide reactors successfully. On the other hand, Genetic Programming (GP) is a biologically inspired machine learning method that evolves computer programs to perform a task [2]. GP is used for symbolic regression and, when using industrial data, the evolved models are shown to have better or comparable accuracy to alternative nonlinear modeling approaches such as neural networks [3].

After building the MFI model using two different AI-based modeling techniques, the results were compared. A non-traditional optimization method was applied to optimize the best MFI model and find the optimal reactor parameters for a specific value of MFI. Non-traditional search and optimization methods are found to have a better global perspective than the traditional methods [4][5].

II. AI-BASED MODELING OF MFI

The following steps were followed to build the model of MFI in ANN and GP techniques respectively. The best model obtained was used to optimize the reactor parameters for a fixed value of MFI.

1. Identifying input and output parameters for model building. Since in the present study, we want to predict MFI, laboratory measurement of MFI along with timestamps is put as an output. Plant production engineers, domain experts are consulted about the reactor parameters which affect/impact product MFI to shortlist the input parameters. Once these parameters are shortlisted based on domain expert's experience, a cross-correlation coefficient method is applied to finally shortlist the input parameters. The operating parameters which have a higher correlation coefficient with the MFI are finally selected as the input parameter to develop the model. 8 such parameters and their range are given in table 1.

2. After selection of the eight input variables, the industrial data was cleaned using various mathematical techniques. The data points that are not in consistency with the majority of data are called outliers. Outlier detection and removing them from a data set is very critical for model development because if not detected outliers have a negative effect on the performance of the final soft sensor model [6].

3. The next step involves developing the ANN and GP model. Both the models are tested using a separate dataset which data points were not fed into the programs while training the models. During the model building phase, the performance of the individual model can be judged by unseen validation data [7][8].

4. After developing the MFI model both in ANN and GP methods, model accuracy for each method was examined and the best model was chosen for the optimization process. The mean squared error (MSE), which measures the average square distance between the predicted and the corrected value,is the most popular performance evaluation technique for the models [9].

5. In the last step, genetic algorithm (GA) was used as an optimization technique. GA has been applied to a variety of optimization problems in engineering and science and more recently it has extended to data mining and machine learning applications and the rapidly growing bioinformatics area [9].

The details of all the input variables considered are given in the table.

TABLE I. NAME OF INPUT VARIABLES

Input variable	Name of input variable	Units	Range	
			Min	***Max***
X_1	Hydrogen concentration	Mol percent	4.06	5.3
X_2	Vent pressure	bar	23.61	25.41

X_3	Ethylene concentration	Mol percent	21.34	26.29
X_4	Catalyst flow	Metric ton/hr	3.46	10.08
X_5	H2 to feed flow ratio	Dimensionless	0.18	0.48
X_6	Reactor gas density	Kg/m3	347.79	419.5
X_7	Hydrogen flow	Metric ton/hr	4.13	11.62
X_8	Butane to ethylene ratio	Dimensionless	0.13	0.29

A. Building the MFI model using Genetic Programming (GP)

One of the most important applications of genetic programming is in generating input-output empirical models in process system engineering (PSE) applications [10].

To develop the MFI model based on Genetic algorithm, the training and test dataset is divided. In this work, 80 ± 5% of the total data has been taken as a training dataset and the remaining dataset was fed into the program as a test dataset. The dataset is chosen randomly. This step is comparatively time-consuming as the two different dataset needs to be fed manually. After each run, the value of R^2 for training and testing data is received along with an equation with the best accuracy. The value of the input variables in the test dataset is then put in the equation to find the value of the predicted MFI. The error percentage is calculated for the MFI value. The program is rerun several times and the best model is chosen. The best model gives the highest value of R^2 and the least error percentage.

B. Building the MFI model using ANN modeling method

Neural networks are computer algorithms inspired by the way information is processed in the nervous system. An important difference between neural networks and standard regression is their ability to learn. An ANN paradigm is composed of several highly interconnected processing elements, analogous to biological neurons that are tied together with weighted connections analogous to synapses [11].

Training a network consists of an iterative process in which the network is given the desired inputs along with the correct outputs for those inputs. It then seeks to alter its weights to try and produce the correct output (within a reasonable error margin). If it succeeds, it has learned the training set and is ready to perform on previously unseen data. If it fails to produce the correct output it rereads the input and again tries to produce the correct output. The weights are slightly adjusted during each iteration through the training set (known as a training cycle) until the appropriate weights have been established. Depending upon the complexity of the task to be learned, many thousands of training cycles may be needed for the network to correctly identify the training set. Once the output is correct the weights can be used with the same network on unseen data to examine how well it performs [9].

MATLAB was used to build and train the ANN model for this project. The software has a feature called Neural Network Toolbox which is equipped to generate Artificial Neural Networks with custom specifications for training the model set by the user.
On being provided with a set of input and corresponding output data in the form of a matrix, the tool divides up the data into training, test, and validation sets. In the case of this study, the data was divided into the following composition-

Training – 70%
Test – 15%
Validation – 15%

The number of hidden layers was provided and the training was done by the Levenberg-Marquardt method.

After a large number of trials and errors, by changing the number of nodes and training multiple models, multiple times, a satisfying value was reached for R2 and percentage error.This particular ANN model was selected for further testing and comparison against the model mode using Genetic programming.

III. RESULTS AND OBSERVATION

For MFI using GP, the best model, performance metrics for the model and the error percentage was calculated. The least percentage error has been calculated for the test set which is 3.8%.

Error %=((actual MFI value- predicted MFI value)/actual MFI value)*100 (1)

Overall model for calculating MFI:

$$y = 0.00353x_2\text{^}2 - 1.52x_2x_5 + 96.75\text{^}2 - (3.58x_3x_5\text{^}3)/x_4 + (5.41e15x_3x_4\text{^}2x_5)/(2.31e18x_4 - 2.31e18x_7) + (1.1e\text{-}4x_3x_4x_5)/(x_4 - 1.0\,x_7)\text{^}2 + 2.28 \quad (2)$$

The following tables show the results obtained for the genetic programming model.

TABLE II. PARAMETERS FOR EVALUATING MODEL PERFORMANCE

Parameters	Training Data	Test Data
R2	0.94	0.98
RMSE	0.21	0.23
MAE	0.07	0.11
SSE	14.13	4.09
Max. abs. error	3.29	1.16
MSE	0.04	0.05

ANN modeling result is shown in table III. From very high R2 value and low MSE, it is concluded that the developed model is very accurate and learns the relationship between MFI and reactor operating parameters.

TABLE III. ANN MODELING RESULT

No of nodes in the hidden layer	Best R2 value	Least percentage error	Algorithm used for training	Transfer function
6	0.99	2.36	Levenberg-Marquardt	Sigmoidal

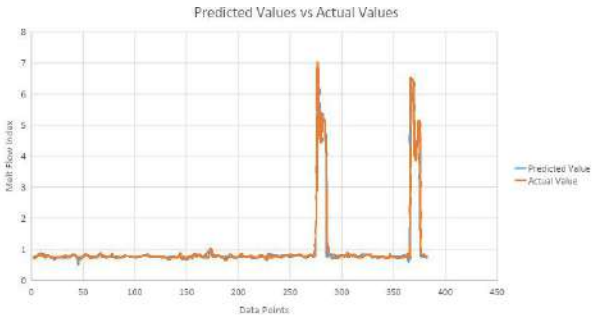

Fig 1: Comparison of the actual vs. the predicted MFI for test dataset in ANN

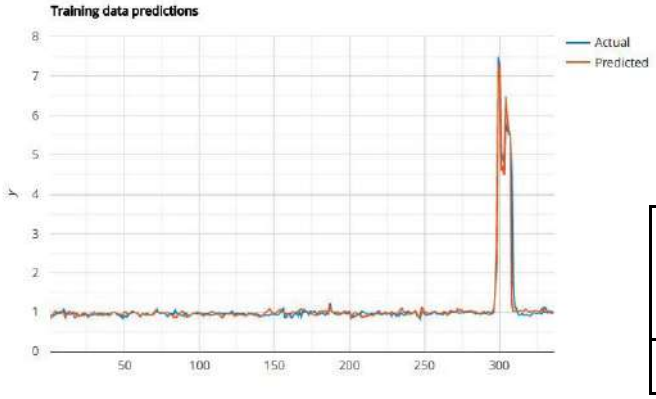

Fig 2: Comparison of the actual vs. the predicted MFI for training dataset in genetic programming

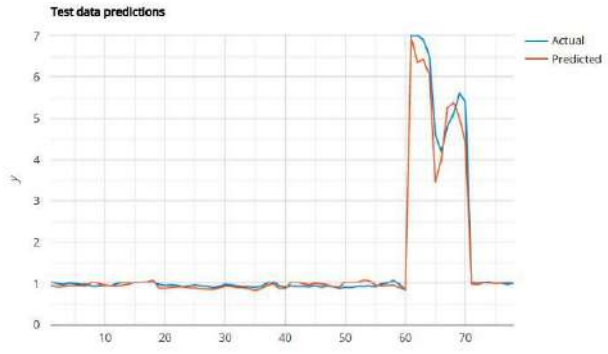

Fig 3: Comparison of the actual vs. the predicted MFI for test dataset in genetic programming

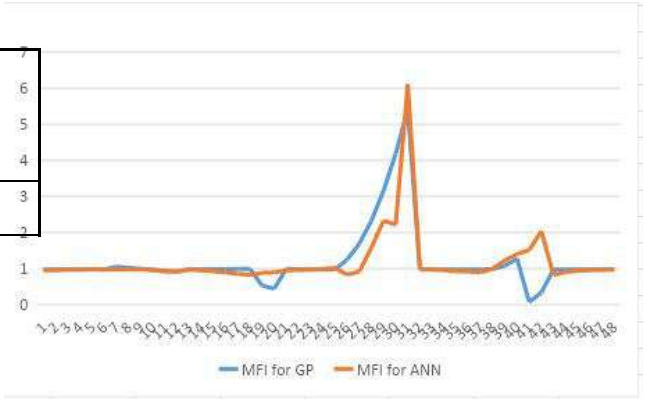

Fig 4: Comparison between the predicted MFI data for genetic programming and ANN model

From the GP and ANN models of MFI, the ANN model is better as it has comparatively less percentage error and better R2 value. So, the ANN model was chosen for optimization purposes.

IV. OPTIMIZATION

In optimization, the optimal values of all the eight input parameters were calculated in MATLAB using genetic algorithm (GA). For any fixed value of MFI, the optimal condition can be calculated from the obtained model. Table IV shows the optimal values of input parameters for MFI 1.

TABLE IV. OPTIMAL VALUES OF INPUT PARAMETERS

MFI	X_1	X_2	X3	X_4	X_5	X_6	X_7	X_8
1	4.06	25.40	23.88	3.57	0.48	367.35	4.13	0.13

V. CONCLUSION

AI-based data driven modeling can be used in chemical engineering where any first principle model is not available. In this project, we have created a model of MFI using two different AI-based modeling techniques. We have chosen the best model and considered it for optimization. Optimization gives the optimal value of the input parameters of a fixed MFI instantly so that the production engineers can manipulate their range to achieve the target value. This model can be further deployed in plant DCS to receive real-time MFI data and take necessary steps based on the output.

NOMENCLATURE

ANN: Artificial Neural Network
GA: Genetic Algorithm
GP: Genetic Programming
MAE- Mean absolute error
MFI- Melt Flow Index
MSE- Mean squared error
R2- Accuracy of fit (coefficient of determination)

RMSE- Root mean squared error
SSE- Sum of squared errors

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Ensemble Methods for Learning: An approach towards handling Class Imbalance and Class Overlapping Problems

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***Abstract*— In this paper we performed different ensembling learning techniques to handle imbalance of classes on a given dataset and do further analysis of the result obtained. At first various techniques were identified to handle class imbalance such as data pre-processing, cost sensitive and ensemble learning methods. After separating testing and training dataset, we implemented the data pre-processing techniques such as oversampling and undersampling and then implemented neural networks which train on imbalance dataset by respecting the introduced class weights. We introduced the SMOTE algorithm and further refined it by adding Bagging and Boosting methods. Any errors that emerged in the streamlining of the process was taken into consideration as well. The results obtained by training the models on Training data were collected and further verified it by testing it on Testing data. Then results were compared based on their ROC value and various parameters obtained from the confusion matrix. During the comparative analysis, we found that data pre-processing by oversampling outperformed undersampling+random forest method based on ROC values. Among all the methods used, Neural Networks combined with the cost sensitive learning's performance in terms on ROC value was the best. In general, ensembling learning mechanism based on boosting yielded better results than bagging and SMOTE+Bagging along with Neural Networks technique resulted in the best precision value.**

Keywords—Class Imbalance, Oversampling, Undersampling, Ensemble Learning, Bagging, Boosting

I. INTRODUCTION

Class imbalance is a situation in predictive machine learning where the classes present in testing datasets is not proportional. This is a commonly faced problem in application of machine learning in fields such as fraud detection, risk prediction, image recognition etc.

The most common scenario of class imbalance is when we have more examples for a class compared to the other class in a training dataset. This would lead to our predictive model being biased towards the class with more examples as not enough samples were present for minority class. This would lead to poor performance or reduction in predicting and analysing ability especially when the minor class is also important.

Oftentimes the class with less data points is our main focus and we aim to get the best result on this class. Whether we treat the training data to reduce the imbalance will largely determine if the machine learning model is performant. It is of utmost importance to reduce the balance in classes so that the model doesn't treat the minority class as noise, leading to a high bias in the model.

Machine learning and deep learning for class imbalance problem has become high on demand. For highly imbalanced datasets machine learning and deep learning approaches has given an expected result than the traditional approaches.

Synthetic Minority Over-Sampling Technique (SMOTE) is a heuristic over-sampling method. It generates synthetic samples from the minor class by interpolating existing instances that remains closer. In [1-4] SMOTE is combined with boosting and oversampling techniques to solve the class imbalance problem.

The other way for solving a class imbalance problem upto some extent is Cost Sensitive approach. This is one of the ongoing areas in deep learning research. Cost Sensitive approach examine the costs corresponding with misclassified data points. It applies different cost matrices for finding the misclassified data points [5].

The Ensembling techniques that is Bagging and Boosting are highly used these days for fraud detection, disease, transaction etc. They take decision using the base learning algorithms [6]. Boosting works better for noiseless data and bagging works good for noisy data. The combination of both can result to better prediction [6].

Our main goal in this paper is to study the different techniques and implement it on the given dataset and then resultant output is compared with different parameters.

The rest of the paper is synchronized as Section II discusses the existing works, Section III defines the problem statement, objectives along with the methodologies, Section

IV shows the experimental results and Section V is the conclusion part followed by the future work.

II. LITERATURE SURVEY

In this literature survey part, we will go through the related research works done by the different researchers. In [7] the authors had introduced an oversampling approach in which the minority class is oversampled by creating synthetic examples rather than oversampling with replacement. This approach improves the accuracy for a minority class and provides a diverse test bed. But this increases overlapping of classes and adds noise. The authors [8] has implemented a method that only oversamples the border line example which results into better True Positive Rate and better F-measure. But the method is restricted to define the border example. In paper [9] the authors have designed a method to eliminate the outliners and redundant data. This helps in convergence towards a balanced class. In paper [10] the authors have designed a Cost Sensitive Learning Method that is the splitting criteria is based on minimum total cost rather than the minimum entropy value. But it doesn't help in the concept of removing data points. In [11] they have introduced Metacost which is a common technique for creating classifiers. The benefit is that it reduces the cost but it's main drawback is computation time is very slow. In [12] the authors have designed Ensemble techniques, SMOTE (Synthetic Minority Oversampling Technique) Boosting. This method avoids overfitting and also takes care of meaningful information without loss. The main demerit of the method is it doesn't consider neighbour points and creates noise due to overlapping. It is an Ensemble learning technology [13] to improve the SMOTE boosting technique. The resultant output gave better results than its previous techniques. The drawback which it holds is it doesn't consider the difference of useful features. In [14] SMOTE Bagging algorithm is used to generate synthetic samples. The major drawback is misclassified data doesn't get priorities. In [15] the authors have designed a method to resample the non-balanced data points in binary classifier. The authors [16] has designed a combined algorithm using Support Vector Machine(SVM) and AdaBoost. The major advantage is that the multiple weak classes can be regularized but due to overlearning it may lead to overfitting problem. In [17] the authors had experiments using 10-fold cross validation on different datasets. The paper [18] provides broad analytical discussion and objective evaluation of class overlap in the data imbalance problem and its effect on accuracy. In [19] proposed method helps to minimize the data imbalance problem and prediction in E-commerce. It works for real time problems. The paper [20] in detail studies the credit risk factors in Point-to-Point network and used SMOTE algorithm for the imbalanced data.

III. PROBLEM STATEMENT

For a given set of data, to build-up an adequate decision boundary between the classes, providing easy discrimination to any learning model using Ensemble methods of learning.

A. Motivation and Objective

The Ensembling techniques find major use many of the real world classification problems where there is an unequal distribution of classes in the training dataset.
It is currently used in evaluating following anomaly problems like Fraud Detection, Churn Prediction, Medical Diagnosis, Spam Detection.
The main objectives of this paper are:

- To study the strategies and methods for handling data with the Class Imbalance and Class Overlapping Problem.
- To perform comparative analysis by addressing classification with imbalanced data using Pre-processing, Cost-sensitive learning and Ensemble techniques.

B. Dataset

For Implementation purpose the Credit card dataset has been used. Link to the dataset: https://www.kaggle.com/mlg-ulb/creditcardfraud. This dataset contains information on credit card transactions in September 2013 by European users. This is an unbalanced database with positive class (frauds) being less than 0.2% of all transactions.
Class 0 is representation of absence of fraud.
Class 1 represents the possibility of a fraudulent transaction.

C. Methodology

Different data-preprocessing techniques like oversampling, undersampling, cost sensitive learning and ensemble techniques are implemented in the given dataset. The results are compared with different parameters like ROC (Receiver Operating Characteristic), precision, recall and F1-score.

- Data pre-processing

Resampling of respective class data points is the most common way to tackle imbalanced datasets. It aims to reduce the difference in available data points of the classes under scrutiny. Two most common resampling methods are-

1. Undersampling
2. Oversampling

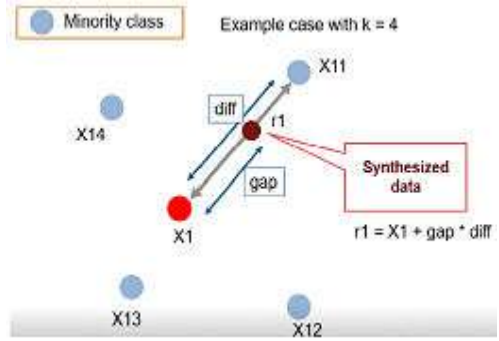
Oversampling is the common way of implementing resampling because undersampling could lead to loss of some important data points that carries useful information.

a) SMOTE (Synthetic Minority Oversampling Technique)

SMOTE is an oversampling procedure on which artificial created based on the class which is in the minority. This avoids the conundrum posed by random oversampling which could easily lead to overfitting.

Working Procedure:
The first step is to establish a total number of oversampling observations. It is usually selected by making sure that the binary class distribution of 1:1 or close to it is respected

though it could be tuned down based on the needs of the observers. In the next step iteration is initiated by randomly selecting an instance of positive class. Next, the KNN's (default 5) for that instance is obtained. The N of these K instances is arbitrarily picked to create new artificial instances. For that we need to calculate the distance difference between the feature vector and its neighbours with the help of any distance metric. Now this difference is multiplied by any random value between 0 to 1 and is then added to the previous vector. It is illustrated in Fig. 1 by the following diagram.



Source:https://github.com/minoue-xx/Oversampling-Imbalanced-Data

Figure 1: SMOTE

b) NEAR MISS

Near miss algorithm is used to bring balance back to an imbalanced dataset. It is a type of undersampling technique and is considered efficient to balance the data. This algorithm looks at the class distribution in the dataset and then eliminates random samples belonging to the larger class. When two data points that belongs to two different classes are very close to each other, it removed data points belonging to the larger class to balance the overall distribution. The following are the steps involved:

- It first calculates the distance between data points belonging to the larger class with the data points of the minority class. It leads to undersampling being easier.
- Select the instances belonging to the larger class which are closest with the smaller class. These n classes are marked for purging.
- It will return m*n instances of the larger class where m is the total number of instances of the class in the minority.

Types of the near-miss algorithm:

- In the first version, the balancing of data points is enacted by measuring the average minimum distance between the majority distribution and three closest minority ones.
- In the second version, the balancing of data points is done by measuring the average minimum distance between the majority distribution and following three furthest minority distributions.
- In the third version, minority class instances are considered and 'm' neighbours are selected. The distance between this and the majority distribution is measured and largest distance is removed.

c) RANDOM FOREST CLASSIFIER

Random forest models are mainly used for classification and regression. These models are a type of ensemble learning methods where several trees are trained simultaneously and the majority result of the trees is used as the final decision of the model. Although individual trees are not difficult to interpret, the model is not unique and high variance is observed. But this model where hundreds or thousands or tree models are combined reduces bias which is difficult to achieve due to the bias-variance threshold. The trees trains various subsamples from the database which are chosen at random (also called bootstrapping) and various subsamples of the available features. This is a type of ensemble classifier based on bootstrapping followed by aggregation (jointly referred to as bagging). Random forest classifier is easy to develop, implement, and leads to generation of robust classification.

➢ Cost Sensitive Method

Cost-sensitive learning takes into account the cost of prediction errors (and other possible errors) when training a machine learning model. It is a subfield of machine learning that is closely interconnected with imbalanced learning that is the study and application of database classification with a biased class distribution. As a result, many concepts and procedures developed and are applied for cost-sensitive learning can also be transferred to imbalance classification problems.

a) Cost Sensitive Using Neural Networks

In our method, we have used both the general neural network as well as cost sensitive neural network methods. The easiest way to adopt this technique is to use a fixed weighting of error scores for examples based on their class representation where the prediction error is increased for examples in a more important class and decreased (or unchanged) for those examples in a less important class.

A large error weighting is applied to examples belonging in the minority class as they are often more important in an imbalanced classification problem than the samples belonging to the majority class.

Large Weight: Assigned to examples from the minority class.

Small Weight: Assigned to examples from the majority class.

The weighting can use the inverse of the class distribution present in the

selected dataset. The class distribution of our dataset under observation is 1:550 ratio of smaller class to the larger class. The inverse of this ratio can be applied with 1 for the larger class and 550 for the smaller class.

➢ Ensemble Techniques

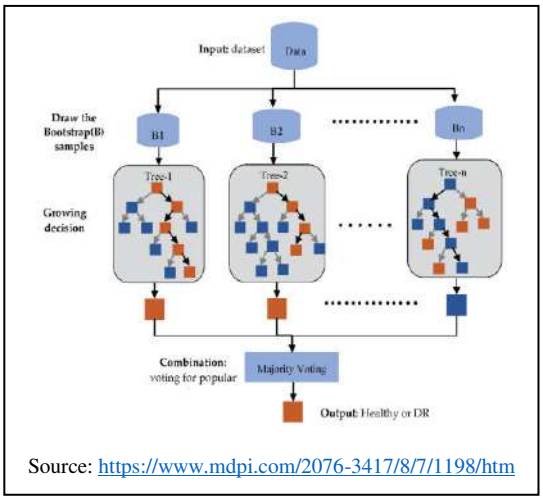
Ensemble learning methods leads to improvement of Machine Learning results by combining several models. This technique allows the production of better predictive performance as to just using a single model. Basic principle

is to learn a set of classifiers (experts) and then to allow them to vote. Ensemble techniques typically lead more precise solutions than using one model would as it is an aggregation of several models which are trying to optimize the model independently without the influence of one another.

Types of Ensemble techniques:

a. BAGGING

Bagging is the combination of Aggregation and Bootstrapping to form one ensemble model. From a given sample of data, multiple subsamples are selected and one decision tree is implemented on each of the randomly selected subsample of data points. After the formation of decision trees, an efficient algorithm is used to combine them to lead to the formation of an efficient predictor mechanism. The following image in Fig. 2 explains it visually:

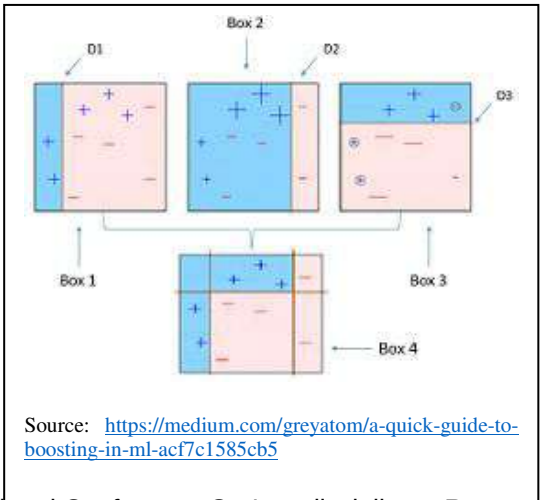


Source: https://www.mdpi.com/2076-3417/8/7/1198/htm

Figure 2: BAGGING

b. BOOSTING

Boosting is an ensemble technique of creating a strong classifier from a number of weak classifiers. In Fig. 3 the steps are shown for boosting. Firstly, a model is made from the given data points. The second model is created which attempts to remedy the errors present in the first model. This method is iterated and models are added until either the given training dataset is predicted correctly or the maximum number of predetermined models are added.



Source: https://medium.com/greyatom/a-quick-guide-to-boosting-in-ml-acf7c1585cb5

Figure 3: BOOSTING

IV. EXPERIMENTAL RESULTS

The model was split into training and testing dataset with a ratio of 3:7. Here, 0 is the representation of absence of fraud and 1 represents the possibility of a fraudulent transaction. A comparative analysis of the different techniques with the various parameters like ROC (Receiver Operating Characteristic), precision, recall, F1-score has been compared.

The confusion Matrix for each of the matrix is shown below in Table 1-6.

Table 1: NEAR MISS + RANDOM FOREST

	0	**1**
0	2890	82417
1	0	136

Table 2: SMOTE + RANDOM FOREST

	0	**1**
0	85266	23
1	22	132

Table 3: NEURAL NETWORK

	0	**1**
0	85299	8
1	35	101

Table 4: COST-SENSITIVE NEURAL NETWORK

	0	**1**
0	83881	1426
1	13	123

Table 5: SMOTE-BAGGING

	0	**1**
0	85288	8
1	39	108

Table 6: SMOTE-BOOSTING

	0	**1**
0	83606	1690
1	21	126

In Table 7. we have shown the comparison of different approaches using different parameters

Table 7: COMPARATIVE ANALYSIS

Approach	***ROC Value***	***Precision***	***Recall***	***F1-score***
NEAR MISS + RANDOM FOREST	0 .516938	0.00	1.00	0.00
SMOTE + RANDOM FOREST	0 .928436	0.85	0 .86	0 .80
NEURAL NETWORK	0.914187	0.93	0.74	0.82
COST-SENSITIVE NEURAL NETWORK	0.966238	0.08	0.90	0.15
SMOTE+ BAGGING	0.867300	0.93	0.73	0.82
SMOTE+ BOOSTING	0.918664	0.07	0.86	0.13

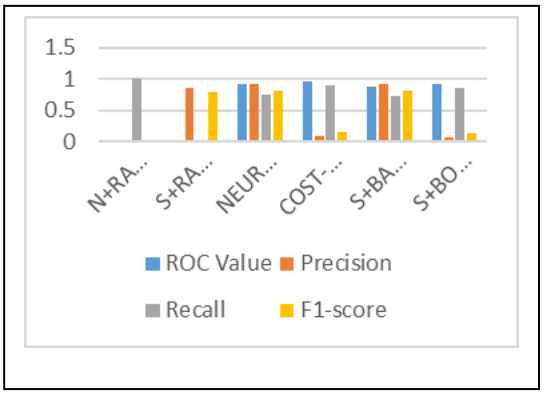


Figure 4: COMPARATIVE ANALYSIS CHART

In Fig. 4 the comparative analysis is done considering various techniques. After performing the comparative analysis we have seen that:

- Specifically, for Data Pre-processing the Oversampling Method(SMOTE) [ROC: 0.928436] clearly outperformed the undersampling + random forest method [ROC 0.516938].
- Neural Networks combined with the cost sensitive learning's performance in terms on ROC Value (0.966238) was the best among all the methods.
- In general Ensemble learning mechanism ROC value obtained in Boosting technique (0.918664) was better than Bagging (0.867300).
- SMOTE + Bagging along with Neural Networks technique showed the best precision value (0.93).
- The best Recall value was shown by the undersampling technique but it had the worst performance in terms of precision, ROC and F1-score.
- For F1-score the Ensemble technique of Bagging and general Neural Networks showed the best performance (0.82).

V. CONCLUSION AND FUTURE WORK

Our research work performs a comparative analysis with different undersampling, oversampling, ensemble learning, cost sensitive and neural network approaches. The analysis is done on different parameters like ROC, Precision, Recall, F1-Score. In case of ROC for Data Pre-processing SMOTE+Random Forest performed well. For Cost sensitive learning, Neural Network combined with cost sensitive learning gave better result. In Ensemble Learning the Boosting technique gave better performance. In terms of Precision SMOTE + Bagging along with Neural Networks technique showed the best result. The best recall value was shown by the undersampling technique but it showed poor result for other parameters. For F1 score the Ensemble technique of Bagging and general Neural Networks showed the best performance.

In future we are going to modify the existing algorithms for the class imbalance problem and implement it on multiple datasets.

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Investigation of methanol fuel fires inside the enclosure

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Abstract— The enclosure fire experiments are conducted on methanol fuel, size of 40 cm and 60 cm diameter to investigate the fire behavior. The test facility consists of an enclosure of size 4m×4m×4m and door opening of 2m height and 0.5 m width in both experimental conditions. The total fire duration is 1500 s. The maximum heat release rate is found 32kW and 77kW in case of Exp.1 and Exp.2 respectively. The rate of burning per unit pool area is found similar in both experimental conditions due to lesser effect of enclosure on burning of methanol fuel. The thermal conditions are measured with thermocouples located at different locations inside the enclosure such as at ceiling, above the pool surface, along the heights of enclosure and door vent. The thermal environment is found to be proportional to heat release rate in both pool conditions. The smoke production rate, extinction coefficient and Yield of CO and CO_2 are measured with oxygen consumption calorimeter fixed outside the test room to analysis the gas sample continuously.

*Keywords—**Enclosure, Fire, Heat Release Rate, Methanol, Temperature***

I. INTRODUCTION

Fire is a chemical reaction between a substance (combustible material, i.e. solid, liquid and gas) and a suitable oxidant (oxygen, hydrogen peroxide (H_2O_2), florine (F_2), nitric acid etc.) in presence of a suitable environment (ignition source, temperature and pressure). Fire is an exothermic reaction, in which released large amount of energy in terms of heat, light and gaseous products (CO_2, H_2O, CO, soot, etc.) is used for self sustaining of fire. Fuel, oxidant and heat are main element in combustion chemistry; an additional fourth element is the chain reaction, which stands for the continuous reaction for sustaining the fire for longer periods. According to National Crime Record Bureau, India 2012 [1], the total fire accidents were estimated 24987 in year of 2012. The main causes of fire accident according to National Crime Record, India was fireworks, short circuit, cooking gas cylinder. According to a report of NFPA (2014) [2], the main causes of fires in residing and non residing area of USA were cooking, smoking, electrical malfunction. As per data of Centre of Fire Statics [3], average fire deaths/year were 10,000-20,000 and 1,000-10,000 in India and USA respectively during year 1993-2013. To overcome the fire hazards problems, the codes and standards were adapted globally in various areas of engineering, i.e. construction, designing and fire protection engineering to improve the design aspects and simultaneously reducing the fire hazards. These codes were based on prescriptive and performance based design methods to achieve the objectives of fire safety engineering. The principle and methodology of both methods are distinct on various parameters, i.e. accuracy of design, cost, and feasibility. Fire safety engineering is used the principle of fire science and engineering to reduce loss of life and damage of properties. International Organization for Standardizations (ISO) i.e. ISO 9705 [4] and American Society for Testing and Materials (ASTM) i.e. E1354:11a [5], E176:10a [6], were developed to provide guidelines for enclosure fire.

Several fire experiments were performed on large and small scale [7, 8] to investigate the fire characteristics and impact of fire. Closed and mechanically ventilated enclosure fire studied [9] were used heptane and dodecane fuels in different pool sizes. At very low ventilation conditions and larger pan sizes, heat release rate decreases significantly due to lack of oxygen availability and during this period concentration of CO was found to reach 1%. The effects of pool sizes in development of fire were investigated inside the enclosure [10, 11, and 12]. The different liquid pool fires inside the enclosure studied [13, 14]. They found that development of fire and production of smoke and CO gas significantly affected with fuel properties.

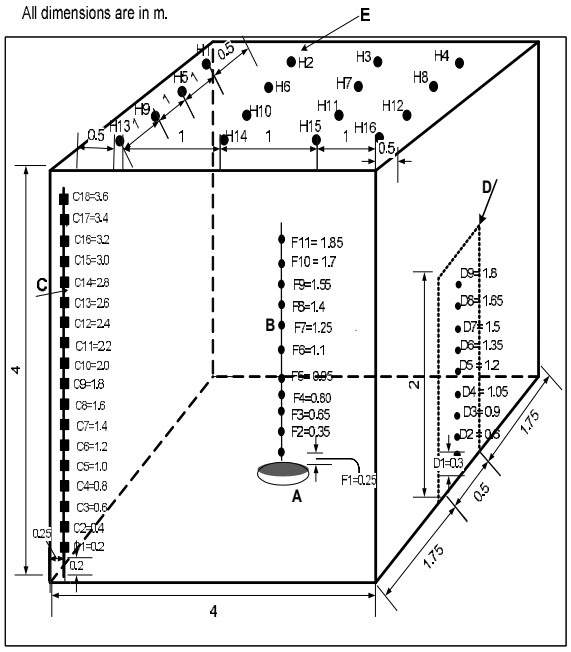
In particular, fires development in enclosure constitute a terrible threat. The hazard in enclosures is caused by rapid rise of temperatures, presence of high concentrations of toxic gases like CO and smoke. The measurements for the yield of major species CO and CO_2 in exhaust gases, and the extinction coefficient and smoke production rate from single compartment fire are useful for designing of fire safety system in enclosure

Further, improvement in fire safety design and protection system is required regularly by upgrading the fire safety codes and standards. These can be performed through experimental and mathematical modeling. Therefore, the present research is focused on determine the effects of pool sizes on development of fire and thermal environment inside the enclosure.

II. MATERIALS AND METHODS

The experimental facility is developed in the Mechanical and Industrial Engineering Department, IIT Roorkee as shown in Figure 1. The enclosure is a size of 4m × 4m×4m and door size 2 m height and 0.5 m width. The material brick and reinforced cement concrete used for construction of walls and ceiling of enclosure. The total duration of experiments is 1500 s. The methanol fuel is used as a fire

source placed at centre of enclosure. The experiments are conducted on pool of size 40 cm and 60 cm to study the effects of pool size on development of thermal environment inside the enclosure. In case of Exp.1, pool of size 40 cm diameter and in the Exp.2 pool size is taken as 60 cm diameter. The height of fuel inside the enclosure is maintained constant at 12 cm during experiments. A reservoir system has been designed to maintain the continuous supply of fuel inside the enclosure. The properties of surface materials and fuel supplying system are detailed in paper[15].



A: Circular pan; B: Thermocouples tree above the pool center; C: Thermocouples rack at corner of back wall; D:Thermocouples rack at centre of door opening; E:Thermocouples layout located at 1m below the ceiling;

Figure 1: Fire test enclosure

III. Instrumentation

The different instruments are placed inside the enclosure to investigate the thermal environment in case of Exp.1(40 cm diameter) and Exp.2 (60 cm diameter) conditions. A series of thermocouples "B" is placed in midpoint of pan above the fuel source to measure the temperature of flame at different heights and time. The thermocouple rack "C" is positioned corner of enclosure to measure the temperature variations with heights of enclosure and time. The rack of thermocouples "D" is located at the centre of vent location to measure the exhaust gas and inlet air temperature with door height and time. Additional set of thermocouples "E" is positioned at ceiling of enclosure at height 1 m below from roof to measure the hot gas variations horizontally along the enclosure.

IV. Results and Discussion

Figure 2 depicts the variation of heat release rate and mass loss rate per unit pool area of methanol. The maximum heat release rate is resulted about 32 kW and 77 kW in the Exp.1 and Exp.2 respectively. The average rate of mass loss per unit pool area is found to be 0.0159 and 0.0145 kg/m^{2}s in Exp.1and Exp.2 respectively. The theoretical combustion efficiency is found to be approximately 94 % in both experimental conditions. The effects of fuel size on mass burning rate flux is not seen much, which showing that the availability of oxygen is sufficient in both pool conditions., this is due to large enclosure size.

The extinction coefficient and smoke production rate are measured with smoke extinction system as located exterior of enclosure. Figure 3 shows the extinction coefficient, smoke production rate averaged over the period of 300 seconds. The average value of extinction coefficient is resulted 0.0315 m^{-1} and 0.022 m^{-1} in Exp.1 and Exp.2 respectively. The smoke production rate is found to be 0.057 m^2/s and 0.0415 m^2/s in Exp.1 and Exp.2 respectively.

Figure 4 shows the yield of CO and CO_2 in exhaust gases in different pool conditions. The average value (over the period of 300 seconds) of CO yield is resulted about 0.0037 (kg/kg), and 0.0022 (kg/kg) in Exp.1and Exp.2 respectively. In addition, average value of CO_2 yield is about 1.92 (kg/kg) and 1.66 (kg/kg) in Exp.1 and Exp.2 respectively.

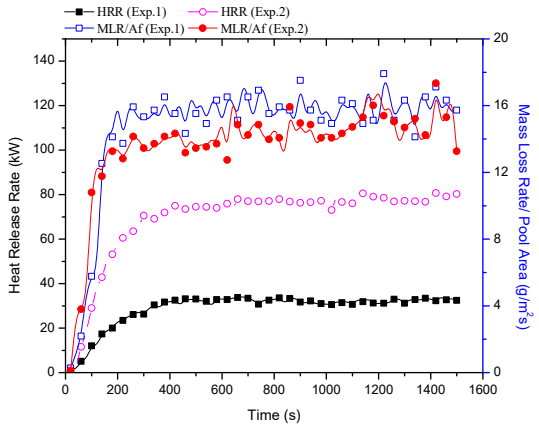


Figure 2: Heat release rate and mass loss rate per unit pool area in the Exp.1 and Exp.2

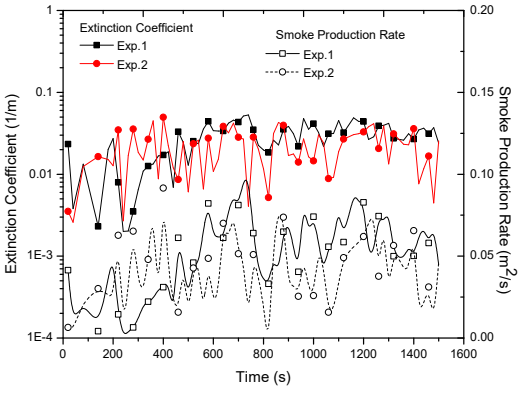


Figure 3: Variation of extinction coefficient and smoke production rate in case of Exp.1 and Exp.2

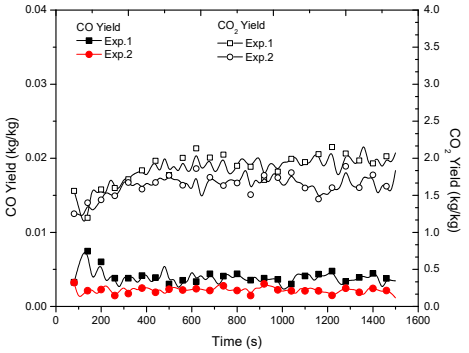


Figure 4: Yield of CO and CO_2 under Exp.1 and Exp.2 conditions

The temperature with time at different heights above the fuel pan surface as shown in Figure 5. Temperature distribution above the pool surface is found to be similar in height of 0.25 m in both experimental conditions. However, differences is resulted 77˚C and 55 ˚C in the region of intermediate and plume region in between Exp.1 and Exp.2 conditions.

The temperature distribution beneath the ceiling is shown in Figure 6. The maximum mean ceiling temperatures is found 83 ^{O}C and 129 °C in Exp.1 and Exp.2 respectively. Hot gas layer temperature is distributed below the ceiling uniformly. The profile of hot gas temperatures is found to be proportional with heat release rate profile.

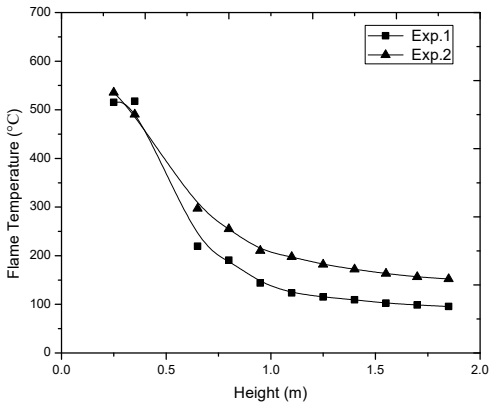


Figure 5: Variations of temperature above the pool

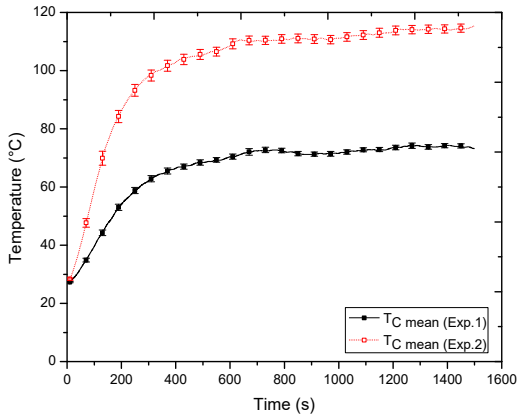


Figure 6: Variation of hot gas temperature with time under different pool sizes

The temperatures measured at the corner of the rear wall at different times and heights is shown in Figure 7. A discontinuity of enclosure temperatures into the hot and cold zone is observed and this discontinuity height varies with fire sizes. The thermal discontinuity layer occurs at approximately at 0.9 m and 0.8 m above the floor in Exp.1 and Exp.2 respectively. The maximum temperature in the hot zone is 73°C and 117 °C in Exp.1 and Exp.2 conditions respectively.

The variation of door temperatures with heights is shown in Figure 8. The maximum hot gas temperature found to be 66°C and 106°C at a position of 1.8 m above the floor. The area of transition between hot and cold zone at a door is at a height of 1.0 and 0.9 m above the floor in Exp.1 and Exp.2 .

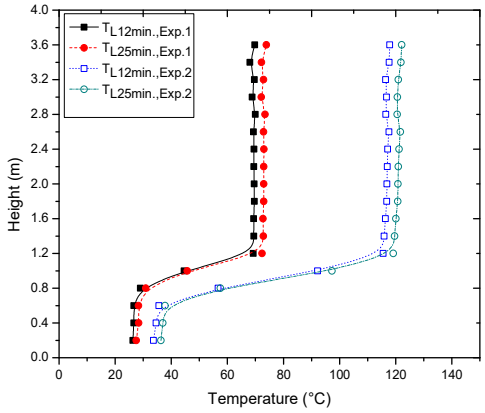


Figure 7: Variation of temperature with heights of enclosure at different times under different pool size

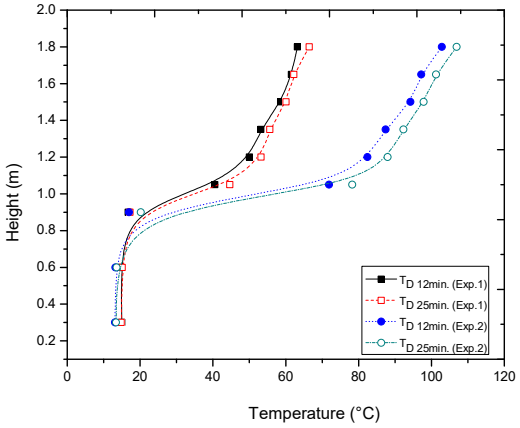


Figure 8: Variation of doorway temperature with door heights at different times under different pool size

The energy release during burning of methanol fuel is dissipated into enclosure surfaces, door opening and part of it accumulated inside the enclosure. However, the maximum part of release energy is distributed into different surfaces of the enclosure. Figure 9 shows enclosure surfaces with time and different pool size. The maximum average heat flux is observed in ceiling location, the value being 1.72 kW/m^2 and 3.19 kW/m^2 in Exp.1 and Exp.2 respectively.

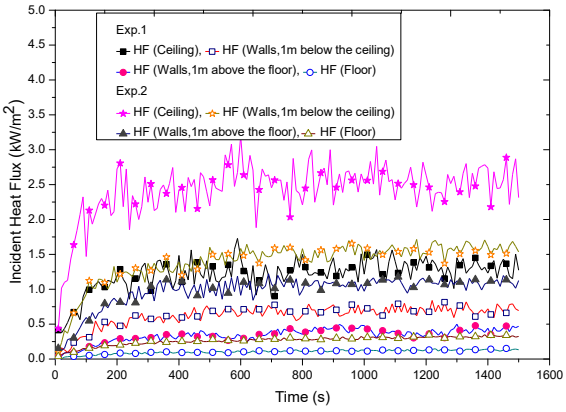


Figure 9: Incident heat flux variation with time at different enclosure surfaces

V. Conclusion

In the range of 0.2 m - 1.0 m pool diameter, burning mode is radiative and optically thin. In this region, burning of fuel is normally increases with increases of the pool size. However, in the present study on methanol fires, the average mass loss rate per unit pool area is found almost equal in both 40 cm and 60 cm pool diameter conditions. This is due to heat feedback towards the fuel is lower in methanol fires. This behavior is also observed due to the low fire load and higher enclosure volume condition. The extinction coefficient is found minimum in methanol fire, that shows the nature of fuel as a clean fuel.

Acknowledgment

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MERGERS AND ACQUISITIONS-A KEY CHALLENGE TOWARDS EMPLOYEES' ADAPTABILITY

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Abstract— **Purpose of the study-**The phenomena of mergers and acquisitions are inevitable in nature . It brings a drastic change in the organization in terms of policies, practices , strategies and employees are supposed to adopt those. During this process , employees experience challenges in their adaptability. Thus it is the prime responsibility of any organization to identify those factors which provide a hindrance for the adaptability of the employees in this situation.

Methodology-In continuation of this issue, this study is designed to evaluate the factors which provide an hindrance on employees' adaptability during the merger of Dalmia Cement and OCL Cement . The sampling unit is 80 collected from Burdwan, Kolkata and Hooghly District. The sampling is simple random sampling. The sample consists of Off-payroll employees, Officers and Managers. The SPSS-21 is used for data analysis.

Findings-In this paper, Exploratory Factor Analysis has identified four factors which provide challenge towards the adaptability of the employees during the merger of Dalmia Cement and OCL Cement i.e. Psychological Factor, Work Culture , Organizational Factor and Job-Related Factor. Multiple Linear Regression Analysis has revealed that organizational factor has a vital role to play in inculcating organizational citizenship behaviour among the employees whereas work culture is not having any significant influence .The Hypothesis Testing reveals that there exists no significant difference towards challenges of adaptability among the employees on the basis of area, employability status, age, experience and company.

Originality/Value- This study is considered to be one of the unique research dealing with the challenges of employees' adaptability during mergers and acquisitions in cement industry and how these challenges are affecting on Organizational Citizenship Behaviour of the employees.

Keywords: Mergers, Acquisitions, Psychological, Adaptability, Organisational, Employability.

I. INTRODUCTION

In this dynamic and volatile business environment , mergers and acquisitions have become an ongoing process. The prime reason of the success and failure of any merger and acquisition is centered around to handle the change management. This is one of the sensitive area which is been ignored in most of the mergers and acquisitions. During the process of mergers and acquisitions, most of the companies leverage their organization by analyzing the status of their business, financial stability, the legal formalities, technological upgradation and restructuring the organization structure but they do not pay attention to the importance of human resources within their organization which led them to fail in the long run. Coombs et.al have emphasized certain patterns of emotional reactions practiced by human resources when merger or acquisition is initiated (Coombs., 1988). They mentioned 'Merger-Emotions Syndrome Denial' which emphasis that initially workers react to the declared merger with denial . The failure of a merger or acquisition is based on the negligence of Human Resources . When a merger or acquisition takes place , the company analyses the feasibility on the business and financial issues rather giving importance to the human resources involved in the organization. Mergers &Acquisitions are nothing but drastic forms of organizational change, and workers often view change as risky because of their sense of insecurity and fear of losing protection (A.Thornhill, 2003). It was established in the research of Victoria Bellou (Bellou, 2006) that after a merger or acquisition, employee perceptions towards organizational obligations and contributions change and employees who possess less coping ability consider themselves more insecure. Organizations must realize that employees play a pivotal role in successful amalgamating and uniting two organizations. Sugandh Kansal and Arti Chandani (2014) highlighted that during the merger and acquisition the following factors disbalances the equilibrium of the organization i.e. System Dynamics, Structure-focused change, Person-focused change, Profitability issues and Government Policies (Sugandh Kansal, 2014). During this process, both the companies faces many challenges like managing an uniformity in work culture, stress handling and low motivation of employees, redundancies of jobs, restructuring of HR activities, job insecurity and draining of talents. The pace of merger and acquisition has become a very common proceeding in Indian Cement Industry. This consolidation through the aid of merger and acquisition in the cement industry in recent few years has brought production discipline streamlined which lead to price stability in the long run. But badly affected the human resource in the

organization. The employees are facing a great setback for their adaptability during this process and leads them to leave the organization.

II. BACKGROUND OF THE STUDY

Two or more companies participate in some negotiation in mergers which ultimately leads to transaction. Acquisition also involves two or more companies but the larger company swallows the smaller company in the acquisition. Thus the process of combining two or more organizations with different principles, traditions, and powers into one unified entity is merger or acquisition. Merger and acquisition forms an important element driving business growth and excellence. It is one of the important tool to gain competitive advantage. Cartwright and Cooper emphasized that 40 percent failure rates for change in the efforts followed by 50 percent of Mergers and Acquisitions fail in a few years later in 1996 (S.Cartwright, 1992).Following the same track, Weber (1996) explored that 35 percent of Mergers and Acquisitions fail in their first three years of life due to poor employee relations (Y.Weber, 1996). It has been reflected from several researchers that more than two -thirds of Mergers and Acquisitions failed to generate shareholder value (R.Carr, 2004) (R.N.Ashkenas, 1998) (P.H.Mirvis, 1998).

Observations reflect that the prime reasons for the failure of a merger or acquisition is centered on Human Resources neglect. Human resources are the most sensitive issue which is often ignored in a merger and acquisition. During merger and acquisition, most of the company evaluates the feasibility on the business, financial and legal fronts but unable to realize the importance of involvement of human resources in the organization. This consolidation has probably taken the name of the game in Indian cement industry in the near term.

The cement industry in India is cyclical in nature. In the month of March, cement production typically peaks, while it is at its nadir in the months of August and September. While domestic players have seen consolidation in the industry since the mid-1990s, it was only in the late 1990s that foreign players entered the market. The snapshot of consolidation is explained below:

Birla Corp acquired the 5.5 MTPA capacity of Reliance Cement in the central region in FY2016. Nuvoco Vistas (formerly Nirma Cement) acquired the 10 MTPA capacity of Lafarge Cements spread throughout the east and north in FY2017.In FY2018, UltraTech acquired the 21 MTPA potential of JP Associate across the northern, central, and southern regions.UltraTech further acquired 14 MTPA capabilities from Century Textiles in FY2019.UltraTech also acquired Binani Cement's 6 MTPA in the north in the same year.As per Motilal Oswal report Dalmia Bharat's (DBEL) approved the amalgamation with OCL India in their respective board meeting on 5th November 2016 (Ghosh and Gadia,2016). DBEL shareholders received two OCL shares for every single DBEL share. The deal is part of a restructuring exercise undertaken at the beginning of 2016. This merger completes the balance of the restructuring exercise. OCL was renamed as DBEL, following amalgamation. Dalmia acquired Murli Industries' 3 MTPA in Maharashtra in FY2020.In addition, the Kolkata-based diversified conglomerate EMAMI Ltd declared in a media release dated Feb 06, 2020 that it has entered into a binding agreement with Nuvoco Vistas Corp, part of the Nirma group, to divest its 100.0 percent equity stake in Emami Cement for an enterprise value of Rs 5,500 cr. The transaction is subject to customary approvals, including those of the Competition Commission, and is expected to be concluded within the next three to four months.

These consolidation of cement companies created a wave of uncertainty among the employees. Most of the cases they are under the threat of many factors such as inequity in compensation, leave rules, incompatible of organisational policies, lack of role clarity, stability of job etc.

This crisis has drawn the attention of the researcher to conduct the research in this field by identifying the factors which had created challenges towards the adaptability of the employees during the consolidation process between OCL Cement and Dalmia Bharat Cement considering some districts of West Bengal.

III. OBJECTIVES OF THE STUDY

-To identify the factors which had provided challenges towards the adaptability of the employees during the consolidation process of OCL Cement and Dalmia Bharat Cement.

-To identify the challenging factor of Employees' Adaptability having significant influence on Organizational Citizenship Behaviour.

-To test whether there exists significant difference in challenges of adaptability among the employees on the basis of area, age , experience and employability status.

IV. METHODOLOGY OF THE STUDY

The proposed research was conducted on the basis of Saunders' Onion model of research (Saunders, 2019).The sampling unit was 80 collected from Burdwan, Kolkata and Hooghly District. The time frame of data collection was from December, 2016 to October, 2017. The sampling is simple random sampling. The sample consists of Off-payroll employees, Officers and Managers. A Likert five point scale is used to gather information from the employees . The reliability of the questionnaire i.e. the value of Cronbach's alpha=0.85 and validity of the questionnaire is tested through content validity. The SPSS-21 is used for

data analysis.

V. DATA ANALYSIS

The data is analyzed Quantitatively with the help of SPSS 21. The analysis is comprised of Descriptive Analysis consists of Frequency Table, Exploratory Factor Analysis, Multiple Linear Regression Analysis and Hypothesis Testing is discussed below:

TABLE-1 : DESCRIPTIVE STATISTICS

Demographic Variable	Demographic Characteristics	Burdwan		Hooghly		Kolkata	
		Frequency	%	Frequency	%	Frequency	%
Employability Status	Manager	3	13.6	1	3.7	4	12.9
	Off-payroll employees	9	40.9	13	48.1	13	41.9
	Officer	10	45.5	13	48.1	14	45.2
Age	≥20 years and < 30 years	1	4.5	3	11.1	1	3.2
	≥ 30 years and < 40 years	5	22.7	11	40.7	13	41.9
	≥40 years and < 50 years	9	40.9	8	29.6	10	32.3
	≥50 years	7	31.8	5	18.5	7	22.6
Experience	< 1 year	2	9.1	1	3.7	2	6.5
	≥ 1 year and < 5 years.	6	27.3	12	44.4	15	48.4
	≥ 5 years and < 10 years.	9	40.9	9	33.3	8	25.8
	≥ 10 years	5	22.7	5	18.5	6	19.4

TABLE-2- TOTAL VARIANCE EXPLAINED

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.969	33.163	33.163	5.969	33.163	33.163	4.408	24.489	24.489
2	3.431	19.063	52.226	3.431	19.063	52.226	3.479	19.326	43.816
3	1.239	6.883	59.109	1.239	6.883	59.109	2.663	14.793	58.608
4	1.074	5.967	65.075	1.074	5.967	65.075	1.164	6.467	65.075
5	.809	4.494	69.570						
6	.798	4.436	74.005						
7	.699	3.885	77.891						
8	.589	3.272	81.163						
9	.574	3.190	84.353						
10	.499	2.774	87.127						
11	.407	2.260	89.386						
12	.370	2.054	91.441						
13	.328	1.825	93.265						
14	.293	1.626	94.891						
15	.254	1.410	96.302						
16	.250	1.391	97.693						
17	.210	1.166	98.858						
18	.206	1.142	100.000						

Extraction Method: Principal Component Analysis.

Exploratory Factor Analysis

To justify the objective: To identify the factors which had provided challenges towards the adaptability of the employees during the consolidation process of OCL Cement and Dalmia Bharat Cement.

Analysis- On Exploratory Factor Analysis 18 variables are reduced into 4 factors i.e. factors related to psychological aspect, factors related to work culture, factors related to organization and factors related to job. Performing the Varimax rotation to extract the factors that obtained 4 impact factors, reflecting 65.075% of the value of the representative variables.

TABLE-3:ROTATED COMPONENT MATRIX

Subfactors	Component			
	Psychological factors (1)	Organizational factors (2)	Job-centric factors (3)	Work culture (4)
Psychological support	0.805			
Psychological competencies	0.769			
Psychological protection	0.761			
Organizational policies		0.699		
Management style		0.699		
Growth & development		0.800		
Career development opportunities		0.848		
Recognition & reward		0.782		
Civility and respect		0.851		
Compensation policies		0.644		

Job security			0.800	
Job promotion			0.580	
Job enrichment			0.866	
Job monotony			0.514	
Employee participation				0.722
Work-life balance				0.721
Physical safety				0.740
Work pressure				0.761
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 6 iterations.				

Table 3 shows The Rotated Factor Matrix represents the rotated factor loadings, which represent the correlations between the variables and the factors. The factor column shows the rotated factors that have been extracted out of the total factors after data reduction.

Interpretations - Table 2 shows the Exploratory factor analysis where four factors are extracted. The explained variance is 65.075 , the Kaiser-Meyer-Olkin (KMO) is 0.849 and the p-value (Sig.) of 0.000 < 0.05, therefore the Factor Analysis is valid. Likewise, the Cronbach's alphas were high for factor 1 (0.957) followed by factor 2 (0.824), factor 3 (0.786), and factor 4 (0.817). Four factors are obtained that describe the main dimensions which has created challenges for the adaptability of the employees during the consolidation process in Dalmia Cement .

The first factor is signified as " psychological factor " accounts for 24.489 % of the variance, which defines the psychological well-being of the employees during the consolidation process comprises of the psychological support, psychological competencies and psychological protection of the employees.

The second factor is identified as "organizational factors" accounts for 19.326 % of the variance which signifies the policies and practices implemented by the organization after the consolidation process, comprises of organizational policies, management style, growth, development and career development opportunities for the employees, recognition & reward, civility and respect for employees and compensation policies.

The third factor is symbolized as "job-centric factor" accounts for 14.793% of the variance which determines the various aspects and attributes related to job that is job security, job promotion, job enrichment and job monotony.

The fourth factor is identified as "work culture" accounts for 6.467% which indicates work environment of the organization comprises of the employee participation, workload, work-life balance, physical safety and work pressure.

To justify the objective: To identify the challenging factor of Employees' Adaptability having significant influence on Organizational Citizenship Behaviour.

Analysis-The Multiple Linear Regression Analysis is used to measure the impact of the factors of employees' adaptability on Organizational Citizenship Behaviour of the Employees with respect to various dimensions i.e. altruism, courtesy, sportsmanship, civic virtue and conscientiousness (Dennis W. Organ, 2006) . Organ (1997) defined OCB as "Positive behaviors in the work place that are not formally rewarded by the organization, but carried out by the discretion of the employee".

TABLE - 4 : MULTIPLE REGRESSION RESULT COEFFICIENTS WITH RESPECT TO THE VARIOUS FACTORS OF EMPLOYEES' ADAPTABILITY ON ORGANIZATIONAL CITIZENSHIP BEHAVIOUR OF THE EMPLOYEES.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	VIF
		B	Std. Error	Beta			
1	(Constant)	2.059	0.540		3.687	0.000	
	Psychological factor	1.367	0.304	0.228	4.500	0.000	3.081
	Organizational factor	2.130	0.165	0.676	12.915	0.000	3.278
	Job-centric factor	1.328	0.228	0.212	5.829	0.000	1.576
	Work culture	-.428	0.153	-0.092	-2.801	0.006	1.301
Adjusted R Square-0.934 R Square-0.937 Durbin-Watson value-1.967 Anova – F value- 280.311							

Interpretation – This table 4 shows that the collinearity statistics of the four variable of Employees' Adaptability lies within the range of 1 < VIF < 10 which indicates that the regression analysis can be conducted . The Multiple Linear Regression analysis reflects that Organizational factor (β=0.676) is having the highest impact in inculcating organizational citizenship behaviour among the employees followed by Psychological factor (β=0.228) and then Job-centric factor (β=0.212) whereas on the other hand Work culture is not having any significant influence on Organizational Citizenship Behaviour (β= - 0.092)..

The regression equation follows:

Y = 2.059 + 0.228X1 + 0.676X2 + 0.212 X3 - 0.092 X4

Where- Y = Organizational Citizenship Behaviour.

X1= Psychological factor

X2= Organizational factor

X3 = Job-centric factor

X4 = Work culture

To focus on the objective:

-To test whether there exists significant difference in adaptability of employees on the basis of area, age , experience and employability status.

To emphasis on this objective four hypotheses have been drawn.

H1-There exists significant difference of challenges of adaptability of employees on the basis of area.

H2- There exists significant difference towards challenges of adaptability of employees on the basis of employability status.
H3- There exists significant difference towards challenges of adaptability of employees on the basis of experience.
H4- There exists significant difference towards challenges of adaptability of employees on the basis of age.
H5- There exists significant difference towards challenges of adaptability of employees on the basis of company (Orissa Cement Ltd and Dalmia Cement Ltd.)

Analysis

Hypothesis- 1 (Based on Area)
H0-There exists no significant difference towards challenges of adaptability among the employees on the basis of area.
H1-There exists significant difference towards challenges of adaptability among the employees on the basis of area.

TABLE:5- ANALYSIS (ON THE BASIS OF AREA)

Adaptability of Employees								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Burdwan	22	31.36	7.588	1.618	28.00	34.73	23	49
Hooghly	27	31.74	9.301	1.790	28.06	35.42	18	51
Kolkata	31	30.84	9.335	1.677	27.41	34.26	18	55
Total	80	31.29	8.776	.981	29.33	33.24	18	55

TABLE: 6 - ONE-WAY ANOVA(ON THE BASIS OF AREA)

Adaptability of Employees	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11.918	2	5.959	0.076	0.927
Within Groups	6072.470	77	78.863		
Total	6084.388	79			

Interpretation- The table 5 and table 6 shows that the value of F=0.076 and p(0.927) >0.05.This implies that Null Hypothesis is accepted and Alternate Hypothesis is rejected . So, the challenges towards the adaptability of employees does not differs on the basis of area. The mean value of the challenges towards adaptability of employees of Hooghly (31.74) is slightly highest followed by Burdwan (31.36) and Kolkata (30.84).

Hypothesis- 2 (Based on employability status).

H0- There exists no significant difference of challenges towards adaptability among the employees on the basis of employability status.

H2- There exists significant difference of challenges towards adaptability among the employees on the basis of employability status.

TABLE:7-ANALYSIS (ON THE BASIS OF EMPLOYABILITY STATUS)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Off-payroll employees	35	32.20	8.159	1.379	29.40	35.00	19	49
Officers	37	30.16	9.468	1.557	27.01	33.32	18	55
Managers	8	32.50	8.502	3.006	25.39	39.61	24	47
Total	80	31.29	8.776	0.981	29.33	33.24	18	55

TABLE:8-ONE-WAY ANOVA(ON THE BASIS OF EMPLOYABILITY STATUS)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	87.760	2	43.880	0.563	0.572
Within Groups	5996.627	77	77.878		
Total	6084.388	79			

Interpretation- The table 7 and table 8 shows that the value of F=0.563 and p(0.572) >0.05.This implies that Null Hypothesis is accepted and Alternate Hypothesis is rejected . So, the challenges towards adaptability of employees does not differs on the basis of employability status. The mean value among the managers (32.50) is highest followed by off-payroll employees (32.20) and then officers (30.16).

Hypothesis- 3 (Based on experience).
H0- There exists no significant difference towards challenges of adaptability among the employees on the basis of experience.
H3- There exists significant difference towards challenges of adaptability among the employees on the basis of experience.

TABLE:9-ANALYSIS(ON THE BASIS OF EXPERIENCE)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
< 1 year	5	33.00	13.693	6.124	16.00	50.00	19	55
≥ 1 year and < 5 years.	33	30.21	8.688	1.512	27.13	33.29	18	49
≥ 5 years and < 10 years.	26	32.46	8.774	1.721	28.92	36.01	21	51
≥ 10 years	16	31.06	7.767	1.942	26.92	35.20	22	48
Total	80	31.29	8.776	.981	29.33	33.24	18	55

TABLE 10: ONE-WAY ANOVA(ON THE BASIS OF EXPERIENCE)

Adaptability	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	89.473	3	29.824	0.378	0.769
Within Groups	5994.914	76	78.880		
Total	6084.388	79			

Interpretation- The table 9 and 10 shows that the value of F=0.378 and p(0.769) >0.05.This implies that Null Hypothesis is accepted and Alternate Hypothesis is rejected . So, the challenges towards the adaptability of employees does not differs on the basis of experience. The mean value of employees reflects that employees less than 1 year (33.00) faces slightly more challenges towards adaptability whereas employees more than and equals to one year and less than five years (30.21) faces less challenges.

Hypothesis- 4 (Based on Age).

H0- There exists no significant difference towards challenges of adaptability among the employees on the basis of age.

H4- There exists significant difference towards challenges of adaptability among the employees on the basis of age.

TABLE: 11-ANALYSIS (ON THE BASIS OF AGE)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
≥20 years and < 30 years	6	32.17	12.671	5.173	18.87	45.46	19	55
≥ 30 years and < 40 years	30	29.57	8.012	1.463	26.58	32.56	18	47
≥40 years and < 50 years	25	32.76	8.772	1.754	29.14	36.38	18	51
≥50 years	19	31.79	8.886	2.038	27.51	36.07	20	49
Total	80	31.29	8.776	.981	29.33	33.24	18	55

TABLE 12: ONE-WAY ANOVA(ON THE BASIS OF AGE)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	152.470	3	50.823	0.651	0.585
Within Groups	5931.918	76	78.052		
Total	6084.388	79			

Interpretation- The table 11 and 12 shows that the value of F=0.651 and p(0.585) >0.05.This implies that Null Hypothesis is accepted and Alternate Hypothesis is rejected . So, the challenges towards the adaptability of employees does not differs on the basis of age. The mean value of employees reflects that employees more than equals to forty years and less than 50 years (32.76) slightly faces more challenges towards adaptability whereas employees more than and equals to thirty years and less than forty years (29.57) faces less challenges.

Hypothesis- 5 (Based on Company).

H0- There exists significant difference towards challenges of adaptability of employees on the basis of company (Orissa Cement Ltd and Dalmia Cement Ltd.)

H5- There exists no significant difference towards challenges of adaptability of employees on the basis of company (Orissa Cement Ltd and Dalmia Cement Ltd.)

TABLE: 13-ANALYSIS (ON THE BASIS OF COMPANY)

		N	Mean	Std. Deviation	Std. Error Mean
Adaptability	Dalmia Cement Ltd.	41	30.85	8.943	1.397
	OCL India Ltd.	39	31.74	8.690	1.391

TABLE 14: INDEPENDENT SAMPLE T-TEST (ON THE BASIS OF COMPANY)

			Adaptability	
			Equal variances assumed	**Equal variances not assumed**
Levene's Test for Equality of Variances	F		0.970	
	Sig.		0.983	
t-test for Equality of Means	T		-0.451	-0.451
	Df		78	77.963
	Sig. (2-tailed)		0.653	0.653
	Mean Difference		-0.890	-0.890
	Std. Error Difference		1.973	1.972

	95% Confidence Interval of the Difference	Lower	-4.818	-4.815
		Upper	3.038	3.035

Interpretation- The table 13 and 14 shows that the value of p(0.983) >0.05.This implies that Null Hypothesis is accepted and Alternate Hypothesis is rejected . So, the challenges towards the adaptability of employees does not differs on the basis of company. The mean value of employees reflects that employees of OCL cement (31.74) are facing slightly more challenges towards adaptability rather than Dalmia cement (30.85).

VI.FINDINGS

The Exploratory Factor Analysis reveals four factors i.e**.** psychological factor, organizational factor, job-centric factor and work culture which create challenges towards employees' adaptability after the consolidation of Dalmia Bharat Cement and OCL India Cement Ltd. When this consolidation took place , the employees of both OCL and Dalmia cement were becoming psychologically weak and were under tremendous stress, confused in understanding that employees of which company would get more privilege and autonomy .As a result employees were lacking Psychological Competencies and thus were unable to establish a link between interpersonal and emotional competencies. They had become more impulsive and looking for psychological protection by asking several questions to the management, seeking feedback ,reporting mistakes and problems, proposing a new idea without bothering the negative consequences to themselves, their job or their career. After the consolidation process, Dalmia cement started implementing their policies which sometimes proved unacceptable for the part of the employees of OCL. The reallocation of manpower, performance appraisal policies, training and development policies sometimes created difference of opinion among the employees. But as far as compensation is concerned , the employees are very satisfied. As far as job security is considered, employees are in dilemma. After the consolidation process, there was excess of manpower so the employees felt that their job is at stake.

The Multiple Linear Regression establishes that organizational factor has a vital role to play in inculcating organizational citizenship behaviour among the employees. It has been observed that employees were expecting changes in the organizational policies with respect to proper KRAs mapping, sound welfare schemes, employee empowerment schemes and systematic performance appraisal schemes whereas work culture was not having any significant influence. After the consolidation, the organization had incorporated some amendments on KRAs mapping i.e. the existing employees are put strictly in KRA rating and without paying attention to loyalty of employees, the company had initiated new recruitments followed by centralization of decision-making process. On the other hand, transfers had become a frequent activity. Some of the policies were quite impressive for the employees like women safety and security measures ,promotion and increment policies.As far as hypotheses are concerned there exists no significant difference towards challenges of adaptability among the employees on the basis of area, employability status, age, experience and company. This signifies irrespective of the above bases all employees are facing same type of challenges during this consolidation process.

VII. RECOMMENDATIONS

It has been observed that during this amalgamation process the employees of both the companies were under huge psychological stress. Thus the company could handle this situation through proper one-to-one counselling, acknowledging them with their job-role, present status of the company and listening carefully their grievances.

Employees are very much worried about some of the human resource policies like performance- appraisal policies, transfer and promotion policies. Company should adopt effective man-power policies so that existing employees should not have job-insecurity. Frequent transfers should be minimized. Promotion policies should be backed by both merit and seniority.

The reflection of this amalgamation showed with diverse feelings comprises of excitement, apprehension, confusion, enthusiasm and resistance among. An effective and well-planned communication strategy could have been an effective instrumental tool reflecting the shared vision for the new organization, the essence and progression of integration and the expected benefits. For future decisions, the findings and rough timelines should be also be effectively communicated to the employees. The personnel of the Human Resource Department should pay regular visits to the District offices for acknowledging the employees regarding the strategic decisions of the new organization.

It had been observed that for a stipulated time period ,employees' collision had taken place. This had led many key employees to leave the organization. It was the prime responsibility of the top management to handle this micro-level issues effectively.

VIII.CONCLUSION

Merger and Acquisition is a strategic driven process. When this process is initiated, apart from structural-focused change and policies-focused change, organization should give importance to employees-focused change by redefining the organization goals and strategy. It can be concluded stating that during this process companies should adopt a proper and systematic change management system through an integrated process by associating economic performance with non-economic performance factors. During this amalgamation process, companies should understand each other culture by actively involving employees. Both the leaders should be very clear and honest in their communication part otherwise risk of confrontation and disruption will proliferate. Transparency in communication not only retain employees but also increase loyal customers base which in turn enhance the efficiency of the consolidated unit.

"Adaptability is about the powerful distance between adapting to cope and adapting to win."

- Max McKeown

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Internal Marketing Orientation, Customer Satisfaction and Profitability: an empirical enquiry

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In the present scenario the service industries have gained immense importance due to the customer inclination towards it, but they are facing challenges regarding profit generation. Service industries are customer driven. Therefore, customer satisfaction and retention is the only mean to profitability. Proper implementation of Internal Marketing Orientation within the organization would develop customer orientation among the employees as they are the service delivery points and their quality of service deliveries would influence the satisfaction level of the customers to a great extent. This ultimately would enhance the profitability as well as financial performance of the company.

Various studies have explored different dimensions of Internal Marketing Orientation, Customer satisfaction, and Financial Performance in isolation, and also the nature of relationships among them in the context of advanced nations. But due to the Cultural difference, studies conducted on the employees of the advanced nations might result differently if the same is executed on the employees of the developing nations like India. Hence, the present study aims at developing a comprehensive model that would explain the nature of relationship among IMO, CS and Financial Performance, especially in the context of India.

For the purpose of the present work employees and customers of the selected companies from Hospitality, Healthcare, and Banking Sectors have been surveyed. A model of IMO has been developed post EFA. CFA confirms the strength of the model. Finally, Bivariate Correlation analysis has been employed to establish relationship among organization wise IMO, CS and FP values which revealed significant correlation between them.

The influence of IMO on CS and Profitability of the firm has been established here. A precise model of IMO is suggested in the present study, which may encourage service industries in implementation of IMO in the future.

Key words: Internal Marketing Orientation, Customer Satisfaction, Profitability, Exploratory Factor analysis, confirmatory Factor Analysis, Correlation

1. INTRODUCTION**:**

In the human capital reach countries like India, service sectors have contributed almost fifty percent of the GDP in last decade. This is because people are now more inclined towards consumption of various services like health care, hospitality, tourism etc. than consumption of material and agricultural goods. Service sectors are now flooded with demands [1]. Customers are the key component in service industries [2]. And success of any organization, operating in these sectors depends upon the customer satisfaction and retention [3].

In the absence of other measures, financial performance has been considered as the key indicator of customer satisfaction and profitability has appeared to be the most popular proxy measure for it [4]. Hence all the activities of the firms are directed towards achieving customer satisfaction and retention. In service industries employees are the service delivery points. Their qualities of services influence the level of customer satisfaction immensely [5]. Considering this, now service industries have recognized employees as the important factor in generating profitability. A successful implementation of customer orientation is impossible without the participation of employees [6]. Therefore organizations are now in the need of some Internal marketing practices in order to build customer orientation among the employees [7].

Further it has been observed that trained and motivated employees are more focused towards their jobs. They understand the importance of their service role and put best of their ability while serving the customers [8].

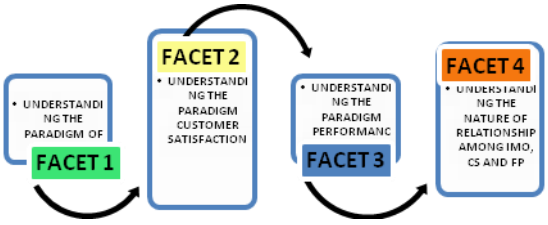
According to the Internal Marketing concept, employees are the internal customers of the

organization [9] and job is the product offered to them with various financial and nonfinancial benefits like salary, incentives, promotion, training etc [10]. A proper implementation of Internal Marketing Practice would develop Internal marketing Orientation among the employees, which in turn would enhance their service performance [11]. When customers are served with best quality services their level of satisfaction enhances. As a result, instead of moving to the other organizations, they will prefer to be attached this firm and a tendency to repeat purchase of the same service from the same organization could be observed among them [12]. This would lead to the improvement of financial performance and ultimately profitability objective of the firm.

2. THEORETICAL FRAMEWORK

A. Internal Marketing Orientation

The Internal Marketing Orientation happened to be the prime concern for the industries since last four decades [13] especially in service sectors [14]. It is the process of hiring, motivating and maintaining employees to deliver best possible service to the customers. Therefore IMO holds greater importance than external marketing [15]. According to this approach organizations are the markets [16] where employees are the internal customers [17a., 17b.]. Organizations offer ‘ ’ Job’ as the product with various financial and nonfinancial attributes in such a way that it would meet the need of the internal customers [18a., 18b., 18c.]. The behavioural approaches of employees in service sector play as the prime influence on customer satisfaction [19] because they represent the organizations while interacting with the external customers [20]. This magnifies the requirement of highly expertised service providers [21]. An evidence of strong relationship between service providers and end customers could be observed in service industries [22]. The main focus of Internal marketing practices is to intensify customer orientation among the employees [23] because customers are the key elements of enhancing financial performance of the firm, particularly in service sectors [24]. Due to the absence of an established internal marketing model [25] organizations use different marketing tools such as training, education, rewards, promotion etc as a measure to create internal marketing orientation among the employees [26a., 26b., 26c., 26d., 26e.]. Authors have considered various dimensions namely ‘ Internal communication’ , ‘ training’ and ‘ internal market research’ as the primary factors in constructing IMO model [27]. Further components like ‘ organizations approach to the career development of employees’ , ‘ opportunities of learning’ , ‘ effective learning while doing jobs’ were also considered in some IMO constructs [28]. Some of the authors included factors such as ‘ recognition’ , ‘ organizational Policies’ , ‘ nature of job’ , ‘ Salaries, promotion and fringe benefit’ , ‘ working environment including physical safety at work place’ , ‘ management decision relating to employees’ , ‘ Team work’ , ‘ co-workers’ , ‘ supervision’ , ‘ process of hiring employees’ , ‘ leadership style’ in developing IMO constructs [29a., 29b., 29c., 29d., 29e., 29f.].



STEPS FOLLOWED IN THE LITERATURE REVIEW

B. Customer satisfaction

As defined by author customer satisfaction is the pleasure that customers derive from the service offered to them as per their expectation [30]. Customers are now very conscious about the quality of service and any fluctuation in the quality would lead them to the shift the organizations [31]. Therefore service industries are now facing challenges in serving best of their abilities without any delay, error or defect [32]. Other than quality of service [33], factors like easy availability, post - sales service facility etc also hold a significant role in creating customer satisfaction [34].

Authors have suggested ‘ overall Satisfaction’ as one of the major components in measuring customer satisfaction in retail sales [35]. It has been considered as one of the nonfinancial paradigms in understanding the perception of the customers about the quality of service and their perceived satisfaction [36]. Further in some of the studies, the overall feeling of the customers towards the organization has been incorporated as a single item scale in measuring customer satisfaction [37]. Even in case of hotel industries, ‘ overall satisfaction’ happened to be one of the dominant variables [38]. Therefore now organizations pay full attention to it [39].

C. Financial Performance

In this highly competitive market, most of the industries, especially service sectors are in search of a standard measure that could predict financial performance and future possibility of financial distress accurately [40]. Financial ratios are one of the determinants in exploring financial condition of the firm [41]. Because various dimensions of financial condition of the firm such as financial strength, ability to loan repayment, portfolio position, share price etc could be well analyzed by using appropriate financial ratios [42]. Profitability ratios among others have been the most suitable in predicting the financial performance [43]. They are proved to be very significant in predicting bankruptcy, even individually [44]. As they are able to analyze future prospects of revenue

generation with accurate time frame [45]. Therefore industries have considered profitability ratios as one of the key components in evaluating the financial position of the firm [46].
Most of the organizations have considered improved service quality as the only aid to survive [47]. There is a strong connection between the employees' service quality and customer satisfaction, specifically in service sectors [48]. Implementation of IMO would develop customer focus among the employees [49] and improved customer satisfaction as a result of it [50]. Customer satisfaction develops a sense of customer loyalty [51] and an inclination towards repeat purchase [52].This would magnify the profitability of the firm [53].

3. IDENTIFICATION OF RESEARCH GAP

During the literature review, it was found that in most of the studies, researchers have explored various dimensions of Internal Marketing Orientation, Customer Satisfaction and Financial performance of the firm in isolation whereas some have explored partial relations among them. So it was necessary to establish a comprehensive relationship among all of them. Further most of the studies were conducted on the employees and customers of the western countries and a very little work has been done in eastern countries. There is a difference in culture between western nations and eastern nations and it affects the behaviour, level of motivation of people. Therefore researchers found it necessary to conduct the study on the employees and customers of eastern countries such as India, to analyse the comprehensive relationship among IMO, CS and financial performance in the context of eastern countries namely India.

4. DEVELOPMENT OF HYPOTHESIS

So as per the findings of various authors, there is a significant influence of IMO on enhancing the level of customers' satisfaction. Therefore we would anticipate the following:

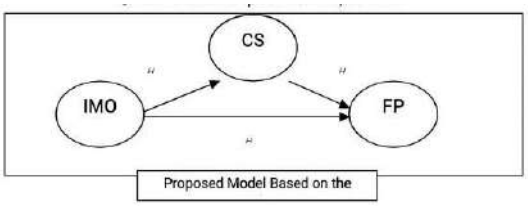
H_1: there is relationship between IMO and CS

Further, from various literatures it has been observed that customer satisfaction has an enormous influence in enhancing the financial performance and profitability of the firm. Therefore we would anticipate the following:

H_2: there is relationship between CS and FP

Since various studies have established influential function of IMO in building Customer satisfaction and again impact of CS in enhancing financial performance and generating profitability partially, we would anticipate the following:

H_3: there is relationship between IMO, CS and FP



4. METHODOLOGY

To develop a comprehensive model that explains the nature of the relationship among IMO, customer satisfaction and financial performance of the firm primarily some service sectors i.e. Hospitality sector, the Healthcare sector, and the banking sector have been selected as interaction between employee and customer necessitates the delivery of the profit performance of the business. PROWESS Database has been employed to generate the complete list of the companies operating in India under the Hospitality sector, Healthcare sector and Banking sector. Further, the list has been narrowed down to the number of Hotels Hospitals and Banks which are having Head Office, Registered Office or Branch operating in Kolkata. 81 organizations in total satisfied the criteria. But 9 Hotels, 7 Hospitals, and 14 Banks are randomly selected finally from this list and employees and customers of these organizations are surveyed to identify the variables.

Separate sets of questionnaires have been prepared for employees (valid scale of IMO developed by Naude, P., Desai, J.& Murphy, J. (2003) [54] has been employed to identify the variables with Required modification of the language in accordance to the service sectors) and customers (single item has been considered i.e. Overall satisfaction) of the selected companies. Further Secondary data related to the profit of the selected organizations for a period of ten years 2006 to 2016 have been collected from prowess database. The survey has been executed among randomly selected employees and customers of the selected companies after receiving formal consent from them.

5. METHOD OF SURVEY

Prowess database has been employed in collecting the list of Hotels, Hospitals and Banks either having head office, or registered office of branch operating in Kolkata. 9 Hotels, 7 Hospitals and 14 banks have been chosen randomly for the purpose of survey.

Table 1: DETAILS OF ORGANIZATIONS SELECTED FOR THE STUDY

Category	Total No. Of Organization in India	No. Of organization selected		
		As per the condition	Randomly selected for the study	%
Hotels	335	31	9	29
Hospitals	128	25	7	28
Banks	25	25	14	56

During the process of questionnaire development for employees, IMO scale suggested by Naude, P., Desai, J.& Murphy, J.(2003) [55] has been employed scale after customization of the language in relevance to the service sectors. Separate questionnaire has been prepared for the customers of the selected companies in order to understand their perspective on the overall satisfaction. For all measures 5-point Likert scale rating " 1' as ' highly dissatisfied' to ' 5' as " highly satisfied" have been applied. Finally " Profit after Tax" has been considered as the profitability indicator of the company.
Total 132 employees of Hotels, 117 employees of Hospitals and 176 employees of Banks were approached and formally requested to participate in this survey. Ultimately 103 employees of Hotels, 71 employees of Hospitals and 139 employees of Banks were agreed and interviewed. The response rate of the employees was between 62% - 78%. For customer survey, total of 115 customers of Hotels. 120 customers of Hospitals and 165 customers of Banks were approached and requested to participate in this survey. Later 36 customers of Hotels, 23 customers of Hospitals and 27 customers of Banks were selected randomly for the purpose. The response rate of the customers for the survey ranges between 16% - 31%.

Exploratory Factor Analysis is the most realistic approach for variable reduction and latent factor identification as it also explains the inter-correlation among various factors. Thus the merit of the developed model could be well analysed through this. Therefore EFA has been proposed to be executed to identify latent factors of the Internal Marketing Orientation model. Further Degree of the model fit of the newly developed model of IMO has been tested in isolation with Confirmatory Factor Analysis. it is a process of Sequential Equation Modelling to ensure the Goodness of fit between the sample data and hypothesized model developed by Exploratory Factor Analysis where modification indices explain the useful path accumulation to the model. AMOS 21 software has been employed in executing Confirmatory Factor Analysis. But application of CFA, in order to develop a comprehensive model among IMO, CS and Financial Performance of the company would be methodically inappropriate. Because employee responses and customer responses are available at the individual level whereas PAT is available at the organizational level. So, all data needs to be converted at the organizational level, in order to explore impact of IMO on Customer Satisfaction and PAT, from the extent of correlativity among them.

6. ANALYSIS

A. Exploratory Factor Analysis to identify the relevance of dimensions of Internal Marketing Orientation

Further to refine the collected data, Exploratory Factor Analysis has been executed as it is the most realistic approach for variable reduction and latent factor identification in order to study the merit of the construct. SPSS software has been employed for the purpose.

The Bartlett' s test of sphericity identified significant (0.000) degree of correlativity among the variables and the value of Kaizer-Meyer-Olkin (0.746; *the recommended value is >0.50* [56]) explained the suitability of the sample for execution of Exploratory Factor Analysis.
Two factors were extracted with ' Eigen Value' greater than one having 66.301% capacities to explain variance of variables together [57]. Furthermore seven variables namely IMO4, IMO9, IMO10, IMO2, IMO3, IMO6 and IMO15 having communality greater than 0.6 which means these variables play great role in elucidate the latent factors. But two variables IMO11, IMO1 with < 0.6 commonality have been considered in this study due to their high factor loading. The pattern matrix table illustrates pattern loadings for variables in all factors *(recommended value > 0.4* [58]). It is the last and the final step before deciding upon the number of components to be considered in the model. Under two factors total nine variables are identified with pattern loading greater than the reccomended value.nd the factors are labelled as : (i) TRAINING & EMPLOYEE SERVICE (IMO Factor 1) and (ii) POSITIVE PHILOSOPHY (IMO Factor 2).

Table 2: SUMMARY OF EXPLORATORY FACTOR ANALYSIS

KMO		0.746					
BARTLETT'S TEST OF SPHERICITY		0.000					
Total variance explained		Factor 1		Factor 2		Total	
		51.588%		14.713%		66.301%	
Commonality		Pattern Matrix					
IM04	0.668	Factor 1 TRAINING & EMPLOYEE SERVICE	IMO4	0.807	Factor 2 POSITIVE PHILOSOPHY	IMO2	0.526
IM09	0.743		IMO9	0.856		IMO3	0.469
IMO10	0.843		IMO10	0.932		IMO6	0.820
IM02	0.749		IMO11	0.732		IMO15	0.783
IM03	0.626					IM01	0.785
IM06	0.633						
IMO15	0.629						
IMO11	0.493						
IM01	0.582						

B. Test of Reliability and validity of the newly developed Internal Marketing Orientation model

To measure the accuracy of the newly developed model reliability, internal consistency, and convergent validity have been examined. The Cronbach' s alpha scores for IMO F1 (**0.851**), and IMO F2 (**0.825**) are as per the recommended value (*higher than 0.7* [59]). Average Variable Extracted (AVE) value for IMO F1 (0.697), IMO F2 (0.480) are also within the recommended range (*recommended value >0.5* [60]). So the result is highly satisfactory.

Table 3: SUMMARY OF RELIABILITY STATISTICS

RELIABILITY STATISTICS				
	Cronbach's Alpha		AVE	CR
Recommended values	>0.7 (Hair et al., 2010)		>0.5 (Hair et al., 2010)	>0.7 (Hair et al., 2010)
Items	Cronbach's Alpha	No. Of items	AVE	CR
IMO1	0.851	4	0.697	0.901
IMO2	0.825	5	0.480	0.815

Initially, fifteen indicators have been considered for the Internal Marketing Orientation model. But post execution of EFA only nine Variables are extracted under this newly developed model of IMO.

Table 4: RESTRUCTURED MODEL FOR INTERNAL MARKETING ORIENTATION

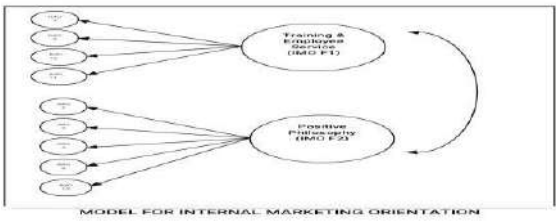
(Based on the model developed by Pete Naude et.al, 2002)

IMO FACTOR 1 TRAINING & EMPLOYEE SERVICE		IMO FACTOR 2 POSITIVE PHILOSOPHY	
IMO4	Our organization views the development of knowledge and skills in employees as an investment rather than a cost.	IMO1	Our organization offers employees a vision that we can believe in.
IMO9	Experience gathered from employees is used to improve jobs and to develop the strategy of the organization.	IMO2	Our organization's vision is well communicated to all employees
IMO10	In our organization, those employees who provide excellent service are rewarded for their efforts.	IMO 3	This organization prepares employees to perform well.
IMO11	In this organization, employees are properly trained to perform their service roles.	IMO6	Our organization teaches employees "why they should do things" and not just "how they should do things".
		IMO 15	Our organization communicates to employees the importance of their service roles

C. Result of Confirmatory Factor Analysis on the Internal Marketing Orientation model developed during Exploratory Factor Analysis

Exploratory Factor Analysis eliminates factors with low correlation and provides factors with high factor loadings. But all the dimensions of the construct could not be explained through this. Hence Confirmatory Factor analysis is executed. It is the process of Sequential Equation Modelling to ensure the Goodness of fit between the sample data and hypothesized model developed by Exploratory Factor Analysis [61]. Hence to establish the strength of the result of EFA we have conducted the Confirmatory factor analysis using AMOS 21 software.

The CMIN/DOF value for the IMO model is 4.605 which reveals the goodness of model fit (*recommended value less than or equals to 5* [62]). The GFI (0.948; *recommended value >0.80* [63]), AGFI 9 0.871; *recommended value >0.80* [64]), RMSEA (0.108; *recommended value < 0.10* [65]), RMSR (0.053; *recommended value is close to zero* [66]*),* NFI (0.953; *recommended value >0.80* [67]), CFI (0.963; *recommended value >0.90* [68]*),* TLI (0.925; *recommended value >0.80* [69]), PNFI (0.477; *recommended value ranges between 0 to 1* [70]) reveal satisfactory result in assessing the goodness of model fit. Therefore, IMO model is well established because more than or at least one from each types (Absolute, Relative, Parsimonious based fit indices) of goodness of fit indices are sufficiently accepted.



MODEL FOR INTERNAL MARKETING ORIENTATION

Table 5 : Summary of Goodness of Fit statistics of Confirmatory Factor Analysis

Table 5: Summary of Goodness of Fit statistics of Confirmatory Factor Analysis

Indices	CMIN/Df	GFI	AGFI	PGFI	RMR	RMSEA	NFI	CFI	TLI	PNFI
Obvserved Value	4.605	0.948	0.871	0.379	0.053	0.108	0.953	0.963	0.925	0.477

D. Test of Composite Reliability (CR) and Convergent validity of the developed models

The internal consistency of the measures has been examined through Composite Reliability Test. The results are satisfactory (CR IMOF1 0.901; CR IMO F2 0.815; *recommended value .0.7* 0[69]). Therefore variables chosen under the factors are well fitted for the construct and show better internal consistency. Furthermore in order to understand the ability of the latent factors in representing the convergent validity, Average Variance Extracted has been examined. The result is also highly satisfactory (AVE IMOF1 0.697; AVE IMOF2 0.480; *recommended value > .0.50* [70]).

In addition to that, Maximum Shared Squared Variance (MSV) and the Average Squared Variance (ASV) are examined to investigate the discriminant validity of the measurement model. The value MSV and ASV for both IMOF1 and IMOF2 is lesser than the AVE. The results interprets that the discriminant values of the measurement model are in accordance with the initial hypothesis.

Table 6: SUMMARY OF COMPOSITE RELIABILTY AND CONVERGENT VALIDITY OF THE DEVELOPED MODEL

Variance & Reliability					A factor Correlation matrix with √AVE on the diagonal	
Construct	AVE	CR	MSV	ASV	IMO1	IMO2
IMO1	0.697	0.901	0.06368	0.06368	0.8348	
IMO2	0.480	0.815	0.06368	0.06368	0.798	0.6928

E. The nature of the relationship among Internal Marketing Orientation, Customer Satisfaction and Financial Performance (PAT)

The focus of the present study is to establish a comprehensive model that establishes a relationship among IMO, CS and Financial performance of the organization. But the study

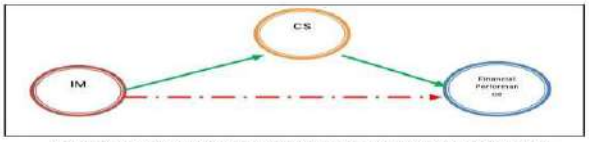
faced challenges in terms of Methodology for establishing the comprehensive. Because Part of this model is based on the employee's opinion and the other parts of the model are based on the customers and secondary data related to the profit. Now data related to profit is available at the organizational level, though customer and employee data is available at the individual levels. Therefore analysing the comprehensive relationship among IMO, CS and FP from the degree of correlation is impossible. Hence the values of IMO have been calculated at the organizational level by taking representative value of employees based on qualitatively judged opinion leader one from each organisation and average (Arithmetic Mean) view of customers of the corresponding organization. All the data are now at the level of organization. Finally Bivariate correlation between each possible pair has been executed to observe correlativity among these three dimensions. The best score of the correlations of each dimension have been taken. Actually the possibility of considering the highest correlation values is not eliminated as they could have been optimistic or non pessimistic in order to predict the nature of relations. The result revealed significant positive correlation between IMO-CS, CS-PAT (Financial Performance) and IMO-PAT which explains that there is a positive influence of IMO on Customer satisfaction. Then customer satisfaction influences financial performance and finally there is a significant influence of IMO on Financial Performance of the firm (PAT).

TABLE 7: SUMMARY OF CORRELATION AMONG VARIOUS FACTORS

Various factors	CS	PAT
IMO	.649**	.638**
PAT	.532**	———

6. CONCLUSION

Service industries are customer-driven. Therefore all the activities of the organizations are directed towards developing customer satisfaction and retention. The present study has identified the significance of IMO in enhancing the customer satisfaction. Because a successfully implementation of internal marketing practices would develop customer centric behaviour among the employees. This will help firms to generate satisfied customers and when customers are happy with the service of the organization, it will contribute to profit maximization. The present study has recommended uniform IM practice which brings together all the major determinants of Internal Marketing Orientation specifically applicable in all service industries. Another outcome of the study is the significance of IMO in enhancing the financial performance of the company. As continuous execution of various internal marketing orientation programs will enhance the expertise of the employees and will increase the rate of employee retention with the organization. Thus the firm would be able to minimize its cost and maximize the profit. This comprehensive model among IMO, CS and Financial Performance would be beneficial for industries and academics as it suggests a direct relationship of IMO with customer satisfaction and financial performance. Furthermore this realistic model has suggested a set of IMO practices which would help service industries in application. The study also brings the probable explanation of why some organizations with good IMO fail to generate profit while others are achieving so.



A deductive model explaining the relation between IM, CS and Financial Performance

7. LIMITATIONS OF THE STUDY

The study has been executed based on the data collected from Banks, Hotels, and Hospitals operating in Kolkata. Due to the time and resource constrains a limited number of employees and customers have been considered during survey. Therefore the newly developed model should be tested on the large numbers of employees across all the levels of the organization to ascertain the model. The possibilities of varied outcomes cannot be overruled, if the model is experimented on large groups of populations, from different regions of the country. Finally, the present study has considered single parameters namely ‘ Overall satisfaction” and “ Profit after Tax” in measuring Customer satisfaction and Financial Performance of the firm which limits the acceptability of the outcome. Therefore other parameters should be incorporated in future studies.

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Assessing the implications of digital media piracy in India

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Abstract— Digital media piracy is a major concern in sales in industries of music, motion pictures, software, eBooks, etc. Since the advent of file sharing technologies, there has been a steep rise in the levels of media piracy and a significant drop in the sales from various forms of media. This study aims to understand if there is any relation between the age and the gender of the user, and their tendency to participate in the act of file-sharing. The study also tries to check if there exists any relation between the age and gender of a person and their attitude towards piracy, variation in the types of media they pirate and the knowledge they possess on the effects of piracy on various industries. Data for the study is collected through a survey conducted amongst 260 people, across various age groups and settlements. The results suggest that there exists a strong association between the age of a person and their tendency to participate in the act of file sharing. The results show that the attitude of a person towards piracy changes with their age. However, no strong relation could be established between the age of a person and their knowledge of the effects of piracy on various industries.

Keywords— File sharing, age and gender dependence of piracy, Chi-square test

I. INTRODUCTION

Digital media includes any form of media that are encoded in a machine-readable format. Computer software, digital imagery, digital video, audio and eBooks are all examples of digital media. Most of the digital media is protected by the copyright laws, legal right created by the law of a country that grants the creator of an original work exclusive rights to its use and distribution, usually for a limited time. The unauthorised use or reproduction of such copyrighted material is often referred to as "piracy," an issue which has become rather prevalent in the modern society.

II. LITERATURE REVIEW

[1] in their paper "The Effect of File Sharing on Record Sales: An Empirical Analysis" aimed at analyzing whether file-sharing reduced the legal sales of music. The authors use data collected from OpenNap servers for a period of 17 weeks from September 8 to December 31, 2002 and a sample of albums sold in U.S. stores in the second half of 2002. They find that file sharing [1] doesn't have any statistically significant impact on purchases of albums.

[2] in "How Reliable is the Oberholzer-Gee and Strumpf Paper on File-Sharing?" that Oberholzer-Gee and Strumpf data might have overstated the impact of German users on U.S.-based downloads. It was observed that Oberholzer-Gee and Strumpf's estimate indicates that the predicted increase in piracy levels is very large, to an extent that in weeks where no German school kids were on vacation, all the U.S. file sharing should fall to zero.

[3] in their paper "Don't Blame the P2P File-Sharers: The Impact of Free Music Downloads on the Purchase of Music CDs in Canada" also find no harm on CD sales from file sharing after having analysed the results of survey responses of Canadian file sharers in 2006.
On the contrary, [4] in their paper "The Impact of Free Music Downloads on the Purchase of Music CDs in Canada" found the opposite result using the same dataset, after having corrected two "fundamental errors" in the analysis by [3].

[5] in their paper "Piracy on the High C's: Music Downloading, Sales Displacement, and Social Welfare in a Sample of College Students" studied the purchase and piracy behavior of 412 college students at 4 colleges in 2003. They found that for every pirated download, 0.2 album sales got displaced, and hence, overall piracy reduced about 20% of the expenditure on music per capita.

[6] in their paper "Piracy or promotion? The impact of broadband Internet penetration on DVD sales" use the DVD sales data and broadband internet penetration for the years 2000-2003. It was found that higher internet penetration resulted in a 9.3% or the $14.1 billion increase in DVD sales in the period.

[7] in his paper "Testing File-Sharing's Impact on Music Album Sales in Cities" suggests that there was a significant decrease in the sales of music CDs in the period, this study suggests something very contrary to the results. This could be attributed to the fact that the surge in motion picture piracy occurred only after the introduction and development of the Bittorrent Protocol, which was not developed by this period.

[8] in his paper "Measuring the Impact of File Sharing on the Movie Industry: An Empirical Analysis Using a Panel of Countries" shows that DVD and VHS sales combined, dropped by about 27% from 2004 to 2008. [8] uses data from over a period of time, in multiple countries to control for factors unrelated to the broadband penetration.

III. Research Methodology

A survey was conducted to gather more information on the percentage of people involved in file sharing in the set of people responding to the survey. The survey also helped in gathering information about the various factors which might or might not be affecting the file-sharing behavior of the responders, such as their age group, gender, and the type of settlement they live in. It also helped understand the perspective of the public towards piracy and the amount of knowledge people had on the effects of piracy on a larger scale. Also, information regarding the kinds of files usually pirated by them and the reasons behind such behavior were also obtained as a part of the survey. The survey questionnaire and the responses have been attached in the report as Appendix A and Appendix B respectively.

The survey was shared over social networking websites, e-mails and through other channels such as WhatsApp groups and broadcast emails. Efforts were put to ensure that the survey was filled in by people from all the age groups.

The survey got 260 responses after being circulated for about 2 weeks. The age groups of 16-30 years and 31-45 years responded the most with about 29.3% and 26.6% of the responses, respectively. This could be because of social networking sites amongst the age groups, where the survey was shared highest. The least number of responses were obtained from the age group of "Above 60 years", which could be attributed to the lower level of internet usage in this age group. The survey also took the information on the gender of the responder and it was observed that about 54% of the responders were male as compared to the 46% of female responders.

In addition to these details, the survey also gathered information on the living conditions of the responders and the statistics for the same can be seen in the chart below.

Of the 260 responses, 179 people answered that they have participated in the act of file sharing in one form or the other. Also, 144 people feel that it is acceptable to illegally share files over the internet, while 16 people are not sure of it. It was found that music was the most frequently pirated form of digital media over the internet, closely followed by movies. 158 people responded with a "Yes" to having downloaded music illegally over the internet, while 154 people did so for movies. TV shows, eBooks and software followed with lower numbers.

When asked about the reasons for participating in file sharing, the reasons were primarily the high prices of genuine goods and limited availability. People also argued that there was no point in paying for media forms which were available for free over the internet (and hence, justify piracy). Also, about 170 of the 260 responders said that they had an idea of the effects piracy had on various industries.

The information collected from the survey can be used to find correlation between factors such as the age group, living conditions, etc. and the tendency to participate in illegal file sharing.

IV. Analysis and Result

The aim behind the study is to find correlation between the various factors and the level of piracy and the type of media pirated. In order to achieve the same, Pearson's Chi-square test needs to be performed for the following sets of data to test for independence.

A. Pearson's Chi-square test

In order to establish the independence (or dependence) of the levels of piracy and the type of media pirated, Pearson's Chi-Square tests must be performed for the following data fields. For the results, a significance level of 95%, which implies that the p-value must at least be 0.05.

B. Age Independence:

This test can help establish any relation between the age of a person and their tendency to pirate digital media. The survey divides the entire population into 5 age groups viz. 0-15 years, 16-30 years, 31 - 45 years, 46 - 60 years, and above 60 years.

- A person who falls in one of the age groups cannot be a part of another age group, hence making the events mutually exclusive.
- The chosen set of events ensure that all the age groups are covered in the dataset, hence making the total probability 1.
- The frequency of each value is more than 5, hence making it valid for a Pearson's Chi-square test.

The data available on age is, hence, valid to perform a chi-square test on.

C. Age vs. Participation in file sharing:

The answer for participation in file sharing can only be "yes" or "no", hence making them mutually exclusive

The total probability of the set of events is 1

The frequency of each event is more than 5

This implies that the data available on participation in file sharing is valid for a Pearson's chi-squared test.

Null hypothesis (H_0): There is no association between the age of a person and their participation in file sharing.

The computed Pearson Chi-square ratio is 28.742, with 4 degrees of freedom and has an associated probability (p-value) of nearly 0. This implies that the null hypothesis can be rejected.

It was observed that there is a strong association between the age of a person and their tendency to participate in file sharing, χ^2 (4) = 28.742, p = .000.

D. Age vs. Acceptability of file sharing

- ➔ The answer for acceptability of file sharing can only be "yes" or "no", hence making them mutually exclusive
- ➔ The total probability of the set of events is 1
- ➔ The frequency of each event is more than 5

This implies that the data available on acceptability of piracy is valid for a Pearson's chi-squared test.

Null hypothesis (H_0): There is no association between the age of a person and the attitude towards the act of piracy.

The computed Pearson Chi-square ratio is 19.422, with 4 degrees of freedom and has an associated probability (p-value) of 0.0006, which is lower than 0.05. This implies that the null hypothesis can be rejected.

It was observed that there is a strong association between the age of a person and their attitude towards file sharing, χ^2 (4) = 19.422, p = .0006.

E. Age vs. Forms of digital media

- ➔ The answer for pirating any form of digital media can only be "yes" or "no", hence making them mutually exclusive
- ➔ The total probability of the set of events is 1 for each media type
- ➔ The frequency of each event is more than 5

This implies that the data available on piracy of each media type is valid for a Pearson's chi-squared test.

Null hypothesis (H_0): There is no association between the age of a person and the level of piracy of the type of digital media.
Table 1 shows that the p-value for all the 5 forms of digital media are lower than 0.05, and hence, the null hypothesis is rejected.

It was observed that there is a strong association between the age of a person and the piracy level of all the 5 major forms of digital media, viz. music, movies, TV shows, software and eBooks.

F. Age vs. Knowledge on effects

This test will help in understanding if the knowledge on the effects of piracy is related to the age of the person in any way. In order to perform this test, the data available the knowledge on effects should satisfy all the criteria for a chi-square test.

- ➔ The answer for knowledge on the effects can only be "yes" or "no", hence making them mutually exclusive
- ➔ The total probability of the set of events is 1
- ➔ The frequency of each event is more than 5.

This implies that the data available on knowledge on effects of piracy is valid for a Pearson's chi-squared test.
Null hypothesis (H_0): There is no association between the age of a person and their knowledge on the effects of piracy.

The computed Pearson Chi-square ratio is 3.169, with 4 degrees of freedom and has an associated probability (p-value) of 0.53, which is greater than 0.05. This implies that the null hypothesis holds true.
It was observed that there is no association between the age of a person and their knowledge on the effects of file sharing on various industries, χ^2 (4) = 3.169, p = .53.

G. Gender dependence

The survey divides the entire population into male and female.

- A person who belongs to one gender cannot belong to the other, hence making the events mutually exclusive.
- Both the genders, viz. male and female, are a part of a survey, hence making the total probability 1.[2]
- The frequency of each value is more than 5, hence making it valid for a Pearson's Chi-square test.

H. Gender vs. Acceptability of file sharing

Null hypothesis (H_0): There is no association between the gender of a person and their attitude towards file sharing.
The computed Pearson Chi-square ratio is 1.762, with 2 degrees of freedom and has an associated probability (p-value) of 0.41. This implies that the null hypothesis holds true.
It was observed that there is no association between the gender of a person and their tendency to participate in file sharing, χ^2 (2) = 1.762, p = .414.

I. Gender vs. Forms of digital media

This test will help in determining if the type of media pirated by people is different for both the genders.

Null hypothesis (H_0): There is no association between the gender of a person and the level of piracy of the type of digital media.
The p-value is greater than 0.05 for 3 of the 5 data types, hence rendering the null hypothesis true for them. However, for TV shows and software, p-value is lesser than 0.05, and thus, the null hypothesis is false.

- Music, movies, TV shows and eBooks: There is no association between the gender of a person and

[2] The intersex, transgender, and bisexual together represent about 0.1% to 1.7% of the world's population and is very small when compared to the total. Hence, this is neglected for approximation.

their contribution to the level of piracy in music, movies, TV shows, and eBooks.

- Software: There is a strong association between the gender of the person and their contribution towards piracy of software, χ^2 (1) = 8.127, p = .004.

J. *Gender vs. Knowledge on effects*

Null hypothesis (H_0): There is no association between the gender of a person and their knowledge on the effects of file sharing.

The computed Pearson Chi-square ratio is 0.031, with 1 degree of freedom and has an associated probability (p-value) of 0.86. This implies that the null hypothesis holds true.
It was observed that there is no association between the gender of a person and their knowledge on the effects of file sharing on various industries, χ^2 (2) = 1.762, p = .414.

V. Conclusions

Piracy has been a constant reason for leakage in the sales of digital media, and has been at large since the introduction of Napster in 1999 and Bit torrent in 2003. This study was aimed at checking if there was any association between the age and gender of a person and their inclination towards piracy. The following results were obtained:

1. There is an association between the age of a person and their participation in file sharing.
2. There is an association between the age of a person and their attitude towards file sharing
3. There is an association between the age of a person and the piracy level of all the 5 major forms of digital media, viz. music, movies, TV shows, software and eBooks.
4. There is no association between the age of a person and the knowledge they possess on the effects of piracy on various industries.
5. There is no association between the gender of a person and their willingness to participate in piracy.
6. There is no association between the gender of a person and their attitude towards file sharing.
7. The association between the gender of a person and the piracy level of the 5 major forms of digital media is as follows
    a. Music, movies, TV shows, and eBooks: There is no association between the gender of a person and their contribution to the level of piracy in music, movies, TV shows, and eBooks.
    b. Software: There is an association between the gender of the person and their contribution towards piracy of the type of digital media.
8. There is no association between the gender of a person and their knowledge on the effects of file sharing on other industries.

A. *Figures and Tables*

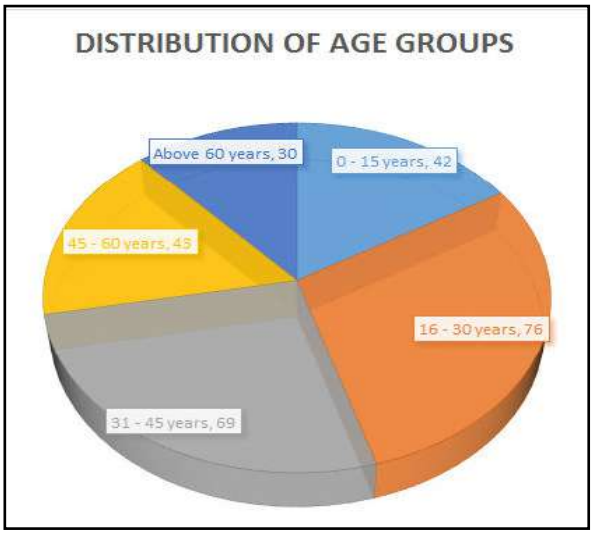


Fig.1. Distribution of responders across age groups
Source: Primary data obtained from the responses to the survey.

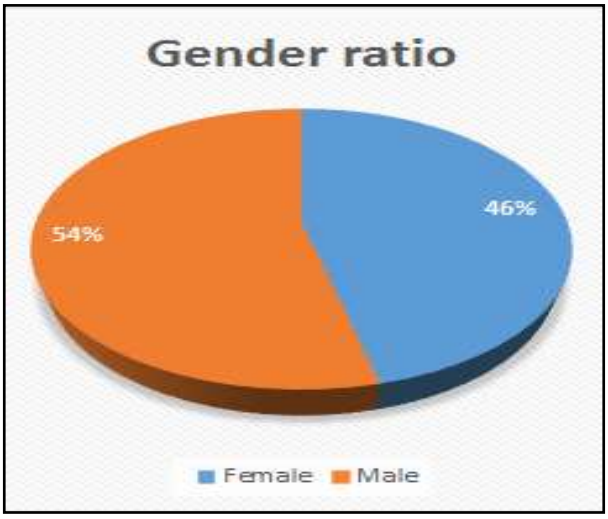


Fig. 2. Distribution of responders across
Source: Primary data obtained from the responses to the survey

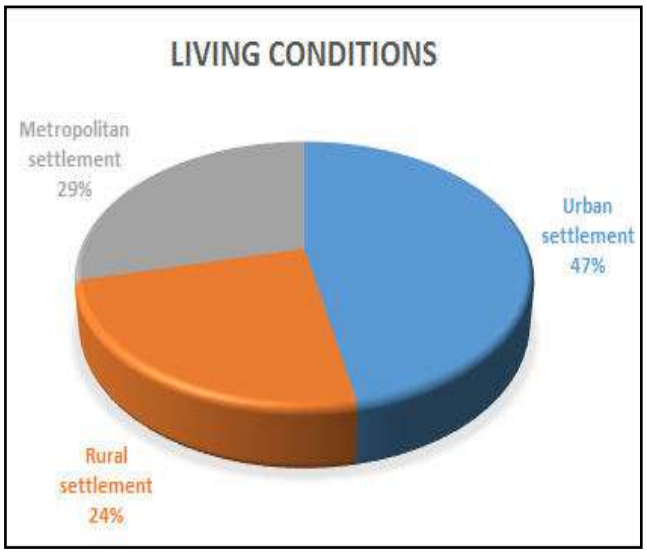
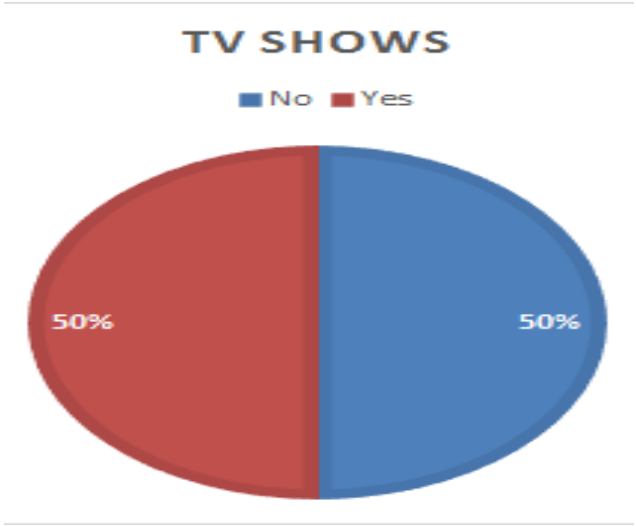
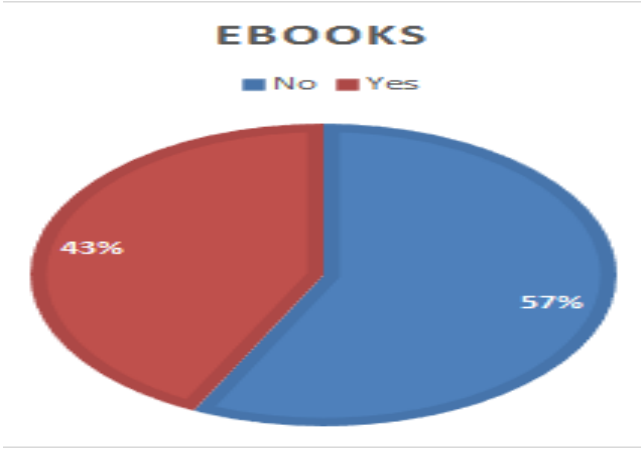
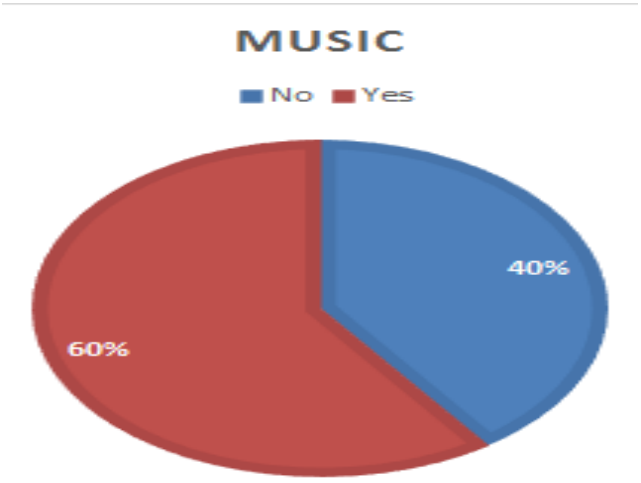
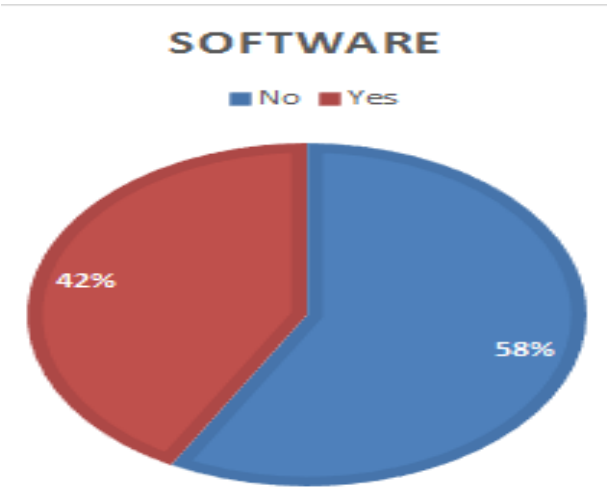


Fig. 3. Distribution of responders across living conditions
Source: Primary data obtained from the responses to the survey.









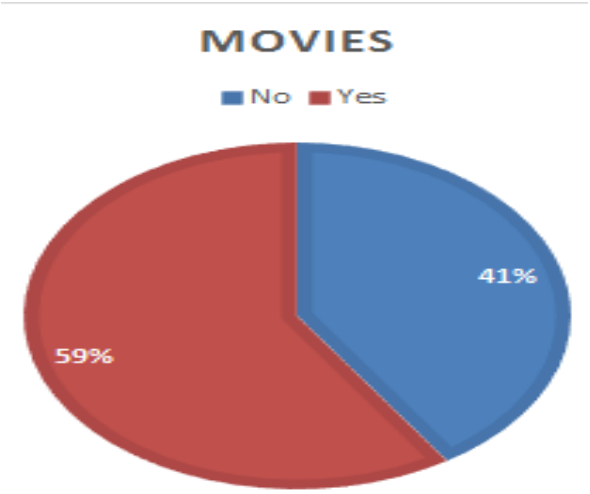


Fig. 4. Responses to tendency to pirate various forms of media.

Source: Primary data obtained from the responses to the survey

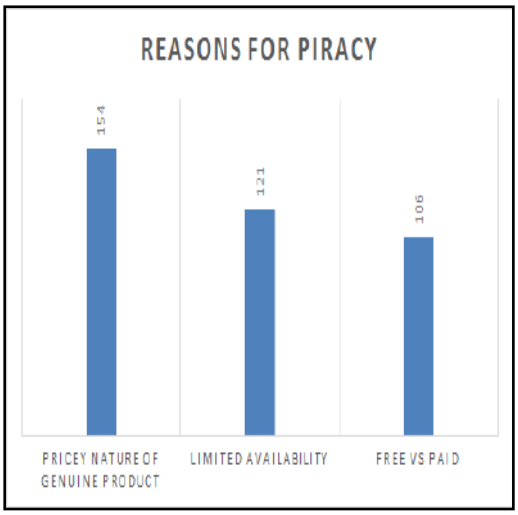


Fig.5. Distribution of reasons given by responders for pirating digital media.

Source: Primary data obtained from the responses to the survey

Table 1: Types of media vs. results of chi square test across genders

Type of media	Pearson Chi-square ratio	Degrees of Freedom	P-value
Music	2.277	1	0.131
Movies	1.652	1	0.199
TV Shows	0	1	1
Software	8.127	1	0.004
eBooks	1.731	1	0.188

Source: Results of tests performed on primary data

Table 1: Type of Media vs. Chi-square test results across age groups

Table 1: Type of Media vs. Chi-square test results across age groups

Type of media	Pearson Chi-square ratio	Degrees of Freedom	P-value
Music	24.016	4	0.0001
Movies	17.690	4	0.001
TV Shows	28.294	4	~ 0
Software	23.205	4	0.0001
eBooks	28.209	4	~ 0

Source: Results of tests performed on primary data

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Multi Layered Approach Based On Real Time Data: Hybrid Approach to deal with Credit Card Frauds

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***Abstract*—**Data breach is a common problem in the current age of digitalization and paperless transactions. Banking and payment industries are preferred targets for this type of cyber-crime. Both rule based fraud-monitoring systems and predictive modelling systems have failed to provide a fool-proof solution to the problem owing to their respective limitations in its approach and manner of institutional handling of such cases of frauds. This paper proposes a hybrid approach to solve the problems posed by various models and techniques. A comparative analysis of models proposes a loan-blend method addressing the issues. It proposes a methodology of detecting data crimes in Credit Card industry. It compares and contrasts various machine learning algorithms in terms of their accuracy and effectiveness in combating the same. Real time data-sets are used for modelling and testing different algorithms in it and validating the model using confusion matrix. A functional architecture is undertaken for exploration of its uniqueness, relevance and implications

Keywords — Credit card fraud, Multi layered approach, Machine learning, Confusion Matrix, Loan blend method

I. INTRODUCTION

In recent times, there has been an unprecedented hike in the number of people preferring online paperless transactions and other process. Unlike physical processes, digital procedures create inordinate data seams that are difficult to analyze by traditional conventional tools. This leads to divergent crimes affecting various aspects of system behavior and outcomes. Credit Card fraud is a form of deception and theft where a person uses the confidential details of another's credit/ debit/ ATM card without the latter's knowledge or authorization and does so for personal gains at the cost of latter person's finances and privacy. These frauds are caused by negligence and negligence is part of consumer's behavior profile. Credit Card frauds involve theft of the physical card or unauthorized acquisition of Credit Card details, which may then be used for purchases, diverting funds, other personal gains or, in limited cases, to hurt or spite the original owner of the card.
The offence is compounded in cases where identity theft also becomes part of the equation. The perpetrator passes off himself as the owner, assuming his identity on paper and non-personal channels. Potentially catastrophic, this form of fraud is the hardest to nail or punish considering the fact that an innocent person loses his virtual identity to an offender, while the offender acquires, maliciously, an innocent identity that he could use to befool commercial as well as general targets.
Sheer volume of transactional data creates the biggest hurdle to successful adoption of monitoring systems. It is extremely difficult to examine or alienate problematic and fallacious transactions from an already crowded stream of transaction data because of the constant changes in patterns of such fraudulent transactions. Hence, most of the 'rule based' systems fail to predict these kinds of frauds as they end up with 'false alarms'.

Credit Card fraud prevention is not a Zero-sum-game. While taking preventive measures, many times legitimate transactions are blocked also. called as 'False Positives', False positives not only hit the merchant's sale but also dampen the trust of customers. At times, fraud prevention tools have known to create hurdles for the legitimate customer like high value of shopping, cart baskets, etc, Then merchants are left with no choice but to switch off some of the features of fraud prevention, which leaves the customer exposed to cheating by fraudsters.
'Rule based' fraud monitoring systems have their own limitations. For example, they only follow the rules defined in the system and generate an alarm in accordance, which result in majority of cases in false positives. On the other hand, if predictive modelling systems, work on the concept of probability. The output does not exhibit accuracy, but provides probability of occurrence of a fraudulent event.
Majority of white papers available on fraud detection lack databased analysis. Theories and predictions are proposed on the basis of mathematical models that, due to lack of availability of the data, are not tested in a real-time scenario. As such, it is difficult to prove robustness of a model or to attest probability to the success of modelling techniques used:

- To develop and analyse a multi layered red model to assess its effectiveness in detecting and preventing Credit Card frauds.
- To do a detailed analysis of 'variables of importance' and to conduct a comparative study between different models of Credit Card fraud detection

II. RESEARCH METHODOLOGY

The stages involved in generating the classifiers include: problem identification; collection of data; pre-processing of data, which includes cleansing of data; and analysis of data, which is basically data exploration.
Once defined, select classifier algorithm is formulated and the data is divided into training and testing (evaluation)

modules. During the pre-processing stage, the data is converted into useable format and fit, and sampled. Since 99% of the data is non fraudulent while 1% of data only is classified as fraudulent, there is clearly an Imbalance Class problem; a hybrid of under-sampling (the negative cases) and over-sampling (the positive cases) is carried out to achieve two sets of data distributions. In the analysis stage, feature selection and reduction would already be carried out on the given dataset using PCA. The training stage is where the classifier algorithms are developed and fed with the processed data. The experiments are evaluated using True positive, True Negative, False Positive and False Negative rates metric. The performance comparison of these classifiers is analysed based on accuracy, sensitivity, specificity, precision, Matthews correlation coefficient and balanced classification rate.

The Dataset used for the analysis here has been sourced from Kaggle, which consists of 31 variables. It comprises of transactions done by various customers, including time and amounts involved.

Totally, 284315 records are present in the dataset used, out of which only 492 have been tracked as fraudulent, which leaves 99% of data points. In this study, to evaluate these models, 70% of dataset has been used for training while 30% has been set aside for validating and testing. It means that the dataset is highly unbalanced in nature. Dataset consists of only one continuous numerical input except the dependent variable, which is a **Class variable** that gives idea about nature of the transaction. Hence, PCA analysis is used in order to predict the 'Variable of importance'. The results of PCA analysis represent that 'Proportion of Variance" reaches up to 85% by PC10. Hence, 10 variables are sufficient for the analysis

A. Sampling of the Unbalanced Class Problems:

Here the data shows 0's as the total number of cases in the data, which is 284315, and out of which class, '1' which represent the count of fraudulent case having a count of 492 cases. It means that Class 0, which is the dominating class and represents non-fraudulent cases, consists of 99.9% of entire data, while Class 1, which represents 0.0173% of total cases, reflects the fraudulent cases. Difference between Class 0 and 1 shows that it is an **Imbalance class problem** In such kinds of problems, when we are developing predictive models, one of the classes will be dominating while the other will be suppressed. When we predict a dominating class, the model will show maximum accuracy; it probably reaches 99% because Class 0 is comprised of 'Non Fraudulent' cases, occupying 99% strength of data. However, our objective is to predict Class 1, which is the 'Fraudulent Class', and which happens also to be the suppressed class. We don't achieve the accuracy desired in the model because of the same.

When few data points are available only for one class, in such cases, 'Sensitivity' and 'Specificity' always show a bigger difference. Here, sensitivity refers to prediction about the Objective Class and 'Specificity' denotes the dependent class.

In this scenario, we have to introduce 'Over Sampling techniques'[i] in order to bypass the imbalance class effect. For the same, here, we'll use the ROSE package (Random Over Sampling Examples) to do the sampling.

B. Results and Discussions:

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III. RESULTS AND DISCUSSIONS

A. Performance Evaluation and Results

Confusion matrix approach is used to evaluate the experiments. Confusion matrix is a table used to examine a classification model provided true values are available for a given data set. [The name of the matrix is a misnomer considering the ease of use and adaptability that it offers].

B. Right Case:

- TP (True Positive): When a Customer is buying the product; and the model too predicts that the customer would be buying the same.
- TN (True Negative): When a Customer is not buying a product; and model too predicts that the customer would not buy the same

C. Error Case:

- FN (False Negative): When models say that a Customer would buy a product but in reality, the customer is not buying the same. ***(Type-2)***
- FP (False Positive): When models says that a customer will not buy a product but in reality, the customer buys the same. ***(Type-1)***

The performance of naïvebayes, k-nearest neighbour and logistic regression classifiers are evaluated based on accuracy, sensitivity, and specificity.

Accuracy:
Sensitivity:
Specificity:
Precision:

Sensitivity and specificity play an important role here.

D. Solution: Approach

The most important feature, which every service provider looks for, is proactive fraud monitoring i.e. fraud detection as well as transaction blocking prior to payment, in order to minimize the losses. How the above details with each of the three classes of frauds outlined need to be discussed with specific attribute based functional and distorted outcomes in

case of fraud ,as an analogy to 'opportunity cost' concept in economics.

- Merchant-related Frauds
- Internet-related frauds
- Other frauds techniques

To create an off-the-shelf solution, in the case of fraud and risk, is very challenging. Hence, we propose a 'Hybrid approach' where the mode will act in two ways. It should cover, in a wider manner, both the components, which act during and after the transaction. Hybrid approach consists of multi layered security stack, which acts as a combination of 'Rule Set based System' and 'Predictive Data Analytics'.

IV. DATA ANALYSIS AND MODEL PREDICTION

Below mentioned are the details of the Comparison Model obtained from various Machine Learning Techniques.

A. *Conclusion*

This paper investigates the comparative performance of RPART, TREEBAG, NEURAL NETWORK, RANDOM FOREST, LOGISTIC REGRESSION, and GLM BOOST models in binary classification of imbalanced Credit Card fraud data. Comparative analysis has been performed due to lack of actual analytical and comparative analysis on real time data. Six classifiers based on various machine learning techniques i.e. NRPART, TREEBAG, NEURAL NETWORK, RANDOM FOREST, LOGISTIC REGRESSION and GLM BOOST models) were evaluated with original Credit Card transactional data, and their performances on Credit Card fraud detection were evaluated and compared on the basis of several relevant metrics. The highly imbalanced dataset has been sampled in a hybrid approach, where the positive class is oversampled while the negative class is under-sampled, achieving two sets of data distributions. The performances of the three classifiers are examined on the two defined sets of data distributions using accuracy, sensitivity, specificity and precision. Performance of classifiers varies across different evaluation metrics. Results from the experiment shows that the RANDOM FOREST shows significant performance for all the metrics evaluated.

As explained above, RANDOM FOREST is highly effective in detection of fraudulent cases. Apart from its efficiency, its ability to alienate requisite variables from others, less important, is exemplary. Another commendable feature of RANDOM FOREST is the fact that it sets aside the assumption of data normality.

The aptness of this model in fraud detection may be attributed to the fact that it does not require a data set to adhere to show theoretical variance. Data distribution and variance does not always adhere to theoretical norms, as a result of which, non-parametric tests like RANDOM FOREST find a higher rate of success with them than parametric models. The practical application in cases of credit card frauds, due to unusual and unpredictable distribution of data, RANDOM FOREST meets with a higher degree of success than the other models verified and proves to be a successful tool in proactively detecting the offence.

B. *Figures and Tables*

TABLE I. PCA ANALYSIS: IMPORTANCE OF VARIABLES

Sr. No.	*Standard Deviation*	*Proportion of Variation*	*Cumulative Proportion*
PC1	3.4213	0.3902	0.3902
PC2	1.8580	0.1151	0.5052
PC3	1.55338	0.08043	0.58567
PC4	1.36779	0.06236	0.64803
PC5	1.25516	0.05251	0.70055
PC6	1.18939	0.04715	0.74770
PC7	1.02958	0.03533	0.78304
PC8	0.98703	0.03188	0.81492
PC9	0.8950	0.0267	0.8416
PC10	0.85436	0.02433	0.86595
PC11	0.80500	0.02136	0.88731
PC12	0.76765	0.01964	0.90696
PC13	0.67146	0.01503	0.92199
PC14	0.64023	0.01366	0.93565
PC15	0.59850	0.01194	0.94759
PC16	0.53332	0.00948	0.95707
PC17	0.49010	0.00801	0.96508
PC18	0.47711	0.00759	0.97266
PC19	0.39194	0.00512	0.97779
PC20	0.37302	0.00464	0.98242
PC21	0.33685	0.00378	0.98621
PC22	0.30163	0.00303	0.99169
PC23	0.27137	0.00245	0.99357
PC24	0.23717	0.00187	0.99357
PC25	0.21762	0.00158	0.99515
PC26	0.20808	0.00144	0.99659
PC27	0.19036	0.00121	0.99780
PC28	0.17809	0.00106	0.99886

Sr. No.	*Standard Deviation*	*Proportion of Variation*	*Cumulative Proportion*
PC29	0.15979	0.00085	0.99971
PC30	0.09388	0.00029	1.00000

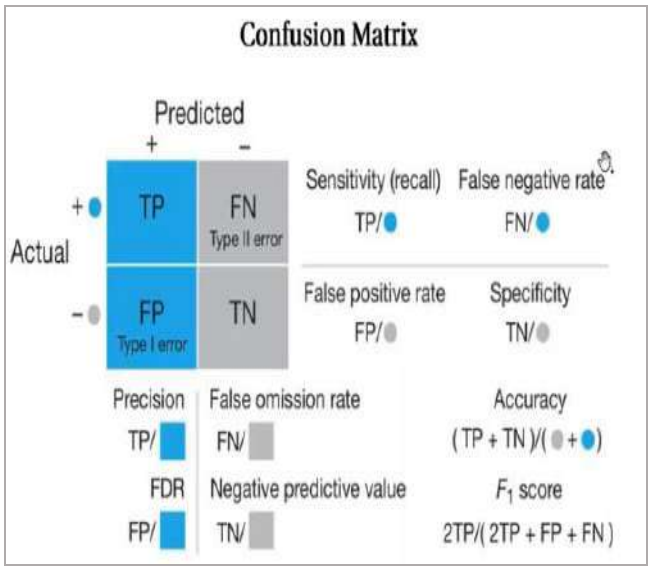


Fig. 1.

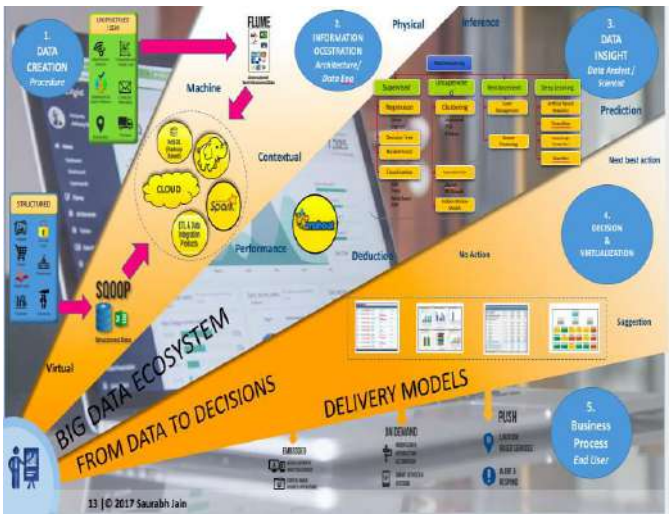
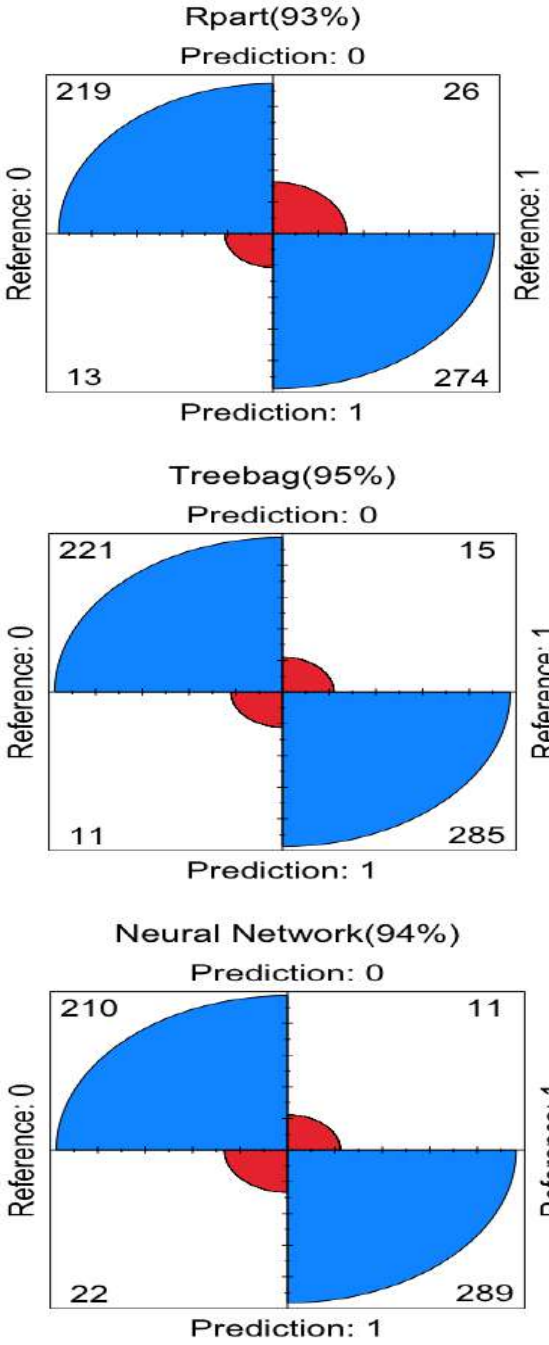


Fig. 2.



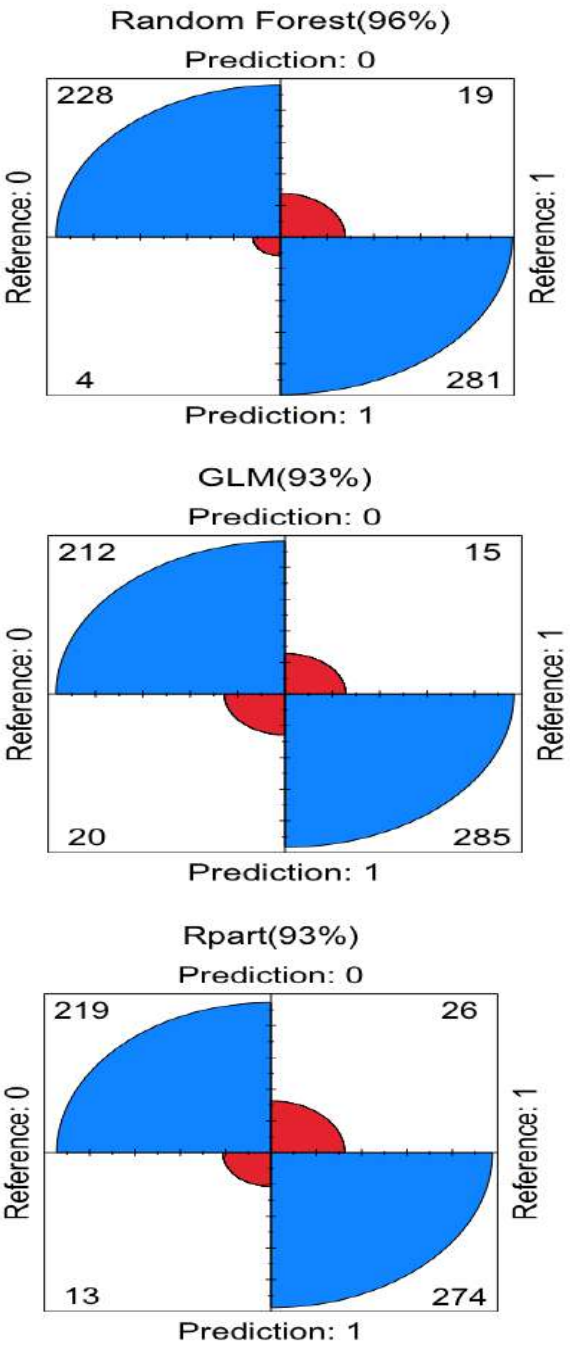


Fig. 3.

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Dynamic Analysis between ETF and underlying asset using tracking error

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Abstract— Exchange Traded Funds (ETFs) have grown tremendously in recent times, although they have been in India for over sixteen years now, with the first ETF, Nifty BEes listed in 2002. As the ETFs are issued to follow the prices of their underlying assets, their price movements are expected to track those of the underlying index or other assets they represent. Using the latest data from NSE, this paper evaluates the relationship between prices of ETFs in India and those of their underlying assets of the previous two years using the econometric techniques of Vector Autoregression. The study also focuses on understanding tracking error across the cross-section of ETF's present in the Indian Markets. The key findings of the study are a lag of two days between the price change in index and ETFs. Further, the tracking error is significantly decreased when the number of days for rolling standard deviation are increased.

Keywords— *Exchange Traded Funds, Vector Autoregression (VAR), Tracking Error, Stationarity, Nifty50.*

I. INTRODUCTION

Exchange Traded Funds (ETFs), unlike listed equity securities, track and replicate performance of an underlying security which ranges from equity, debt securities to commodity and indices. The stock bourse enabled listing and trading brings in much needed liquidity and price efficiency to ETFs as against counterparts index funds. Active creation and redemption of ETF units enables them to trade close to its fair value viz. net asset value. ETFs allow investors to indirectly take position in asset classes which would otherwise be let-off due to paucity of funds. Besides, access to foreign markets, portfolio diversification, lower transaction costs, among others, are factors which lure investors interest towards ETFs. Risks of underlying asset however get attached to the ETF and despite return benchmarking being at the core of ETF investment strategy, prior studies often contradict this theory by reporting some tracking error (see, for instance, Engle & Sarkar, 2006; Charupat & Miu, 2011; Bae & Kim, 2020 [1-3]). Tracking error is commonly referred to as difference between ETF return and underlying benchmark return. Error of such kind stems from the interaction of primary and secondary market in creation/redemption of ETF units. In creation (redemption) process, the authorised participant purchases (sells) ETFs underlying securities from (to) the primary market and exchanges them for ETF units (underlying securities) with the fund sponsoring the ETF. While demand-supply forces determine the unit market prices, the fund computes the Net Asset Value (NAV) based on market value of underlying securities. Ideally

though arbitrageurs swing into action immediately to restore equilibrium in market and NAV which prevails in the short-term such tacking error remains for longer duration and many a times persistent. Consistent deviation in accrued returns get investors sceptical on ETFs as an investment instrument. The remainder of the paper is organised as review of literature in section II, research methodology in section III, followed by empirical results in section IV and finally conclusion in Section V.

II. LITERATURE REVIEW

Prior studies have explored factors which widen the gap between ETF and underlying. Although such investment offers benefits of liquidity, low fund fees, transparency and tax advantages, fund expense ratios, transaction & rebalancing costs deter their performance as against its peers. Bansal & Marshall (2015) [4] cite quality of index replication, frequency of rebalancing, dividend effect, time and volatility effect, fund management costs, and compounding effect as factors influencing the size of tracking error. Charupat & Miu (2011) [2] document emergence of tracking errors in leveraged ETFs for holding periods greater than one day. Subject to constant end-of-day rebalancing, tracking errors become increasingly larger in longer investment period (those over a month) as against smaller errors in week long holding period. Kanapuri (2012) [5] predicts co-movements of equity and commodity ETFs to strongly correlate with underlying index or asset in the decade long study in Indian capital market. Interestingly, the author finds stronger co-movement relation in equity ETFs and no relation in commodity based ETF. The results suggest the magnitude of tracking error to vary with the investment objective/underlying security of the ETF. In the backdrop of citations on leveraged exchange-traded funds failing to mimic corresponding index returns over quarterly/annual investment horizons, Avellaneda & Zhang (2010) [6] validate the use of a dynamic rebalancing strategy to consistently match estimated index return.

Generally volatility in securities increases in time thus offering possible explanations to greater long-term errors. In a different note, Zhou & Chen (2016) [7] examined the cross-correlation between Chinese treasury ETF and treasury futures contracts and found presence of greater volatility and significant cross-correlation in future markets. Shaikh, Fernandes, & Patnaik (2020) [8] observe difference in return on equity ETFs and its benchmark Nifty50 index. Furthermore, existence of volatility clustering, a phenomena which enthuses investors to demand premium/higher returns, resulted in ETFs earning, on average, lower returns compared to the underlying tracking index. Shank & Vianna (2016) [9] suggest use of ETFs to hedge against exchange rate volatility is potential source of funds volatility. With a sectoral approach to performance of ETFs, Tiwari, Albulescu, C & Yoon (2017) [10] conclude that utilities and consumer goods sector funds performed better than to financial services and telecommunications sector. The over-performance was an outcome of market efficiency and adverse impact of global financial crises which made financial services sector more volatile.

Bae & Kim (2020) [3] lend explanation to presence of tracking error by constructing its relation with fund liquidity. Illiquid ETFs raise the transaction costs, fund variance and hence results in failure to meet fund objectives. Both underlying asset and fund liquidity affect tracking errors. Ivanov (2013) [11] find price deviation as a function of growth of volumes. Evidence form intraday trading data suggests decreasing popularity among ETFs causes

the fund underperformance. According to Defusco, Ivanov & Karels (2011) [12] price deviation in exchange traded funds is the additional cost of administering the fund, dividend accumulation and its distribution.

A significant gap exists in studying cross section of ETFs tracking the same asset offered by different financial firms. Further, while a significant number of studies analyse ETFs and related assets, there is scope for conducting econometric analysis of past ETF data and understand the relationships. Finally, the temporal aspect of relationship between ETF and underlying assets, especially using rolling tracking error and vector autoregression have significant scope for analysis.

III. RESEARCH METHODOLOGY

A. Data extraction and Pre-processing

The present paper studies six ETFs that follow NIFTY50 index namely; Edelweiss Nifty 50 ETF, Kotak Nifty 50 ETF, Motilal Oswal Nifty 50 ETF, SBI Nifty 50 ETF, Aditya BSL Nifty 50 ETF, and Nippon India Nifty 50 Bees ETF. The daily open, low, high and close data for all the ETFs is extracted in Python from the application program interface of the data provider. Price data of Nifty50 index is extracted from NSE website. The extracted data is processed to obtain uniformity of data of all ETFs in a specified time period.

B. Analysis of Tracking Error

Building on Stock & Watson (2001) [13] work on vector autoregressions, we perform analysis of ETF tracking error and corresponding underlying. The paper utilizes tracking error to measure the dependence of ETF returns on NIFTY50 index returns. Log returns are calculated for all the aforementioned ETFs and NIFTY50 index on closing price each trading day. Error term is subsequently calculated for each ETF by subtracting NIFTY50 index returns from that particular ETF's returns for the particular day. The paper further analysis tracking error of each ETF by the use of rolling standard deviation of the error term with rolling windows of 10, 20, 30 and 40 days.

C. Analysis through Econometric techniques

This paper analysis the interdependence between ETF and the underlying asset using Vector Auto-Regression (VAR) and Vector Error Correction (VEC). In order to conduct the analysis, we use MATLAB's econometric toolbox and its VAR and VECM model. The hypothesis for the analysis is to find whether a causality exists between daily returns of Nifty 50 index and daily returns of the ETFs that track this index. For the purpose of the analysis, default VAR(4) model was used with Nifty and only one ETF as estimation parameters.

IV. EMPIRICAL OBSERVATION & RESULTS

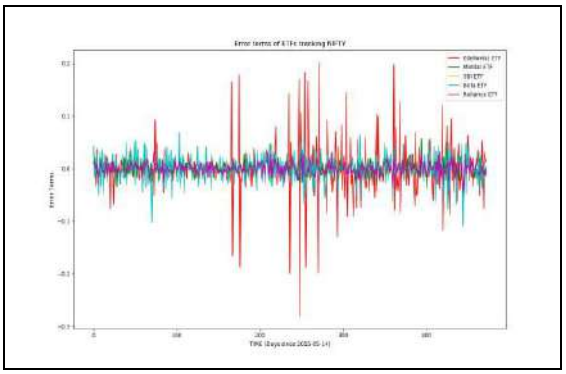

Fig. 1 Difference in ETF and its benchmark NIFTY50 return

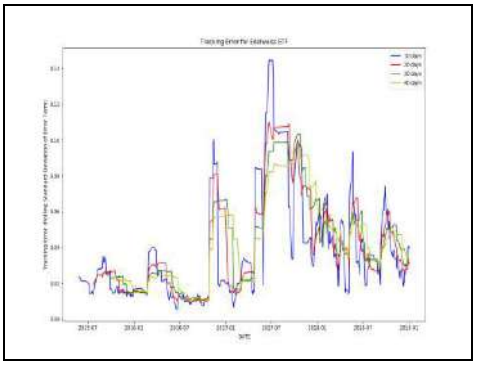

Fig. 2. Tracking Error of Edelweiss ETF over time

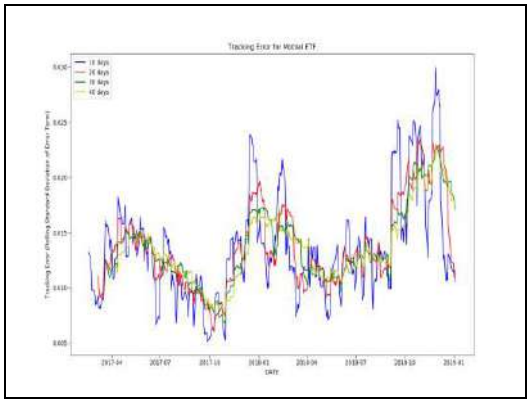

Fig. 3. Tracking Error of Kotak ETF over time

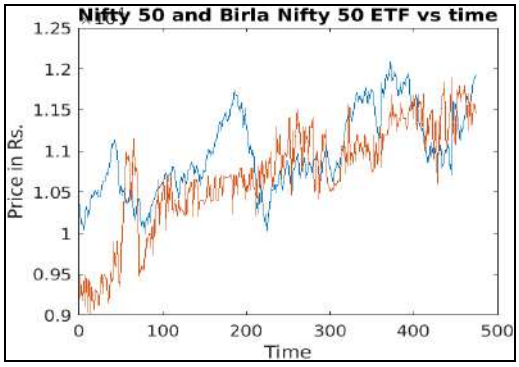

Fig. 4. NIFTY50 & Birla Nifty 50 ETF price levels over time

A. Tracking error analysis

Fig. 1 clearly shows that the difference in the returns of ETF and NIFTY Index are not uniform across ETFs, but vary considerably across different ETFs. The paper finds that the Edelweiss Nifty 50 ETF and Motilal Oswal Nifty 50 ETF have the highest deviation in the sample. Further, analyse tracking errors of Edelweiss Nifty 50 ETF and Motilal Oswal Nifty 50 ETF by taking rolling standard deviation overtime. From Fig. 2 and Fig.3 it can be seen that when the lag is minimum, the tracking error is maximum. Subsequently, the finding can be reinforced with other ETFs (not reported in the paper for the sake of brevity). Also, across time, the peaks become sharper, which mean that the tracking error starts decreasing considerably with time. This effect can be attributed to the rebalancing of the ETF following the rebalancing of indexes.

B. Results for Econometric Analysis

The analysis VAR model shows p-values of 0.35 for lag 1, 0.03 for lag 2, 0.09 for lag 3 and 0.20 for lag 4. This suggests that the null hypothesis of the existence of causality is strongly true for lag 2 while it is not true for all other lags. The above results indicate that the causality of index returns, and ETF returns are caused by lag of 2 suggesting that the returns from the index take 2 days for realization the ETF. It also suggests that no causality is present between ETFs and index returns when the lag exceeds 2. Similar results are observed when VEC model is used instead of VAR model and the results are consistent among all ETFs that track Nifty50.

V. CONCLUSION

This paper identifies the lag between ETFs and underlying assets through econometric method of vector autoregression. Further, paper successfully proves high degree of causality between the same. Also, the analysis of rolling tracking error leads to fundamental insights about how the ETFs and underlying asset often diverge significantly in their returns often during times of rebalancing. Lastly, we explore the temporal aspect of rolling standard deviation and conclude the lag in the number of days and tracking error have an inverse relationship.

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Sensor Selection for Optimal Information Utility

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***Abstract*—In Wireless Sensor Network (WSN), considerable number of smart sensor nodes are interconnected to carry out a specific set of sensing task within the geographic area. WSN is generally heavily resource constrained. Hence judicious placement of optimal number of sensor nodes is of high importance to produce meaningful inference from the sensed data. Improper and unplanned sensor placement for event sensing produces trivial data and that too at the cost of higher network resource utilization. It reduces efficiency of the overall network. This work proposes a wiser criterion for sensor node selection that would produce optimal information utility from the sensed data. The proposed criterion is based on the performance of specific sensor-positioning approaches where the performance measure is the accuracy of estimated location information produced by each of them. The proposed approaches provide a quantitative basis for communication-link selection during network discovery and self-localization. The same optimal criteria may also provide theoretical basis for node-selection towards achieving optimum accuracy in target localization by the sensor network.**

Keywords—optimum accuracy, self-localization, smart senor nodes, target localization, wireless sensor network.

I. INTRODUCTION

Wireless Sensor Network (WSN) based parameter sensing and event monitoring is a multidisciplinary research area which has found its scope into various small and large scale applications. Smarter industrial manufacturing and automation, IoT, video surveillance and physical security, military espionage and sensing, distributed robotics, air traffic control, traffic surveillance, building and structures monitoring, environment monitoring are few among many fields where WSN has established tremendous scope. Accurate parameter sensing, smart information processing, and establishment of relentless communication links with global networks are the three key features when combined in one tiny node within WSN, enables the network to be applied for a vast number of critical applications [1]. WSN composes many densely deployed sensor nodes that are placed either inside the event to be sensed or nearby. WSN has found its applications even in those areas which are not easily and continuously accessible by human beings. Volcanic eruption detection, tsunami detection, coal mine parameter detections are some of such application fields. Randomly deployed sensor nodes of WSN produce very valuable and time critical information during disaster relief operations as well.

Self-organization and self-healing are two very important features inbuilt within the WSN based algorithms and related protocols. These two features enable event localization, accurate event detection, and WSN target tracking even in a highly dynamic environment. Very powerful and smart sensor nodes are designed with latest MEMS technology and highly advanced micro-sensor technology. WSN, comprising such technologically advanced nodes is capable of accurately track and monitor physical parameters and integrate humongous amount of data toward accurate information processing. Diverse national and social applications like military warfare, area surveillance, environmental monitoring, agriculture, child education, remote medical assistance and micro surgery etc. have also found use of WSN technology [2].

Detection of soil quality, monitoring weather conditions, finding the presence of parasites in soil, and helping to select appropriate kind of insecticide are some of the basic features of WSN enabled smart agriculture system. Smart buildings are nowadays integrated with WSN nodes for distributed monitoring and control of various building parameters. It improves the living conditions and ensures safety by controlling room temperature, air flow, air quality and oxygen content in indoor air. Smart energy consumption strategies help to reduce overall energy consumption in building which reduces the electric bill for the housing society. Ad-hoc wireless sensor networks have found tremendous scope in military application with new and promising sensing and data integration technologies. It helps with smarter military command, control, communication, computing, intelligence, surveillance, target tracking and localization which are integral part of all military applications. Health sector has also found several uses of WSN in remote patient condition monitoring, assisting disabled patients etc. Product quality monitoring, inventory management, disaster management are few more scopes of WSN with enormous commercial bearings [3].

Static and dynamic target detection is described as the main application field of WSN. This application requires local and global sensor node collaboration for the purpose of detection, classification, and tracking of even highly dynamic targets. An efficient WSN can track a low-observable target with smart information processing by well-connected sensor nodes. Target detection accuracy can be enhanced with aggregation of a multitude of sensor node data. Latency in the sensor network may be reduced by informed selective collaboration among sensors whereas flooding of data-requests to all sensor nodes increases latency. Risk of node or link failure can be mitigated by minimizing the bandwidth consumption within network which is possible through reduction in latency. The longevity of the network directly depends on the reduction in rate of power consumption within the network while performing computation and communications. In every aspect of the sensor network design, hence, node or network power optimization is given high importance. For any WSN based application, it is critical to select a bunch of embedded sensor nodes that helps in balancing the workload with task distribution and also take part in smarter data collaboration. These attributes reduce network resource consumption which in turn increases potential utility of the networks [4].

Initially, it is of great importance for any WSN to estimate the locations of the randomly deployed sensor nodes within a specific geographical area. This process is called as

network discovery. The process of sensing and localization of targets cannot be performed without carrying out network discovery process properly and accurately. The sensing accuracy of a WSN depends on the accuracy with which the network discovery process was carried out. During the target localization process, first the WSN nodes sense the presence of an event through coarse measurement which is part of a local data processing at every node. The local nodes then transmit this coarsely processed target location information to the sink node for final and more accurate global information processing and data extraction. A WSN with highly dense sensor nodes will produce event location estimation of high accuracy, only if the information from all sensing nodes is properly collaborated. But energy of such dense WSN gets drained out very fast reducing the lifespan of the network.

This work is targeted for accurate estimation of event location information by a judiciously chosen sensor nodes. A novel criterion for node selection is proposed in this work. Mathematical model development for selection of set of most suitable sensor nodes for this purpose is a novel contribution of this paper. Initially, the sensors are considered to be deployed randomly within a network. Three different network discovery approaches are explained next, and in each case, localization accuracy and node link distances are calculated. For coarse detection which is the consequent step to network-discovery, it is proved that highly accurate target location information is obtained through proper collaboration among all mearing nodes, for a static and cooperative target. Finally, the overall utility of a sensor node is quantified at any particular location for the precise event localization.

II. Node Localization in Ad-Hoc Wireless Networks

Just after all the sensing nodes are deployed randomly within a specific area, all nodes collaboratively conduct the network discovery process. This process helps the nodes in pin pointing its own location and identifying the position of its neighboring nodes. In a properly structured network, the network topology is known as a priori, but for ad hoc networks, the network topology is established in real time through the network discovery process. Moreover, the node location information is periodically updated as many sensor nodes fail during operation or new sensor nodes are added to the network to keep it functioning. Within the networks with high mobility, different algorithms are inbuilt in static and mobile sensors nodes to discover the position of each other [5]. In places where GPS based self-localization facility is not provided, relative position estimation within network through collaborative information processing is the only solution. Many published researches have discussed about the localization of ad hoc sensor nodes. But a standard algorithm for accurate and precise sensor node localization within WSN is not available. We have proposed a novel network discovery and target location estimation algorithm.

A WSN with total of N sensor nodes is considered here. Among these N nodes, N_k nodes are anchor nodes. The geographic locations of $N\text{-}N_k$ sensor nodes are unknown. Consider $N_u=N\text{-}N_k$. The x and y coordinates of these N_u nodes are estimated during network discovery process. Collaborative range measurement estimation is carried out next based on the time difference of arrival (TDOA) of signals between the N_u and N_k nodes. The propagation delay between the N_k and N_u nodes is given by

$$t_{k,u}=\frac{d_{k,u}}{c}+\tau_k-\tau_u, \quad (1)$$

where $d_{k,u}$ is the Euclidean distance between unknown nodes and the anchor nodes, c is the speed of signal propagation and τ_k and τ_u are the biases of clock of anchor nodes and unknown nodes. Clock bias for any sensor node is the difference between absolute network time and relative node clock value. Considering range measurements is performed by transmitted and received signals with known signature and considering absence of any multipath propagation, the measured value of propagation delays can be modeled as

$$\tau_k,\tau_u=t_{k,u}+e_{k,u}, \quad (2)$$

where, $e_{k,u}$ is the Gaussian type measurement noise with zero mean. Noise variance is given by $\sigma^2_{k,u}$ (error). All estimation errors are assumed to be independent of one another, the position of all N_u nodes can be determined by minimizing all elements in x, y and τ. It will be a multidimensional nonlinear criterion function. The least-squares criterion is given by

$$\min_{x,y,\tau}\sum_{k=1}^{N}\sum_{u=1,k\neq u}^{N}\frac{1}{\sigma^2_{k,u}}.(\hat{t}_{k,u}-\frac{d_{k,u}}{c}-\tau_k+\tau_u)^2 t_{k,u}+e_{k,u}, \quad (3)$$

The theoretical lower limit for mode localization parameters is given by the Cramer Rao bound or CRB. It involves formation of the covariance matrix of parameter of interest,

$$\mathrm{cov}\begin{bmatrix}\hat{x}\\ \hat{y}\\ \hat{\tau}\end{bmatrix}\geq\begin{bmatrix}I_{x,x} & I_{x,y} & I_{x,\tau}\\ I_{x,y} & I_{y,y} & I_{y,\tau}\\ I_{x,\tau} & I_{y,\tau} & I_{\tau,\tau}\end{bmatrix}^{-1}. \quad (4)$$

The 3×3 matrix in (4) is called Fisher Information matrix. The Fisher information is a method by which we can measure the amount of information that a variable x carries about an unknown parameter θ upon which the probability of x depends. Here x is an observable random variable. In case all nodes are time-synchronized with each other and τ_k for all nodes are known. Here, parameters like $I_{x,\tau}$, $I_{y,\tau}$, and $I_{\tau,\tau}$ become irrelevant. The identity shown in (4) then reduces to 2×2 matrix

$$\mathrm{cov}\begin{bmatrix}\hat{x}\\ \hat{y}\end{bmatrix}\geq\begin{bmatrix}I_{x,x} & I_{x,y}\\ I_{x,y} & I_{y,y}\end{bmatrix}^{-1}=(I)^{-1}. \quad (5)$$

Each element of the matrix gives the lowest achievable covariance for parameters related to it. The Fisher Information matrix found for every element is given by

$$\left(I_{x,y}\right)_{m,n}=\sum_{k=1}^{N}\sum_{u=1}^{N}\frac{1}{\sigma^2_{k,u}}\frac{\partial t_{k,u}}{\partial x_n}\frac{\partial t_{k,u}}{\partial y_m}. \quad (6)$$

Eigenvalue decomposition is carried out next for the covariance matrix given in (5). It indicates an elliptical region in which the localization error will be confined. This error region or the Geometric Dilution of Precision is shown in Fig. 1 below. This error region is also referred as initial error belief. This CRB based error belief is the theoretical lower limit of the estimation error. Similar error bounds can be constructed for $\hat{t}$, if synchronization uncertainties are present in the system.

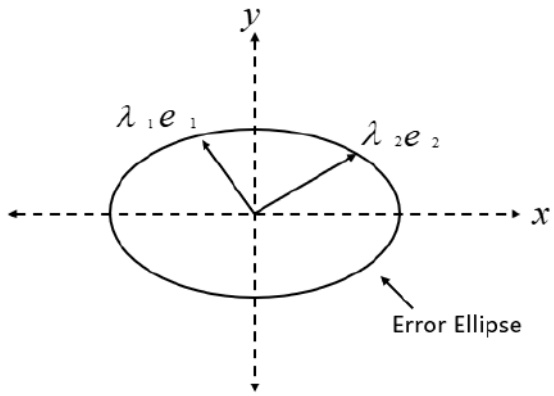

Fig.1. Estimated Dilution of Precision for unknown sensors where λ_1 and λ_2 are Eigenvalues and e_1 and e_2 are Eigenvectors.

III. Network Discovery

The network discovery process helps all the randomly deployed nodes to identify their own location as well as discovering the positions of the neighboring nodes. Here, three different approaches for network discovery are mentioned. Cramer Rao Bound (CRB) based error limit is determined for all the three cases.

A. *Conventional Node Positioning*

This is a traditional method or strategy 'P'. Here the communication links, only from the query node to anchor nodes are considered. Number of communication links is less here and so is the amount of information exchanged between nodes, Fig. 2. Long communication links are observed here. Total energy consumption here is also less and accuracy of query node localization is poor. This method is applied where conservation of the network energy is of highest priority than the node localization accuracy.

B. *Collaborative Node Positioning Without Crosstalk*

In this strategy 'Q', the communication links between the query node and all the other anchor nodes and other query nodes are considered. Though location information of other query nodes is unknown, but their inclusion in this criterion improves the main query node localization accuracy. The crosstalk among other query nodes and anchor nodes is not permitted here, Fig.3. Number of communication links is more in this case and very long communication links are observed to be formed. As communication link length is directly proportional to the network energy utilization, communication energy requirement for this criterion is high. Accuracy of node localization is higher in this case compared to conventional positioning. Involvement of higher number of nodes has improved the localization accuracy. This method gives more importance to localization accuracy of the query node than energy conservation by the network.

C. *Collaborative Positioning with Crosstalk within Radius*

In this strategy 'R', the communication links are considered from the query node to all anchor nodes. Also considered are crosstalk between anchor node and all other nodes, Fig. 4. The crosstalk is permitted only around the query node within a smaller area, with a pre-specified radius. The total number of communication links is higher in this case, compared to the conventional case. But the overall communication link length is lesser here. This very criterion

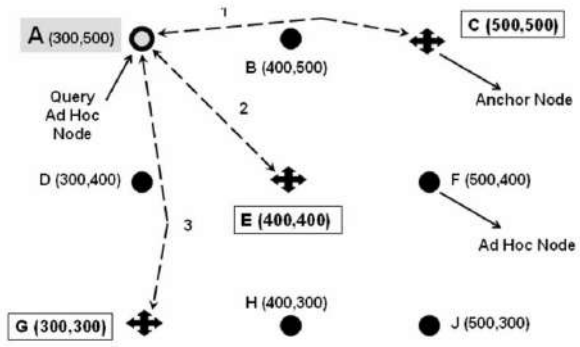

Fig.2. Node positioning for query node 'A' localization **(Strategy P)**

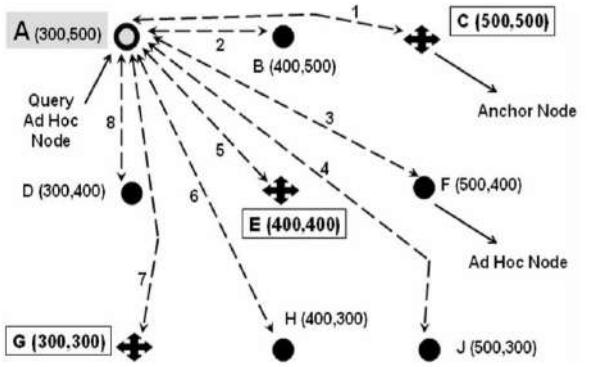

Fig.3. Collaborative node positioning without crosstalk, 8 communication links from query node to all other nodes & anchor nodes (**Strategy Q**)

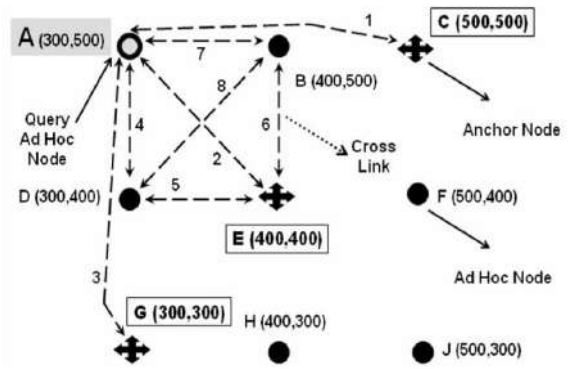

Fig.4. Collaborative Node Positioning with crosstalk within radius $100\sqrt{2}$: Sensor 'A' query node – No. of links is 8 – total link length less than that of strategy P, accuracy higher than strategy P & Q both **(Strategy R)**

offers highest accuracy during query node localization during network discovery process and that too with lesser communication energy. This is the optimal criterion in network discovery. The results of node localization accuracy improvement over the three criteria will be explained in the result section with the help of result table.

IV. Target Localization Process

The effectiveness of WSN based target localization and event tracking directly depends upon the accuracy of the network discovery process explained previously. This process may use the same technique of TDOA based estimation for acoustic target localization. Initially, a coarse target location is estimated using only the anchor nodes and then the initially estimated location information is gradually refined to obtain more accurate final target localization.

Determination of exact location of an unknown target within a certain area is a complex process. For approximate estimation of the geographic coordinates of the target node, it is necessary to have a priori position information of few of the surrounding anchor nodes. Inside the network, anchor nodes can be positioned manually, or they can be equipped with an absolute location reference such as a global positioning receiver system (GPRS) [6]. In a 2D network, three anchor nodes cooperate to determine the geographic location of the target by performing range measurements among them & the target. For A 3D network, a minimum of four anchor nodes are required for the purpose of target localization.

In the network discovery process, range measurement was carried out between the main query node and the anchor nodes and other unknown query nodes and that too within a certain radius, Fig. 4. In target localization, first the range measurement is carried out among the anchor nodes and the target whose location information is unknown as of now. If the target is cooperative, and if there exists an absolute time reference between the anchor nodes and the target, then the procedure of range measurement technique which was applied during the network discovery process can directly be applied for target localization. But in the practical scenario, it is highly unlikely for the network and the target to have the same absolute time reference. So, when there is a synchronization uncertainty present or τ_k and τ_u are not known, then (4) is applied instead of (5). If $\hat{t}_{k,u}$ and $\hat{t}_{u,k}$ are readily available, then

$$\begin{aligned}&\frac{1}{2}\left(\hat{t}_{k,u}+\hat{t}_{u,k}\right)\\&=\frac{1}{2}\left(\frac{d_{k,u}}{c}+\tau_k-\tau_u+e_{k,u}+\frac{d_{u,k}}{c}-\tau_k+\tau_u+e_{u,k}\right)\\&=\frac{d_{k,u}}{c}+\frac{e_{k,u}+e_{u,k}}{2}\end{aligned} \quad (7)$$

Even if there is a clock bias present for each node, the identity given in (7) may be applied for each node and it would still provide an unbiased estimate [7]. Knowing $\hat{t}_{k,u}$ and $\hat{t}_{u,k}$ effectively implies that round trip measurement data between the anchor node and the target is available. In such case, the clock biases will get canceled eventually. At the end of the coarse target location estimation by the anchor nodes, we obtain initial elliptical localization information which is termed as initial error belief. The area of this initial error belief is quite large which means that the accuracy of target localization is less. This is the first stage or coarse target localization stage. The number of communication links formed during this coarse target localization is less and is equal to the number of anchor nodes within the network. This coarse target location acts as a-priori or a reference information about the target for the consequent stages. In the next step, many more sensor nodes whose locations are now perfectly known due to network discover process, would simultaneously conduct range measurement on the target. Number of communication links would be more during this step. The process will be used to refine the location information obtained during initial coarse measurement and a more accurate elliptical belief will now be obtained. This updated belief would have lesser dilation area which means higher accuracy in target location information. Few sensor nodes, placed strategically within the network, help to produce higher target localization accuracy, with smaller number of communication links [8].

V. Measure of Information Utility

The information utility gives the quality of information provided by a sensor node positioned at any location within the network. Location information regarding the initial belief state of an event can be obtained through collaborating the range measurement signals only from the anchor nodes. The challenge now is to determine the new locations at which if a sensor is deployed, would improve the accuracy of the initial error belief to a great extent. It is to be seen at the same time that the communication cost or communication link length is kept to minimum. Selecting a sensor node nearer to the event would provide highest level of improvement to the initial belief estimation, that too at least communication cost. The optimization problem of sensor node selection may be seen as a combined optimization problem where sensor node Utility and Communication-Cost are the two main cost factors. The optimization problem formulation is shown as

$$\begin{aligned}&M\left(p\left(x \middle/ z_1, z_2 \ldots\ldots z_j\right)\right)\\&=\alpha.\phi_{UTILITY}\left(p\left(x \middle/ z_1, z_2 \ldots\ldots z_j\right)\right)-(1-\alpha).\phi_{COST}(z_j)\end{aligned} \quad . \quad (8)$$

Here, measure of information utility is given as $\varphi_{UTILITY}$ and communication cost is depicted by φ_{COST}. The relative weight factor of information utility and communication cost is given by the symbol α. Sensor node information utility may be measured as a function of how effectively and efficiently the target location information would be sensed by a newly deployed sensor node. The optimal sensor placement and communication link selection criteria as shown in Fig. 4 produces most significant initial error belief. This criterion produces initial error belief ellipse with least area and that too utilizing comparatively lesser network energy. It means that the criterion of Fig. 4 produces highest information utility through more judicious sensor placement and proper communication protocols which allows crosstalk only within a pre-specified small radius. In this section, the Mahalanobis Distance measure is introduced to actually quantify the utility factor of information-update for any new sensor which would be deployed around the initial error belief to get a more accurate updated error belief. This measure is simple to implement and it helps to quantify the relevance of node utility measurement.

The Mahalanobis distance criteria for measurement of the information utility produced by any sensor node, may be explained with the help of Fig.5. The basic assumptions are-

i) the initial target localization error belief has a Gaussian distribution which is approximated by the three anchor nodes and is available as a priori

ii) each new sensor data generally provides a range estimate in a scenario where acoustic amplitude sensing based measurements are being carried out [7]. The coarsely estimated initial error belief for the target location information is shown within the top rectangle, as a big error ellipse in Fig.5. The star shown at the center of this ellipse is

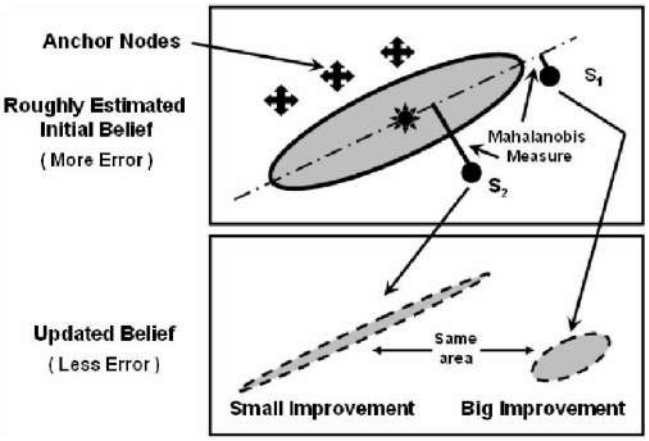

Fig.5. Sensor node selection for target location estimation; based on the contribution from individual sensor node toward information gain/utility

the mean position of actual target or event. The major axis, shown along with the coarsely estimated initial belief, plays an important role while positioning a new fourth sensor node for information update. The three anchor nodes and this judiciously positioned fourth sensor node, perform range measurement on target and updates the initially estimated belief. Fig. 5 shows two different positioning of the fourth sensor nodes as S_1 and S_2. When the three anchor nodes and the fourth sensor node placed at position S_2 is used for location information update of the target, it produces a more elongated ellipse which is shown in the left side of the bottom rectangle in Fig. 5. But when the three anchor nodes and sensor placed at position S_1 is used for estimation update, it produces a more concentrated error ellipse shown toward the right side of the bottom rectangle in Fig. 5. Both the ellipses shown within the bottom rectangle have lesser dilation area compared to the error ellipse shown in the top rectangle. It means that combining the initial target location estimation (by the three anchor nodes) with that by another (4^{th}) sensor node (either at position S_2 or S_1) would definitely improve upon the initial target location estimation. Moreover, it is assumed that the area of the elongated ellipse and more concentrated rounded ellipse in the bottom rectangle of Fig. 5 are also same. Then also, it may be found that the information utility produced by sensors placed at S_2 and S_1 positions are different. The reduction in the size of the error ellipse is a measure of the information gain. Reduction in error ellipse size along the major axis of the initial error ellipse signifies a larger improvement which reduces measurement uncertainty to greater extent. In such case, information utility factor is higher. Sensing modality and sensor placement geometry, both may be used to determine the potential information gain provided by S_1 and S_2 sensor nodes.

The new updated belief state is estimated by mixing current belief (for nodes positioned at S_1 or S_2) with the initial belief state, using Bayes' rule (8). Sensor placed at S_1 is found to be providing more improvement in target location information than sensor at S_2 as per Mahalanobis Distance criteria. The ratio of major axis to minor axis of the error ellipse produced by node at S_1 is closer to 1 whereas the same error ellipse axis ratio for the node at position S_2 is a lot higher than 1. Hence it is concluded that the node at position S_1 gives higher information utility and better information update during target localization, than node placed at S_2. It is because, sensor at S_1 is having closer proximity to the major axis of the uncertainty ellipse (initial belief), than sensor at S_2. Mahalanobis distance is the perpendicular distance between the sensor node position and the major axis of the initial uncertainty belief. Hence while determining the overall information utility, the measurements from node placed at S_1 should be allotted with higher weights as it is having lesser Mahalanobis distance from the initial belief major axis. Sensor at S_1 would be favored over that at S_2 for higher information utility and lesser Mahalanobis distance [7]. When a Gaussian distribution approximates the current belief, the overall utility function is given by

$$\phi_{UTILITY}\left(\chi_j, \hat{x}, \hat{\Sigma}\right) = -\left(\chi_j - \hat{x}\right)^T \hat{\Sigma}^{-1}\left(\chi_j - \hat{x}\right), \quad (9)$$

where $\hat{x}$ is the target position estimate (or mean of initial belief), χ_j is the newly added sensor at position j, $\hat{\Sigma}^{-1}$ is the inverse of the covariance matrix.

Cost-Utility measures the total cost for i) sensing of the event-related information ii) processing it at local sensor nodes iii) sending the event information to the sink node for advanced signal processing and final parameter extraction. The communication cost is proportional to the Euclidian distance of the communication path. The objective function for sensor node utility measurements is the weighted sum of the Euclidian Distance and the Mahalanobis distance as given in (10).

$$M\left(\chi_j\right) = \left[-\alpha.d_{Mahalanobis}\right] - \left[(1-\alpha).d_{Euclidian}\right]$$
$$d_{Mahalanobis} = \left(\chi_j - \hat{x}_T\right)^T \hat{\Sigma}^{-1}\left(\chi_j - \hat{x}_T\right) \quad . \quad (10)$$
$$d_{Euclidian} = \left(\chi_j - \chi_l\right)^T \left(\chi_j - \chi_l\right)$$

VI. Results and Discussions

The simulation is carried out using MATLAB® R2020b platform. The network discovery strategy is developed with the help of mathematical modeling and is based on Cramer Rao Bound. Comparative results for initial belief & updated belief for strategy P, Q and R is given in Table I. All results are shown for localization of query node 'A' only. It is seen in the table, that initial belief area or dilution of precision error ellipse area for conventional sensor node positioning (strategy P) is 1.5078 sq. unit. When strategy Q is applied, communication link length increases from 541.42 units to 1471.5 units. The ratio of accuracy improvement of initial error belief in strategy Q and R is calculated with the formula given below.

Increment in precision in target location estimation
= Initial belief area (with only anchor nodes) / Updated belief area (anchor nodes & Ad-Hoc nodes).

With the same formula, it may be found that the query node localization accuracy in strategy Q increases by 6.38 times, compared to strategy P. In strategy R, the communication link length is found to be reduced, compared to both P & Q, and the query node localization accuracy has increased by 8 times, compared to P. So, it can be seen that during network discovery, the crosstalk links (as used in strategy R) provide significant improvement in information utility. From table I

TABLE I. NETWORK DISCOVERY STRATEGY-PERFORMANCE COMPARISON

Strategy	Number of Links	Total Link Length	Area of Error Belief (Sq. Unit)	Factor of Improvement
P - Fig 2	3	541.42	1.5078	--
Q -Fig 3	8	1471.5	0.2462	6.38 times
R - Fig 4	8	1082.8	0.1963	8 times

it can be found that more is the number of sensor nodes used for performing range measurement either during network discovery or node utility measurements (strategy Q and R), higher will be the accuracy of target localization. Though the total communication link length and hence network level power consumption increases both in strategy Q and R, but the trade-off is acceptable as range measurement in these two strategies produces higher target localization accuracy. For both, strategy Q and R, the number of communication links is 8. But the node localization accuracy is higher in strategy R than that in strategy Q and that too at lesser communication cost. Hence, the strategy R is proved to be the optimal strategy for range measurement during network discovery and target localization. Information utility of range measurement estimated by the strategy R will also be highest compared to the other two strategies.

VII. CONCLUSION

The network discovery strategy is developed with the help of mathematical modeling and based on Cramer Rao Bound. The target location estimation and total utility measurement for newly deployed sensors are also developed on Cramer Rao Bound based mathematical model. In the process of network discovery, the crosslinks are used which gives a significant improvement in cost-utility. Larger number of deployed sensors gives higher accuracy in target localization. But in such case, network level power consumption is also more. So, at the cost of network resource highly accurate target location information is obtained. The overall objective function for sensor node-based target location estimation, as shown in (10) allows the computation of the utility function for the entire region of interest that leads to a consistent strategy for further sensor deployment. The approaches mentioned in this paper provide a quantitative basis for communication-link selection during self-localization and for node-selection towards achieving optimum accuracy in target localization by a wireless sensor network.

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Automated Guided Vehicle in Material Handling for Industry 4.0 Plants

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***Abstract*— Automated Guided Vehicles or Automated Load Carriers are portable robots that self-navigate to move materials around warehouses or other manufacturing facilities. They shorten logistics times and ensure safety for an otherwise risky process. This paper presents the development of a Line Following Robot. In this project, Arduino Uno R3 is used as an open-source, single microcontroller board based on the Microchip ATmega328P microcontroller which is chosen as the main controller to react towards the data received from IR sensors to give fast, smooth, accurate and safe movement of the robot tracking the line. Adafruit Motor Shield mounted on an Arduino Uno R3 has been used, which consists of two L293D Motor Driver ICs connected internally by 74HC595 Shift Register. The experimental results show that the robot is working with high precision and speed, enabling it to perform under real-time requirements and can be used for any specific application after required modifications.**

Keywords – Automated Guided Vehicle, Arduino Uno R3 ,Industry 4.0, IR Sensors

I. INTRODUCTION

Automated Guided Vehicle systems that enable the flexible movement of materials without human intervention for various production phases such as receiving of raw materials, raw material supply to production lines, work-in-progress collection from production lines to buffer area, work-in-progress supply to subsequent processes, mobile working bench of car assembly lines, finished product storage into warehouse, finished product loading to delivery trucks.
A Line Following Robot is an automated (self-operating) mobile machine that detects and follows a line on the floor. The path on which the robot travels is already predefined and it can be a visible black line on a white surface or vice-versa. Certain advanced line following robots follow paths that are invisible like a magnetic field.

The line following robots sense their paths with the help of IR (INFRARED RAY) Sensors that are fitted on them. These IR sensors consisting of an IR EMITTER LED and an IR RECEIVER LED sense the line and commands the robot whether to stop or take a turn.
A Line Follower performs certain operations:
1) It captures the position of the line with the help of the sensors mounted at its front. It can have several numbers of sensors as the line sensing process requires high resolution and high robustness.
2) Steering the robot to track the line without any steering mechanism.
3) It controls its speed automatically. It reduces its speed during passing a curve.

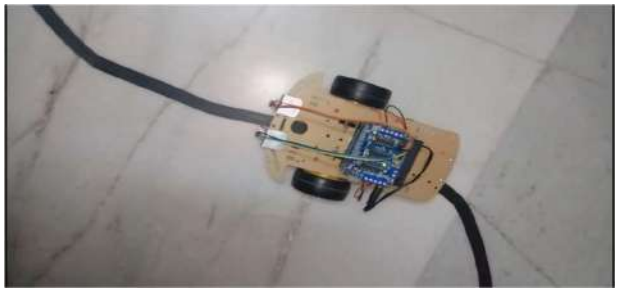

Figure 1. Prototype

This robot has a wide range of applications world-wide. This kind of robot can be used for military purposes, delivery services, transportation systems, etc.

Robots have already replaced us humans in almost every field of technology, being more efficient and providing quick actions to specific given tasks. These self-operating vehicles have paved their way into being used in hospitals or nursing homes with the nursing facilities [1]. In certain areas, these line robots can navigate through a predefined path and reach a destination as and when required [7]. They are capable of moving smoothly along any track, accompanying faster transportation and stopping as soon as it senses any obstruction in its path [10]. Such line following robots can run at a high speed covering maximum distance using dynamic PID algorithm, consuming less energy and time to complete one whole circuit [9]. Work has been done to obtain emerging visually driven behaviors for the mobile robot travelling in unconstrained environments using evolutionary computation [2]. In a similar manner, these robots serve as entertainment options for children in shopping complexes [3]. Applying the method of barcode reading, works on Library Inventory Management System were conducted as well [4]. Low cost educational microcontroller-based tool for fuzzy logic enabling control of complex systems more

effectively has been proposed [5]. Placing sensors on the robots to track junctions and overcoming certain problems occurring at high velocities were solved by a second sensor array [6]. Surprisingly, these robots could maneuver accordingly to stay on their course as well as correct their wrong moves using feedback mechanism [8].

II. COMPONENTS REQUIRED

Arduino UNO R3, L293D Motor Driver Shield, 2 Dc Motors 2 Plain Wheels, A Caster Wheel, 2 WD Robot Chassis, 2 IR Sensor Modules, 2 L – Clamps, 4 – Cell AA Battery Holder, Female – Female Jumper Wires, Black Tape (Electrical Insulation Tape)

Figure 2. Components Required

III. WORKING PRINCIPLE

A. Working Principle Of IR Sensor Modules:

The mechanism is very simple to understand. An IR Sensor senses a black or white surface by emitting an Infrared Signal through the IR Transmitter and receives the signal through IR Receiver in case of white surface but doesn't receive the signal in case of black line. If there is a left turn to be taken, the left IR Sensor senses the black line sending a high voltage analog output signal close to 1023 while the right IR Sensor sensing the white surface sends a low voltage analog output signal close to 0. An opposite phenomenon occurs during a right turn. If there is no deviation and the line is straight, both the IR Sensors sense the white surface, thereby sending a low voltage analog output signal. In case there is a divergence of the line or path, both the IR Sensors sense the black line and sends a high voltage analog output signal.

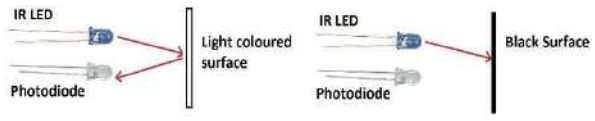

Figure 3. Working Principle of IR Sensor Modules

B. Working Principle Of DC Motors

For taking a left turn, the left motor (connected to the left wheel) rotates in the backward direction while the right motor (connected to the right wheel) is rotated in the forward direction. In a similar manner, the right motor rotates backward while the left motor moves in the forward direction, allowing the robot to take a right turn. If the line is straight, both the motors hence both the wheels rotate in the forward direction. In case, there is a divergence of the line or path, both the motors are stopped thus stopping the Robot.

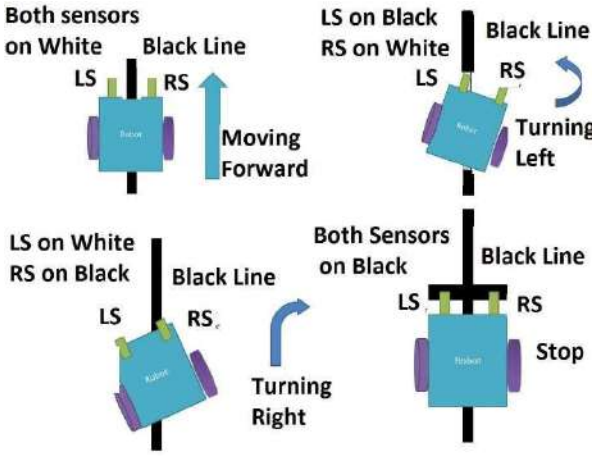

Figure 4. Direction Control

IV. CIRCUIT DIAGRAM AND EXPLANATION

A. Structural Explanation Of The Robot:

The robot should be constructed on the chassis carefully. Firstly, 4 – Cell AA Battery Holder is attached on the top of the chassis, then Arduino Uno R3 Microcontroller Board is attached to the top of the Battery Holder. The L293D Adafruit Motor Driver Shield is mounted on an Arduino Uno R3 Microcontroller Board. Now, two IR Sensors are attached in front of the chassis to detect the path while two DC Motors are attached to the bottom side of the chassis and then wheels are added to the motors. The two plain wheels attached to the DC Motors serve as the front wheels of the Robot. For providing support to the back side of the Robot, we use a Caster Wheel to ensure that the Robot can move. Distance between IR sensors and the DC motors should be minimum to ensure proper working of the prototype. Finally, the IR Sensor Modules are connected to the Motor Driver Shield with jumper wires and the DC Motor wires are also connected to the Shield. Thus, the Robot is ready to be used after programming, and then it is tested on a black electrical insulation tape pasted on a white surface.

B. External Hardware Connections:

It is built around an ARDUINO UNO R3 microcontroller which is connected to an L293D Motor Driver Shield and two IR Sensor Modules. The whole system is using a 6-volt external power source as 4 – Cell AA Battery Holder, which is connected to the power supply port of the Arduino Board. The L293D Adafruit Motor Driver Shield, which is like a replica of the Arduino Board, is mounted on the Arduino Board so that the pins below the Shield get inserted into the ports and become internally connected to the Arduino Pins.

Thus, instead of using the Arduino Board ports, we will use the Shield ports and pins for other external connections.

External connections include connecting the DC Motor wires to the DC Motor output pins of the Motor Shield which are named M1, M2, M3 and M4. We have connected the Left Motor to M1 and the Right Motor to M4. Also, the 3 pins of each IR Sensor Modules namely VCC (Input Pin), GND (Ground) and OUT (Output Pin) are connected to the IR Sensor Terminals of the Motor Shield by Female – Female Jumper Wires. An External Power Supply Terminal is present in the Shield which draws power from an External Power Source like battery although it is not required for our purpose as a Power Supply Selection Jumper is attached to the Shield which draws power from the Arduino Uno R3 Board and supplies it to the Motor Driver Shield. A Reset Switch is also present on the Shield to load the coding or the program in the microprocessor as many times as required.

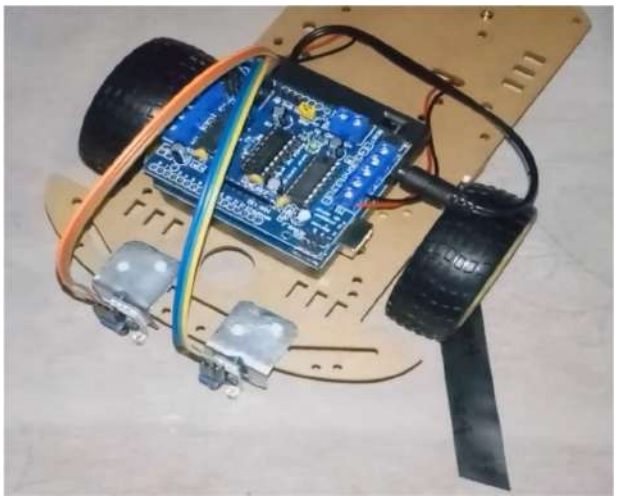

Figure 5. External Connections

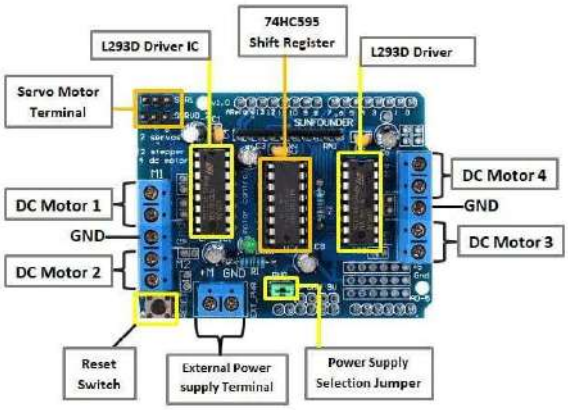

Figure 6. L293D Motor Driver Shield

C. *Internal Circuit Connections:*

The motor driver shield comes with two L293D Motor Driver ICs and 74HC595 Shift Register IC. Each Motor Driver IC can drive two DC Motors. The next key component of the motor shield is the 74HC595 shift register IC that extends 4 digital pins of the Arduino to the 8 direction control pins of the L293D ICs. The output channels of both the L293D ICs are broken out to the edge of the motor shield with two 5-pin screw terminals (M1-M2-M3-M4) to connect four dc motors having voltages between 4.5V to 25V DC. The motor shield puts out the 16-bit PWM output lines to a pair of 3-pin headers to which the IR Sensor Modules are connected. The Output pins of Left and Right IR Sensors are connected to Analog Input Pins A0 and A1 respectively indirectly through the Motor Driver Shield. The PWM (Pulse Width Modulation) Digital Output pins 11 and 3 are connected to the 1-2 and 3-4 enable pins respectively for any one L293D Motor Driver IC and PWM pins 5 and 6 are connected to the 1-2 and 3-4 enable pins respectively for the remaining L293D Motor Driver IC. The Digital Pins 9 and 10 are connected to the Output Pins of any one L293D Motor Driver IC for controlling two DC Motors attached to it, while 74HC595 Shift Register Output Pins 15 and 6 are connected to the Output Pins of the remaining L293D Motor Driver IC for controlling other two DC Motors attached to it. The Digital Output Pins 4, 7, 8 and 12 of the Arduino Uno R3 serve as the Input Pins of the 74HC595 Shift Register.

V. SCOPES FOR FUTURE WORK

The prototype making is completed and tested successfully. The test results are up to the mark as it satisfies all the requirements with high accuracy, precision and maximum speed. Apparently, a pair of wheels have been used and two sensors to sense the robot's path of travel. In the near future, to be useful in real life situations, the robot must have advanced facilities such as navigation to navigate past moving and stagnant objects. It may require upgrading to anticipate the cars and humans coming in its path of travel. Furthermore, installation of cameras and tracking devices would help in tracking the current location of the robot. Similarly, theft detection menus should also be included in the robot, for example, a heavy sound to detect that some disruption has occurred. A wireless network could be connected so that the user can be in contact with the robot directly from the phone. The Robot should have safety measures, thus not hampering the lives of humans in case of any collision or internal circuit damage.

VI. CONCLUSION

In this project, we have studied and programmed a Line Following Robot with high precision and maximum speed for material handling in industry 4.0 plants. The logic is really simple and understandable to all. Also, the coding becomes much easier with the use of Adafruit Motor Library Functions (AFMotor.h). The user can be in contact with the robot directly from the phone by using a wireless network. Speed of the vehicle can also be controlled through a smart mobile remotely.

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Timing the downside risk in mutual funds: Indian evidence

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***Abstract*— Studies on downside risk timing in asset management utilize both parametric and non-parametric methodology for calculation of Value at Risk (VaR) as a measure of downside risk timing skill. We utilize parametric methodology for calculation of VaR on a robust sample of 36 large cap open-ended equity mutual funds over a ten-year horizon. We sort funds on the basis of 3-year and 5-year ranking and conduct panel data analysis on variables shortlisted to gauge the impact of VaR. Since, Covid 19 pandemic presented an economic shock to the world economy, we break the time period of study into Non-Covid (2011-2019) and During Covid (Dec 2019 onwards). To the best of our knowledge, our study is the first ever study in Indian context to utilize VaR estimates in assessing the ability of fund managers to capitalize on macroeconomic information & generate superior returns by shifting funds between high and low downside risk assets.. Our study leads us to three valuable inferences – One, fund managers have limited array of mechanisms available for timing downside risk – shifting funds between cash & other assets and making transmission between high beta to low beta stocks with equity holdings within constrained interplay as per regulations. Second, funds skilled in downside risk timing attract high fund flows and carry out swift transmission between small-cap and large cap stocks in response to macro-economic information, hence generating superior returns during market uptrends (13-25% on an average) & at least two-times the alpha generated by unskilled downtimers Third, most skilled fund managers' exhibit persistence in downside risk timing skill across 3-year and 5-year ranking periods, and this continues even during Covid-19 pandemic, an economic shock**

Keywords*— *Downside risk timing, value at risk, alpha, asset pricing, persistence

Introduction

Global literature on asset management is replete with studies focusing on measuring the downside risk timing ability of fund managers in anticipation of broader macroeconomic information. Investors strongly differentiate their response to price movements, being more sensitive to losses than the gains. Loss aversion requires a premium for holding high beta assets during downturns. Securities posing high downside risk deliver abnormal positive returns in good times to make good the loss sustained during market downfalls (Roy 1952; Levy and Sarnat 1972, Chen, Ang and Xing 2006). We examine the ability of fund managers to utilize broader market information in value enhancing ways by swiftly shifting fund corpus from high downside to low downside risk assets during market declines, in an attempt to improve their risk-adjusted performance. We utilize parametric method for calculation of Value at Risk (VaR) estimates by calculating maximum possible tail risk at 95% and 50% level of confidence. The lag values of VaR estimates with lag-length of 1-quarter are utilized across 3-year and 5-year ranking periods to run panel analysis.

I. RESEARCH PROBLEM

A. Mechanism adopted in managing tail-risk

One, mechanism adopted in managing the tail risk, how do funds in different risk adjusted performance quartiles adjust performance in response to lag-VaR values?

B. Does fund risk management vary with fund ranking?

Second, are funds in higher quartiles of ranking more skilled in downside risk timing that is how efficiently fund managers shift portfolio assets in anticipation of market downturns as indicated by varying VaR values?

C. Does downside risk impact fund flows?

Third, do funds more skilled in timing the downside risk attract larger flows and exhibit superior return to compensate and offer premium to investors?

Our study leads us to valuable inference across all the levels of analysis as we find that funds more skilled in downside risk timing ability not only generate superior returns as risk-premium but also attract higher flows &carry out swift transmission between portfolio assets with varying market conditions. Rest of the paper is organized as follows Section II gives a glimpse of the prior research work referred & findings on the topic in our attempt to identify the research gap, Section III describes the data and details research methodology, Section IV covers empirical analysis including our findings as we try to answer three important research questions laid out in present section, Section V concludes the paper with a brief snapshot of future research plan.

II. REVIEW OF LITERATURE

There is a famous hypothesis that investors willingly tolerate underperformance in funds because in active periods funds outperform and compensate for bad performance during recessionary phases. This hypothesis was formulated by Moskowitz (2000) with the question whether active funds provide hedge against downturns. Glode formalized it (2011) by developing model explaining superior performance generated by fund manager with help

of state of economy, measured by various macro-economic factors. There is enough evidence available to prove that investors treat upward and downward movements in the price differently; investors react more to loss than to gains. Thus, securities with higher risk should offer higher returns; confirming risk-reward continuum (Levy & Sarnat (1972), Ang, Chen and Xing (2006)).

A significant implication of this for fund managers is that they can achieve superior returns by altering AUM allocations and by making successful transmission between cash, bonds and equity and between high beta to low beta stocks, controlling the damage done by downside risk in varying macro-economic conditions. Fund managers in general have limited options available to engage in downside risk timing, since mutual funds are guided by the regulators' guidelines.

Earlier studies by Chance& Hemler (2001), Bollen & Busse (2001), Jaing, Yu and Yao (2007), found evidence of market timing by fund managers, the thought rejected prior by Treynor & Mazuy (1966), Henriksson & Merton (1981); Jiang (2003). We draw our inspiration of research on downside risk timing & widely refer to work done by Bodnaruk, Chokaev & Simonov (2016). They extended the Henriksson & Merton (1981) market timing model and developed their own measure of downside risk timing, that being Active Change in Relative Beta (ACRB), based on mutual fund holdings and changes in the relative beta. The author(s) focused on linear regressions of realized fund returns against market returns to counter the deficiencies of earlier models focusing on non-linear regressions which could have been rather induced by dynamic trade strategy or embedded option-like feature in returns (Jagnannathan & korajczyk (1986); Chen, Ferson & Peters (2010)).

We conduct our study on a sample of 36 equity oriented large-cap open-ended funds under growth category over a ten year period 2011-2020. We utilize lagged Value at Risk (VaR) values at lag-length 1 under parametric setting as the measure of downside risk timing skill. Through our study, we demonstrate that on average, funds in our sample possess significant downside-risk timing ability in upper quartiles when sorted on basis of 3-year and 5-year ranking of risk-adjusted performance. Managers also adjust funds' risk of downside prior to economic downturns & achieve superior return capability by altering AUM allocations between asset classes (cash, debt and equity) & market-cap allocation percentage (between mid-cap, small-cap to large-cap and vice versa). Skilled funds tend to load more of small-cap & mid-cap stocks and are lesser inclined towards large-cap growth stocks prior to the market upside, the changes are however, lesser pronounced before market downturns indicating the transmission made more on the front of getting better quality holdings within the same category, just prior to market declines. We also investigate the economic significance of downside risk timing skill in our sample of funds

Our work, as per our knowledge, is first academic investigation of downside risk timing skill in the Indian context. While in the US economy, it being home to more than 50% of world's assets under management (AUM), downside risk timing has been formally investigated by number of researchers, utilizing different measures of ability to time the downside risk. Polkovnichenko, Wei and Zhao (2015) show that actively managed funds' returns exhibit stronger ability to hedge the downside risk than their passive counterparts. The results of our study highlight that funds not only aim to control the tail risk but also manage it in ways that enhances investor value.

III. DATA AND METHODOLOGY

This section details various sources of data consulted for conducting the study and methodology adopted for empirical investigation, various statistical tools and techniques utilized.

A. Time period and population

There are at present 44 Asset Management Companies (AMC) operating in Indian Mutual Fund Industry managing assets worth 23.5 Trillion USD. We work on database of 36 open-ended equity mutual fund schemes investing in large cap securities and having growth orientation. The data is obtained on a quarterly frequency from ACE MF database of mutual fund holdings for a time period of 10 years from (January 2011 to July 2019), non-Covid period. During the Covid period, data is extracted on monthly frequency, there being limited data points to corroborate and run the analysis. The data consulted is free from any survivorship-bias as both existing as well as redeemed schemes have been taken into account. Time period of the study has been decided keeping into consideration number of economic cycles, systematic events affecting equity markets and data availability for respective variables. Our focus is only on active domestic equity funds and we exclude passively managed & sector mutual funds since, the downside risk ability is substantially constrained in such funds. With above defined parameters, the scope of present study is limited to population set of 186 Equity oriented schemes in Indian Mutual Fund Industry.

B. Sampling

We conduct our research on equity-based schemes existing as well as launched after January 01, 2011 till Oct,2020. Open-ended schemes investing in equity across all categories have been considered as the sample -set and analysis is conducted scheme-category wise. Our sample set, hence, constitutes 34 Open-Ended Equity schemes investing in Large Cap funds out of a population set of 186 Equity oriented schemes in in this category in Indian Mutual Funds market.

C. Data Collection

Secondary data sources (both restricted & open access) have been utilized for carrying out research. ACE Mutual Fund is a dedicated database for mutual fund research covering all existing players and more than 16000 mutual funds schemes across all asset classes since inception. The data provided is free from survivorship-bias and therefore, has been referred for the study.

D. Methodology

We conduct panel analysis on mutual fund holdings extracted on a quarterly frequency. We obtain quarterly

returns of each individual scheme for calculation of Value at Risk (VaR) with respect to tail-risk on 95% and 50% confidence interval. VaR is calculated as a measure of downside risk based on parametric methodology for time period Jan 2011 till July, 2020. Funds are then sorted on the basis of 3-year and 5-year ranking periods to run the panel analysis. We utilize lagged VaR values with lag-length of 1 as one of the independent variables. We take BSELargecap quarterly returns as proxy of the market returns. The return series calculated through this procedure might differ from actual returns because transaction costs, expenses & other intra-portfolio adjustments are ignored. We ensure at least 85-90% portfolio representation in our sample for all time periods observed. A time-period of 10 years from January 2011 till July 2020 across all schemes under the sample gives us a robust database of more than 40 observations per variable under every scheme. The time period of study is broken down into two parts – Non-Covid and During Covid time period, Covid being an economic shock required special investigation as it also offers insight into ability of funds managers in carrying out downside risk timing in ways that enhance investor value.

TABLE I. SUMMARY STATISTICS

3-year ranking	**Descriptive Statistics**			
	Qtile1	***Qtile2***	***Qtile3***	***Qtile4***
Qrtrly Returns	3.672	3.001	2.672	2.655
Qrtrly Flows	1890.863	4612.909	4941.319	4586.158
VaR 95	-4.542	-4.408	-0.148	-6.036
VaR 50	0.875	0.275	4.093	-0.512
Small Cap (%)	2.948	1.274	1.973	14.415
Large Cap (%)	81.509	83.379	73.311	63.199
MidCap (%)	9.187	8.105	17.517	18.017
Equity (%)	0.852	2.176	3.274	1.274
Debt (%)	93.645	92.783	87.368	95.788
Others (%)	6.178	6.546	14.089	4.106
5-year ranking				
	Qtile1	***Qtile2***	***Qtile3***	***Qtile4***
Qrtrly Returns	2.363	2.191	1.984	2.655
Qrtrly Flows	3074.813	6496.110	2287.021	4586.158
VaR 95	-5.144	-5.288	-5.417	-6.036
VaR 50	-0.037	-0.206	-0.461	-0.512
Small Cap (%)	7.861	8.004	3.977	14.415
Large Cap (%)	73.084	72.827	80.045	63.199
MidCap (%)	12.138	13.594	9.608	18.017
Equity (%)	2.993	0.408	2.875	1.274
Debt (%)	93.293	94.507	93.824	95.788
Others (%)	6.240	5.302	5.617	4.106

Source: Author's own calculations

$$VaR_{\alpha}(X) = -inf\{x \epsilon R : F_x(x) > \alpha\} = F_Y^{-1}(1-\alpha) \quad (1)$$

Value at risk can be written as distortion risk measure given by distortion function, g(x)

$$g(x) = \begin{cases} 0 \ if \ 0 \leq x < 1-\alpha \\ 1 \ if \ 1-\alpha \leq x \leq 1 \end{cases}$$

In Table 1, we report summary statistics for all the schemes under the sample over 2011-2019. The schemes have been sorted into quartiles on basis of 3-year and 5-year post ranking period. It is noteworthy that funds in upper quartiles on an average generate excess returns to those in lower quartiles to the extent of (2.5-3.95)% on an annualized basis. The sorting of funds into ranking order also confirms to the tail risk being higher in lower quartile funds as mean VaR values are higher for the funds in lower quartiles both on the basis of 3-year and 5-year ranking. The funds in lower quartiles of 3-year and 5-year ranking load more on large-cap assets that being the guidance factor of portfolio allocation in large-cap equity funds, higher quartile funds also tend to manage outflows from the corpus during economic downturns though allocation to cash & cash equivalent while funds in lower quartile maintain 1.5-2.5% allocation in debt to manage higher mid-cap associated outflows. Fund rankings, both 3-year and 5-year are not affected significantly by quarterly flows received by funds under the sample, which implies that younger funds also tend to make a cut and qualify to be in higher quartiles based on rank.

IV. EMPIRICAL ANALYSIS

A. *Do fund managers carry out smooth transition between cash & non-cash assets in response to tail risk?*

Mutual funds employ several tools to manage the downside associated risk of portfolios. For instance, equity-oriented funds can move funds between equity holdings and cash. We consider changes in downside risk exposure as the factor explaining the fund manager's decision of keeping proportionate allocation in cash & liquid assets. The fund manager can also resort to shifting funds within the equities asset class between securities having low-downside beta and downside beta. We first analyze the ability of fund managers in shifting funds between cash and non-cash assets during difference phases of economy – upswing and downswings. We divide our sample into quarters followed by a consecutive 3-months positive returns and quarters characterised by negative returns on consecutive basis. In each Panel we analyse scheme-wise data collected on quarterly frequency. To do this, we sort funds into quartiles on the basis of 5-year risk adjusted performance ranking and then test whether Cash and cash equivalent allocations in portfolio emerge on the basis of Value at risk and other allocation characteristic of portfolio. Our sample time period (2011-2020) witnessed 3-economic upsides (Jan 2015-Nov 2017, March-June 2020 and June-Nov 2020) and one economic downside (Nov 2017-Mar 2020). We investigate portfolio characteristics – cash & cash equivalent holdings by the fund manager and market-cap allocation shifts within the equity asset class just prior to economic upsides and economic downside. We note that across quartiles, funds increase their allocation to equity asset class just before the

onset of economic upside. However, funds in top quartiles across Panel A (representing economic upside) increase allocations to midcap and small-cap category within equity asset class. It is also noteworthy that funds in bottom quartile maintain highest allocation in liquid funds and allocating the least AUM to mid-cap and small-cap category within equity asset class. Just before the onset of economic downturn, exhibited in Panel B, successful down timers, funds in top quartiles increase holdings in cash and cash equivalents significantly to manage cash outflows due to high small-cap allocations. Across, we find that funds skilled in downside risk timing, are less eager to take a step away from high momentum stock holdings than the unskilled ones.

TABLE II. MECHANISM OF DOWNSIDE RISK TIMING BY MUTUAL FUNDS

Panel A: Changes in folio characteristics prior to upside in market				
	Median Returns	***Equity***	***Debt***	***Cash***
Top Quartile	4.0739	95.9729	0.0039	4.0267
Qtile2	3.9195	93.8022	0.3597	6.0539
Qtile3	3.6498	93.3704	0.7664	6.3011
Bottom Qtile	3.6389	95.7473	0.1975	4.1539
March-June 2020				
Top Quartile	6.1976	94.9018	1.1365	5.0524
Qtile2	5.8217	93.4745	0.4575	7.6422
Qtile3	4.9228	90.4047	0.59	9.3424
Bottom Qtile	5.5461	89.0584	0.301	10.258
Jan2015-Nov 2017				
Top Quartile	0.9358	95.4079	0.2451	4.5849
Qtile2	0.9037	93.1633	2.6263	5.435
Qtile3	0.7891	93.6755	4.9495	5.5002
Bottom Qtile	0.758	90.3802	0.3064	9.5134
Panel B: Changes in folio characteristics in response to market downside				
Nov 2017-Mar 2020				
Top Quartile	-0.4371	96.6144	0.083	3.3819
Qtile2	-0.5143	92.4266	1.1945	6.9886
Qtile3	-0.6093	91.4887	0.9578	7.969
Bottom Qtile	-0.5804	95.1726	0.1756	4.7649

Source; Author's own calculations

B. Economic significance of downside risk timing

We deliberate & investigate the economic value generated by effective downside risk timing. We conduct a comparative analysis of performance generated by different funds - successful and unsuccessful in timing the downside risk. Rationally, positive downside-risk timing skill should enhance fund performance. We investigate the extent of contribution by sorting funds into 4 groups on the basis of their downside risk timing skill, measured by VaR estimates computed as per equation (1). Fund performance is computed in reference to asset pricing models – Capital Asset Pricing Model (CAPM), Fama-French 3-factor, Carhart Four Factor and Five Factor models.

TABLE III. ABILITY TO TIME DOWNSIDE RISK AND FUND PERFORMANCE

Panel A: Successful down timers				
	Average Returns	***Fama-French***	***Four Factor***	***Five-Factor***
α	0.6912	0.0412	0.0881	0.5776
	(0.03)	(0.02)	(0.02)	(0.01)
RMRF		0.9389	0.9746	0.9657
		(0.001)	(0.010)	(0.00)
SMB		-0.1039	-0.1035	-0.10554
		(0.010)	(0.020)	(0.003)
HML		-0.0848	-0.0744	-0.0781
		(0.02)	(0.01)	(0.003)
WML			0.0681	0.0696
			(0.02)	(0.02)
Industry MoM				-0.01408
				(0.03)
Panel B: Unsuccessful down timers				
α	0.3556	-0.0147	-0.0856	0.2331
	(0.01)	(0.05)	(0.01)	(0.01)
RMRF		0.9483	0.9678	0.9574
		(0.02)	(0.03)	(0.012)
SMB		-0.0557	-0.0554	-0.0637
		(0.00)	(0.003)	(0.004)
HML		-0.0405	-0.0348	-0.0423
		(0.01)	(0.02)	(0.01)
WML			0.0374	0.0370
			(0.01)	(0.005)
Industry MoM				-0.0298
				(0.03)

Source; Author's own calculations

As detailed in the Table III above, funds successful in timing the downside risk (qualifying to be in top 25% quartile) on an average offer at least 2-times the alpha (superior returns) when compared to the alpha generated by funds in bottom quartile (categorized as unsuccessful in timing the downside risk on basis of VaR estimates). The excess return (alpha) generated by successful funds outperforms unsuccessful funds across the factor models utilized for performance measurement. P-values are reported in parentheses and as is evident, values of alpha are significant at 95% level of confidence. This establishes the hypothesis that downside risk timing skill adds economic value with enhanced performance attained by funds successful in timing the downside risk. The fund alpha of

successful down-timers overshadows higher coefficients of factors of momentum across models.

C. *Did Covid-19, the economic shock impact tail risk management?*

We investigate the famous hypothesis that investors willingly tolerate underperformance of active funds as these funds outperform in the periods particularly relevant to investors. We analyse the efficacy of tail-risk management by fund managers during the Covid-19 pandemic crisis of the year 2020.The crisis has thrown unique challenges to the world economy in a span of 100 years. The crisis, in nature of economic shock has led to unanticipated contraction in the economic output and subsequent mass scale unemployment, the fastest one on record. On the other hand, however, it has also created unusually large dislocation in prices prevailing in financial markets, offering unique opportunity to outperform by altering allocations. Portfolio returns after the onset of pandemic Covid-19 are mentioned in detail in Table 3, as we analyse returns generated during market upturns (19 Mar-02 June 2020 and 02 June-05 Nov 2020). In table 7 below, we share the average returns (mean & median returns) generated by funds sorted on the basis of downside risk timing ability (Quartile 1 being the top quartile). We find that despite very high negative returns booked by funds in first two weeks of March 2020, fund across quartiles manage positive average returns during Covid period (post December 2019). Also as highlighted in Table 3, funds generate substantial positive returns during market upsides (higher in value during medium intensity period (June-Nov 2020)), which substantiates.

TABLE IV. DOWNSIDE RISK TIMING DURING COVID-19 PANDEMIC, THE ECONOMIC SHOCK

Panel A: 9-Month Ranking (%Midcap allocation)				
	βlargecap	***βothers***	***βLagVaR***	***Median Rp***
Top Quartile	0.1317**	-0.2474	0.5205**	1.9201
	0.0033	0.0559	0.5507	
Qtile2	0.1112**	-0.1581	0.6050**	1.3882
	0.0072	0.0307	0.3064	
Qtile3	0.1351**	0.1399	4.5661**	1.2790
	0.0068	0.3930	1.5991	
Bottom Qtile	-0.0093*	0.0080	2.8018*	1.1152
	0.0146	0.0590	1.2280	
Panel B: 9-Month Ranking (%Cash and equivalent allocation)				
Top Quartile	-0.0549**	-1.2531**	0.6826	0.3397
	0.0175	1.0058		
Qtile2	-0.0448**	-0.5351**	0.7623	0.2447
	0.0296	1.2772		
Qtile3	-0.0025	0.8327	0.0020	0.3220
	0.0022	0.5099		
	-0.1774*	-2.4805	0.5874	0.4707
	0.0297	3.5414		

Source: Author's own calculations

V. CONCLUSION

Ability to manage the downside risk is one of the value enhancing skills in fund management. The area has been an area of interest for industry practitioners, academicians and researchers alike as it is at the core of development of mutual fund management. Earlier studies in this area have shown that securities with returns highly correlated with market during economic downturn on an average deliver higher non-normal returns. The finding suggests that portfolio managers can carry out successful transmission between assets with high downside risk to low downside risk and generate superior returns in the periods most relevant to fund investors. Our study investigates the concept of tail risk management in Indian mutual fund industry and we find that on an average funds possess downside risk timing ability. Managers anticipate broader macro-economic changes and adjust downside risk exposure of the portfolio. We segregate funds into skilled down-timers and unskilled down-timers on the basis of risk-adjusted returns ranking on a quarterly frequency. Skilled funds successfully transmit funds between cash and non-cash assets as well as high downside risk to low downside risk in varying macro-economic conditions and achieve superior returns (on an average twice the alpha and 13-25% higher returns in comparison to unskilled down-timers). This leads us to an important infer the economic impact of downside risk timing abilities in fund management. We analyze time period related to Covid-19 pandemic separately as Covid-19 pandemic came as an economic shock, albeit unfolding unique opportunity due to unusual dislocation in prices of financial securities. We could find that downside risk timing ability persists even during period of economic shock and skilled down-timers loaded more on quality mid-cap stocks in low intensity phase generating higher abnormal returns than unskilled down-timers. Our study contributes to the vast literature available on market-timing skill in fund management. Since, funds are constrained in usage of tools to time downside risk, more so because of regulations governing the fund management. Given rules of the game, downside risk timing skill assumes great importance as a tool for managers to deliver enhanced value as well as capitalize on predictive skills as macro-economic situation undergoes change.

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Competitiveness of Traditional Indian Manufacturers like Tata Motors and Ashok Leyland in the Indian Heavy Commercial Vehicle Segment

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Abstract:

India has a vast and intricate road network utilized predominantly for the transportation of goods and passengers. As per NHAI which is National Highways Authority of India, 65 percent of cargo and freight and 80 percent of passenger traffic is carried on the roads. Vehicles used to transport cargo or passengers who pay are called as commercial vehicles. Commercial vehicles are classified as LCVs and M and HCVs which stands for medium and heavy commercial vehicles. The LCVs are those vehicles that have a GVW which is gross vehicle weight of not more than 6 Tonnes and for M and HCVs, the GVW is more than 6 Tonnes, between the two, 60percent of CV sales is in LCVs and for M and HCVs it is 40 percent. In the passenger segment, most state governments provide public transportation services. Besides, there are several private players in the segment. The cargo segment is significantly dominated by private players. Both domestic and international makers play a vital role in this industry over the decades. Due to several updates and up-gradation of technology, the vehicle makers have become more competitive among the markets with the product innovations and efficient operations. The international players in the Indian markets have world class technology and superior engines. Despite this, the Indian makers, especially Tata Motors & Ashok Leyland always hold the top place in the market share as well as in the segment sales. Indian makers are very conscious about the needs of the Indian customers and the Indian road conditions which results in higher reliability and serviceable products with lower operating costs. In this paper, we are discussing only the M and HCV sector and aims to understand what makes the commercial vehicle makers, especially Tata Motors and Ashok Leyland more reliable and competitive than the others in the Indian market.

Background of the commercial vehicle makers in India

The market share of the various segments in the Indian automotive industry is as shown below in the table below

Table 1 Market share information

Type	Market share percent
Two wheelers	81
Passenger vehicles	13
Commercial vehicles	3
Three wheelers	3

From Society of Indian Automobile Manufacturers-SIAM, 2017 to 18

Several commercial vehicle makers are competing in India in both the LCV & M&HCV sectors. The table below shows the list of some of the reputed national & international commercial vehicle (CV) makers in India

Table 2: List of CV makers in India

National	International
Tata Motors	Volvo India
Ashok Leyland	Scania India
Mahindra & Mahindra	Daimler India
Eicher Motors	MAN trucks
Swaraj Mazda Isuzu	AMW Trucks

Although there are several players, the emphasis of this paper is to discuss players who are dominating with significant sales & and also with the existence of more than 20 years in the field in the Indian scenario. Therefore, subsequent analysis is for the three major players, viz; Tata Motors, Ashok Leyland & Volvo.

Let us see the overview of these three companies as showcased on the respective company official websites

TATA Motors:

- Tata Motors was established in 1945. Today the Tata is a leading global automobile manufacturing company.
- Its diverse portfolio includes an extensive range of cars, sports utility vehicles, trucks, buses, and defence vehicles.
- Tata Motors is one of India's largest OEMs offering an extensive range of integrated, smart, and e-mobility solutions.
- Tata's mission is to innovate mobility solutions with a passion to enhance the quality of life.
- Tata's vision is to deliver superior financial returns, exceeding customer expectations, and creating a highly engaged workforce.
- World-class manufacturing forms the essence of Tata Motors. Their facilities ensure that every step – from design to production to assembly – follows the highest standards of quality.
- Tata plants combine modern manufacturing practices with cutting edge technology.
- Tata Motors' overseas plants to are equipped with state-of-the-art manufacturing and assembly lines to cater to large numbers and different variants of vehicles.
- Tata's constant focus on automation and technology makes them the leader in India's commercial vehicle market and also top vehicle makers in the world.
- Tata trucks are designing to offer global styling, enhanced driving comfort, and superior performance. While designing commercial vehicles, the designers pay emphasis on safety, maintenance, user comfort, and life cycle cost.
- Tata Motors is driven by a passion for excellence, which is reflected across all our operations.
- Tata's unmatched lead in auto technologies has helped them strengthen their leadership position in the automobile industry.
- Innovation is deeply embedded in the DNA of Tata motors and is demonstrated through their path-breaking vehicles.

Ashok Leyland:

- Ashok Leyland is an Indian automobile company owned by the Hinduja Group.
- It is the second-largest manufacturer of commercial vehicles in India and the third and the tenth-largest manufacturer of buses and trucks in the world respectively.
- Ashok Leyland has its headquartered in Chennai and consists of 9 manufacturing plants.
- A joint venture with the Al-teams Group for the manufacture of high-press die-casting extruded aluminium components for the automotive sectors.
- Ashok Leyland has a well-diversified portfolio across the automobile industry.
- Ashok Leyland has a product range from 1T GVW to 55T GTW in trucks, 9 to 80 Seater buses, vehicles for defence and special applications, and diesel engines for industrial, and marine applications.
- Ashok Leyland launched India's first electric bus and Euro 6 compliant truck in 2016.
- Ashok Leyland is the first CV manufacturer in India to receive the OBD-II certification for BS-IV engines, SCR, EGR, and CNG technologies.
- Ashok Leyland was the first truck and bus manufacturer to receive the Deming prize outside of Japan for its Pantnagar plant in 2016 and Hosur plant in 2017.
- A global network of over 550 touch points and an Indian network of over 3000 touch points that facilitate on-road service for millions of vehicles.
- Ashok Leyland provides driver training across India and has trained over 800000 drivers and service training for technicians by training institutes located in 9 places across India.

People, Planet, and Profit for all stakeholders especially their customers is at the core of Ashok Leyland which resonates with their philosophy of 'AAPKI JEET, HAMARI JEET'.

Volvo:

- Volvo, Sweden was founded in 1927.In India, they started operations in Bengaluru in the year 1998. Today, Volvo is one of the world's leading manufacturers of heavy commercial vehicles and diesel engines, with operations in more than 190 markets.
- Volvo Buses is one of the world's leading brands of buses and coaches, operating in more than 85 countries. They are driven by a passion to help create the cities of the future, free from congestion, emissions, and noise.
- Volvo's mission is to help operators and communities offer people safe, clean, and efficient transportation to and from work, around the city, or across the continent.
- Annually delivering more than 9000 vehicles across the globe.
- Volvo knows that business performance depends on the quality of the products and services they supply

- Quality not only reflects their promise to the customers when it comes to delivering uptime and durability. It's beyond that and concerns all aspects of their operations, from product development to customer support.
- At the test facility, there are 15 different test tracks where everything Volvo buses and coaches may face during its lifetime is tested.
- Harsh testing of chassis and components on demanding road surfaces, high-speed driving, aggressive curves, slippery roads.
- Safety always comes first at Volvo Buses. It's a core value and has been their guiding star since 1927. Already back then Volvo's founders stated that "Safety is and must be the basic principle in all design work". Today, almost 90 years later, we stand by this with our vision: zero accidents with Volvo Group products.
- Volvo introduces Power Steering in 1951, ABS in 1983, EBS in 2000, ESP in 2004, FIPS in 2005, Cornering lights in 2011, CWEB and VDS in 2015, Enhanced rollover safety in 2017, Driver Alert System in 2018.

Every new safety technology of Volvo takes them closer to their zero accident vision

SWOT analysis of the three companies

To have a better understanding of the prevailing environment, let us now have a look at the SWOT analysis of these three companies

Table 3a: SWOT analysis for TATA Motors

Strength	**Weakness**
• R&D activities • Focus on quality • Diversified geographic presence	• Dependent on third party suppliers
Opportunity	**Threat**
• Agreements • Launch of new products • Growing global automotive industry	• Intense competition • Increase in input prices • Stringent environmental regulations

Table 3b: SWOT analysis for Ashok Leyland

Strength	Weakness
• Income execution • Indian market position • Robust manufacturing capabilities	• Heavy dependence on the Indian market
Opportunity	**Threat**
• Contracts • Development activity • Demand for the global automobile industry	• Changing innovation • Competition pressures • Regional and economic influences

Table 3c: SWOT analysis for VOLVO

Strength	Weakness
• High-end demand in the Indian bus market • Focus on differentiation strategy with high configuration engines, AC coaches, etc.	• Improvement steps in the cost of ownership and maintenance of the vehicle for a lifetime • Needs to research more on the Indian market &Indian road conditions
Opportunity	**Threat**
• Launch of new products • Growing global automotive industry	• Intense competition • Tata & Leyland making luxury buses

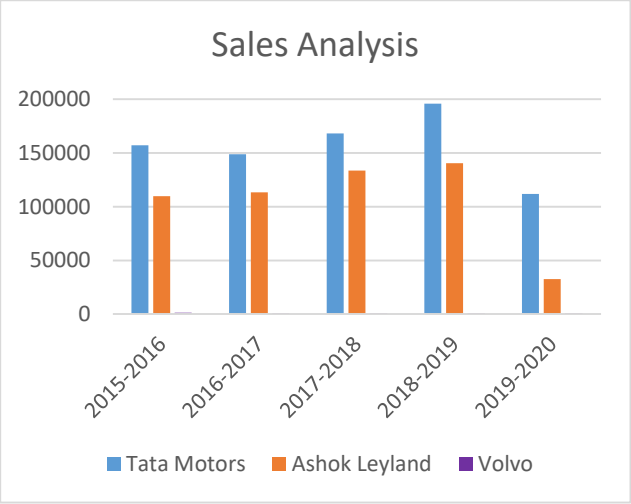
Comparison of Sales data for these three companies

To look at the market position & the sales volumes achieved, the data from the past five years is collected & is as shown in the table below

Table 4: No of M&HCV Units Sold (Sales Data: 2015 – 2020)

Fiscal Year	Tata Motors	Ashok Leyland	Volvo
2015 – 2016	156961	109762	1244
2016 – 2017	148901	113315	1054
2017 – 2018	168013	133439	1055
2018 – 2019	195712	140361	1123
2019 – 2020	111752	32702	1107

Note: All the values are taken from the official website of Tata Motors, Ashok Leyland and Volvo India.



Environmental friendly vehicles from the three players

The prevailing pollution levels have prompted Governments across the world to take stringent actions to curb and curtail the impact on the environment. Electric vehicles are going to be the future. They have been significantly progressing in the car & SUV segments and are yet to make inroads in the heavy vehicle segments. However, the electrification is viable & currently developing only in the LCV segment because of the power & load requirements. The preparedness and progress and plans of the three players is briefly shown below

Table 5: Future readiness of the three CV makers

Tata Motors	Ashok Leyland	Volvo Trucks
Tata has launched India's first fully electric truck, Tata Ultra T7,with GVW of 3.6 to 4.9 Tons	Ashok Leyland delivered its first BS-VI compliant commercial vehicles range in 2020	Volvo has launched several models in the European market and are likely to launch them shortly in India too

Finally, it is important to notice the core competencies & strong points of Tata Motors & Ashok Leyland listed below

Enhanced Product Designs and Operations:

1. Power of Enhanced Performance:
    - Faster Turnaround Time
    - Enhanced Drivability
    - Higher Uptime
    - Higher Productivity
2. Lower Cost of Ownership:
    - Powerful Engines with high fuel economy
    - Enhanced Reliability and Uptime
    - Lower Maintenance Cost
3. Individual Customization:
    - Engine Specifications
    - Axle Configurations
    - Fully Built Unit / Chassis
4. Total Peace of Mind:
    - 18000+ spare part retail outlets
    - 1500+ service workshops
    - Less than 4 hours – Reach time for both Ashok Leyland and Tata Motors
    - Less than 24 hours – Service Resolution Assurance by Tata Motors
    - Less than 48 hours – Service Resolution Assurance by Ashok Leyland
    - Online as well as Breakdown / Highway Support

The process behind these enhanced operations is the Market Research by the Indian makers. The Market Research process involves

Objective – Research – Analyze – Measure – Results – Refine

The top Indian makers (Tata Motors &Ashok Leyland) did several market pieces of research in the heavy commercial vehicle segments and providing long term sustainable products and services to the Indian Customers.

Conclusion

As seen in the exclusive features of the Tata Motors and Ashok Leyland, it is evident that they have more advantages over the Volvo and other players in the Indian market. It is because they have been in the Indian market for more than 70 years with several market researches. They providing enhanced performance with lower cost of ownership and individual customization. The above aspects aptly convince our assumption that enables these two Indian companies, viz; Tata Motors & Ashok Leyland to be more competitive and sustainable in the Indian Heavy Commercial Vehicles market when compared to the other players.

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Risk Analysis and Assessment Toolkit

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***Abstract* - The purpose of the Risk Assessment toolkit is to depict how organizations can manage risks associated with projects, systems, applications and departments. Before an organization can use the toolkit provided, they will need to complete the administrative side of risk management. This includes formulating policies, completing SWOT analysis on each proposed asset, project feasibility analysis and they must complete asset valuations. Once, that is completed the organization will move on to the assessment phase. In the assessment phase an organization will utilize the toolkit to discover the impact that the risk will have on their organization and they will be provided a summary of the impacts of each risk. Next, the organization will need to complete the alleviation process. In the alleviation process the organization will review what options they have, what remediation techniques they can perform, and they will continue to monitor major assets. Once an organization completes these three methods of Risk management then their organization will experience significantly less risks and increased capabilities.**

Keywords - Risk Assessment; SWOT Analysis; Feasibility Study; Asset Valuation; Risk Remediation; Risk Policies; Risk Monitoring

I. Introduction

The Risk Assessment toolkit has been created and tested in Microsoft Excel. This was done due to the popularity of the Microsoft Excel application and feasibility that it will provide each organization. In the next section the Risk assessment toolkit will be discussed in more depth. The administrative method that organizations should do prior to using the toolkit and the alleviation methods after using the toolkit will also be discussed in more depth.

II. Proposed Method

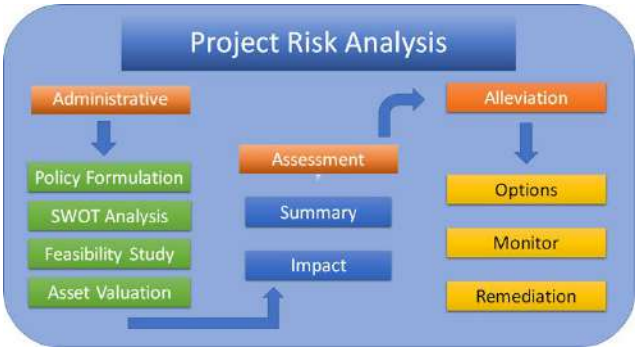


Fig. 1, depicts the three methods that organizations will follow to obtain the most accurate risk assessment data about their organization. The first method is administrative, this is completed before using the toolkit and this consists of policy formulation, SWOT analysis, feasibility studies, and asset evaluations. Policy formulation is where the organization will need to create an Information Risk Management Policy (Harris, 2013). This policy will address the acceptable level of risk the organization will assume, the mapping of risks to performance targets and budgets, and the key indicators to monitor the effectiveness of controls and the responsibilities that fall under Information Risk Management and the roles to fulfil them (Harris, 2013). After formulating the policy, the organization will then need to assign members to a Risk Management and analysis team. This team needs to consist of various department members, so each department has a voice. In a larger organization these teams could meet in a similar fashion to a steering committee. In a smaller organization the executive team would complete the activities. The Risk Management and analysis team would be responsible for providing security awareness training, mapping legal and regulatory compliance requirements, documenting risk assessment processes and procedures, and establishing a risk acceptance level provided by upper management (Harris, 2013).

Once established, the team must conduct a SWOT analysis within the organization:

The team must start by completing a SWOT analysis for all projects, systems and departments. It is important to note that each project, system and department should have a separate SWOT analysis for more accuracy. To complete the SWOT analysis, be sure to focus on identification of the Strengths, Weaknesses, Opportunities, and Threats. In Fig. 2, an

illustration of what a SWOT analysis chart looks like can be seen.

After the SWOT analysis at the organization's discretion, it is highly recommended that the organization should complete a feasibility study.

The team is also in a unique position to complete a feasibility study to determine the likelihood of success for a new project over four distinct considerations (Tilley, 2019).

1. Operational - Does it fit into our organization and will it be accepted by current staff?
2. Technical - Do we have the technical skills and/or capabilities to complete the project?
3. Economic - Can we afford the anticipated costs vs the benefits?
4. Schedule - Will the project fit within the available resource schedule timeline?

The answer to the above questions will provide the team with the necessary awareness to move forward to Risk assessment, if warranted. Armed with this additional information, the team can begin.

It should also be noted that due to the pandemic more and more organizations have been hit with inherent risks such as communication issues. These communication issues can cause slowdowns in the supply chain or mistakes when completing projects due to departments not communicating efficiently. In addition, some solutions to the inherent risks to organizations due to the current pandemic in the world are listed below:

- Ways around communication conflicts are utilizing collaborative technologies such as Zoom, Google Meet, and Microsoft Teams.
- Another solution is using the Delphi Technique, in this technique processes of remote interviewing to get group feedback are used and the feedback received is then analyzed and sent back to the groups for further analysis (Piney, 2003).

Along with the above administrative tasks, the financial establishment of asset valuations must be completed for use in the assessment tool (NIST, 2002). As part of the tool, a worksheet for each asset class is available. Below is a sample of the asset class worksheet (Excel SS #1) that feeds directly into the asset valuation analysis:

Asset Class Valuation - Class:

Name	Number	Description	Value	Life	Annual
			$0	1	$0
			$0	1	$0
			$0	1	$0

In addition to the Name, Number and Description, in the 3 numeric columns, the first is the actual value, the second is the life valuation (in years) and the third column represents the annual risk associated with the asset class. That number is calculated for division of Value/Life and summarized to the risk analysis detail sheets.

The asset classes used in our analysis include:

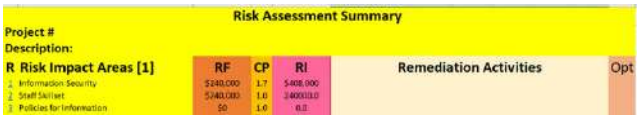
1. Cash and Liquid Investments
2. IT Asset Dollars
3. Key Asset Dollars
4. Differentiation Value
5. Staff Assessment
6. Competitive Advantages
7. New Project Expenditures

III. Experimental Data Analysis and Results

To begin the Risk Analysis, following the completion of the SWOT Analysis and Feasibility Study, a couple of steps must also be completed in advance:

1. Review the Asset Value Sheets to verify completeness.
2. Save the Risk Assessment Excel Master document with the name of the Project for the new analysis as part of the Excel filename for reference.
3. Add the Project Number and Description of the new analysis to the top of the Risk Assessment Summary sheet.

The actual Risk Analysis/Assessment process (Excel SS #2) is as follows:



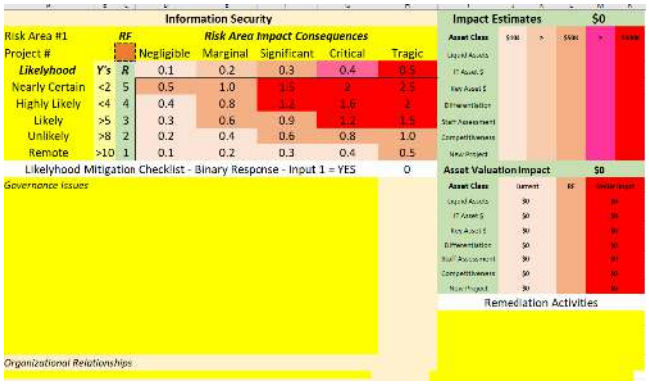
The summary sheet includes the Risk Impact Areas and a link to each representative sheet of the 21 in the list (3 shown above). The full list of 21 Risk Impact Areas we recommend is listed below: (ISACA, 2014)

1. Information Security
2. Staff Skillset
3. Policies for Data
4. Compliance
5. Lack of Technology
6. Departments
7. Data Interchange
8. Supply Chain
9. New Technologies
10. Image
11. Clientele/Customers
12. Environmental Occurrences
13. Fund Allocation
14. IT Hardware

15. Software Application Portfolio
16. Projects
17. Legal
18. Policies for Users
19. Policies for Vendors
20. Competitors
21. Physical Security

The RF column (Risk Factor) is the numerical data that is carried forward from each detail sheet. The dark gold column is for the CP (Confidence Probability) that has a potential to impact each of the RF values. The CP could cause the RF to increase or decrease based on the confidence of the process. If the Risk is repetitive in nature for the year, that CP can be used to increase the impact by the number of times it is expected to occur.The resulting RI (Risk Impact) is then used by the organization to display considered risk impacts and identify remediations.

An example of the Risk Area Impact Consequences (Excel SS #3) is shown in the following image:



The example above shows what the completed sheets for each risk impact area would look like. In the tool we have 21 risk impact areas, but an organization could add more if need be. Notice that the Title (Information Security) is automatically brought from the Summary Sheet. The Likely-hood Mitigation Checklist is entered below the Risk Area Impact Consequences in the form of a question with a Y/N answer. Each yes has a binary response value of 1 and this is to be typed in the tan column on the right. After all questions are answered the 1's in the tan column is summarized, and the total is compared to the Likely-hood Y's column for that Y axis of the table.

The Current Valuation in the bottom right comes from the numerical data in the Asset Valuation Sheets. That number is summarized as the Impact Estimate and is used to determine the column for the Impact Consequences to be used in the X axis of the Table on the left. Once a value is selected from the intersection of the Impact Estimate and the Likelihood, that value is inserted in the gold RF column to determine the risk estimate which is then transferred to the corresponding cell in the Risk Analysis Summary (NIST, 2002).

IV. Risk Remediation

Remediation activities are then completed for the Risk Impact that is beyond that threshold originally set in the previous policies (Lavanya & Malarvizhi, 2008). Finally, once the estimated Risk Impact has been established, it is up to the organization to complete the remediations regarding the Options and how they are going to Monitor the Risk (Software Engineering Institute, 2010). It is then that the Remediation results can be implemented.

In addition, the remediation activities are the initial step required based on the Option (Opt.- far right column of the summary sheet in dark brown) selected from the Risk Focus Option list that is below.

Risk Focus Options:

A. Risk Adjusting - Modifying but continuing to meet requirements.
B. Risk Mastery - Acting to virtually eliminate risk.
C. Risk Modification - Re-distributing risk to lower exposure.
D. Risk Observing - Surveillance while responding as needed.
E. Risk Recognition - Being aware but not acting.

Once the risk has been identified, decisions are made to determine the appropriate course of action (Software Engineering Institute, 2010).

The list of Risk Observation Processes (Software Engineering Institute, 2010) is displayed below:

1. The status of the risk needs to be continually observed throughout the process.
2. Even after a risk mitigation plan is initiated, the risk is still observed.
3. The impact estimate is evaluated to determine a cost-effective approach.
4. Compare the estimated remediation cost against the risk impact estimate from the Risk Summary sheet
5. The observation should continue unabated through use of observation tools.
6. Select a method to observe risk continuously.
7. If risk observation determines a risk continues above acceptable thresholds, implement risk handling techniques.

The list of Risk Handling Methodologies (Software Engineering Institute, 2010) is displayed below:

1. Cost-effective risk handling techniques are employed to avoid, reduce and control negative impacts to achieve goals and to bring about acceptable outcomes considering estimated impacts.
2. To effectively implement risk handling techniques, resources need to be applied along with detailed schedule of events.

3. The schedule requires both a defined start and estimated end date.
4. Once resources are assigned, they need to continue until the risk handling is achieved or the estimated end date is reached.
5. Risk handling efforts need to be recorded and reported at the end of the process.

Aside from the Risk assessment tool that was created, another informal survey study was performed.

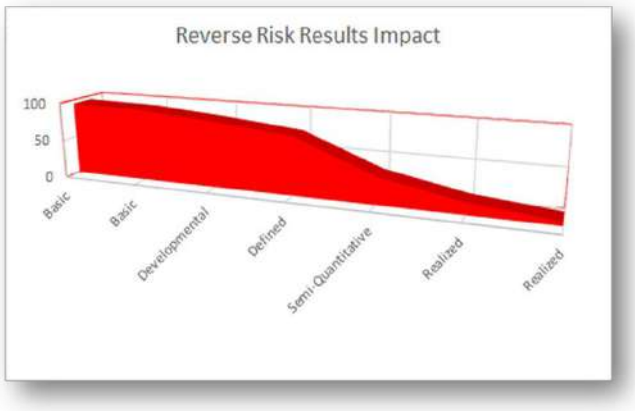
In a survey consisting of 91 upper-level Information Technology students, the students were asked in a zoom poll "If you were an Information Technology Director at an organization and you had access to a Risk Assessment spreadsheet toolkit would you use it?" Out of all 91 students, 89 of them answered with yes, they would use a risk assessment spreadsheet toolkit.

V. Conclusion

The above process is modified and repeated as the organization sees fit. Any organization planning to increase risk assessment capabilities must embark on maintaining up to date training for their workers, so they have the most up to date skillset to accurately and efficiently mediate risks identified. As in implementing any new tool there can be a significant learning curve, but in the end this tool will result in time and capability acceleration. The more risk assessment capabilities, theoretically, the less negative impact from risk.

Implementing such a tool requires time and effort and the organizational realization of how useful the tool is to them (Software Engineering Institute, 2010). This is demonstrated through the learning curve shown below (Excel Chart #1):

The practice of using this toolkit will improve the organizational effectiveness in addressing risk and in addition, the overall organizational ability to address other challenging technical issues will be improved. This toolkit will also provide a simplified visualization of the risk remediation steps and numerical data to efficiently showcase to upper management the risk management process and analysis.



Inversely, as effective use of the Risk Analysis tool becomes realized, (Software Engineering Institute, 2010) the resulting effect on existing risk in the organization can be demonstrated in the table above (Excel Chart #2):

Finally, as more Risk Assessments are completed and saved, a knowledge base of previous Assessments will be available for further analysis, review and of course, consideration for improving subsequent Assessments.

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Designed miniaturized dual-band slot antenna with bandwidth enhancement for cordless telephone application

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***Abstract*— In this manuscript, miniaturized dual-band slot antenna design for cordless telephone application is presented. This proposed microstrip feed dual-band miniaturized slot antenna is designed using rectangular loops and slits. For dual-band miniaturized slot antenna, first resonant is achieved by the reference antenna is loading with six number of slits on both the side of the slot which is antenna 1. Then the second resonant is achieved by the reference antenna is loading with two rectangular loops on the middle of slot which is antenna 2. So, the combination of antenna 1 and 2 then constructs a dual-band antenna that resonates at resonant frequencies of 1.88 and 3.17 GHz. For this antenna, reduced first resonant frequency is 42.85% with 111.18% enhanced impedance bandwidth and reduced second resonant frequency is 3.64% compared to reference slot antenna.**

Keywords—slot, antenna, dual-band, rectangular loops, slit.

I. INTRODUCTION

Today because of the advancement of modern wireless communications system, there is an urgent need of compact size, wideband, miniaturized and multiband antenna. But this miniaturization process may contain some adverse effects on various antenna characteristics. For example, design of a miniaturized dual-band antenna for cordless telephone application is presented. Here we achieved miniaturization and also sometimes achieved bandwidth enhancement in comparison with reference antenna.

Several researchers miniaturized slot antenna reported, because in planar elements it is very easy to fabricate. This slot antennas miniaturization has been reported in [1-4] with different methods of miniaturization technique. The miniaturized slot antenna realization using a folded structure is presented in [1]. In [2], 37.73 and 42.33% miniaturization realization using strip and slit loading have been reported. The CPW-fed miniaturized slot antennas using a split ring with 26% miniaturization and using split-ring resonators with 36% reduction in resonant frequency have been discussed in [3] and [4] respectively.

Not solely miniaturization but also improvement of impedance bandwidth of slot antennas have been reported in [5] - [9]. In [5], 19.33% miniaturization with 23.76% bandwidth enhancement using loop loading planar slot and 26.01% miniaturization non-planar double-loop loaded dipole antennas have been highlighted. Then using folded structure miniaturization and bandwidth improvement of slot antennas, both self-complementary and complementary realizations are described in [6]. Miniaturization and bandwidth enhancement circularly polarized square slot and fractal arrays using square slots antennas have been discussed in [7] and [8]. Bandwidth improvement and further miniaturized microstrip fed slot antenna is proposed in [9].

The different methods have been used but the same objective to design dual-band antennas for wireless local area network (WLAN) applications are discussed in [10]-[12]. After that, dual-band patch and slot antennas miniaturization have also been investigated in [13]-[16]. The dual-band miniaturized with circularly polarized antenna combination of slot and DRA is investigated in [13]. In [14], designed a highly miniaturized dual band patch antenna for application of SFF wireless device is discussed and independent band control, folded, linearly polarized, miniaturized dual-band patch antenna have been discussed in [15]. A dual-band miniaturized slot antenna with enhanced impedance bandwidth is described in [16], for the application of WLAN, GPS and amateur radio.

Hence, the target of this manuscript is to propose miniaturized dual band slot antenna for cordless telephone application. Here not only achieved miniaturization but also sometimes achieved improvement of bandwidth. For this antenna, we have got 3.64 and 42.85% miniaturization in comparison with reference antenna.

II. DUAL-BAND ANTENNA DESIGN AND EVOLUTION

The reference antenna structure is shown in Figure 1. Here used reference antenna slot width (W_{SL})=1.20 mm, length (L_{SL})=20.00, substrate dimensions are (L_S)=(W_S)=50.00 mm. This reference slot is feed by microstrip line with dimensions: microstrip length (L_{ML})=27.14 mm, microstrip width (W_{ML})=2.30 mm, microstrip line stub length (L_{STB})=1.54 mm and microstrip line is located distance (L)=6.19 from origin. Here, the dielectric material RT DUROID 6010LM is used as a antenna substrate with permittivity (ε_r)=10.2, height (H)=2.54 mm, dielectric loss-tangent (δ)=0.0023. Also, here taken substrate and radiating slot dimensions are same for all prototypes designs and those were simulated using HFSS simulator [17].

Then the reference slot antenna is loaded by six slits on either end of the reference slot and this structure is shown in Figure 2 and make antenna 1. The length (L_{SLT}), width (W_{SLT}) and separation gap of slits (S_{SLT}) are 10.00, 1.00 and 1.00 mm respectively. Here feed line taken with the

specifications are line length (L_{ML})=30.20 mm, line width (W_{ML})=2.30 mm, microstrip line stub length (L_{STB}) =4.60 mm and (L)=6.00 mm distance from origin.

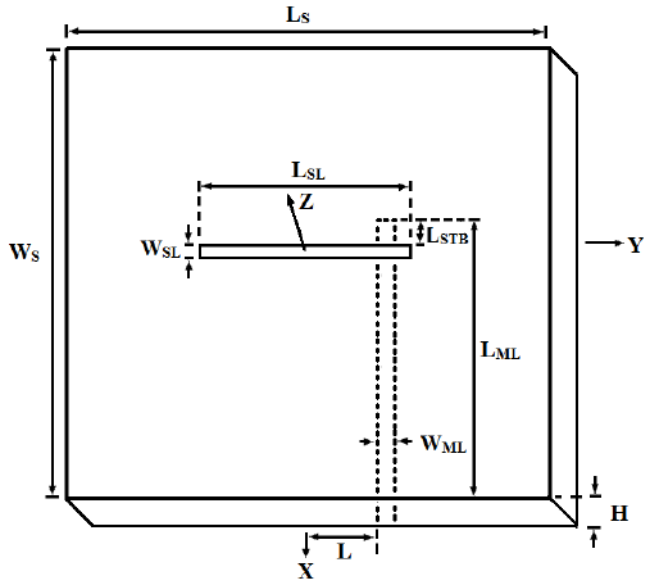

Fig. 1. The structure of reference slot antenna.

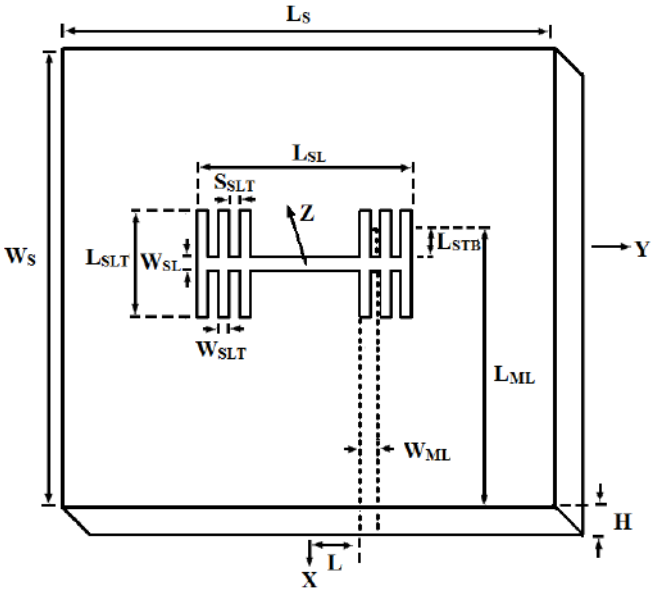

Fig. 2. The structure of antenna 1.

Next, the middle of the reference slot is loaded by two rectangular loops as shown in Figure 3 and make antenna 2. The rectangular loops dimensions of antenna 2 are as follows: long arm of large loop (A_{LL})=10.00 mm, short arm of large loop (A_{SL})=8.00 mm, long arm of small loop (A_{LS})=6.00 mm short arm of small loop (A_{SS})=4.00 mm and width of both the loops (W_L) = 1.00 mm. Here used feed line length (L_{ML}), width (W_{ML}), stub length (L_{STB}) and (L) distance from the origin are 25.61, 2.30, 0.01 and 2.38 mm, respectively.

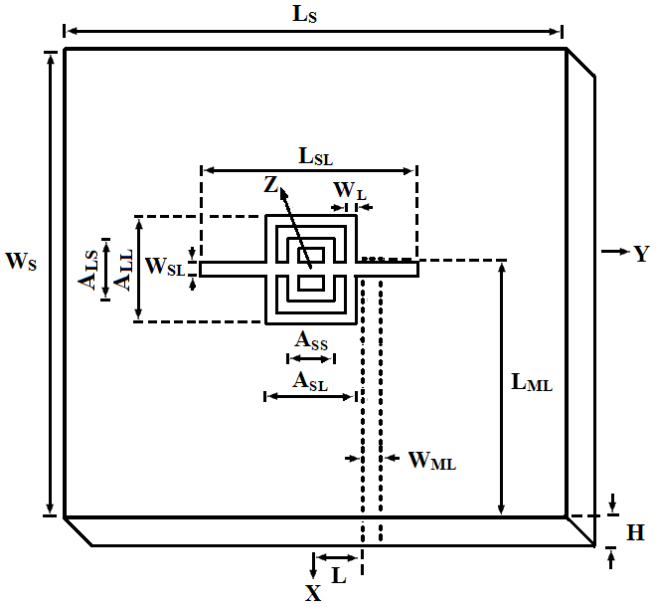

Fig. 3. The structure of antenna 2.

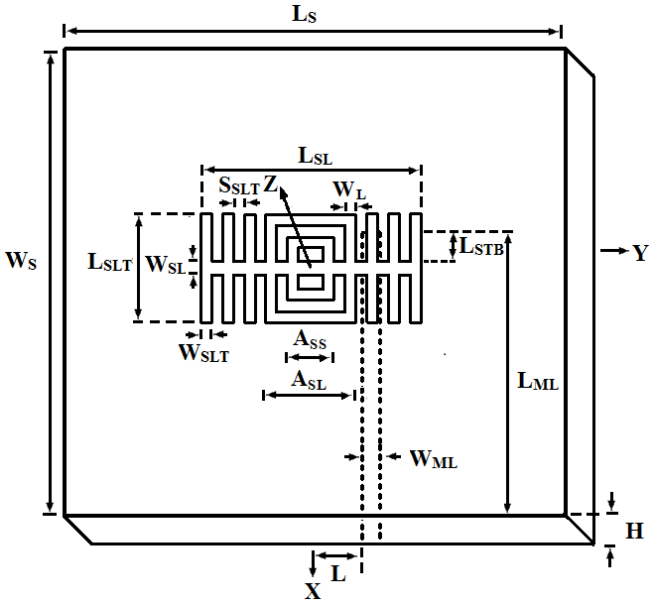

Fig. 4. The structure of dual-band antenna.

Finally, the reference slot antenna is loaded by rectangular loops and slits or combination of antenna 1 and 2 then designed dual-band antenna is shown in Figure 4. To feed this dual-band antenna with feed line dimensions are: width (W_{ML}), length (L_{ML}) and stub length (L_{STB}) is 2.30, 27.53, 1.93 mm respectively and microstrip line is located (L)=2.00 mm distance from origin.

III. Results and Discussions

The simulated resonant frequency of reference slot antenna is achieved 3.29 GHz with 5.37% impedance bandwidth and that is shown in Figure 5. In Figure 6, the simulated resonant frequencies are observed for reference and loaded antennas 3.29 and 1.59 GHz. Here reduction in resonant frequency is 51.67% with 75.01% bandwidth improvement.

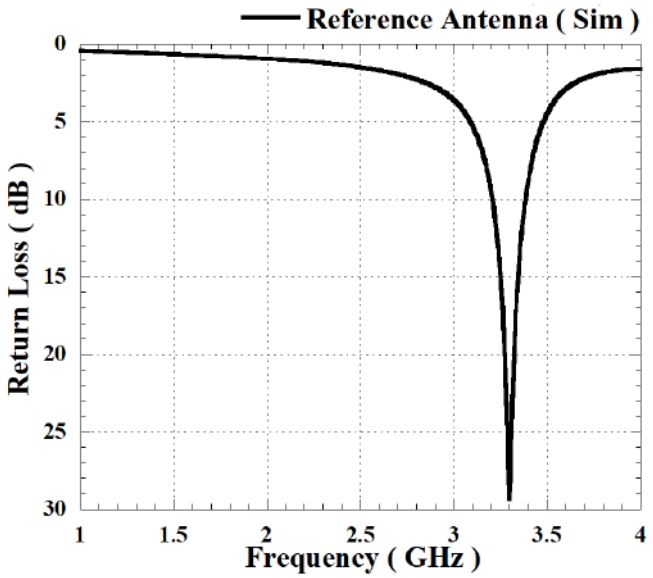

Fig. 5. The simulated return-loss characteristics plot of reference slot antenna.

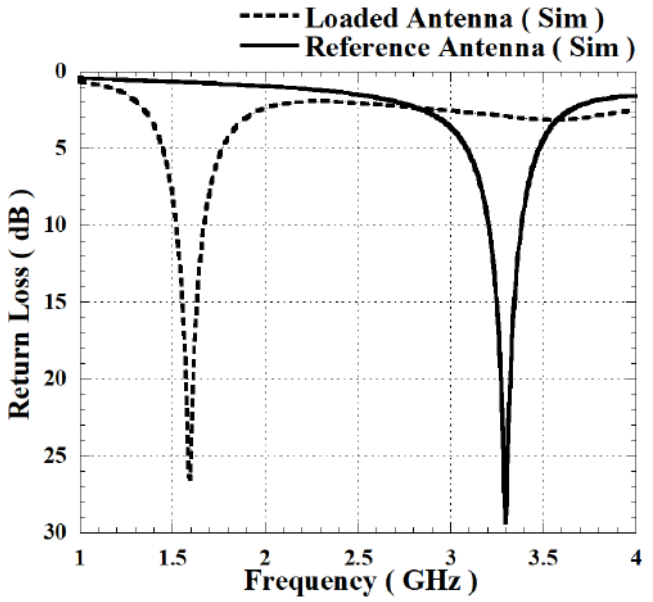

Fig. 6. The simulated return-loss characteristics plot of slits loaded and reference antennas.

In Figure 7, it is shown the simulated return-loss characteristics plot of antenna 2 and observed simulated resonant frequencies are 3.29 and 3.70 GHz, for reference and loaded antennas respectively. Here improvement of impedance bandwidth of loaded antenna is 123.93% in comparison with reference antenna. Then further details of the slits, rectangular loops loaded or antenna 1, 2 and reference antenna parameters are shown in Table I.

In Figure 8, the return-loss characteristics plot of rectangular loops and slits loaded dual-band and reference antennas are shown. This is operating on two frequency bands 1.780 to 1.994 and 3.110 to 3.233 GHz with resonant frequencies 1.88 and 3.17 GHz respectively. Then the input impedance plot of reference and dual-band antennas are shown in Figure 9, for more accepting of matching in return loss and shift the resonant frequency at lower frequency.

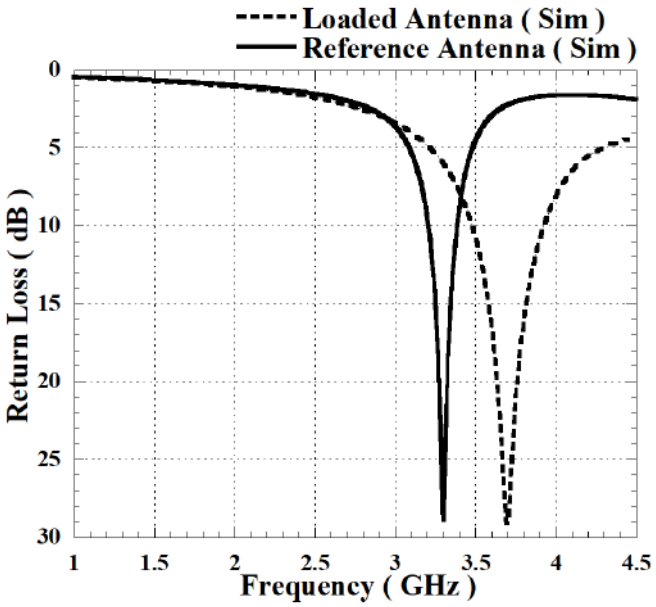

Fig. 7. The simulated return-loss characteristics plot of rectangular loops loaded and reference antennas.

TABLE I. SIMULATED VARIOUS PARAMETERS OF ANTENNA 1, 2 AND REFERENCE ANTENNAS

Parameter	Reference antenna	Antenna 1	Antenna 2
Resonant frequency (GHz)	3.29	1.59	3.70
Miniaturization (%)	-	51.67	-
Impedance bandwidth (%)	5.37	9.39	12.02
Impedance bandwidth improvement (%)	-	75.01	123.93
Operating frequency range (GHz)	3.206 – 3.383	1.521 - 1.671	3.478 - 3.923
Radiation efficiency (%)	89.21	99.56	97.93

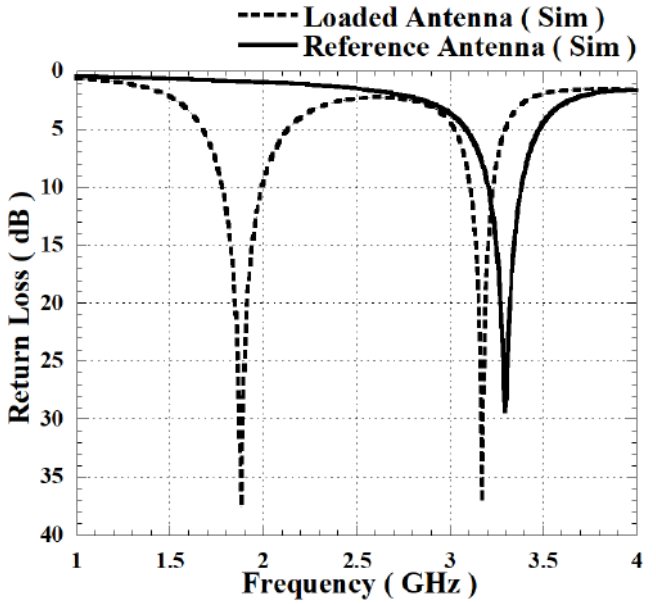

Fig. 8. The simulated return-loss characteristics plot of reference and dual band antennas.

The proposed dual-band antenna H and E-plane radiation plots of first resonant frequency at 1.88 GHz and second resonant frequency at 3.17 GHz are shown in Figures 10 and 11 respectively. In Figure 10, we have found

the simulated values of cross-pol for both H and E-plane are below -20 dB at 1.88 GHz resonant frequency.

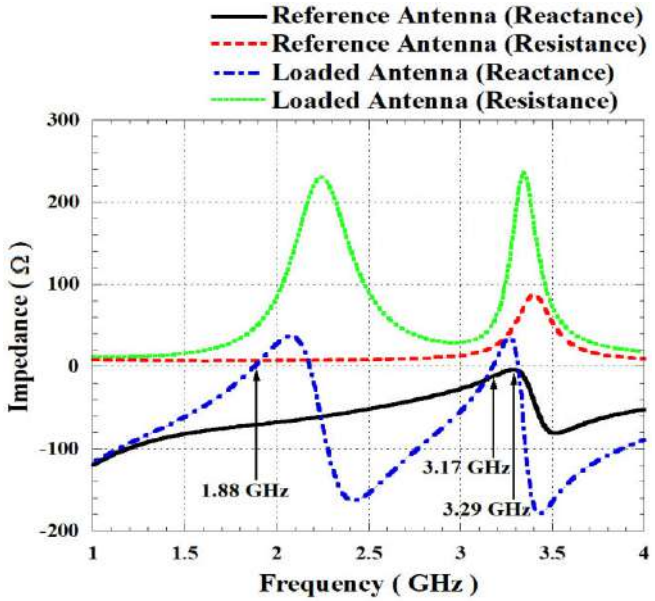

Fig. 9. The simulated input impedance plot of reference and dual band antennas.

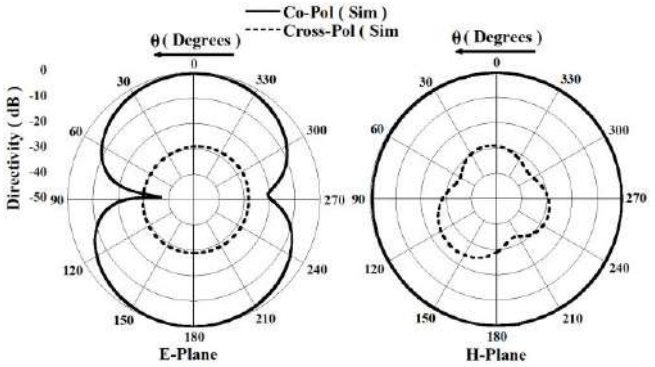

Fig. 10. The simulated radiation characteristics of dual band antenna for first resonant frequency at 1.88 GHz.

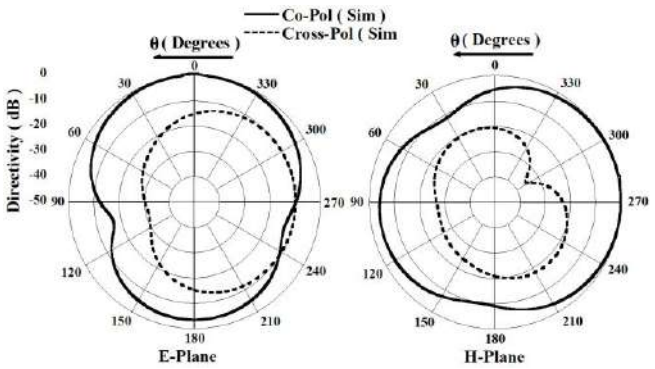

Fig. 11. The simulated radiation characteristics of dual band antenna for second resonant frequency at 3.17 GHz.

This antenna is the example of 1.88-1.90 GHz frequency low power digital enhanced cordless telecommunications (DECT) application. Further details of the parameters of dual-band and reference antennas are shown in Table II.

TABLE II. SIMULATED VARIOUS PARAMETERS OF DUAL BAND AND REFERENCE ANTENNA.

Parameter	Reference antenna	First band	Second band
Resonant frequency (GHz)	3.29	1.88	3.17
Miniaturization (%)	-	42.85	3.64
Impedance bandwidth (%)	5.37	11.34	3.87
Impedance bandwidth improvement (%)	-	111.18	-
Operating frequency range (GHz)	3.206 – 3.383	1.780 - 1.994	3.110 - 3.233
Radiation efficiency (%)	89.21	98.12	95.01

IV. CONCLUSION

The design of dual-band miniaturized antenna loaded with rectangular loops and slits for cordless telephone application is presented in this manuscript. The simulated values of a dual-band proposed antenna can cover two bands of frequency: first resonant frequency at 1.88 GHz (1.780 to 1.994 GHz) with 42.85% miniaturization and second resonant frequency at 3.17 GHz (3.110 to 3.233 GHz) with 3.64% miniaturization. We have also achieved improved impedance bandwidth of 111.18% for the first band of dual-band antenna.

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Blockchain concept and its Area of Applications

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***Abstract*— Block chain is the chain of blocks where the digital information is stored as a block located and organized by a chain in the public database. The blocks contain mainly three important pieces of information, like information about transactions, information about who is participating in the transactions and information about block to distinguish it from the other blocks. This paper explain the concept of Blockchain, its working and the application areas of blockchain .**

***Index Terms*—Blockchain, Hashing, Cryptocurrency,**

I. INTRODUCTION

BLOCK CHAIN is a record keeping technology. It is defined as "blockchain is a distributed, decentralized, public ledger". Blockchain is a chain of blocks where the "block" indicates the digital information stored in the "chain" means the public database. "Blocks" on the blockchain are made up of digital pieces of information which consists of,

The Blocks store information about

- the transactions that can include the timestamp , amount in currency, etc.
- who is participating in the transactions i.e. information of username .
- store a unique code called a "hash" that allows to identify each block uniquely.

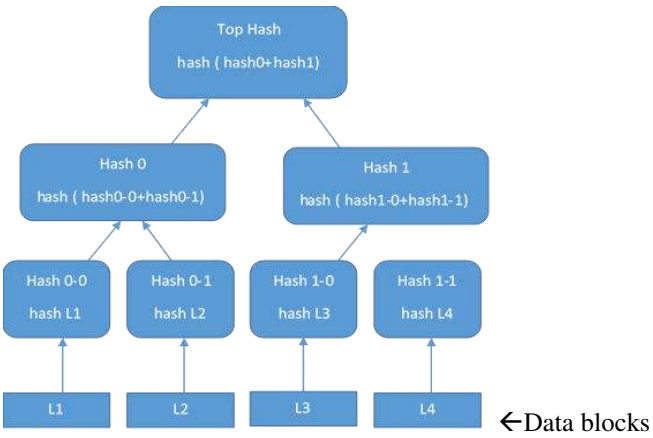

Figure 1: Organization of blocks in block chain.

As shown in Figure 1, A single block on the blockchain can actually store up to 1 MB of data. Depending on the size of the transactions, that means a single block can have a few thousand transactions under one place.

II. WORKING OF BLOCK CHAIN

When a block stores new data it is added to the blockchain. Blockchain, as its name suggests, consists of multiple blocks looped together. A block is added in the block chain based on the sequence of events as follows,

- A transaction has to occur.
- A transaction must be verified.
- The transaction must be stored in a block.
- The block must be given a unique identifying code called a hash, it is also given the hash of the most recent block added to the blockchain.

When that new block is added to the blockchain, it becomes publicly available for anyone to view — even you. If you take a look at Bitcoin's blockchain, you will see that you have access to transaction data, along with information about when ("Time"), where ("Height"), and by who ("Relayed By") the block was added to the blockchain.

III. ISSUES OF CONCERN WHILE USING BLOCK CHAIN

In the public space managed by a cloud, the details of creation of any data object and its subsequent operations performed thereupon are recorded by the data structure mechanism of 'Data Provenance', which is a type of cloud metadata. Thus this is very important to provide the utmost security and trust [15][16] to the data provenance for ensuring its data privacy and integrity [1][2]. Block chain has been demonstrated to be a versatile programmable platform for managing contracts and ownership and providing an audit trail that cannot be easily tampered with, but can be distributed in real time [14].

So these issues are faced by the blockchain technology as well, as listed below.

A. Privacy

- The contents of blockchain can be viewed by anyone. Also users can choose to connect computers to blockchain network, so on connecting their computers to the blockchain network they receive a copy of blockchain, which is updated automatically whenever a new block is added to the network. Each computer in the blockchain network has its own copy of the blockchain, means there are thousands or millions of copies of the same blockchain. Updating blocks in blockchain and managing all the updates of a single block in block chain is

challenging. It is very difficult to manipulate every copy of the blockchain on the network. So with blockchain it is difficult to manipulate the information on network. But at the same time who add the new nodes in the blockchain and what information is partially available to all raises an doubt on the privacy of the blockchain.

B. *Security*

- In blockchain the, new blocks are always stored linearly and chronologically, they are always added to the "end" of the blockchain. For example in Bitcoin's blockchain, each block has a position on the chain which is called the "height" of the block and it indicates the nth block to be added to the blockchain. Once the block is added it is very difficult to edit or remove the block, because each block contains its own hash along with the hash of block before it. Hash codes are created by a math function that creates a alphanumeric string, which is difficult to edit. Let's say a hacker attempts to edit one block on blockchain, as soon as the content on block is changed the hashcode will change, the next block on chain will still carry the old hashcode, and the hacker need to update that block, the hacker has to change the hashcode in all the blocks, so in order to change a single block, a hacker need to change every single block after it on the blockchain, recalculating all the hashcodes would take an enormous and improbable amount of computing power. In other words, once the block is added to the blockchain it becomes very difficult to edit and impossible to delete it.

C. *Trust*

- Blockchain networks have implemented tests for computers that want to join and add blocks to the chain, the tests are called "consensus models" which require users to prove themselves before they can participate in a blockchain network [9]. In the proof of work system, computers must prove that they have done work by solving a complex computational math problem. If a computer solves one of these problems, they become eligible to add a block to the blockchain, but the process to add blocks to the blockchain is not easy, and could take approximately about 1 in 7 trillion time of writing. To solve complex math problems at those odds, computers must run programs that cost them significant amounts of power and energy. Proof of work doesn't make attacks by hackers impossible, but it makes them useless, as the cost of organizing such an attack would almost take trillions of time and effort [10].

IV. Applications of Blockchain in the Real World

Blocks on the blockchain store data about monetary transactions and cryptocurrency and cryptoeconomics [6]. But it turns out that blockchain is actually a pretty reliable way of storing data about other types of transactions, as well [4]. In fact, blockchain technology can be used to store data about property exchanges, stops in a supply chain, and even votes for a candidate.

Blockchain is at an inflection point, with momentum shifting from "blockchain tourism" and exploration to the building of practical business applications. Despite enterprise digital respondents' interest in blockchain's capabilities, nearly 39 percent of the broad global sample said they believe blockchain is "overhyped." In the United States, this number is higher: 44 percent of respondents view blockchain as overhyped, up from 34 percent in a 2016 survey by Deloitte. This perception may be driven by the steep increase in token values over the last 18 months, and survey members conflating blockchain with the incentive layer of public blockchains, namely tokens[5].

A. *Banks*

Blockchain can be applied to baking industries[7]. Mostly the financial institutions operate only during the business hours and five days a week. That means if someone tries to deposit a check on Friday at 7 p.m., it is likely to wait until Monday morning to see that money has deposited in the account. Even if you do make your deposit during business hours, the transaction can still take 1-3 days to verify due to the sheer volume of transactions that banks need to settle. By integrating blockchain into banks, consumers can see their transactions processed in as little as 10 minutes, basically the time it takes to add a block to the blockchain, regardless of the time or day of the week. With blockchain, banks also have the opportunity to exchange funds between institutions more quickly and securely. In the stock trading business, for example, the settlement and clearing process can take up to three days (or longer, if banks are trading internationally), meaning that the money and shares are frozen for that time. Given the size of the sums involved, even the few days that the money is in transit can carry significant costs and risks for banks. Capgemini, a French consultancy, estimates that consumers could save up to $16 billion in banking and insurance fees each year through blockchain-based applications.

B. *Cryptocurrency*

Bitcoin is the most successful and most widely circulated cryptocurrency in the market [11]. Blockchain forms the main base for cryptocurrencies like Bitcoin. The goal of blockchain is to allow digital information to be stored and distributed, but not edited. The Bitcoin protocol is built on blockchain. When it comes to printed money, the use of printed currency is regulated and verified by a central authority, usually a bank or government, but Bitcoin is not controlled by anyone. Instead, transactions made in Bitcoin are verified by a network of computers. When one person pays another for goods using Bitcoin, computers on the Bitcoin network race to verify the transaction. In order to do so, users run a program on their computers and try to solve a complex mathematical problem, called a "hash." When a computer solves the problem by "hashing" a block, its algorithmic work will have also verified the block's transactions. The completed transaction is publicly recorded and stored as a block on the blockchain, at which point it becomes unalterable. In the case of Bitcoin, and most other blockchains, computers that successfully verify blocks are rewarded for their labor with cryptocurrency. Although transactions are publicly recorded on the blockchain, user data is not , at least not in full. In order to conduct transactions on the Bitcoin network, participants must run a program called a "wallet." Each wallet consists of two unique and distinct cryptographic keys: a public key and a private key. The public key is the location where transactions are deposited to and withdrawn from. This is also the key that appears on the blockchain ledger as the user's digital signature. Even if a user receives a payment in Bitcoins to their public key, they will not be able to withdraw them with the private counterpart. A user's public key is a shortened version of their private key, created through a complicated mathematical algorithm. However, due to the complexity of this equation, it is almost impossible to reverse the process and generate a private key from a public key. For this reason, blockchain technology is considered confidential. The Blockchanin not only reduces risk but also eliminates many of the processing and transaction fees. It also gives those in countries with unstable currencies a more stable currency with more applications and a wider network of individuals and institutions they can do business with, both domestically and internationally.

C. *Healthcare*

Health care providers can leverage blockchain to securely store their patients' medical records [3]. When a medical record is generated and signed, it can be written into the blockchain, which provides patients with the proof and confidence that the record cannot be changed. These personal health records could be encoded and stored on the blockchain with a private key, so that they are only accessible by certain individuals, thereby ensuring privacy.

Property Records

The time and effort it takes to Record properties at the local Office and the process of recording property rights is both burdensome and inefficient. Today, a physical deed must be delivered to a government employee at the local recording office, where is it manually entered into the county's central database and public index. In the case of a property dispute, claims to the property must be reconciled with the public index. This process is not just costly and time-consuming — it is also riddled with human error, where each inaccuracy makes tracking property ownership less efficient. Blockchain has the potential to eliminate the need for scanning documents and tracking down physical files in a local recording offices. If property ownership is stored and verified on the blockchain, owners can trust that their deed is accurate and permanent.

D. *Smart Contracts*

A smart contract is a computer code that can be built into blockchain to facilitate, verify, or negotiate a contract agreement. Smart contracts operate under a set of conditions that users agree to. When those conditions are met, the terms of the agreement are automatically carried out. For example, Person X rents his house to Person Y using a smart contract. Person X agree to give the door code to the house to Person Y as soon as Person Y pays the security deposit to Person X. Both Person X and Y would send their portion of the deal to the smart contract, which would hold onto and automatically exchange Person X door code against the security deposit of Person Y on the date of the rental. If Person X don't supply the door code by the rental date, the smart contract refunds the security deposit of Person Y. This eliminates the fees that typically accompany using a notary or third-party mediator.

E. *Supply Chains*

Suppliers can use blockchain to record the origins of materials that they have purchased. This would allow companies to verify the authenticity of their products, along with health and ethics labels like "Organic," "Local," and "Fair Trade." Blockchains may provide a way for all certification and documentation to be gathered in one place that is accessible to all parties. As products move between ports, blockchains may also provide documentation to the consumer about the lifecycle of a product, information that may ethically inform their choices about what to buy. Blockchains may also aid in securing the pharmaceutical supply chain to reduce the prevalence of counterfeit drugs.

F. *Voting*

Blockchain can be applied to voting system [12]. Voting with blockchain carries the potential to eliminate election fraud and boost voter turnout [13], as was tested in the November 2018 midterm elections in West Virginia. Each vote would be stored as a block on the blockchain, making them nearly impossible to tamper with. The blockchain protocol would also maintain transparency in the electoral process, reducing the personnel needed to conduct an election, and provide officials with instant results.

V. Conclusion

Blockchain development is in its beginning phase, but already the technology is promoted to be applied in diverse areas of the real world. The paper covers the major thrust area where the concept can be applied, and still more areas can be recovered, like blockchain can be applied to identity verification, internet of things and edge computing, telemedicine and radiation hardened computing. The application of the concept in a particular area requires to study thoroughly the factors influencing the implementations, like privacy, security, trust and cost of application.

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Simulating Procurement system vulnerabilities by using Fault Tree

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Procurement is an important business function for Public as well as private organizations. Public procurement serves key social and economic purpose apart from achieving strategic objectives. Similarly, procurement function plays a vital role in private organization in improving the business efficiency and resilience. Complexities, lack of understanding and fragmentation of controls make it difficult to achieve desired level of performance. This study adopts a process flow approach to develop a procurement process map to facilitate an improved understanding of procurement function. It then uses fault tree analysis to simulate the vulnerability contribution of individual risk factors to undesired procurement outcomes and analyze their combined effects. The proposed method helps in finding the vulnerability score of risk factors to uncover their significance. It would therefore assist academics and practitioners in addressing the key concerns of procurement process.

Introduction:

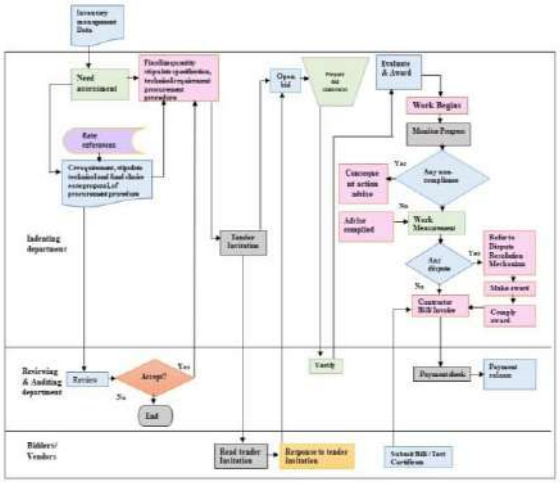
Procurement function affects the complete value chain of the both public and private organizations. Procurement is becoming a core component of many organisations and has assumed a strategic importance (Paulraj et al., 2006). Procurement carried out by public authorities using public funds is known as public procurement (PP). As a business function of government, PP generally impacts many different elements of society (Agbiboa, 2012). It has also broader social, economic and political implications (Morris, 1998). Public procurement has been used to stimulate economic activities; shelter domestic industry; strengthen certain industrial sectors; and reduce regional disparities (Watermeyer, 2000). However, it still remains an underutilized policy and business tool.

Procurement is also considered as a strategic function for improving the profitability in private organization. It is used to aid in streamlining the processes, reducing material costs and improving vendor base by finding better sources. Generally, organizations consider outsourcing activities which are not core competencies so that they can focus on core activities and increase complexities of theirs product and/or market (Prahalad and Hamel, 1990). Well-designed vendor-selection method using a bidding mechanism can contribute to reducing procurement costs (Chaudhury et al., 1995). Whereas overlooking the procurement contracts can cause erosion of value equalling about 9% of firms' annual revenues (Belotserkovskiy et al, 2018).

Procurement process analysis can greatly help in unlocking the potential of additional value for money which is spent in various contracts. In fact, procurement suboptimal outcomes represent the untapped value for money. However, despite procurement policy streamlining measures and recent researchers' focus, procurement outcomes still remain far from satisfactory. The procurement field has progressed upward and is now linked to strategic objectives such as economic growth and job (Murray, 2009) that has fostered research interests. However, there still remains several areas which need to be fully addressed. For instance, many a times, academic research does not represent the contextual reality in which procurement practitioners function (Ramsay, 2004) and organization performs. Moreover, sufficient efforts need to be made to conceptually theorize for helping academics and practitioners in understanding its complexity, uses, and limitations (Snider and Rendon, 2008). This is essential to design effective remedies having practical utility and tapping the additional value and our research makes an attempt to fill this gap.

This work is a continuation and extension of our earlier study dealing with mapping of risks in public procurement for uncovering improvement opportunities and strengthening control. The earlier work combined Grounded theory (GT) with fault tree and Failure Mode Effect and Criticality Analysis (FMECA) and its details can be seen in Sharma et al (2019). GT was used to select the sample data and carrying out grounded analysis to identify the potential contributors i.e. risk factors and intermediate risk events leading to critical procurement failures. The grounded analysis along with deductive reasoning was used to develop fault trees and identify the critical failure pathways.

Then, FMECA was used to score the criticality of risk factors by analyzing selected data. However, a need was felt to study the combined effect of various risk factors and develop the method to simulate their contribution when sufficient data is not available. This study therefore aims at finding out the importance of individual risk factor and simulates their combined effect in the context of procurement failures. The rest of paper is structured in three sections. First section maps the procurement process and clarifies the concept of procurement vulnerability. Second section presents the method for simulating the vulnerability contribution of individual risk factors and their combined effects. Final section summarize the finding and conclusion.



Understanding and Mapping Procurement Process:

In general, multiple terms have been referred for purchase function such as "purchasing," "contracting", "acquisition" and "buying" etc. It employs a wide range of means for providing required inputs for delivering different works, and services. These goods, works and services are to be procured at appropriate cost with optimum levels of quality. In the private sector, the term purchasing was conventionally used (Lee and Dobler, 1977) for a set of widely ranging activities associated with procurement. Recently, it has acquired the broader term of supply management, which highlights the boundary-spanning roles of today's private sector purchasing managers (Snider, 2012). The form and scope of procurement function has diversified with time ranging from purchase of simple goods to complex products like airliner, high speed rail corridor. Similarly, works procurement deals with wide range of works from small works to large mega projects. The planning strategy which works effectively in usual business scenarios may not necessarily delivers desired outcome when plans don't materialize according to plan (Trepte et al., 2020). In fact, procurement cannot be understood either in terms of their elements or parts which make up an institution (Thai, 2001). Rather, procurement should be understood in terms of the emergent property of the combined parts of procurement system i.e. when these parts are combined in a particular way to make a structured whole and performs. Mapping the procurement process and decisions therefore can help in understanding the procurement and clarifying the role of procurement vulnerabilities. Mapping workflows is the first step that is quite useful in a broader organizational assessment (Savory and Olson, 2001). It can be defined as an exercise to uncover the major steps and decisions in a workflow in a diagrammatic form. Actually, it traces the flow of information, materials, and decisions associated with a process and elucidate various tasks, decisions, and actions which are required for translating the inputs to desired outcome. The procurement process is analyzed and the steps and decisions are assembled to develop a process map which is presented in the Figure 1. The figure 1 provides a map of all steps which would facilitate an improved understanding about these processes and their successful flows. This brings out that procurement is a complex and dynamic system where procurement outcome will depend upon interdependent decisions and behaviour of multiple entities. According to Canter (1993), failures in either purchasing process or in overseeing and organizing procurement functions can lead to:

- Over-ordering that result in resource wastage;
- Over-payments due to inadequate administrative procedures;
- Loss of benefits or reduced benefit; and
- Lack of capacity or knowledge

Procurement reforms and studies have mainly concentrated in bidding and award phases of procurement process. As revealed from earlier discussions that certain 'before and after actions' are important for procurement process.

Figure 1: Procurement Process Map

In this context, vulnerability analysis can help in clarifying the concept of procurement risks and

identifying the issues of concern in the procurement system. The vulnerabilities are rooted in actions and factors embedded in organization and environment (Sharma et al, 2016). In the field of disaster and safety risk, vulnerability is referred to as a 'lack of capacity' or 'susceptibility to harm' (Cardona et al., 2012) due to exposure to hazard. Therefore, vulnerability can be thought as a multidimensional concept arising from a set of conditions and components embracing procurement policy, procurement regulations, procurement process, contract execution, feedback and monitoring, vendor base, technology and organization resources which are leading to procurement failures. In other words, vulnerability index can be defined as a fraction of system vulnerability contributed by a particular factor.

Simulating Vulnerability Score

Fault-tree analysis (FTA) has been used for carrying out quantitative and qualitative assessment of the failure characteristics of various systems. FTA is a top-down deductive analysis that works on the principle of multi-causality to trace failure pathways. FT consists of two types of nodes; events and gates linking all the events that contribute to system failure. The gates and events symbols used in FTA and their meaning can be seen from Misra (1992). The system weakness, deficient controls and prevalent work practices represent negative states or risk factors while analyzing procurement system. These negative states can be easily described in terms of multiple aspects like tasks, decisions, process vulnerabilities and factors such as policy, practices, control and resource deficits, etc (Sharma et al, 2019). The conventional methods use probability of failure and equipment downtime for ranking the risk factors. However, failure probability data may not be available many a times and down time is not very relevant in case of procurement failures. Therefore we propose to assess the vulnerability contribution of a risk factor derived on the basis of Minimal cut set theorem.

The system is modelled as a logic diagram composed of a directed graph with a superimposed Boolean algebra. A static fault tree FT is a finite DAG where its leaves represented by B, are called basic events. Its inner nodes, designated by G, are termed as gates. Each set $C \subseteq B$ of basic events characterizes a whole class of those risk scenarios in which all events from set C occurs.

A scenario ξ is a set of basic events that represents the circumstances where all basic events from ξ occur and the remaining other basic events does not occur. These scenarios can be inductively extended to undesired top event. It is stated that event O takes place by a scenario ξ if and only if the type of the top gate G is

a) AND along with all input events of this gate occur by ξ, or
b) OR and at least one input event of this gate occurs by ξ.

Further, it is noted that ξ is a failure scenario if it leads to occurrence of top event. It is also stated that C represents ξ if $C \subseteq \xi$. It is also said that C is a cutset if all represented scenarios are risk scenarios. It implies that the top event takes place in scenarios defined by C.

In continuation, C_m is defined as minimal cut sets (MCS) if there is no smaller cutset $C_i \subset C_m$. MCS represents precisely all risk scenarios. In fact, every failure scenario is a superset of some MCS and every superset of a MCS is a failure scenario (Krcˇál et al, 2015). MCSs is used to identify the most critical basic events a fault tree leading to occurrence of top event. MCS can be considered as a particular risk scenario leading to the undesired outcome. The significance of a risk factor can be accessed on the basis of its relative contribution to the occurrence of the top event. Risk events which features in more number of MCS will be more important.

For a given FT, one can easily compute the total number of all risk scenarios ΣC_m, it characterizes which in turn reflect the number of possible failure scenario in which a system can fail. A cut set represents a system vulnerability, which might be a flaw or weakness in the system's design, implementation, or operation and management which could potentially lead to a system failure (Phan, 2016). Thus, we can characterize vulnerability of system V_s as a set of collection of all minimal cut sets C_m.

Minimal Cut set Theorem *If all conditions of a fault tee are verified and if for each minimal cut set at least one of the basic events is prevented from happening, then the top level event will never happen.*

The theorem shows that it is sufficient to prevent only one primary event of each MCS, to prevent system failure (Ortmeier et al, 2007). The theorem is proved by using structural induction in the FT by Balser et al (2000). By following the theorem, it is proposed that one can obtain the numeric evaluation of overall system vulnerability to a hazard/risk caused by the occurrence of a particular fault. Stated simply, the importance of each event can therefore be measured on the basis of the

number of risk scenarios (minimal cut sets) to which the basic event or risk factor contributes compared to total number of risk scenarios in the fault tree. Vulnerability therefore corresponds to presence of risk factors in the system and resultant failure risk scenario.

To illustrate, if risk factor X_i is eliminated then fault tree T is transformed to another fault tree T_1 where V_s also changes to V'_s i.e. vulnerability reduces by quantity δV_i. It can be easily seen that, δV_i is itself a set of collection of all those C_m which contain X_i .Vulnerability contribution of a risk factor X_i, therefore, can be reflected by δV_i i.e. reduction in risk scenarios when factor X_i is eliminated from the system. Thus relative vulnerability score V_{Xi} can be measured by finding ratio of δV_i and V_s. Mathematically, we express

$$V_{Xi} = \delta V_i / V_s \quad \text{..... (1)}$$

Further, V_s can be expressed as a number of Minimal cute sets i.e. total number of all-risk scenarios. Thus above equation simplifies as under

$V_{X\,i}$ = (Number of minimal cut sets containing X_i)/ Total No of MCSs ..... (2)

Similarly, we can find out the combine vulnerability effect of two risk factors X_i and X_j as $V_{Xij} = \delta V_{ij} / V_s$, Where, δV_{ij} represents reduction in number of risk scenarios if risk factor X_i and X_j are eliminated from the system.

A fault tree for procurement failure developed by Sharma et al (2019) is shown is Figure 2 whose top event T1 is work awarding to a preferred bidder. The FT links T1 to 11 other intermediate risk events from G1 to G11. Here, G1, G2, G3, G4, G5, G6 and G7 represent events of manipulate bidding process; Corrupt relationship, Avoid public Call, Unbalanced bidding, Subjective evaluation and Limit participation respectively. Similarly G8, G9, G10, G11, G12, G13 & G14 are other intermediate events are respectively representing Contract splitting, Unjustified additional work, Urgency Abuse, Undervalue the estimate, Specifications suiting to one bidder, Arbitrary delivery/eligibility conditions, Accelerate the procedures, Bid obscuration and Vendor driven specification. The minimal cut sets are found and shown in Table 1.

[Insert- Table 1]

Following (i) and (ii) above, we calculate the vulnerability score of various risk factors present in the risk model which is tabulated in Table 2.

[Insert- Table 2]

The factor featuring high in the list of importance of relative contribution towards vulnerability of system found to be are namely; X_{15}, X_{16}, X_{17}, X_8 and X_5 . It implies that these factors should need their attention and resource to contain their effect. The score signifies very important meaning in respect of preventing procurement failure of unfair contract award. For instance, vulnerability Score (V_{Xi}) for risk factor X_5 is 0.20, it shows that by eliminating X_5, one can reduce the vulnerable by 20 percent. The combined vulnerability caused by X_{15} & X_{16} is calculated as $V_{X15,\,16} = 30/45 = 0.667$. The vulnerability Score is a relative score however, it can provide important insight for prioritizing the risk mitigation efforts.

Conclusion:

Both public and private organizations invest significantly in procurement contracts. However, procurement process is susceptible to multiple failures. Complexities, presence of multiple factors and their interdependence and fragmentation of controls make it difficult to achieve the intended objectives. Procurement process has not attracted desired level of research attention which has slowed down the academic progress. In addition, procurement reformed and research attention has focused mainly on pre-contacting stage whereas contract execution stage has left largely less understood. Further, risk mitigation strategies in supply chains are usually designed in silos and found to be reactionary (Sherwin et al, 2019). As a result, procurement still remains an underutilized policy and business tool even though it can help in generating additional value.

This study therefore maps the procurement process and conceptualizes the procurement vulnerability to facilitate improved understanding of the procurement and associated vulnerabilities. Thereafter, this study aims at finding out the importance of individual risk factor and their combined effect. In this regard, fault tree analysis is used to understand and analyze the interrelationship among various factors which are embedded in the complex web of organizational policies, procurement processes, vendor's selection, and procurement regulations, etc. It is observed that various measures like Birnbaum importance, Differential importance measure and Fussell–Vesely importance, etc., rely on the data pertaining

to frequency and unavailability. The frequency data may not be readily available and parameter of equipment unavailability is not very relevant in respect of procurement failures. Considering these limitations, importance of a risk factor is measured in terms of its' contribution to vulnerability of the procurement system by considering its presence in number of risk scenarios.

The applicability of proposed method is illustrated by simulating the vulnerability of risk factors by analyzing the fault tree having procurement failure of unfair contract award as a top event. The proposed approach views the procurement process a large system which helps in simulating the relative vulnerability score of individual risk factor and their combined effect. It is acknowledged that the method provides an approximate vulnerability score as the probability of occurrence is not considered. However, the method is easy to use and will provide the insight about relative importance of various risk factors which will be quite helpful in prioritizing the mitigation efforts. Moreover fault tree structure may change with the changes in the value chain. Consequently failure risk scenarios may either increase or decrease and new risk factors may emerge or replace the old ones. There are practical implications also from this research. It shows that an organization can be more vulnerable to certain type of procurement failure because of presence of certain factors or conditions which are conducive to a particular type of procurement failure. Based on findings procurement managers can streamlining the procurement process to reduce the vulnerability to failures.

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Table1: Minimal Cut Set

Minimal Cut Set	Details
Two element minimal cut set	$\{X_1, X_{15}\}$, $\{X_1, X_{16}\}$, $\{X_1, X_{17}\}$, $\{X_2, X_{15}\}$, $\{X_2, X_{16}\}$, $\{X_2, X_{17}\}$, $\{X_3, X_{15}\}$, $\{X_3, X_{16}\}$, $\{X_3, X_{17}\}$, $\{X_4, X_{15}\}$, $\{X_4, X_{16}\}$, $\{X_4, X_{17}\}$, $\{X_5, X_{15}\}$, $\{X_5, X_{16}\}$, $\{X_5, X_{17}\}$, $\{X_6, X_{15}\}$,$\{X_6, X_{16}\}$,$\{X_6, X_{17}\}$,$\{X_8, X_{15}\}$,$\{X_8, X_{16}\}$,$\{X_8, X_{17}\}$,$\{X_9, X_{15}\}$,$\{X_9, X_{16}\}$,$\{X_9, X_{17}\}$,$\{X_{10}, X_{15}\}$,$\{X_{10}, X_{16}\}$,$\{X_{10}, X_{17}\}$,$\{X_{11}, X_{15}\}$,$\{X_{11}, X_{16}\}$, $\{X_{11}, X_{17}\}$, $\{X_{12}, X_{15}\}$,$\{X_{12}, X_{16}\}$,$\{X_{12}, X_{17}\}$,$\{X_{13}, X_{15}\}$,$\{X_{13}, X_{16}\}$,$\{X_{13}, X_{17}\}$,$\{X_{14}, X_{15}\}$,$\{X_{14}, X_{16}\}$ & $\{X_{14}, X_{17}\}$
Three element minimal cut set	$\{X_5, X_7, X_{15}\}$,$\{X_5, X_7, X_{16}\}$,$\{X_5, X_7, X_{17}\}$, $\{X_5, X_8, X_{15}\}$,$\{X_5, X_8, X_{16}\}$ & $\{X_5, X_8, X_{17}\}$

Table 2: Relative Vulnerability Score

Sl No	Risk Factor	Risk Factors details	δV_i	Vulnerability Score (V_{Xi})
1	X_1	No open bidding norms	3	0.067
2	X_2	Discretion abuse	3	0.067
3	X_3	Poor procurement plan	3	0.067
4	X_4	Low decision monitoring	3	0.067
5	X_5	Change order abuse	9	0.20
6	X_6	False urgency	3	0.067
7	X_7	Abusing cost estimation	3	0.067
8	X_8	Share confidential information	6	0.133
9	X_9	Absence of standard code and criteria	3	0.067
10	X_{10}	Absence of verification	3	0.067
11	X_{11}	Staff Capacity deficit	3	0.067
12	X_{12}	Complexity	3	0.067
13	X_{13}	Abuse in choice of procurement procedure	3	0.067
14	X_{14}	Obscure the bid	3	0.067
15	X_{15}	Conflict of interest	15	0.333
16	X_{16}	Intermediary / Agent/ Consultant	15	0.333
17	X_{17}	Undue advantages	15	0.333

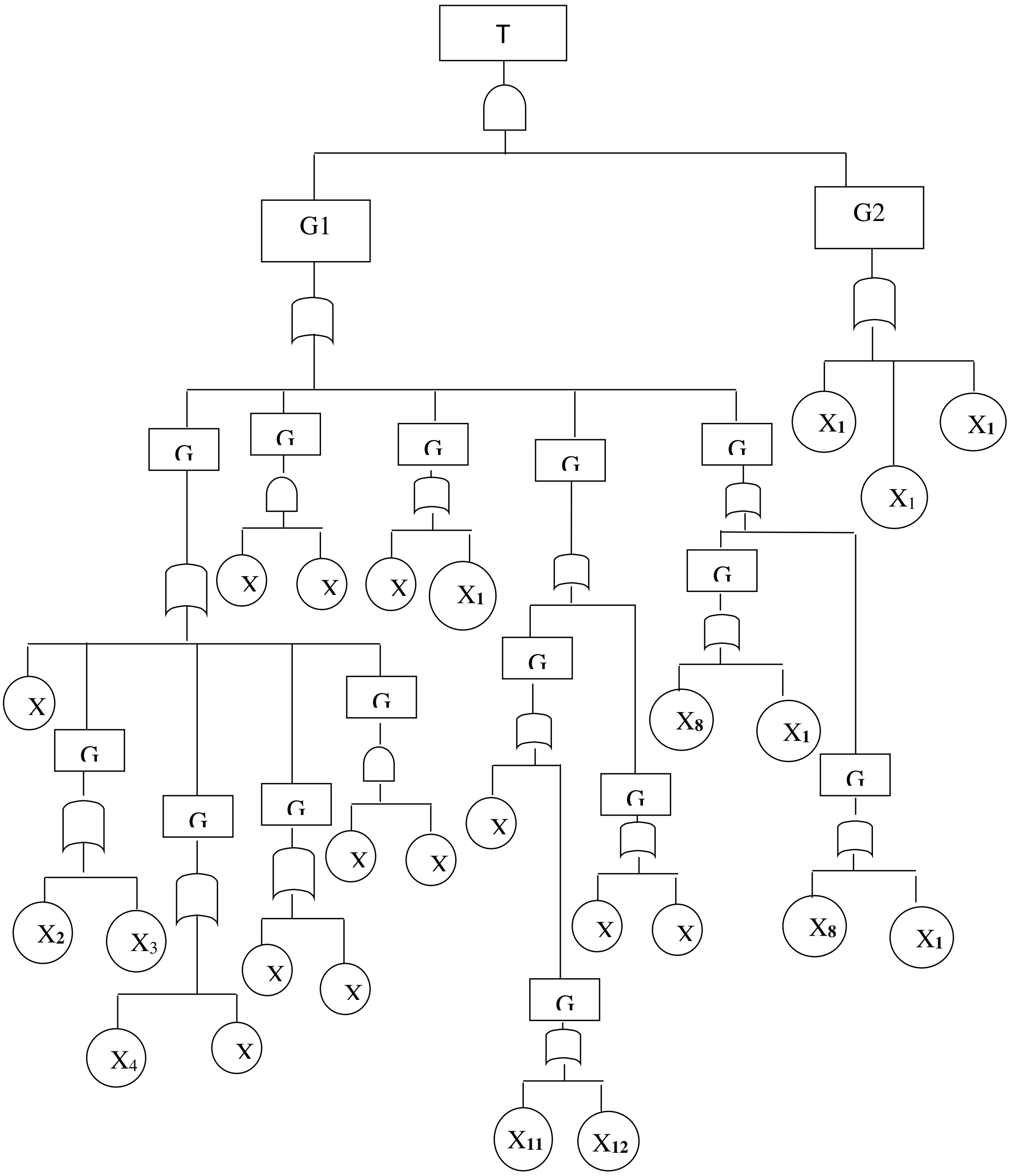

Figure 2: Unfair Contract Award (Ref: Sharma et al, 2019)

Artificial Intelligence and Mental Health: A study on Internet Gaming Disorder in COVID-19 lockdown in India

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***Abstract*-Dependence on artificial Intelligence is the worst result of Cov-19 lockdown over the world. Cope up mechanism by practising online games increased and resulted into Internet gaming disorder (IGD) which refers to the problematic use of on-line or off-line video games. The rapid increase in the number of Covid-19 cases in India resulted into the lockdown. The socio cultural pattern of not taking care of the psychosocial wellbeing of Indian citizens continued and even took tremendous shape with the newly started practice of marginalizing the infected family. During this crisis the increased number of people suffering from IGD and Artificial Intelligence addiction remained threatening. The aim of this paper is to draw a line between the prevalence and the various factors associated with the Gaming disorder in India in COV-19 lockdown. An extensive analysis of a study conducted by us among twenty people from different socio-economic backgrounds and landscapes is done in the mid December 2020. Another study which was approved by the Institutional Ethics Committee, IIT Gandhinagar, India was done from 9th May to 15th May 2020 by Anupam Joya Sharma and Malavika A. Subramanyam would be analysed here. Both the survey questionnaire in Google form was circulated through several Facebook groups as well as WhatsApp and Instagram contacts. Research variables like Gender issues, Socio-economic location, Age, public concept and personal concept differences all were used on the basis of neuro effects of Artificial gaming practice on personal and social life. This paper with its promiscuous approach for extensive research on a larger scale aims to locate the problem and the reason for it.**

Key words: Artificial Intelligence Addiction, Internet Gaming Disorder, Trauma and Violence perpetration, Neuro linguistic Programming of Violence practice, Psychological Mechanism.

I. INTRODUCTION

"The number of hours I am awake, I am using social media. Even if I am going to sleep, I will mindlessly keep scrolling until I fall asleep. Because these are the places currently where you see people. Otherwise it is quite just you. I think it is a good place to connect. It keeps me engaged" said, Tulika, a participant in research survey done by Anupam Joya Sharma and Malavika A. Subramanyam, approved by the Institutional Ethics Committee, IIT Gandhinagar, India, done from 9th May to 15th May 2020.

It is an emergency to face the unavoidable situation that these days there is a tension among the existential question of connecting intelligence, smart media and entertainment and the effects that perpetrate violence and trauma in human psyche. We live in an age when the more media is growing with its quasi divine and super virtual existence and more we are helpless with mental health issues. Entertainment forms which are completely based on Artificial Intelligence, more specifically violent video games are the most popular playful entertainment practise for young urban generations. Video game has become one of the most popular technologies created, with more than 65% of households reporting having video game play as regular practice(Entertainment Software Association, 2008; Lenhart, Jones, & Macgill, 2008). There is also a gender based ratio as we come to know that of those who play, males report

more than double compared to the females as game players (Kaiser Family Foundation, 2009). More importantly, approximately 89% of all video games that are produced are considered violent (Carnagey & Anderson, 2004). The problem of the civilization is our generation grew up with variety of video games, including military first-person shooter (MFPS) video games which are considered as one of the most violent use of artificial intelligence based entertainment ever and subsequently we are facing mental health issues on a larger scale more than ever before. Does this have any connection? If it does how does it do? If we look into the data of our country how does it effect on India? The most significant question is how did it effect our national mental health issue during the COV-19 lockdown in India on the basis of Internet Gaming addiction?

Times of India, Sept 3rd, 2020 reports that according to reports, a fitness trainer from Jammu was admitted to a hospital after PUBG addiction made him partially lose his mental balance. PUBG had highly addictive nature as a game. When a teenager in Punjab reportedly spent 16 lakhs from his parents' bank account to buy gears and upgrade his character in the game we understood the worsening situation. These incidents are a scary reminders at the global level of the fact that why addiction to digital or video-gaming activities have been officially defined as Gaming disorder. World Health Organization stated that gaming disorder is defined as a pattern of gaming behaviour characterized by impaired control over gaming, increasing priority given to gaming over other activities to the extent that gaming takes precedence over other interests and daily activities. And continuation or escalation of gaming despite the occurrence of negative consequences is next to impossible to happen.

The advent of India's online gaming industry brought several middle-income group Indians on digital gaming platforms. During mid 2000s, online gaming was largely in the form of social games with the emergence of PC in to the individual home level. The consequences came after twenty years and that is the massive level of Internet game addiction which took a serious form in this 2020 lockdown.

II. MENTAL HEALTH OVER THE WORLD AND IN INDIA

The World Economic Forum's 2019 report titled "Empowering 8 Billion Minds" highlighted that "the burden of mental illness, in terms of human suffering, is both catastrophic and growing" and that "in the 36 largest countries where treatment is not accessible to everyone, mental health conditions have resulted in over 12 billion days of lost productivity". It is also very important to note according to the latest report of World Health Organization released on 23rd February, 2017, 56 million or 4.5% of the population of India suffer from depression, 38 million Indians suffer from anxiety disorders.7.5% suffer from major or minor mental disorders, as reported by WHO are characterized by sadness, loss of interest, appetite and pleasure, guilt feeling, anxiety disorder, panic, phobias, OCD, PTSD, GAD, fear and social anxiety disorder.

In Indian culture entertainment played a bigger role in constructing the Indian mind for women and other genders for long time and worsened the situation by communicating trauma. It also became very dangerous for minority genders apart from males in India to cope up with the lockdown. But interestingly the data survey finds that as women and LGBTQ community people are less in numbers than males as game players they somehow out stood of IGD. But whether they survived, and if so how many of them survived the domestic violence which also increased in larger scale during lockdown, caused by IGD of male family members is unknown as not researched on yet.

Now, Indian culture and medical industry is open to discuss mental health issues, in comparison, since their inception, video games have caused numerous controversies in Western world. However, with their increasing popularity, it is sometimes difficult to illuminate their possible detrimental effects due to new genres of video games being released as well as new technology that expands the playing experience (e.g., Xbox 360 Kinect®, Nintendo Wii®, the Playstation® Move Controller). In 2017 International Society for Traumatic Stress Studies examined the relationship between video games and posttraumatic stress disorder (PTSD) symptoms. The shooter players group reported higher levels of PTSD symptoms than the participants who did not play any video. This may indicate that the same psychosocial factors predict both PTSD and shooter video game play. So, we do understand the significance to study it In India.

III. THE NEURO-PERSONAL EFFECT OF GAMING DISORDER.

Expert's study on Post Traumatic Stress Disorder or PSTD sum up with three general areas of agreement. First, trauma exercises its effects often long after its impact and produces symptom that are often disguised or symbolic in their manifestation. There remains an effect of dissociation. Second, Freud's insistence in *"Beyond the Pleasure*

Principal (1920), that there is no need to have any direct connection between trauma and the originating event -the survivors experience different event of same type and links with the traumatic memory. And third, the repetitive reliving of traumatic experience must represent a spontaneous attempt at healing. While playing a video game all these three effects function together within a player's psyche. The players enjoy trauma perpetration, connect it with own life situations and they themselves perpetrate trauma as healing. So, we can understand that the IGD can affect human psyche to adverse level and personal knowledge system. The moment it affects the knowledge system of a human being it affects his relationship with the world and also how he communicates. A neuro-linguistic programming of violence and trauma perpetration is done. A person who plays violent games for long time is of course prone to violence whether it be physical or verbal. *Nature Reviews Neuroscience* summarized evidences implicating that video game playing changes the brains. Video games are controlled training regimens delivered in highly motivating behavioural context because behavioural changes arise from brain changes.

a) COVID-19 SITUATION, GAMING INDUSTRY AND GAMING DISORDER IN INDIA.

The novel corona virus (Covid-19), taxonomically termed SARS-CoV-2, first emerged in 59 Wuhan, China during late 2019 and was labelled a public health emergency by the World Health Organization. The rapid increase in the number of Covid-19 cases panic across countries. Every country affected by the virus adopted several measures in order to curb its spread. India, home to 1.3 billion people, announced a nationwide "lockdown" on 25th March 2020. The lockdown restricted citizens' physical mobility, advocated social distancing norms, and limited a majority of public services while allowing the essentials. However, it was equivalent to an extended quarantine, and created a stressful environment for the citizens, irrespective of ages. The sudden disruption in their daily routines, financial crises, increasing stress, fear of death and shock of death and deadly disease created psychological crises.

India, being over populated and crowded individuals never ever had experienced things of this sort ever before. It resulted into adverse psychological outcomes such as post-traumatic stress symptoms and aggressive behaviour to those who already had a history of negative psychological states, could be at higher risk of depression, loneliness, and anxiety disorders during the lockdown. Even the queer individuals, known to be already burdened with minority stressors which likely lead to sense of psychological distress.

The adverse effect of lockdown on collective mental health and hike in Internet Gaming Industry (an article by K.P Amin, D.D. Desouza and M.D. Griffith) states that the area has been relatively unaffected during the pandemic is the gaming industry, with user engagement growing considerably during this period (Javed 2020). For example, *WinZo Games*, an Indian-based gaming company, have reported three times more user engagement and 30% higher traffic in online mobile gaming. Around 35% higher usage has been observed in multi-player modes in comparison with single-user modes, a trend also found elsewhere (Bora 2020). Similarly, *Paytm First Games*, an Indian mobile-based online gaming platform, reported an almost 200% increase in the user base during the pandemic, with 75,000 new users (Ahaskar 2020).

Here we can go through certain significant data. The first quantitative study done on the basis of the survey data collected by Anupam Joya Sharma and Malavika A. Subramanyam from 9th May to 15th May 2020 with the analysis of a sample of 282 Indian adults who responded to the online survey is something we found to be very significant to refer. A majority (~75%) of the participants were 30 years or younger. Around 60% identified themselves as male, and about 77% reported to be heterosexuals. Only a small proportion (~12%) of the participants had education less than 12th standard (high school). Greatest proportion (~81%) of the participants resided in urban areas.

The constant practices of online gaming which are mostly based on violence and living in the virtual world of enmity are the reason which perpetrate trauma within the players. They construct an imaginative subconscious fear of being attacked always and the enemy is invisible. To figure out the abstract enmity the players always remain paranoid and consider everyone else an enemy around in real life. The virtual violent space in their minds makes them socially alienated and disconnected. The empathy is the rarest thing to be found amongst the players because they believe in being rewarded for killing someone. The shocks, bloodshed and killing strangers are satisfying to them. A false sense of controlling the world grows up. As result this mental health condition advocates expressed concern about a potential increase in intimate partner violence (IPV). And pandemic of 2020 left many IPV victims trapped with their abusers. Domestic violence hotlines were prepared for abused partners who were locked down. According to the official data of the National Commission for Women (NCW), domestic violence complaints have increased by 2.5 times since the nationwide

lockdown began in India. Some of the researchers are referring to this as the next pandemic or shadow pandemic of India. In 2019, the commission received 607 cases between March to May, while in 2020, they registered 1,477 cases. While the gaming scene in India is fairly nascent, it is proliferating quickly and gaining momentum. India's online gaming market stands at $360 million, and is expected to grow to $1 billion by 2021, according to a 2017 Google-KPMG report titled 'Online Gaming in India: 2021'. And a contour line which can connect the upper class artificial intelligence users with gamers with the domestic violence practitioners also questions the mental health of domestic trauma perpetrators.

b) SOCIO DEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS OF THE QUANTITATIVE SURVEY.

SOURCE OF DATA 1.Psychological impact of Covid-19 lockdown in India: Different strokes for different folks by Anupam Joya Sharma Malavika A. Subramanyam in March, 2020. Institutional Ethics Committee, IIT Gandhinagar, India

Table 1:

Age group (YRS)	**Participation (%)**	**Anxiety disorder**	**DEPRESSIVE**	**NET ADDICT**	**PORN ADDICT**
18-29	212 (75.71)	7.07(5.84)	12.65(7.13)	29.18(11.53)	13.43(8.54)
30-44	48(17.14)	4.02(3.68)	10.31(7.39)	22.65(8.19)	12.09(6.58)
45-59	15(5.36)	6.28(6.86)	9.87(9.05)	29.55(16.31)	11.71(8.44)
60 and above	5(1.78)	5.8(6.68)	11.48(09.95)	29(12.28)	12.6(9.04)
Gender					
Male	175 62.50	6.15(5.82)	11.31(7.36)	28.43(11.33	14.90(8.37)
Female	102(36.43)	6.90(5.25)	13.14(7.06)	27.43(11.68)	10.08(7.08)
Others	3(1.07)	12.33(9.07)	19.62(4.62)	25.33(13.05)	11.66(8.14)
Sexual Orientation					
Hetero Sexual	218(77.86)	5.95(5.44)	11.72O(7.39)	27.26(11.55)	12.10(8.02)
Sexual Minority	62(22.14)	8.23(6.18)	13.46(6.89)	30.63(10.75)	16.44(8.06)

SOURCE OF DATA 2.Survey done by Piya Majumder and Sreemoyee Majumder on Internet Addiction in COVID-19 lockdown in India on 12th and 13th December 2020 on the basis of the variables of socio-economic back ground. The study is based on the original and Google form testimony with reference to personal mail address of the participants. Few questions were asked to the participants and they answered by filling up the forms. When they were asked if they had any kind of mental health issues during the lockdown 77.78 % of them said no but 22.22 % said yes they had. The percentage needed mental health advices are from different economic landscapes. Interestingly when they were asked whether they have been online more than ever, 65% of them said yes, 20% of them said very much. So we see how the interest either on gaming or on artificial intelligence was at hike during lockdown.

Table 2:

1. 5. Do you think that this Artificial Intelligence Addiction is a result of poor mental health condition?	2. Do you think that Tiktok and PUBG ban during the lockdown left the young generation shocked?	3. Do you think that your family members were surviving over the virtual world during the lockdown period?	4. Do you think that you were online more than ever before during the lockdown period?	5. Do you think that Internet and Online Game Addiction was common to find among the teenagers during lockdown?	6. Add your email Id to the survey for the authenticity and know that it is absolutely safe.	7. Did you have to go for any kind of mental health advices during the lockdown?	8. Did you spend the lock down in big city or in township?
Yes	Yes	Yes	Yes	Yes	bishu.majumder@gmail.com	No answer	No answer
Yes	Yes	Yes	Never	Yes	debasish.das@gmail.com	No answer	No answer
No	No	Yes	Yes	Yes	joshikaushal@outlook.com	No	Yes
No	Yes	No	Yes	Very Much	happy.exam93@gmail.com	No	Township
No	Yes | No	Yes	Very Much	Yes	aksunique.ak@gmail.com	No	Township
No	Yes	Yes	No	Yes	official.debolina@gmail.com	No	Yes
No	No	No	Yes	Yes	shreyas.gawde.phd2020@sitpune.edu.in	No	Township
Yes	No	Yes	Yes	Very Much	bidishasarnakar5@gmail.com	Yes	Kolkata (at home)
Yes	No	Yes	Yes	Yes	sumansamaddar82@gmail.com	No	Yes

The user engagement in online gaming increased. Gaming has been reportedly had a peak time from 8pm until midnight. As directed by the World Health Organization's collaborative campaign (#PlayApartTogether) online gaming has also played a supporting role in public health efforts to enforce effective spatial distancing during the pandemic. The online gaming industry also made a strategy of business encouraging individuals to stay at home and limit the spread of the virus and also projecting gaming ideas.

IV. CONCLUSION.

As lockdowns are eased in India and elsewhere, people who took gaming as an unhealthy coping mechanism resulted into overdependence and addiction on gaming. Mental health experts such as psychiatrists, psychologists, spiritual therapists, and social workers continued to have a new market. The digital culture and medical industry took the advantage of the situation. The result of the data analysis raises certain questions like- is gaming disorder a phallocentric practise? Does gaming practice gives birth to patriarchal pride? Does the cope up mechanism really turn people violence prone? Why are we dependent on artificial intelligence to such an extent which causes sickness? Healthcare and wellbeing over the world in post Covid 19 situation needs to be taken care and Artificial Intelligence Practise must be monitored from now on. And the trauma and violence perpetration as the result of the games must be researched on to find out the actual reason.

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HONGKONG CONVENTION: IMPACT ON ENVIRONMENT DUE TO REFRIGERATION WASTE IN SHIP RECYCLING, AN INDIAN PERSPECTIVE

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Category: Environment & Sustainability

Key Words: IMO, Hong Kong Convention, HCFC, ODP

Abstract

World's largest ships breaking and ship recycling industry is in India. Ship recycling is the process where the breaking up of ships that are the parts of a ship that are broken used to sell as raw materials or to re-use in the future.

In the past few years, it has been observed that the shipbreaking process and its consequences have risen in a huge way. Therefore it is creating a big challenge for the environment as well as to human health. Currently, the ships which have been dismantled today are manufactured or built-in the 70s which is before the time on banning of several harmful materials that are vulnerable for the environment. Hence it has been discovered that if the shipbreaking process has been carried out in a haphazard way by less technical, scientific knowledge and environment management system by taking improper health, environment and safety precautions they could be exposed to the broader range of hazards and the ship breaking process would leave disproportionate biggest environment footprints. Considering growing environment concern during ship recycling process, the International Maritime Organization in 2009) adopted the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships. It is a legal binding instrument to ensure safe ship recycling process related to human health, safety and environment. This paper examines the deficiencies of the Kong International Convention for the Safeand Environmentally Sound Recycling of Ships and improvements in ship recycling process in India.

I. Introduction

India is producing a large amount of refrigeration waste while running its largest business of ship recycling. The wastes are continuously growing and are causing harm to the environment. According to Devault, Beilvert, and Winterton (2017), ship management and ship-breaking are performed in most of the developing countries and the name of India comes at the top [1]. The shipbreaking process is the dismantling of the vessels or scraping out the vessels. The workers come to dismantle the ships and the operation goes on for a few months. The result of the dismantling process is leaving the parts or the wastes in the yard only which will then get segregated for the re-use purpose. The biggest reason for conducting ship breaking or ship recycling in developing countries like India is the availability of abundant cheap labour. The industry has created opportunities and employment for a large population.

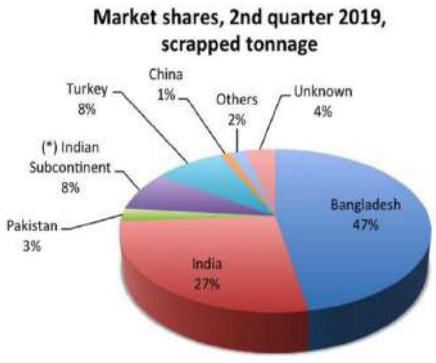

Fig.1. Market share (Second Quarter 2019), *Source*: Bulletin of information and analysis on ship demolition

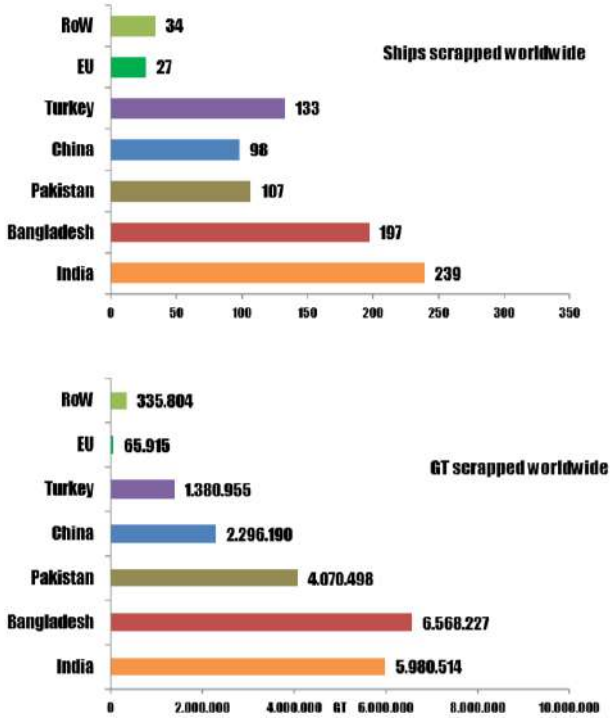

Fig.2. 2017 Ships scrapped worldwide *Source*: NGO-Shipbreaking, Platform-stats Graph, (2017)

The scraps out of the ships are sold for re-use or as raw materials and this is why it generates a huge income level. Ships are made of steel and it created opportunities for the steel industry to grow as well in India. The shipbreaking is a parent industry of India and many downstream industries are generated from it. Such child industries are oxygen plants, foundries, transportation companies, local scrap stores, and re-rolling mills. The two most important ship graveyards of India are Alang and Sosiya, both located on the Arabian Sea coast in Gujarat. This industry is growing but the hazardous situation of worker's safety and environment's safety is keeping it down. The scraps produced after the shipbreaking have no such proper place for storage. Pollution and environment disgrace occur as there is no right disposal of the wastes. The toxic wastes that get generated while the ship breaking procedures work are responsible for both the harm of the workers' health as well as the environment. The high tide zone of the Gujarat coast made the ship breaking easily possible for India. The future of India in the ship recycling process is very bright but environmental protection is essential.

Fig.1 and Fig.2 show India's market share in ship breaking industry.

Year	2020 1st, 2nd and 3rd Quarter Total	FY 2019	FY 2018	FY 2017	FY 2016	FY 2015
Total Nos. of Ship Recycled In India	129	214	453	259	249	275

Fig.3. Market share, *Source*: Bulletin of information and analysis on ship demolition, Shipbreaking.

Misra (2019) stated that Alangis the largest shipyard in India, located in Gujarat where the maximum amount of shipbreaking takes place [2]. The operations of ship recycling have been going on there for over 3000 years. Alang is nearly 15km stretched in recent times and the environment is friendly for ship breaking. The ship disposal procedure has become popular and came a long way for many years. 50% of the total ship dismantling is performed in this place. According to John and Srivastava (2018), shipbreaking industries dismantle the vessels and scraps out the vessels which is why a huge amount of wastes gets produced and left in open in the cost yards [3] . These wastes generated from the ship recycling procedures affect the environment on a large scale as the wastes are toxic. The toxic wastes are heavy metals, asbestos, polyaromatic hydrocarbons, organotin such as tributyltin, and polychlorinated biphenyl. The wastes exist in different forms like gas, solid, and liquid. Copper, lead, manganese, nickel, chromium, cadmium, iron, and zinc are found in the firm of solid heavy metals from the ship scraps [4]. Organic metals such as polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and organochlorine pesticides (OCPs) are generated as well. Gaseous wastes are also generated such as chlorofluorocarbons (CFCs), hydro chlorofluorocarbons (HCFCs) present in the air conditioners which are used in refrigerants in the form of solvent and insulating foams, and ammonia. CFC and HCFC gaseous forms released from the ship recycling goes to the air and affect the ozone layer. The depletion of the ozone layer (ODP) then

causes the dangerous ultraviolet rays to enter into the earth's atmosphere.

II. The Hong Kong International ConventionTwo-Fold Application

The Hong Kong International Convention [5] for the Safe and Environmentally Sound Recycling of Shipsguides survey and certification of ships are be followed for recycling approach and process as well as for the authorisation of ship-recycling facilities. The Hong Kong convention sets out a minimum and is a first step towards creating a level playing field for a sustainable future.

Hong Kong Convention mainly consistsof three main parts - articles, regulations and appendices.of:

- 21 Articles which sets out the legal provisions.
- 25 Regulations which describes the technical requirements and is dividedinto 4 (four) sections, namely:

General provisions (Regulation 1-3)

Requirement for ships (Regulation 4-14)

Requirements for ship recycling facilities (Regulation 15-23)

Reporting requirements (Regulation 24-25)

- 7 Appendices which contains the list of hazardous materials and the formats of documents required pursuant to the Convention.

The Hong Kong Convention will only enter into force when:

- At least 15 states have ratified it
- The merchant fleets of the ratifying states account for 40 per cent of global gross tonnage
- The ratifying states have recycled at least three per cent of their combined tonnage over the past ten years

On 28 November, the largest one, India ratified the International Maritime Organization-IMO's the Hong Kong Convention for the Safe Recycling and Environmentally Sound of Ships.With India's ratification, the number of states required has now been reached. Approximately 10 per cent of the tonnage and 0.4 per cent of the recycling volumes need to be added before the Convention can enter into force.

The Hong Kong International Convention has "two-folds" approach as it is not applicable to Government owned non-commercial ships, warshipsand exclusively domestically operated ships and ships of less than 500 GT by Mikhelis, 2009 [6]. So this convention is a comprehensive approach towards the problems related to environmental aspects, human safety and health.

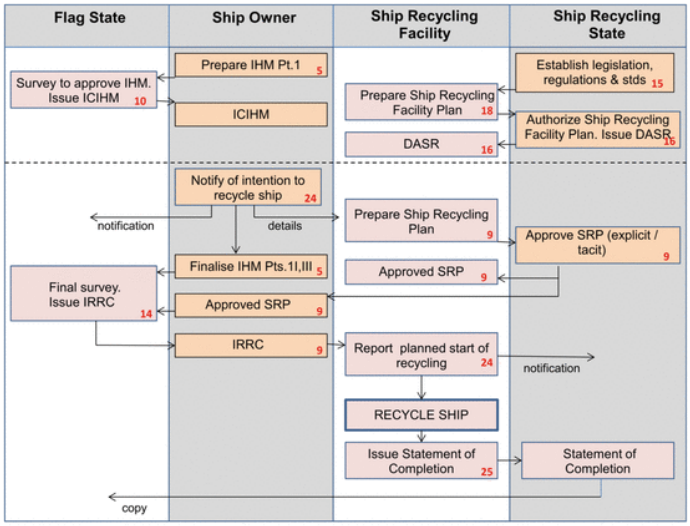

Fig.4. The Hong Kong Convention, *Source*: Springer Link.

The Hong KongConvention defines it by *"the activity of complete or partial dismantling of a ship at a ShipRecycling Facility in order to recover components and materials forreprocessing and re-use, whilst taking care of hazardous and other materials"*. Hereafter the Convention and the application limits the further waste management, storage and disposal process of hazardous materials for human safety and environment effects. Additionally convention does not

III. Result and Discussion

The shipbreaking industry is found to be the most hazardous industry as it causes tones of different types of wastes that are harming the environment in a bad way. Hence the contention is to make the sustainability of the process and the industry. So to carry out this ship recycling industry in an eco-friendly way all the necessary safety guidelines should be followed along with the implementation of the EMP with formulated principles that are provided by the ISO. To reduce the effects of the hazardous substance in the environment the global community must be committed towards sustainable development and also in promoting the eco-friendly process of dismantling the ship in the necessary sites where the operations are carried out. Other than this, locally the policies and regulations should be formulated concerning the ship breaking activities for focusing mainly on the safety of the recycling process. Moreover, the challenges which the ship recycling process is mainly facing

nowadays are due to the refrigeration wastes it produces such as CFC, HCFC and other heavy metals. For minimizing the effects of these harmful substances the action plan should be implemented at the global scale to reduce the wastes onboard and also to handle the wastes in a proper way for safeguarding the workers from the occurrence of any kind of casualties. Apart from this, the global, as well as the local safety measures and waste management guidelines, should be followed to reduce the impact of wastes generated at the time of dismantling.

IV. Conclusions

This research has been conducted to obtain relevant data and information on the refrigeration wastes that have been produced at the time of the ship recycling activities. It has been recognized that the ship dismantling industry in India is a part of the global ship recycling process. The industry possesses various opportunities and challenges. Furthermore, in India, this ship breaking industry is considered to be the prime economic activity as most of the steel used to obtain through ship dismantling and recycling procedure. Therefore, maintaining sustainability is needed for this industry.

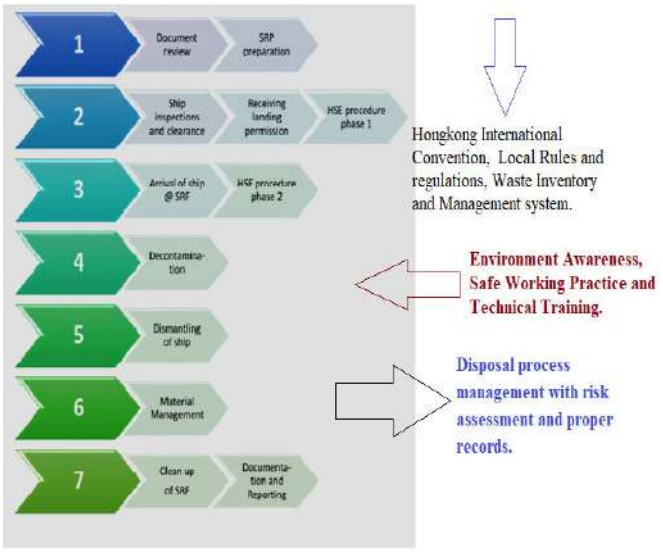

Fig.5. Ship breaking Management Plan

The wastes this industry possesses are high and hence it needed preventive measures to reduce the wastes. The government of India must implement proper guidelines that must be global and local based so that it could be followed to manage and handle the wastes in an effective manner. The government must consider implementing of going green process to handle the bulk wastes which the shipbreaking process used to generate at the site. Proper handling of the refrigeration wastes must be carried out in order to minimize the impact of the air, land and water. It has been found that heavy metals are causing depletion in the marine ecosystem and also causing a high rate of air pollution. Thus it is essential that the appropriate steps such as Hongkong International Convention, It require systematic work process, controlled mechanism of materials handling and storing, safety of workers, proper training and education personnel involved, close monitoring by managements, risk assessment and following of international and local rules and guidelines.

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A Proposed Theory for Predicting Employee Performance Using Machine Learning

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Abstract— **In this fast-paced world, choosing a highly qualified and efficient employee that would be appropriate for the job has become a huge challenge. In job sectors, companies and management are concerned about these employees' performance. Predicting employee performance will be a necessity for companies and a pivotal to success. In this paper, the principal objective is to predict employees' performance using machine learning. The building of the classification model and identification of the crucial factors that categorically affect the performance was done by two machine learning algorithms: The Random Forest Classifier and K-Nearest Neighbor (KNN). The dataset that was utilized for the to build the model for prediction of the employees' performance is the IBM HR Analytics Employee Attrition & Performance from Kaggle. This system provides a suitable model which determines the performance and makes it convenient for the HR department to find the most skillful, knowledgeable and efficient employee on their performance report which depends on various factors.**

Keywords— Machine Learning; Business; Software; Employment

I. INTRODUCTION

The term human resources was first coined in the 1960s when the value of labor relations began to garner attention and when notions such as motivation, organizational behavior, and selection assessments began to take shape. Human resources is used to describe both the people who work for a company or organization and the department responsible for managing resources related to employees, basically employed by a company or department in a company in charge of hiring, training, benefits and record. So, it is the authority of the HRM to assign employees to the jobs appropriate for them and manage the administrative aspects of the employees.

One of the most critical factors that lead to a success of a company or organization is employee performance and that they are able to meet deadlines, make sales and get the job duties fulfilled effectively, qualitatively and efficiently. Every employee makes an individual contribution to the performance of the organizational unit and thus to your entire organization. If the performance of an organizational unit or individual employee falls behind for too long, as a rule this will lead to reorganization or redundancy. When your employees are not performing well, it negatively affects productivity and ultimately, the bottom line. Don't make the mistake of thinking that poor performance indicates a poor employee. HRM decides which job suits an employee best based on performance and accordingly allocates or recruits the employee to the suitable job. With the development and evolution of technologies in business organizations, HR employees need not handle the massive amount of data manually. In this paper, we apply Machine Learning methods to extract usable data from a larger set of any raw data.

II. BACKGROUND

A lot of researchers have already used ML classification algorithms for predicting different attributes in various fields of science. Predicting employee performance efficiency is a crucial field in supervised learning. In this section, a complete study of employee's performance prediction model and the aspects on which this model is working based on the following literature review has been shown below:

Mona Nasr, Essam Shaaban and Ahmed Samir (2019) applied C4.5, Naive Bayes and SVM on Egyptian Dataset collected from the Ministry of Egyptian Civil Aviation (MOCA). First they applied the three algorithms on the dataset and found the accuracies. After that, by the help of feature selection method, found out which set of attributes gave the best accuracy in those three algorithms. The paper applied some of these classification techniques to build a proposed model for supporting the prediction of the employees' performance.

Desouki M. S., Al-Daher J (2015) presented a study for applying DM techniques such as DT, Key Nearest Neighbors (KNN), and SVM to the HRM field through analyzing the Performance Appraisal (PA) results, which supported by a multidisciplinary academic research organization in order to improve the appraisal method and assess the compatibility of practical implementation with the objectives of PA process. To achieve that, various DM tasks have been utilized such as clustering, classification, and prediction. This study concluded that DM tasks can be hopeful and important in dealing with the activities of human resource like enhancing the methods of performance's evaluation

Lipsa Sadath (2013) used Data Mining (DM) techniques for automated intelligent decisions from a rich employee database for predictions of employee performance implementing the finest KM strategies, thus achieving a stable HR system and brilliant business.

Naharuddin and Sadegi (2013), in recent years, employees comfort while working, due to workplace conditions and environment has been recognized as an important factor for measuring their productivity.

Kossek et al. (2012) states that management maximizes employee productivity center around two major areas: personal motivation and the infrastructure of the working environment

Qasem et al. (2012) discussed data mining techniques which were utilized to build a classification model to predict the performance of employees. They used the Decision Tree to build the classification model, where various classification rules were generated. To validate the generated model, more than a few

experiments were conducted using real data collected from several concerns.

Salleh et al. (2011) have tested the influence of motivation on job performance for state government employees in Malaysia. The study showed a positive relationship between affiliation motivation and job performance. As people with higher affiliation motivation and strong interpersonal relationships with colleagues and managers tend to perform much better in their jobs.

J. Ranjan (2008) paper discusses how Data Mining discovers and extracts useful patterns from this large data to find observable patterns. The paper demonstrates the ability of Data Mining in improving the quality of decision making process in the pharma industry.

Chein and Chen (2006) have worked on the improvement of employee selection, by building a model, using data mining techniques, to predict the performance of new applicants. Depending on attributes selected from their CVs, job applications and interviews. Their performance could be predicted to be a base for decision makers to take their decisions about either employing these applicants or not.

Jackson and Schuler 1995, reviewed the empirical evidence which shows that a variety of environmental conditions can influence the approaches organizations use to manage their human resources. These conditions include aspects of the particular organization itself (e.g., its size, life cycle stage, competitive strategy, technology, job design and work characteristics, culture, structure, and characteristics of its workforce) as well as conditions of the external environment (e.g., industry dynamics, institutional pressures, economic and political conditions, and country cultures

In general, this paper is an attempt in the supervised learning module of the ML domain for supporting decision makers and HR's professionals by identifying and studying the main factors of their employees that affect their performances. It finds individual accuracies of different models like Random Forest, Naive Bayes, KNN and SVM. Then finally with the help of Ensembling of these four classifications, final accuracy of the model has been concluded. In the following sections, a complete description of the study is presented, explaining the methodology, the experiments and results, and discussions of the results, finally conclusions and recommendations for future work.

III. CONSTRUCTING THE CLASSIFICATION MODEL

Initially, Classification has to be done by completing its seven main steps. The first step is data collection which must be relevant as its quantity and quality will determine how accurate our model is. Here we are using pre-collected data for testing and training purposes. Each variable is assumed that it has a relation and regards to a predefined class. The second step is data preparation, wrangling the data and preparing it for training and testing, cleaning it which may require removing duplicates, correcting errors, dealing with missing values, normalization, data type conversions, etc. Visualize data to help detect relevant relationships between variables or class imbalances, or perform other exploratory analysis. Split into training and testing sets. The third and fourth step is to choose and train the model. The goal is to solve a problem or make a prediction correctly as often as possible. The fifth step is to evaluate the model. Model evaluation aims to estimate the generalization accuracy of a model on future (unseen/out-of-sample) data. The sixth step is parameter tuning to improve the performance. And lastly, the seventh step is to make predictions. Using test set data which have, until this point, been withheld from the model (and for which class labels are known), are used to test the model; a better approximation of how the model will perform in the real world. If the model's accuracy was considered acceptable, then it can be used to find the employees best suited whose records meet the criteria of an efficient employee for the job based on the target value (i.e. Performance Rating). There are various classification techniques that have been used in the prediction process such as Random Forest, Naïve Bayes, SVM, etc and lastly Ensembling to get the best results among all the individual classifiers.

1. Problem Definition and objective structuring

The first step in data mining is to understand and define the right problem and specify the objectives. Meanwhile, we should also have knowledge about the nature of the problem, so that we can implement the proper classifiers which will be relevant and give more accurate effectiveness and efficiency. Human resource management activities are very complicated and thus few quantitative approaches have been employed in practice. HRM at most other public sectors use traditional assessment techniques that do not enable them to get the perfect assessment for the employees' performance and therefore they cannot predict the performance and discover the talents.
This research concentrates on how we can present a proposed model supporting HRM and Decision makers to predict the employees' performance and identifying the employees' factors that are effective and associate with performance that will help the company to recruit eligible employees with good skills. Moreover, detecting the classifiers with highest accuracies and finally ensembling to get the best outcome.

Abbreviations and Acronyms used in this paper:

ML- Machine Learning
SVM- Support Vector Machine
HRM- Human Resource Management
HR- Human Resource
RFC- Random Forest Classifier
KNN- K-nearest Neighbor
NB- Naïve Bayes
NN- Neural Network

2. Data Collection and Understanding Process

The goal of this paper is to get the best predictive result among a bunch of them given by all the classification models we have used and use the result to recruit or allocate an employee to a department that complies with the factors with good scores. This study is based on an imaginary dataset which analyses employee attrition and performance of HR made by the data scientists of IBM company. Here they used different regression techniques and analysis techniques to predict the rate and major causes of attrition. The study takes into consideration factors like age, business travel, daily rate, department in company, distance of company from home, education level of employees, field of education, employee number, environmental satisfaction, gender, hourly rate, involvement of employee in job, level of job, satisfaction with job, marital status, monthly income, hike in salary, relationship satisfaction, working hours, stock options, working years, work life balance, years at company, years in current role, years since last promotion and years working with same manager. All these attributes are used to finally calculate the target class (performance rating) to be 3 or 4.

3. Data preparation

After collecting the dataset from Kaggle, an online data science community and machine learning practitioners, it was added to a notebook where all of the work for this paper was done. The raw data contained instances that were not applicable. So some of the data needed to be changed from categorical to numerical. There are multiple ways to convert categorical values into numerical values. For example:

i. **Label Encoder:** It is used to transform non-numerical labels to numerical labels (or nominal categorical variables). Numerical labels are always between 0 and n_classes-1.

ii. **Dummy Coding:** It is a commonly used method for converting a categorical input variable into a continuous variable. 'Dummy', as the name suggests is a duplicate variable which represents one level of a categorical variable. Presence of a level is represented by 1 and absence is represented by 0. For every level present, one dummy variable will be created.

Here, we have used **factorization** where the total variety of categorical values in a column is first found out and then the categorical values were assigned to numeric 1,2 etc. accordingly.

In our work, we have converted Gender (II), MaritalStatus (III), Department (IV), JobRole (V) and EducationField (VII) into numerical values and proceeded to implement the data in our models to get the accuracies using Random Forest Classifier, Naive Bayes, K-Nearest Neighbour, Support Vector Machine (SVM) and finally Ensembling.

Table 1. All the Used Attributes to Predict the PerformanceRating of Employees

Variable number	Variable name	Variable description
I	Age	Employee's Age
II	Gender	Employee's Gender
III	MaritalStatus	Employee's Marital Status
IV	Department	Employee's working department
V	JobRole	Employee's job in company
VI	Education	Education obtained by Employee
VII	EducationField	Education field of Employee
VIII	EnvironmentSatisfaction	Satisfaction in job environment (in employee's opinion)
IX	JobInvolvement	Employee's job involvement
X	JobLevel	Level of employee's work
XI	JobSatisfaction	Satisfaction in job (in employee's opinion)
XII	MonthlyIncome	Monthly income of employee
XIII	TotalWorkingYears	Total No. of Working Experience Years
XIV	TrainingTimesLastYear	Training times since last year
XV	YearsAtCompany	Years working at the current company
XVI	NumCompaniesWorked	Number of companies worked before this
XVII	WorkLifeBalance	Existing Work life balance for the job (in employee's opinion)
XVIII	PerformanceRating	Employee's Performance. This is the target class.

All the other attributes were input values and the PerformanceRating attribute serving as the target class. The target class attribute was discrete in nature with only 3 and 4 as the values which indicates whether the performance of the employee is either bad or good.

IV. EXPERIMENTS

Now that all the data collection and processing has been done, we have to begin with the classification and calculating the accuracies. Classification techniques that have been used are Random Forest, SVM, K-Nearest Neighbor, Naive Bayes classifiers. The dataset was implemented using these classification techniques to build the performance rating prediction model to get the model with the proper accuracy and figure out how many employees are suited for the job.

i. The First Experiment:

In the first experiment we have used all the variables from Table 1 provided in the dataset, trained and tested them by using the 'train_test_split' evaluation which is a technique for evaluating the performance of a machine learning algorithm imported from sklearn.model_selection. It can be used for classification or regression problems and can be used for any supervised learning algorithm. Then we measured the accuracy applying the four classification techniques.

Table 2. Algorithm Accuracies

No.	Classification Technique	Prediction Accuracy
1	Random Forest	85.03%

2	Naive Bayes	79%
3	KNN	84.14%
4	SVM	96.19%

From the results provided in Table 2 we can see that the accuracy of SVM technique is the highest with an outcome of 96.19%, which might be considered a bit overfit. These results show that all these variables have an impact on employee's performance rating in some way.

ii. The Second Experiment:

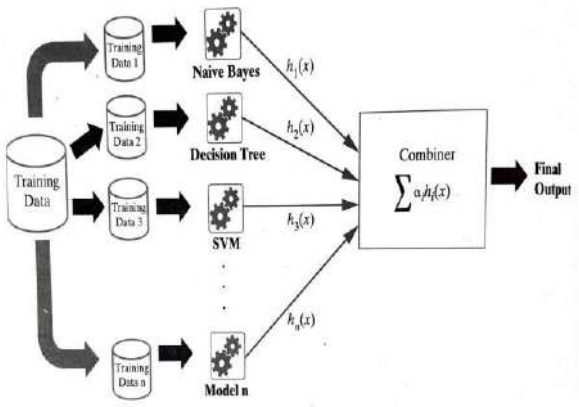
The second experiment involves ensembling (refer to diagram 1). It is a machine learning technique that combines several base models in order to produce one optimal predictive model. Some of the ensemble methods are bagging, boosting and stacking.

Table 3. Accuracy Percentages including Ensemble.

No.	**Classification Technique**	**Prediction Accuracy**
1	Random Forest	85.03%
2	Naive Bayes	79%
3	KNN	84.14%
4	SVM	96.19%
5	Ensemble	92.31%

As we can see from Table 3, Ensembling has given a good accuracy i.e., neither overfit nor underfit, with an accuracy of 92.31%.

Diagram 1. Ensembling in Machine Learning.



We have applied here an AdaBoost Classifier. It is a meta-estimator that begins by fitting a classifier on the original dataset and then fits additional copies of the classifier on the same dataset but where the weights of incorrectly classified instances are adjusted such that subsequent classifiers focus more on difficult cases. This implements the AdaBoost-SAMME algorithm. The principle here is to fit a sequence of weak learners on repeatedly modified versions of the data. The predictions from all of them are then combined through a weighted majority vote (or sum) to produce the final prediction. The data modifications at each so-called boosting iteration consist of applying weights like w1, w2, …, wN to each of the training samples. Initially, the weights are set to wi = 1/N, so that a weak learner is trained in the first step on the data.

For each successive iteration, the sample weights are individually modified and the learning algorithm is reapplied to the reweighted data. At a given step, those training examples that were incorrectly predicted by the boosted model induced at the previous step have their weights increased, whereas the weights are decreased for those that were predicted correctly. As iterations proceed, examples that are difficult to predict receive ever-increasing influence. Each subsequent weak learner is thereby forced to concentrate on the examples that are missed by the previous ones in the sequence.
The SVM technique gave the highest accuracy but it is overfit so cannot be taken under consideration as it may negatively impact the model's ability to generalize. Whereas ensembling with AdaBoost gave us good accuracy which will be helpful in decision making.

V. Results and Discussion

In this paper, we have done supervised learning of the dataset chosen and applied classification techniques on the attributes. The four algorithms were Naive Bayes, KNN, Random Forest and SVM. All the accuracies of the four algorithms have been shown in the above Table (2). All the accuracies had convergent and standard accuracies. All the accuracies have been greater than 70%. These accuracies can be considered as acceptable accuracies. All the first four experiments yielded acceptable models for each of the algorithms.

The prime goal of this research was predicting the employee performance. First part of the work was based on finding the most suitable classification technique for the used dataset. As shown in the above Table (2), SVM gave us the best accuracy among other selected algorithms. Thus, we conclude that SVM is the best suitable classifier for the chosen dataset. Though it is a 1% overfit model, we can consider this for now.

The goal was to take all the variables together and find a better and a reliable solution with no overfitting or underfitting. To increase the reliability of the model performance of the model has been boosted using the Ensemble method. An approach of increasing the performance of the model, several models may be combined together. The models in such combination are complimentary with each other, i.e. one model may learn one type datasets well while struggle with another type of datasets. This approach of combining different models with diverse strengths is known as ensemble as shown above in Diagram (1).

Ensemble helps in averaging out biases of different underlying models and also reducing variance. Ensemble methods combine weaker learners (Naive Bayes, RFC, KNN, SVM) to create a stronger one. A performance boost can be expected even if models are built as usual and then ensembled. Though the ensemble result

was less than the SVM model, it succeeded in overcoming the overfit model which SVM was predicting.

VI. CONCLUSION

ML has become a very recurrently used subject in almost every domain in recent times. Applying it in solving existing problems in the HRM domain is very important and urgent. The post-covid times will be very tough for employees as well as the recruiters. There will be many applicants for the job and the openings will be very less due to the huge loss in profits due to pandemic. So, finding effective and efficient workers will be the need of this decade.

This paper has concentrated firstly on finding a suitable model for the IBM dataset among four common classification methods. Among these methods SVM gave the best accuracy thus we conclude it is the best fit model for the dataset. Then secondly, to find a better solution and to improve the performance of the whole model we combine these models together. This approach of combining different models with diverse strengths is known as ensemble. Thus, after doing ensemble, we find the final accuracy of the IBM dataset employees.

Every company has a HR department. The HR department & the decision makers can use this model or an advanced one for predicting employee performance and choose whom to promote or demote according to their performance of the applicant employees where different actions can be taken for avoiding any risk related to hiring employees with a low performance.

For future work, the same experiment will be done but only to those variables which positively affect the accuracy. Feature selection techniques and other techniques which were not used in this paper would be used so that we can find which factors affect the accuracy positively and which affect negatively, and try to find the reasons behind that. Also, the decision tree algorithm has not been utilized which will be done in the future as well. These factors will help in getting a higher accuracy for the predictive model.

At the end of the full work, a working application can be developed which can be easily used by the companies. This will help officials to choose the best employees for crucial work based on the rules imputed beforehand for predicting the performance of the employees.

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A low power fast settling aided acquisition PLL for MICS band applications

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***Abstract*— In this paper the architecture and simulation results of an aided acquisition phase locked loop is presented which is suitable for wireless sensor node applications. Considering stringent energy requirements for these battery driven systems the proposed PLL consumes low power and has a fast settling time. It uses an energy efficient frequency locked loop (that measures the frequency by comparing the fraction phases and calibrating the oscillator's frequency by negative feedback) to bring the oscillator's frequency within the acquisition range of the PLL and then using a type-I PLL to further reduce the frequency error within the band specifications along with phase aligning. The frequency calibration circuit also has a small frequency correction time and the settling time of a type-I PLL is independent of the supply current drawn. It has been analytically proved in this paper that the proposed system consumes lower energy than a type-II PLL working alone.**

Keywords—phase locked loops, frequency calibration system, ultra low power, fast convergence time, aided acquisition, wireless communications

I. INTRODUCTION

Wireless sensor nodes (WSNs) are battery powered systems that consist of sensors, signal acquisition and processing circuitry and radio. Of the three modules the radio is the most power hungry component [1] and efforts are directed to reduce its power consumption. In this paper we have considered the application of implanted biotelemetry where a small transmitter is implanted inside the body and periodically sends data to an out-of-body detector. The band used for this purpose is the Medical Implant Communication Service (MICS) band that occupies a frequency range of 402-405MHz. Details of the band can be found in [2].

The commonly used modulation schemes for WSNs are MQAM (M-ary quadrature amplitude modulation) and MFSK (M-ary frequency shift keying) [3]. For the latter no explicit phase locking is necessary and a frequency locked loop (FLL) suffices. But for MQAM, a phase locked loop (PLL) is necessary to provide the different phases. From the circuit point of view different phases can be obtained from a ring oscillator (RO). Here we have considered a 2-stage differential RO that provides quadrature phases. The delay cell is similar to [4] but a MOS resistor in triode region has been added at the source coupled point to improve I-Q mismatch and provide for frequency tuning.

Now the PLL must consume low power and have a fast settling time, the latter to minimize transient energy consumption. A type-II PLL can very well do the job. However, in order to bring the frequency from one band edge to the other, the settling time would be large. Hence the help of a very energy efficient FLL, reported in [5], has been taken to minimize the target frequency error in very small time and consuming ultra low power. Thereafter, a type-I PLL takes over, bringing the frequency resolution within the band specifications and phase locking it to a reference. The FLL is based on measuring the fraction when the oscillator frequency is divided by a reference frequency. It further time amplifies the reference to resolve finer differences in frequency until the target resolution is reached. A salient feature of the FLL architecture is that all components are clocked at the baseband rate (as the fraction is sensed at the reference edges) that reduces power considerably. Also using fractions instead of integers gives a faster calibration time. So, in this way, we have an aided acquisition type-I PLL. Now in a type-I PLL, the settling time constant is independent of supply current. However, its acquisition range is small which is complemented by the FLL. This combination achieves low power and fast locking than a type-II PLL counterpart (this has been theoretically shown in Section III).

The rest of the paper is organized as follows: In Section-II a literature review of typical PLLs used in MICS band and their performance parameters are presented. In Section III the theory behind our proposed architecture is presented together with comparison against a type-II PLL. Also circuit level design features are discussed. In Section IV simulation results are provided. Conclusions are presented in Section V.

II. LITERATURE REVIEW

In [6] a plain integer-N synthesizer has been provided that uses a 24MHz crystal as reference and has a current consumption ≈5.5mA. .No settling time has been reported. In [7] an all digital fraction-N FLL for MICS band application has been designed. Like in fraction-N synthesizer, a noise shaping ΣΔ modulator is present so that a good close-in phase noise performance of the system is obtained. The FLL draws a current of 700μA and settles to ±1% accuracy in 110μs. An integer-N PLL specially designed for MICS band applications has been presented in [8]. It operates the transistors in weak inversion and achieves

a power consumption of 430µW and a settling time of 350µs. The PLL however can be only used for FSK modulation. In [9] another PLL design has been done, where its power consumption is 160µW. However passive polyphase filter is used for generating quadrature signals which would consume large area. We are considering integration with a two-stage differential ring oscillator where the quadrature phases would be automatically provided. In [10], an out-of-body frequency correction loop has been made considering that the out-of-body detector can be complex. The latter periodically sends frequency correction information to the transmitter. However in spite of being low power, such an external loop would create adjacent channel interference and no provision of using the transmitter with MQAM modulation scheme has been explored.

From the above literature survey it is found that a PLL with less than 300µA current consumption and less than 150µs settling time has not been designed for MICS band applications. The theory of design of such a PLL is the subject matter of the paper. The applications include usage with both MQAM and MFSK modulation schemes at this low energy specification.

III. Theory of Operation

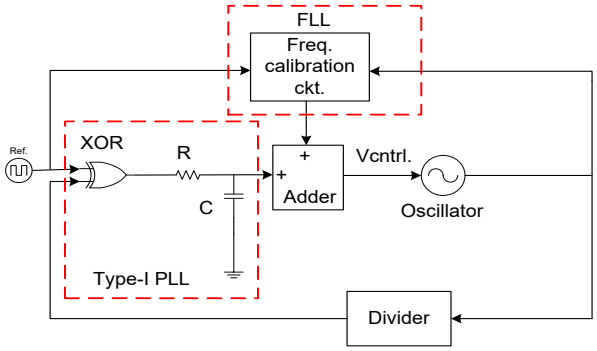
The acquisition range in type-I PLL is equal to ω_{LPF} which is the cut-off frequency of the loop filter. Now if ω_{LPF} is used to reduce ripple on the control line then the acquisition range reduces. The inverse of settling time constant of this PLL is given as :

$$\varsigma\omega_n = \frac{1}{2}\omega_{LPF} \tag{1}$$

In (1), ζ is the damping factor and ω_n is the natural frequency of the PLL transfer function. This shows that the settling time is independent of supply current (if the loop filter is implemented in the form of a passive filter). On the other hand the inverse of settling time constant of type-II PLL is given as :

$$\varsigma\omega_n = \frac{R_P I_P K_{VCO}}{4\pi} \tag{2}$$

In (2), R_P is the loop filter resistance; I_P is the charge pump current and K_{VCO} is the oscillator's conversion gain. Now from (1) and (2) it is inferred that type-I PLLs can consume low power and is a viable option if some form of aided acquisition is done to increase the acquisition range. This is precisely the topic of this paper and the energy efficient frequency calibration architecture in [5] has been chosen for increasing acquisition range. In [5] all the components are clocked at the reference frequency rate which reduce power consumption and using fraction information instead of integer counting gives fast convergence time. The type –I PLL consists of a divider, a XOR gate and a RC passive 1st-order low pass filter. A simplified architectural representation of the whole system is shown in Fig. 1. In Fig. 1 both the oscillator output and the reference frequency output go to FLL and PLL. The detailed FLL architecture is not shown. It is there in [5]. The type-I PLL employs a XOR-gate, divider and a passive 1st-order RC low pass filter. The outputs of both FLL and PLL are summed and sent to the V_{cntrl} line of the oscillator.



Fig,1 Simplified diagram of the proposed aided acquisition type-I PLL

For the FLL, if the number of delay cells required is say m, and the current drawn is I_4 from a power supply of V_{DD}, and the delay cell is on for a duration of time ΔT, then the total power consumption at the initial level is given as:

$$\frac{2.m.V_{DD}.I_4.\Delta T}{T_{Ref}} + P_{dig} \tag{3}$$

In (3), T_{Ref} is the reference time period and P_{dig} is the power consumption of the digital section which is given as :

$$P_{dig} = n_4 C_{L4} \alpha_4 V_{DD}^2 f_{ref} \tag{4}$$

In (4), n_4 is the total number of gates; C_{L4} is their average output capacitance; f_{ref} is the reference frequency and α_4 is the activity factor. The average power consumption after *l* levels have been reached with an amplification factor p is given as :

$$P_{FLL} = \frac{2.m.V_{DD}.I_4.\Delta T.(p-1).l}{T_{Ref}.(p^{l+1}-1)} + n_4.C_{L4}.\alpha_4.V_{DD}^2.f_{ref}.\frac{(p-1).l}{(p^{l+1}-1)} + P_{osc} \tag{5}$$

and the calibration time is given as :

$$T_{FLL} = T_{ref}.\frac{(p^{l+1}-1)}{p-1} \tag{6}$$

After the FLL has calibrated to a frequency resolution of ΔF, the type-I PLL takes over and the time taken (T_{PLL}) to reach a resolution of f_{ref} by it is given as [8] :

$$T_{PLL} = \frac{1}{\varsigma\omega_n}\ln(\frac{\Delta F}{f_{res}}) \tag{7}$$

The power consumption of the PLL consists of that of oscillator, phase detector, low pass filter and divider. From Fig.1, phase detector is implemented as XOR gate and the low pass filter as a simple passive 1st-order filter. They work at low frequency and hence their power consumption is small compared to other blocks. The divider power consumption can be written as:

$$P_{div} = n_5 C_{L5} \alpha_5 V_{DD}^2 f_{RF} \tag{8}$$

In (8) n_5 is the total number of gates; C_{L5} is their average output capacitance; f_{RF} is the oscillator's frequency and α_5 is the activity factor. The energy consumption of the type-I PLL can then be obtained as given in (9) and the total energy consumption of the whole system is given in (10).

$$E_{PLL} = (P_{osc} + P_{div}).T_{PLL} \quad (9)$$

$$E_{type-I} = P_{FLL}.T_{FLL} + E_{PLL} \quad (10)$$

If we compare the energy consumption of a type-II PLL alone that corrects the frequency of an MICS band oscillator, then the calibration time will have the same expression as in (7) but ΔF being higher and the loop bandwidth given by (2). The oscillator power will remain the same as the aided acquisition system along with the divider power consumption. The PFD power is negligible as it operates in the reference frequency range. Likewise the average current drawn from supply by the charge pump is also small as it is on for a very small time w.r.t. the reference time period. But as in [8], it employs current mirrors and servo amplifiers to match the up and down currents and also eliminate charge injection and clock feedthrough of the MOSFET switches. This draws a steady DC current given as $V_{DD}.I_6$. The total energy consumption of the type-II PLL then becomes:

$$E_{type-II} = (P_{osc} + P_{div} + V_{DD}.I_6).T_{PLL\_type2} \quad (11)$$

A. *Comparison of Energy Consumption between Our System and Type-II PLL*

If m=4, ΔT=312.5ps in (2), V_{DD} =1V, T_{ref} =125 ns, l=4, p=2 in (6), T_{FLL} = 16μs and the energy consumption of the FLL is $(I_4.2.58*10^{-3}+P_{osc}+P_{dig})*16$ pJ (the time is expressed in μs and the power in μW). The channel spacing of MICS band is 300 KHz and so is the reference frequency. In order to maintain stability, the loop bandwidth ($\zeta\omega_n$) must be maximum one-tenth of the input frequency [11], so the latter's value is taken as 10 KHz. For our proposed system, the FLL initially corrects to 400ppm (160KHz) and then the PLL phase locks it and also brings the resolution down to 100 ppm (40 KHz). Hence the settling time of the type-I PLL is 22.06μs. The energy consumption of the type-I PLL section is $(P_{osc}+P_{div})*22.06$ pJ. For type-II PLL the frequency must settle to a resolution of 40 KHz from 3MHz frequency separation (assuming frequency change from one corner of the band to other). Then the settling time of the type-II PLL is 68.71μs and the energy consumption is $(P_{osc}+P_{div}+I_6)*68.71$ pJ (for V_{DD} of 1V). The difference between the type-II PLL energy consumption and type-I PLL energy consumption is $P_{osc}*46.65+P_{div}*46.65+I_6*68.71$ pJ. We have to show that this value is greater than the energy consumption of the FLL. The energy consumption of the FLL has an oscillator energy consumption term. If that is subtracted from the difference in oscillator energy consumption of type-II and type-I PLL, the overhead that remains is $P_{osc}*30.65$ pJ. The energy consumption of the delay cells is very small compared to the overhead term as I_4 is multiplied by a factor of $2.58*10^{-3}$. The only term remaining in the energy equation of FLL is the energy consumption of the baseband digital section. Its value can be written as $n_4.C_{L4}.\alpha_4*1.03*10^6*16$ pJ (for V_{DD} =1V and using equation 5). The overhead energy consumption of the divider is $n_5.C_{L5}.\alpha_5*4*10^8*46.65$ pJ. If $C_{L4} = C_{L5}$ then $n_4\alpha_4$ can be inflated by 1132.28 in order to make their energy consumption same. For the divider section if we assume the simplest form of the divider i.e. a cascaded chain of mod-2 counters with each counter dividing the frequency f_{RF} by 2, then to go down to 300 KHz, the number of such counters needed is 11. If the counters are considered as master-slave flip-flops, then the number of gates required per counter is 9 [12]. The activity factor for the counter nearest to the RF oscillator is 1 and it decreases in geometric progression with common ratio of 0.5 as we move to the next counters. Hence $n_5\alpha_5$ becomes 200. For the digital section of the FLL if a pessimistic value of activity factor (α_4) of 0.5 is taken, then the number of gates required to equate the energy consumptions is 452912 which is an absurdly high number.

Hence the digital section of FLL consumes less energy than the divider section of the type-II PLL. Considering also the overhead of oscillator and the charge pump energy consumption of the latter, our proposed method (FLL+type-I PLL) is energy efficient than a type-II PLL by a considerable margin and having the same acquisition range.

To show a practical implementation as to how the output of FLL and the loop filter can be added (as shown by the adder in Fig. 1) and sent to the V_{cntrl} line of the oscillator, we consider a cross-coupled delay cell with a pseudoresistor connected to the source coupled point. This is shown in Fig.2 and serves as the basic unit of a two-stage differential ring oscillator.

As shown in Fig.2, the voltage outputs of FLL and type-I PLL can be converted to resistances (MOS resistor) and added inversely. This would alter the current flowing through the delay cell. The frequency of the two-stage differential ring oscillator made from this delay cell depends on this current and hence our desired purpose is achieved. Since the FLL covers a larger frequency span than the type-I PLL, M_{n3} is stronger than M_{n4}.

IV. RESULTS

The architecture has been designed in Simulink. The oscillator operates at a nominal free running frequency of 400 MHz (which can be changed at run-time) and the reference has a value of 8 MHz. The PLL works at a reference frequency of 2 MHz which has been obtained by dividing the 8 MHz frequency. The architecture of the FLL follows that which has been explained in [5]. The samplers of the FLL have a value of 312.5 ps. The type-I PLL has a

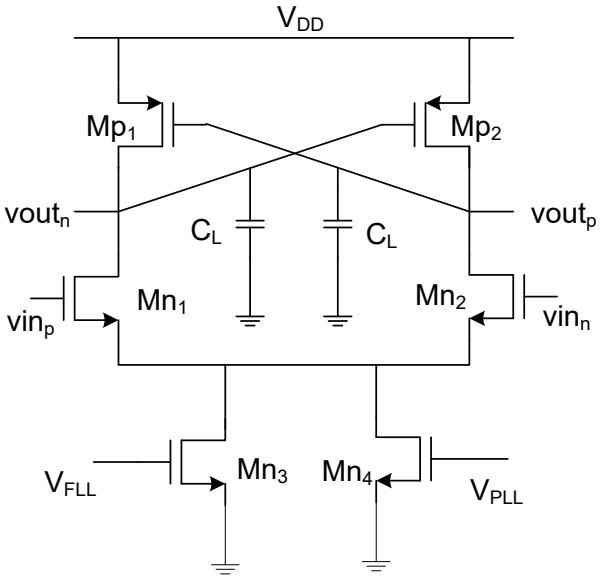


Fig.2 A cross-coupled pseudoresistive delay cell architecture showing how the outputs of FLL and PLL can be added to form the Vcntrl line of the oscillator

XOR gate as phase detector and a first order RC low pass filter to reduce the ripple of the control voltage of oscillator. A digital infinite impulse response (IIR) filter models the loop filter.

The simulation has been done with no continuous time states and the step size is 0.25e-10 s. The reason for it is reduced simulation time. The digital IIR filter, switch and control voltage generator of the overall architecture is depicted in Fig.3.

We have simulated the delay cell of Fig.2 in LTSPICE and found out that the total K_{VCO} is 267 MHz/V. Hence the K_{VCO} of the PLL section is taken as 50MHz/V (M_{n3} is stronger than M_{n4} in Fig.2 by 4 times). The FLL section is digitally controlled and it has nine bits covering a span of 8MHz. The FLL has been constructed in gate level and the combined control voltage (V_{cntrl}) equation of the oscillator is:

$$V_{cntrl} = \frac{8e6}{512}\left(256a_1 + 128a_2 + ...a_9\right) + 50e6.V_{PLL} \tag{12}$$

In (12), a_1,a_2,……a_1 are the switch values of the digitally controlled FLL section and V_{PLL} is the output of the low pass filter. The digital equivalent of the analog low pass filter has been made by impulse invariance method. The V_{cntrl} voltage goes to the control input of the oscillator where a sensitivity of 1Hz/V is kept. When the FLL operates, the PLL is inactive and a constant PLL output of 4mV (equivalent of 200 KHz frequency) is applied along with the dynamic FLL output. The 4mV is fed through a switch (in Fig. 3) whose control input is the end-of-operation line of FLL. When the latter's dynamics is completed, the switch enables the loop filter's output to go to the oscillator's control voltage while the FLL output is now held stationary. The loop filter has a cut-off frequency of 20 KHz. To see the frequency settling distinctly, in simulation the FLL leaves the frequency error at 300 KHz (approx.. 800 ppm) instead of 160 KHz (400 ppm).

The convergence results of the FLL (to 400 ppm resolution, just as a stand-alone block) for the frequency of 403.7 MHz is shown in Fig.4.

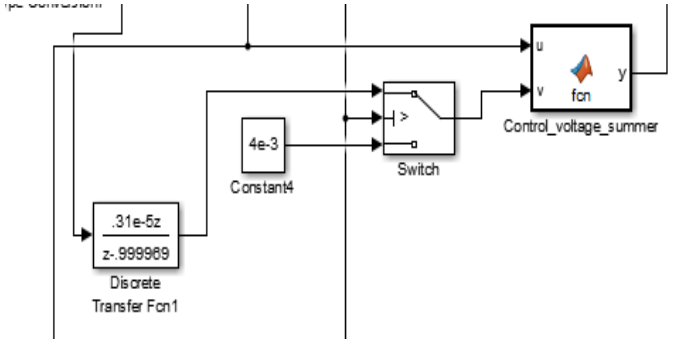


Fig.3 IIR filter, switch and control voltage generator of the proposed architecture

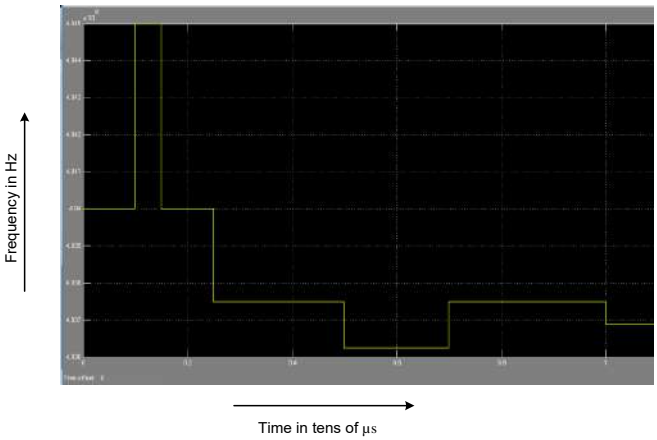


Fig.4 Frequency transient of FLL only showing locking to 403.7 MHz (target reached 403.69 MHz)at 400ppm resolution

From Fig. 4, it is seen that the oscillator stabilizes to the desired frequency in about 12 μs. The frequency transient of the FLL+PLL section when the target frequency is 404 MHz is shown in Fig. 5. The FLL leaves the system at 403.7 MHz and then the PLL takes over correcting to 404 MHz within 100 ppm error. The initial frequency is taken as 398 MHz in this case and the initial random phase as π/7. From Fig. 5 it is seen that the proposed system indeed corrects frequency error upto 100ppm in small time. The time taken to reach a frequency resolution of 100 ppm is 56μs from simulation. Theoretically the value is 53μs with our simulation settings. Fig. 6 shows how the phase error converges with time. From Fig. 6 it is seen that initially the phase error is small but the final frequency has not yet converged. With time the final frequency converges in Fig.5 and the phase error also converges asymptotically to the value of 18 degrees. The present system can be used with both MFSK (frequency convergence required) and MQAM (both frequency and phase convergence required, and small to medium constellation sizes) modulation schemes.

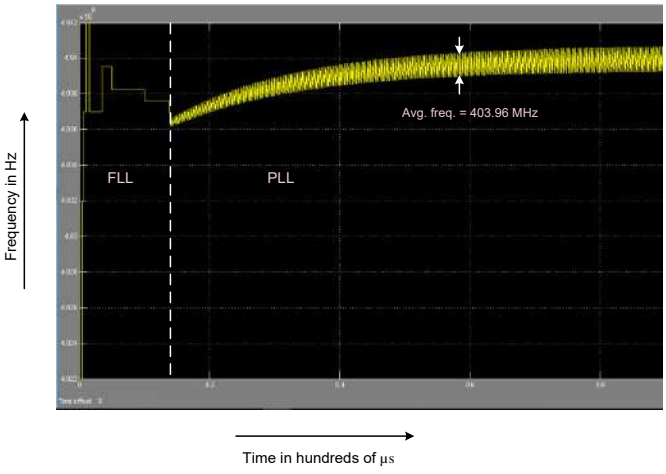


Fig.5 Frequency transient of FLL and PLL showing locking to 404 MHz (target reached 403.96 MHz)at 100ppm resolution

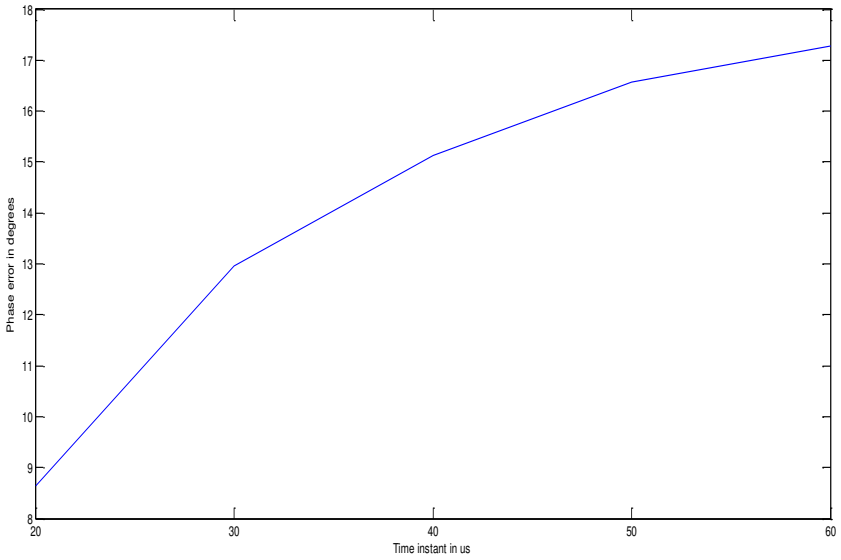


Fig. 6. Phase error convergence plot with time for target frequency of 404 MHz with the same simulation parameters as Fig. 5

V. CONCLUSION

In this paper, the theory behind the design of a low power, fast settling aided acquisition PLL has been proposed. Comparisons with a type –II PLL shows that it is indeed the more energy efficient alternative. Here the architecture of the system has been designed in Simulink and tests for frequency convergence, settling time and phase error has been carried out. The results that have come out show a strong match with the theoretical values. The circuit of the oscillator has not been constructed but design points for circuit level integration has been discussed. The PLL architecture is suited for RO based topology of oscillators where a large number of phases are provided and no off-chip elements are present. The circuit level design of the system is a future work of the project but this study shows that such a system is indeed a viable option for phase locking a MICS band oscillator in the energy constrained context of WSNs.

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COMPREHENSIVE STUDY ON HOW PRIVATE DATA IS COLLECTED AND UTILIZED BY SOCIAL MEDIA AND ITS SOLUTIONS

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ABSTRACT

The paper attempts to understand and explain the various data collection methodologies of Social media. It tells us about what kind of data is targeted and how it is obtained from individuals .It lets us know how the obtained data is used to enhance individual news feeds in addition to targeting personalized advertisements towards the users. The paper presents information about the current market scenario of data brokers. Ultimately it informs us about the preventive measures which can be undertaken to avert the acquiring of private data, and introduces the idea of monetizing personal data, by offering it directly to the requiring companies in exchange of remuneration.

KEYWORDS

FB – Facebook, IG – Instagram, API – Application Programing Interface, News feed, ML-Machine Learning, DL-Deep Learning, AI –Artificial Intelligence, Monetization, cookies, PII-Personally Identifiable Information

I. INTRODUCTION

This paper attempts to answer three basic questions pertaining to one of the greatest addictions of modern life, social media.

- Are we being robbed?
- Are we missing out?
- Are we getting paid?

As an average person goes about his life, he leaves behind an enormous trail of data. It has happened to a majority of members of the technologically advanced population that a person has searched for flights to a particular destination and the next day their news feed is flooded with advertisements of cheap hotel bookings of that destination, or perhaps upon searching for pregnancy symptoms, baby clothes ads started popping up in a while. Travelling to a location using Google maps and the nearby restaurants start getting recommended. An even more bizarre phenomenon is when a mention of a product in casual day to day conversations, in front of "smart" home appliances causes an ad of it to pop up.

A person's personal data is an asset .It belongs to him and he is entitled to its sole ownership. A very famous saying in the 90's goes, "If you are paying for the product, you are the product." The personalized ads which pop up ever so frequently are generated by using the private data of individuals. So the answer to the first question, "Are we being robbed?" is, yes.

II) ANALYSIS

- *How is a person's news feed personalized?*

  The question is elucidated with the help of an instance of one of the biggest technological giants in the field.

  Instagram recently unveiled the 6 factors which determine, whose media pops up into a person's feed and when. This was actually a unique step taken in response to user backlash after 2016, when it stopped displaying posts in chronological order.

  The three major factors are –

  1) **Interest**- Refers to how much IG thinks a person cares about the post, based on past interaction with similar posts.
     The engagement can be gauged through likes, saves and comments, the save option is prioritized. Also uses machine vision technology to actually scan the posts in certain cases.
  2) **Timelines** – Instagram prioritizes newer posts over older.
  3) **Relationships** – Instagram determines how often the user interacts with the other user or business, to conclude how

often to display their posts on the original user's feed.

It should be kept in mind that machine learning is used, so the algorithms keep changing with time as newer data is made available.

Another 3 factors, based on the usage by an individual are-

1) The **regularity** with which the app is opened
2) The **number of people followed**, if many people are followed, IG will try to display a bit of content from all of them to give the users a more wholesome experience.
3) **Usage**, if Instagram is opened for a short period of time, the algorithm tries to display posts with the highest engagement in a short time span to the user.

Instagram claims to neither boost nor hide content.But an individual's feed is based on their own interactions.eg-if a person always tends to scroll past videos, they tend to show up less on their feed.

FB radically changed its algorithms on Jan 13, 2018, to focus more on personalization, and force advertisers to "pay to play" causing it to lose around 119 billion dollars in a day.

The new algorithm focuses on

- Inventory i.e. the content available
- Signals i.e. considerations about the content.
- Predictions i.e. considerations about the person.
- Overall score.

News feed content ranking is decided upon by the following criteria

- Average time spent on content.
- Time of posting.
- Overall engagement.
- Informativeness of the post.

- New posts are encouraged ,if they attract a high amount of
  i) Link sharing ii) Multiple replies iii) Comments iv) Shares (especially using messenger) v) Reacts

❖ *How is this data collected?*

The way this information is collected is illustrated below, using the instance of Facebook.

- Tracking Cookies:

FB tracks its users across the web by using tracking cookies. If a user is logged into Facebook and simultaneously browses other websites, Facebook can track the sites they are visiting. FB doesn't need to use third-party cookies to track the user as he moves from site to site, if the sites contain Facebook's JavaScript code(for e.g. for the Facebook "Like" button). In this case, Facebook's JavaScript code can place first-party cookies on the user's system and communicate back to Facebook's servers to show ads based on sites that they've visited previously.

Secondly, FB uses Conversions API that allows advertisers to send web events from their servers directly to FB. Server events are linked to a pixel and are processed like browser pixel events. The website which the user has visited could have sent information about their visit directly to FB using their "Server-side API". It does not require any client side scripting technology to be enabled, because all the communications happen between the third party website and FB.

- Facial Recognition and tag suggestions:

Deep Learning is suitable for dealing with large training sets and has been recently applied in diverse domains such as vision, speech and language modelling. The Facebook team adopted this tool to apply their face verification algorithm called as Deepface which is currently their latest facial verification system.

Once there is a full-face scan, the FB databases store the facial information of the users. Dynamic grids are formed on the basis of most common visiting locations, the common uploads and geolocation tracking. Based on the grid, the facial data are matched to those present in the database.

With 97% accuracy, a tag-suggestion is sent as a result of the above-mentioned algorithm. But the major problem is that it is possible for an entity to use facial tracking to construct full location histories and profiles.

- Analysing the Likes:

A 2013 study by computational psychologist and big data scientist Michal Kosinski and others, found that Facebook likes "can be used to automatically and accurately predict a range of highly sensitive personality attributes." Kosinski's Algorithm was able to predict whether a person was black or white with 95% accuracy, male or female with 93% accuracy, gay or straight with 88% accuracy in journal stating.

- Geolocation Prediction:

The platform doesn't necessarily need GPS to locate a user. Several clues left involuntarily by users, are enough for it to obtain an estimate of their location such as localized photos, check-ins, and the IP address of users. Facebook extracts location-related information from people in three different ways:

(i) When people enable location services.
(ii) Through people's activities, e.g. stories, posts, likes, location-tagged posts.
(iii) From IP addresses.

❖ How is the collected data used and its unethicalness

Now that it is somewhat understood, how the personal data of users of collected, let us try to understand how and where it is utilized.

A lot of personal data is shared on social media platforms like birthdays, friend lists or favourite places. But in actuality it is a lot more than that. FB can take the info users have provided and combine it with other external data to construct a full blown profile of the users. FB uses nearly 100 different data points to classify a person's interests and activities ranging from basic knowledge like age and sex to more complicated estimations like if the user owns a motorcycle or predict where he is likely to go for a vacation

Researchers have found that by analysing likes and engagement, FB could also predict if the users were in a relationship or going through a breakup.

- People you may know

One of the most controversial features of FB is people you may know .FB uses many different signals of what it knows about the users to determine who else they might be connected to, and these signals may not be things that the users share knowingly, like phone contacts of the users or by geolocating the people who work in the same building.

- What people do?

FB compiles data about the user's political activity like protests or rallies they attend, thus being useful for political advertising, as highlighted during the Facebook-Cambridge Analytica data scandal, in which personal data of millions of FB users was acquired without their knowledge or consent by British consulting firm Cambridge Analytica, which sought to sell the data of American voters to political campaigns.

- Future Prediction

FB can use the private data of users to predict future life outcomes, like when is the user likely to get married or if they will become addicted to substances, all of which is very valuable from an advertiser's point of view.

❖ Monetary value

By virtue of dropping cookies or other tracking technologies, data analysis firms try to identify a person by a number. These numbers can be used to track users as they traverse from page to page within the internet. This enables the data brokers to construct a rich profile of the users, which is extremely valuable to the advertisers. As advertisers learn more about consumer's interests they are able to target them in a more precise manner. An entire market has developed where firms are able to buy personalized data to display targeted advertisements. Ninety percent of Google's revenue is through advertisements. To answer the second question, "Are we missing out?" yes we are certainly missing out.

III) SOLUTION

❖ *What can be done about it?*

Now that it has been established what data is acquired, and how it is obtained and how it is utilized, we now come to the part of its ethicality and how data obtainment can be prevented or monetised.

- Government rules and regulations.

Regulators try to control the outflow of data from the users by passing rules and regulations such as the European Union general data protection regulation, India's IT Act of 2000 and its corresponding Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011 ("the IT Rules"),in India. Facebook was brought under the scanner and CEO Mark Zuckerberg was brought to testify before Congress in 2019.

- User awareness.

  Users should be made aware of the ways in which the data is acquired from them and should know about safeguards such as switching off location services when not required. A huge majority of apps try to access information which is not relevant to their services, such as Uber asking for access to image gallery.

  Most of these app permissions and settings can be managed and turned off, using the customizable settings.

- Privacy policy

  A **Privacy Policy** is a statement or a legal document that states how a company or website collects, handles and processes data of its customers and visitors. It explicitly describes whether that information is kept confidential, or is shared with or sold to third parties. Recently whatsapp updated its privacy policy drawing vast criticism over the increased data sharing with Facebook, however a glaring issue in this is the privacy policies are written in an extremely tedious and technical fashion which is nearly impossible for a layman to comprehend. According to a study by Forbes on a user agreement for software, about 20,000 words long, which 7 lawyers were unable to comprehend fully over a period of a week.

IV) ALTERNATIVE SOLUTION

A creative solution requires us to understand the concept of '**disintermediation**',viz reduction in the use of intermediaries between producers and consumers.

PII (Personally Identifiable Information),is a very sought after commodity. It is important to understand the fact that personal data is not that valuable unless it can be attached to an individual. PII consists of name, biometrics, credit card info etc.

However the data collected by the social media giants ,has to be anonymized due to the aforementioned govt. rules and regulations. The anonymized data is bunched together and sold to data brokers for further usage, who then use AI and various deep learning algorithms to trace the data back to the users. In a nutshell the process has the following stages.

1) User data is collected by social media companies.
2) The data is anonymized
3) The data is grouped and sold.
4) AI and deep learning algorithms are used to trace the data back to the users
5) Targeted advertisements are displayed based on the data.

The alternative idea is to disintermediate and directly jump to step 5. By consenting the companies to collect our data in exchange of monetary benefits, for instance – A user consents to share their geolocation data ,so that he can view advertisements relevant to that area, and in turn he gets a 40% discount off on a meal at the restaurant mentioned in the advertisement, or any other kind of remuneration. The advertisers spent a tremendous amount of money already in step 4 so it will be beneficial for them too to cut out the middle man. This method has the added benefit of consent ,that if a person chooses not to share their data ,they can do at any point of time.

So to answer the last question raised by the paper, "Are we getting paid?" we can certainly do so.\

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Instagram emerging as a new paradigm of Digital Marketing

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***Abstract*—** This research paper discussed that how Instagram has become an approbatory platform for marketing a product or service. It mentions that however Instagram has become a good platform for promoting a product or service. It permits users to transfer media virtually in kind of new posts or stories, to love different users' photos and videos and watch stories. Instagram conjointly permits users to discuss different user's stories and to tag users on another posts furthermore. Through these likes and comments, marketers square measure ready to reach their audience; they will even communicate with their target audience. We've got known four major components that upon used properly will encourage be terribly fortunate for any complete selling over Instagram- Clear vision and sharp, Consistency, Familiarity with the four Ws (Who, Why, What, Where) of your audience and Clear clear-sighted

Keywords*— *Instagram, Facebook, Marketing, Digital Marketing, Influencer

I. INTRODUCTION

As this reality grows more and more digital and interlinked, Marques and marketers exist embrace trendy information marketing schemes to tempt potential purchasers and improve their sales. This rising competition at these selling arenas is compelling content marketers to be a lot of inventive, deliver real time content supported behavioural patterns and build it visually participating. It gets tougher to push these shoppers and take their attention to the marketing campaigns. Investigation indicates that half-hour or less is however so much shopper usually consumes engrossing digital selling content. this is often the challenge today's marketers face with their modified shopper habits and expectations. With advent of innovative tools & technologies digital selling has reached a full new level.

II. DIGITAL MARKETING

A. Digital means anything that you can see or get with a gadget, for example, TV, cell phone, radio. Marketing means to comprehend the requirements of the buyer and give the items or administrations likewise. Advanced Marketing is done in order to focus on crowd so as to examine their requests, to advance item and administrations and to make brand mindfulness utilizing diverse computerized stages present on the web. It is chiefly done on the Internet. Advanced showcasing turned out more modern during the 2000s as well as in 2010s, when the step-up of gadgets equipped for getting to computerized media prompted abrupt development. Insights delivered in 2012 and 2013 indicated that advanced promoting was all the while developing. With advancement of online media during the 2000s, for example, LinkedIn, Face book, YouTube and Twitter, Instagram buyers turned out to be exceptionally reliant on computerized gadgets in day by day lives. They expected consistent client experience across various channels for looking through item and data. The difference in client conduct improved the expansion of advertising innovation. Overall advanced promoting has become the most well-known term, particularly after the year 2013. An expanding segment of publicizing originates from organizations applying Online Behavioral Advertising (OBA) so as to tailor advertising for web clients, even so OBA raises worry of shopper security and information insurance Digital showcasing is one sort of promoting being generally used to advance items or administrations and to arrive at customers utilizing computerized channels, web-based media promoting, show publicizing, web index showcasing and numerous different types of computerized media. With the presence of computerized media, purchasers don't simply depend on what the organization says about their image yet additionally they can follow what the media, companions, affiliations, peers, and so forth, are saying too

B. Digital Marketing- a boost to today's business

Irrespective of what the company sells, digital marketing still involves constructing out buyer's character to identify the audience's needs & creating valuable content online.

- **B2B Digital Marketing**: when organization is business-to-business, advanced promoting endeavors are probably going to be focused on online lead age. The part of your advertising system is to draw in and convert most excellent leads for sales reps through your site and supporting computerized channels.
- **B2C Digital Marketing**: when the organization is business-to-consumer, depending over price point of products, the aim of digital marketing is to draw people to website and have them turn into customers even without talking to salesperson. The focus is on building an accelerated buyer's experience, from the minute someone lands on the website, to minute they make a purchase.
- **Content Performance & Generation of Lead**: Think you've created a product pamphlet & posted it

via people's letterboxes, that pamphlet is a type of content, available offline. The problem here lies is that there is no idea as to how many people opened the pamphlet or how many people threw it in trash.

- **Attribution Modeling**: An impressive digital marketing plan of action concerted with accurate tools & technologies which allows to track all sales back to customer's very first digital interaction with the business organization

Data-driven promotion: Users create a lot of data at every step they make on the road of customer journey and Brands can use those informations to spark their known audience with such data driven media purchasing. Without disclosing users' privacy, users' Data is often gathered via digital channels, brands can also gather data from world user interactions, like brick & mortar outlet visits and from CRM and Sales engines database.

III. KNOWING INSTAGRAM

It was made by Kevin Systrom and Mike Krieger and was earlier launched for iOS in Oct 2010. The Android variant was released in Apr 2012, along with a feature-limited to desktop interface by November 2012, a Fire OS app according to Gregorian calendar month 2014, associated an app for Windows 10 in Oct 2016. Instagram could be a platform that accentuates icon and video sharing through its mobile app. One can take, edit, and create visual content for ones followers to get more likes, comments, and shares. "Do it for the 'gram" has become a typical spoken communication. The app could be a nice likelihood to remain an area of friends'. Plus, one can follow their favorite celebrities or political figures to visualize candid photos of their everyday lives, instead of that specialize in a great deal of various features, Instagram has a core attribute, which makes it particularly simple to share digital media with your friends. Filters are one more reason why folks like using the app. Additionally, it is a fantastic platform for investigation what alternative brands do as an example, Nike uses the Stories' feature so as to push sacred jock content you will not realize anyplace else.

A. Facts

- Adam Mosseri is the current Head of Instagram. He has been with it's parent company Facebook for over 10 years
- There are 1 billion monthly active Instagram users as of 2020.
- 33% of the most-viewed stories are from businesses.
- 200 million Instagram users visit at least one business profile every day and 80% of users follow a business account.
- The most involved brands are: National Geographic: 149 million followers, Nike: 127 million followers, NBA: 53.2 million followers, Chanel: 42.7 million followers, Louis Vuitton: 41.8 million followers, Adidas: 35.4 million followers, Starbucks: 18.1 million followers, Go Pro: 17.6 million follower

IV. WHY INSTAGRAM

Since its origination, Instagram has evidenced to become a strong selling tool for businesses wanting to grow their presence and therefore the perceptibility of their merchandise. whereas promotional material and support possibilities exist, obtaining commenced with Instagram is autonomous and businesses will set up a big following while not even disbursing a dime. A study within the UK discovered that 70.7 % of brands exploited Instagram in 2017. These firms posted an average 4.9 times an image per week. Five hundredth of Instagram users follow a minimum of one complete. Business corporate executive reports that quite ninetieth of Instagram users area unit underneath the age of thirty five. This highlights it as a really engaging platform for brands centered on the 18 to 34 year-old target cluster. Facebook is limiting fan base rights to firms more and more. that's why firms realize their means with Instagram, that offers a picture based mostly storytelling capability, quite the other platform (Mancuso & Stuth, 2015).According to Instagram's own web site seventy five once} Instagrammers take action after being impressed by a post and hr of Instagrammers say they discover new merchandise on Instagram (instagram.com). once it involves influencer selling, Instagram was the simplest playing channel for social policy in 2015, and delivered a social policy rate of three.21 in comparison to one.5 received all social networks, in keeping with Rhythm One's Influencer selling Benchmarks.

Boasting over one billion monthly active users, Instagram has immense potentiality for businesses, however the potential of Instagram lies additional within the user's behavior than just the numbers. Instagrammers want to associate with brands, analysis reflects that brands fancy variety of clear advantages and benefits of the network:

- Brands on instagram fancy day-to-day engagement with four % of their overall followers. On platforms like Facebook and Twitter, engagement is in a smaller amount. (source: Forrester)
- seventy % of Instagram users research a whole brand on the platform (source: Iconosquare)
- sixty two % of users follow a label on Instagram (source: Iconosquare)
- solely thirty six % of marketers use Instagram, in comparison to ninety three of marketers who use Facebook (source: Selfstartr)

Social media influences purchase selections, and if one is able to notice the correct mixture of content, their audience can absorb it and even get without the requirement for a tough push or pitch. It's the dream of a marketer.

V. STORY BEHIND SUCCESS: INSTAGRAM!

The success for a business empire on Instagram does not rely only on simply publishing or advertising of a few attractive images. You also need to keep a look on these following factors as well:

- **Clear perception and Sensible ideas.**
- **Uniformity**
- **Familiar with the 4 Ws (What, Where, Why, Who) of your audience.**
- **Clear sighted**

When you mix them all, Instagram can no doubt will help you to expand your business in no time. “Made well is a well set example of one of the efficient and creative Instagram marketing”. The fashion and style brands have fetched a huge market and engaged with a lot of customers on Instagram (over 7, 00,000 followers and 7,000 to 10,000 likes on a single post). This app acts as a key tool for fetching or connecting with millions of potential customers on an everyday basis. If the marketing team wants to establish their empire in the market then this is definitely one of the best platforms.

Businesses can market their products and services and can also advertise their brands and reach the target audience by having an active flow and schedule of one post on a single day. The famous brands like Coca-Cola and Adidas have set the bars of how effectively uses Instagram to flourish.

Instagram has developed and grown over the years to enable on-platform e-commerce sales. Today, a lot of emphasis is on making money with the help of product placement. The new features is the Shop tab, which is situated prominently on Instagram’s home dock and provides users an opportunity to discover and purchase from brands directly through Instagram.

Instagram also provides influenced posts, which gives an opportunity to businesses to add tags to their products in their photos or videos with links that consist of product description, price and the ability to “shop now,” which will definitely attract the user towards your online store.

Having delivered the services, it’s quite easy to fetch actual sales made in the site. An astonishing 72% of users of Instagram reported buying services as well as products using the social media platform at least once in their lifetime and the quite impressive.

A. Marketing features used in Instagram:

- Stories and Reels are the important features of video advertising
- Instagram Live.
- IGTV - is an app present in Instagram, with that the user can share videos which are more or less than an hour long e.g.- Various TV episodes.
- Stories Features- We can add short clips of videos to a story which is viewable for 24 hours before it disappears.
- Shoppable tags: - Used by business to tag their products in their images.
- Push notifications account: - As it is your official account used for your business purpose you don't want to get huge notifications from that account which you follow as to be your priority. But, you really want your followers to add or post notifications from you.
- Use of Hyperlink and Hashtags in Bio: - When someone use an @ or #, the username or hashtag which will be hyperlinked automatically, it's another way to gain more traffic in your website or engagement.

Geo-tagged Content: If you are using this content for marketing related tasks it can turn out to be very effective and valuable, usually for brick-and-mortar businesses.

VI. CONCLUSION

In today's modern era where every business enterprise tries to grow or expand their business empire. Instagram plays a crucial role for advertising of the business products and various services because it can run both on mobile as well as web platforms. Instagram has a global reach and gathered people who are efficient in photography and those who are not can use the different filters like Clarendon, Gingham, Juno, Mayfair etc. There are many filters which were already there in many applications and web portals for editing purposes, but Instagram makes use of this as a marketing tool, creating a mode through which anyone can share pictures online and share those on social media. Instagram has transformed a lot, it initially started with just a picture sharing app then it emerged as a new marketing tool in social and digital media marketing.

Instagram as a marketing tool has a global recognition as well and is highly used not only by big firms but also business firms as well due to vast target audience as well. A lot of firms use this as a platform to advertise their products, services and also for hiring advertisements. Instagram has provided a unique platform where customers can directly visit the company website, place their orders and can also give their valuable feedback there. Instagram is free and can be used for business purposes as well. Instagram has evolved over the years and trying to innovate by adding various features, hence providing it a visual platform which makes it user friendly.

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Understanding consumer behaviour with respect to availability of two tax regime in India

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***Abstract*— Consumer behaviour is a complex process. It depends on a lot of factors which might include social or political scenario, economic condition and psychological profiles of consumers. It largely depends on the purchasing power of the consumer as well. With the availability of two tax regime of planning savings, as per budget 2020, there has been a significant shift in saving habits for reference of the consumers. Keeping in mind with the tax regime available, the objective of this paper is to understand the consumer behaviour with respect to the income tax provisions and to analyse the benefits before making a choice between the new and old tax regime. In order to correctly predict the consumer behaviour we collected a data of around 50 people ranging from various socio economic background from in and around Kolkata and Howrah districts of West Bengal, India. The analysis of the data has given as a predictive module which shows us how the consumer might behave in this new regime's availability. As part of the paper some points have been provided which might help the consumers decide on which region to go based on their benefits and drawbacks which have been derived from the paper's collected data itself. The limitations and future scope of the paper have also been provided for further study on this topic.**

Keywords—tax, consumer behavior, old regime, new regime.

I. INTRODUCTION

Consumer behaviour is a very important and a very complex process. It depends on the consumer's psychological profile and also socio economical condition. During this time of pandemic various new factors have emerged along the existing ones that has affected the economy of the country along with its residents.

With the introduction of a new tax regime there is a rising debate on which regime should one avail since both the old regime and the new regime can be followed according to the choice of the individual. In this paper we have tried to understand the behavioral patterns amongst the tax payers and tried to find out a relation as to why an individual chooses what tax regime.

II. OBJECTIVE

The objective of this paper is to understand the consumer behaviour with respect to the income tax provisions and to analyse the benefits before making a choice between the new and old tax regime.

III. RESEARCH METHODOLOGY

In view of the pandemic environment, we could not have much of door to door survey or one to one basis. We created questionnaire in Google Form and circulated to about 325 persons at random from the e-mail database of 1201 people that we have. 50 people responded to the survey.

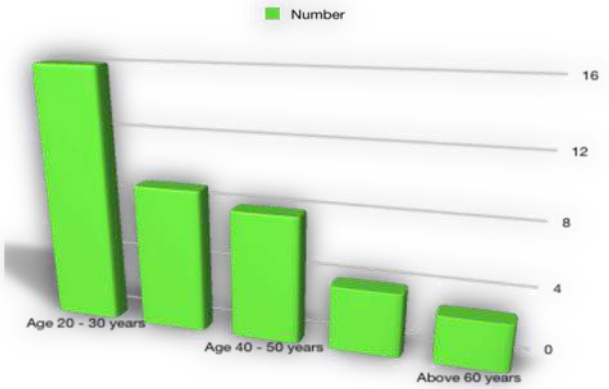
The structured questionnaire was created to understand the influence of two regimes (old and new) as given in the Budget of 2020, on planned savings i.e. whether there has been any significant change in the saving patterns or choice of people.

Thorough study of available literature on these two regimes was done, which has been mentioned in other parts of this study. Answers with clarification were given to the subjects, over e-mail, or phone, when any of the subjects enquired about any of the features of the two regimes. Relying on the responses of the subjects, the table, has been created and enclosed. The data thus generated has been analyzed in Tableau and are presented here.

IV. DATA ANALYSIS AND FINDINGS

The subjects when classified into various groups look as follows:

First in the analysis part we have segregated the data into discrete, continuous and categorical variables. In the primary data we found there are 22 parameters from the primary data and we need to find out the correlation of the parameters with that of the destined parameter that is the participant wants to go for the old regime or for the new regime. After we have found out all the categorical data from the dataset. We have done the test to find out the correlation of the 2 variables. Since we have both categorical data, we used Chi Square test assuming that two variables are independent (null hypothesis), it tests whether the values of the contingency table for these variables are uniformly distributed. If the p-value is small enough (<0.05), the null hypothesis can be rejected and we can say that the two variables are probably dependent. It's possible to calculate Cramer's V that is a measure of correlation that follows from this test, which is symmetrical (like traditional Pearson's correlation) and ranges between 0 and 1 (unlike traditional Pearson's correlation there are no negative values).We found only six variables are significant from the above statistical analysis. Occupation/ Profession, Number of earning members in the family, Your personal yearly income, In view of the new regime of taxation, do you want to increase your investment in, In view of the new regime of taxation, do you want to decrease your investment in want to increase your investment in, What is your philosophy of life are the variables where we found that the variables are significant.



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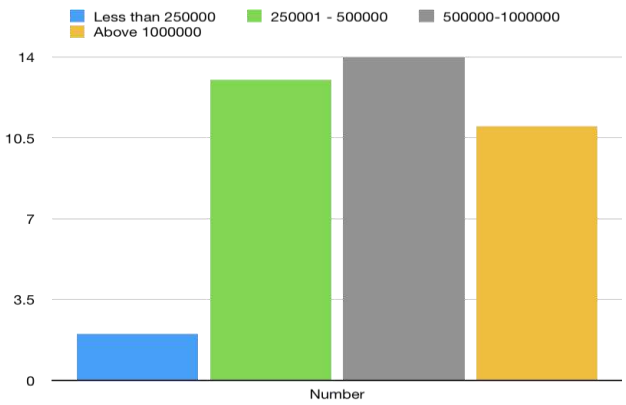
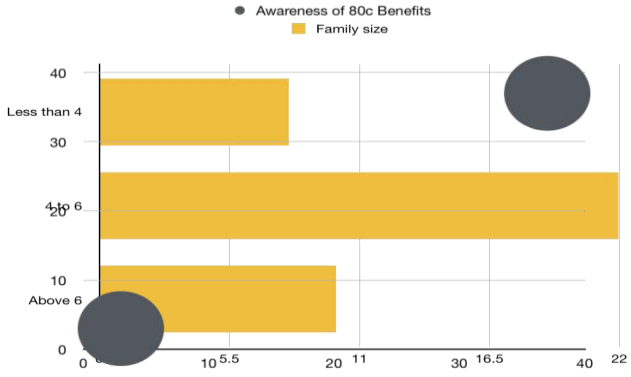


Salary

Male	35				
Female	13				
Prefer not to say	2				
Total	50				
	Age 20 - 30 Years	21			
	Age 30 - 40 Years	9			
	Age 40 - 50 Years	10			
	Age 50 - 60 Years	6			
	Age above 60 Years	4			
	Total	50			
			Married	30	
			Unmarried	20	
			Total	50	
				Professional	30
				Business	12
				Other	8
				Total	50

Fig: Demographic Information



Awareness of 80C benefits

These subjects represent all genders, in different age group, with different marital status and diverse occupation.

IV.A. INCOME GROUP

Based on the data received from the subjects, the income groups then can be determined as follows: A total of 50 people belonged to the following group.

Less than 250000	5
250001 - 500000	15
500000-1000000	15
Above 1000000	15
Total	50

IV.B. AWARENESS

From the inputs it appeared that all but 5 of them of them were aware of the existence of the two regimes or two schemes as per the budget of 2020. Some cases they wanted some clarification, which we answered based on literature study i.e. discussion available in various websites including that of the Income Tax department.

IV.C. WHICH SCHEME

The subjects were asked which tax scheme they considered appropriate for them and the following was the answer.

Old Tax regime	21
New tax regime	29
Total	50

Comparing this table with the table just above, it is very clear than not only people from lower slabs, but also some people from the higher slabs also opted for the new tax regime, looking for more cash in hand, at the cost of stability of long term savings and long term planning.

IV.D. INCOME GROUP-WISE ANALYSIS

42 people out of 50 knew about the new sec 80c benefit.

Income in Rupees

Prospects of Insurance

IV.E. HEALTH INSURANCE

The choice of Mediclaim appears in the portfolio of 12 subjects, which means a very low penetration of Health Insurance, assuming the sample well represents the urban educated tax aware group. Probably many innovative schemes will be required to popularize health insurance.

IV.F. INSURANCE POLICY

27 out of 50 people specifically mentioned insurance policy as one of their vehicles of 80C investment. But when they were giving their new plan in view of the regime choice available only 15 people kept insurance as a choice even in the changed scenario. This is an adverse impact in the insurance sector, which might have to be overcome by active campaign or issuance of innovative insurance policies on life.

IV.G. ATTITUDE TO LIFE

People were asked to indicate their approach to life under 3 parameters and the results obtained were as follows:

Do everything as per life plan	24
Have plan for at least next 5 years	10
Earn, spend and enjoy	16
Total	50

At least 34 out of 50 i.e. 68% of people lead their life with a short term or long term plan which is the real hope for insurance companies. That's where we can pitch in for new insurance. The people in the "Earn, spend and enjoy" category are mostly people of the younger generation with earnings up to Rs 500000 PA. This analysis shows for sure that some people in the younger generation are for immediate gratification, rather than long term planning, which is a bad signal for the life insurance community, because insurance is a very long term product.

V. LIMITATIONS:

The study has urban and education bias. Most of the subjects are IT literate, living in cities and having income from business, profession or services. We could not gather data from subjects living in villages, who are agriculturists, or subjects who have very risky profession, and who could or could not have substantial income and life insurance. In the pandemic environment specific responses from doctors and health professionals also could have been taken to make the study more significant.

VI. FUTURE SCOPE:

Since the study is confined to Kolkata and Howrah only, the researchers may focus on other parts of country to generalize the findings of the study.
Interested researchers may concentrate on marketing mix to have in depth knowledge of the urban or semi urban areas. Many other factors can also be taken into account to understand the consumer behavior in a more appropriate manner.

VII. CONCLUSION:

This paper surveys the factors determining in view of the availability of two options (old regime and new regime) of planning savings, as per the Budget of 2020, there has been any significant shift in the saving habits or preference of people. In the new regime there are many slabs around 10 to 15 and tax is considerably low. But there is no concept of tax reduction. In case of old regime the rate is higher but lot of option to reduce tax. The biggest section for deduction is 80C which you can you can bring down your taxable income by Rs1.5lacs. All the exemptions and deductions that were used by tax payers in the existing regimes could not be available in the new tax regime. This covers both academic research and experiences of tax administrations in implementing and testing new approaches. Through this research we have got to see that people aging between 20 -30 are considering new regime to be the best option for their investments. Investors who are claiming a lot of deductions under the old regime, one can probably save better sticking with the same system as per the calculations. If one were not making any saving investments or claiming any deductions earlier too, then the new system is getting them benefits. The paper concludes by outlining the work being done in Revenue to use this behavioral research as a framework to influence taxpayers. Let us take an example a person annual income comes to Rs6lacs. If one goes by new rates one has to pay Rs60000 (some of the exemptions allowed in the new tax regime may be beneficial). If one chooses the old rates, he can deduct Rs1.5lacs under Sec 80C. His taxable income is Rs4.5 lacs. The old system has many exemptions and deductions under numerous sections-availing a few of these required people to invest in tax saving investment options, which helped inculcate a good habit of investing. On the other hand, the new system gives people more flexibility and tries to simplify the process.

Telecommunication Market Analytics Using Predictive Modelling

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***Abstract*: Customer churn, also known as customer retention, customer turnover, or customer defection, is the loss of clients or customers. Telephone service companies, Internet service providers, pay TV companies, insurance firms, and alarm monitoring services, often use customer attrition analysis and customer attrition rates as one of their key business metrics because the cost of retaining an existing customer is far less than acquiring a new one. Companies usually make a distinction between voluntary churn and involuntary churn. Voluntary churn occurs due to a decision by the customer to switch to another company or service provider, involuntary churn occurs due to circumstances such as a customer's relocation to a long-term care facility, death, or the relocation to a distant location. In most applications, involuntary reasons for churn are excluded from the analytical models. Analysts tend to concentrate on voluntary churn, because it typically occurs due to factors of the company-customer relationship which companies control, such as how billing interactions are handled or how after-sales help is provided. Predictive analytics use churn prediction models that predict customer churn by assessing their propensity of risk to churn. Since these models generate a small prioritized list of potential defectors, they are effective at focusing customer retention marketing programs on the subset of the customer base who are most vulnerable to churn. We have applied logistic regression for modelling (GLM model) and we applied feature selection using RFE method and graphically shown the ROC curve, finally we checked the accuracy and sensitivity of the model.**

Keywords: Customer churn, Tele communication,

I. INTRODUCTION

Reports state that around 90% of the adults in India own a smartphone, i.e., two thirds of India's total population. This saturation has resulted in keeping a loyal customer base very expensive and extremely difficult for the telecommunication companies.

With the competitive commercials and the ease of shifting from one carrier to another within a short span of time without even needing to change your existing number are some of the biggest contributing factors for annual churn rate between 10% and 67%.

However, the biggest reason why people actually switch isn't the cost but the perception of a poor quality service. The keyword here is perception as service doesn't actually has to be poor for a customer to switch Telecom Company. Thus in order to reduce this customer churn the companies must focus on their existing customer base to gain an understanding of what the customers are perceiving as issues and what can be improved. Business Intelligence (BI) and analytical applications can be used to improve service and thus boost the customer loyalties.

Figure 1: Pipeline of the project.

II. OBJECTIVES

The primary objectives of the paper is:

- Run modelling techniques to predict if a customer will churn or not.
- To find the right methods to train machines, fine tune the models and select the best performers.
- To run logistic regression to predict the customer churn percentage.

III. LITERATURE REVIEW

Our paper solely targets the analytical method of predicting churn over a market data (secondary data) downloaded from the kaggle website. In order to use predictive techniques we have researched on many of the relevant papers and articles related to predictive modelling. We have applied data cleaning and organizing using simple methods and then using a modelling technique we predicted the results. In our literature review we have found ample of research on churn analytics and predictive modelling. Various researchers have studied and analysed on unbalanced datasets where they have seen the churn customers is less than that of active customers which is a major issue in churn predictive techniques. We have tried over several sampling techniques and random sampling techniques by comparing it with AUC curves and showed that under sampling technique has outperformed other techniques. Yet we choose to take GLM model to come into action on our data and has given us a 78% of efficient model.

IV. RESEARCH METHODOLOGY

1.1. Method of research:

The project is solely predictive analytics on telecommunication market data.

We have used predictive modelling techniques in order to predict whether the customers will churn from the service or not. For data collection, we have downloaded a secondary dataset, one with churn data, customer data and internet data of size 51403 data. For outlier detection we have used the IQR method. For modelling we have used logistic regression. For feature selection we have used the RFE method. Then we have found out the Accuracy and Specificity of the model by calculating precision and recall scores. Finally we tested the model and checked the overall accuracy and specificity and performed model deployment. This is the flow chart of the process that we have followed in our project.

1> Missing Values
2> Outlier
3> Significance of the variables
4> Variable Mapping
5> Feature Scaling
6> Train and Test split
7> Modelling using Logistic Regression
8> Feature Selection using RFE
9> Confusion matrix
10>Checking VIF values
11>Accuracy
12>Specificity
13>Sensitivity
14>ROC curve
15>Precision and recall trade off
16>Checking precision and recall on test data set

1.2. Type of Research:

Research is fully based on analytics on tele communication market data so that it can help in predicting customer churn.

1.3. Data type: Secondary Data

1.4. Data Analysis tools used: Jupyter notebook for programming in Python.

V. DATA ANALYSIS AND FINDINGS

1. Data classification:

1.1 Churn Rate:

Churn Rate Visualisation was important to find out to observe at what rate churn occurs in the dataset. In this context we have visualized the data and then compared with the modelling which in turns compared was quite similar.

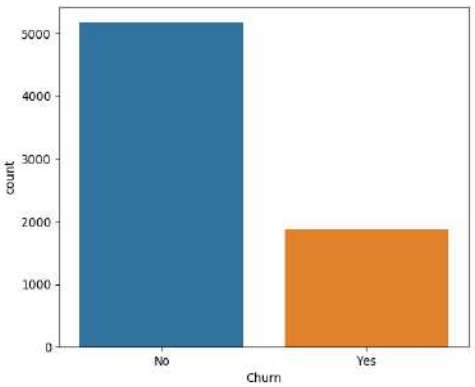
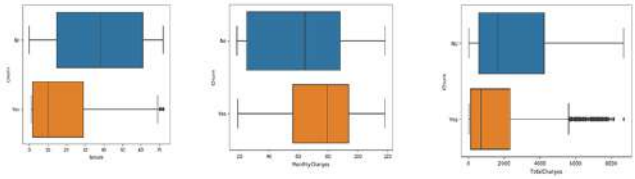


Figure: 1.1. Churn Rate

1.2: Visualization of Quantitative variables:

Churn vs Tenure **Monthly charges vs Total Charges vs churn**



More tenure then churn less **Monthly charges are higher for** **Total charges are low for the customers who have churned.** **Customers who have churned.**

Figure: 1.2: Box plot for Quantitative Variables

1.3: Churn with contract details: Customers with One Year and Two year contracts tends to Churn a lot lesser than month to month contract.

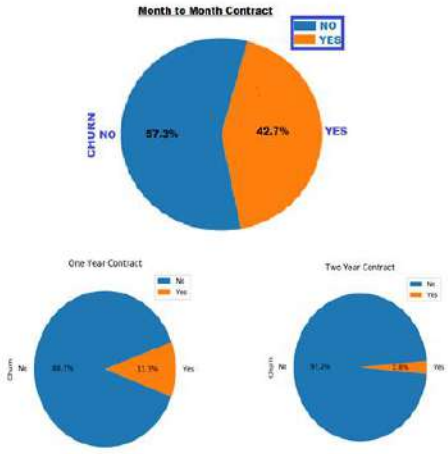


Figure: 1.3. Contract vs Churn

1.4 Churn with connection type details:

Customers with Fibre Optic Connection churn the most whereas least probability

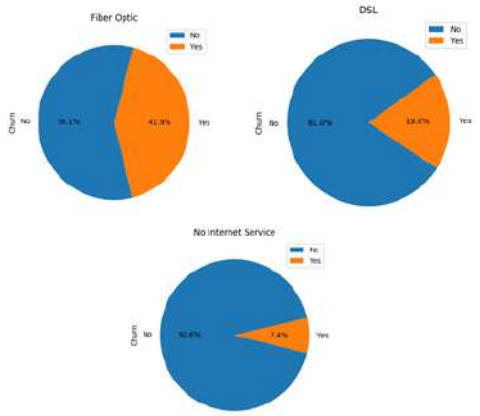


Figure: 1.4. Fibre optic connection vs churn

1.5. Churn with Gender details: There is no effect of Gender on Churn

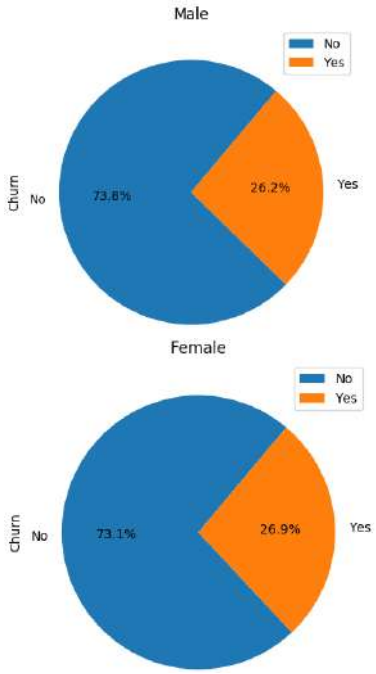


Figure: 1.5. Gender vs Churn

1.6. Churn with Dependency details: Customers with no dependents tend to churn more.

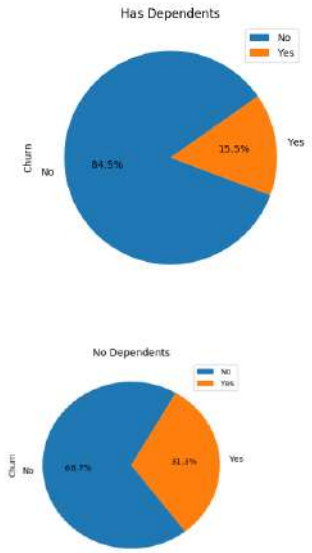


Figure: 1.6. Dependents vs churn

1.7. Churn with Internet Connectivity details: Multiple lines of internet connectivity doesn't affect churn that much.

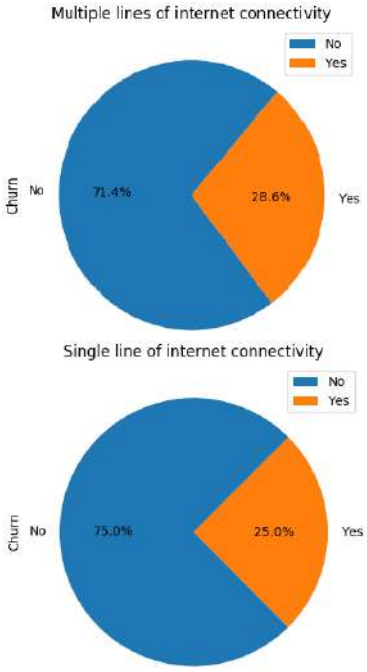


Figure: 1.7.Churn vs Internet Connectivity

1.8. Churn with Online Backup details: Customers opted for Online Backup churn less than who have not opted.

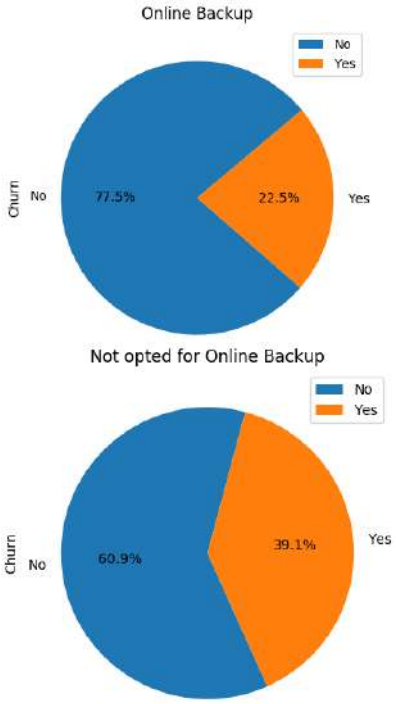
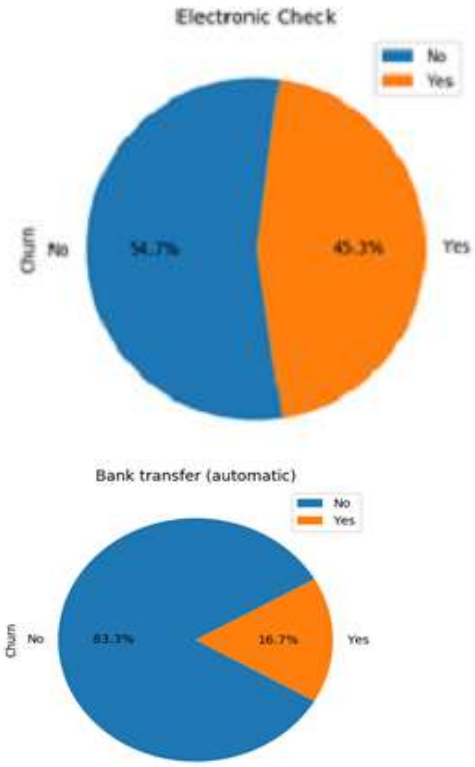


Figure: 1.8. Churn with Online Backup

1.9. Churn with Payment Method details: Customers with Electronic Check tends to churn more than other payment meth**o**d**s**



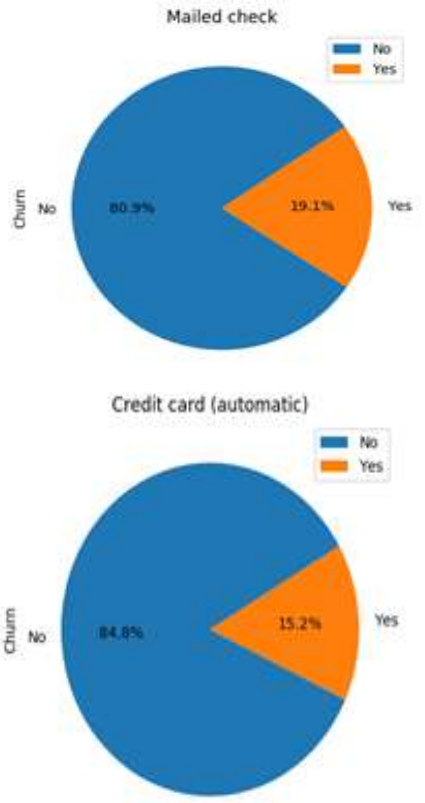


Figure: 1.9. Payment Method vs Churn

1.10. Churn with Online Security details: Customers opted for Online Security churn less than who have not opted.

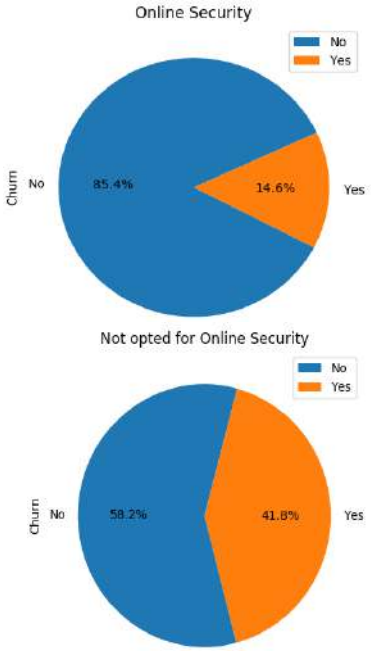


Figure: 1.10. Customers opting online security vs Churn

1.11. Churn with Online Backup details: Customers opted for Online Backup churn less than who have not opted.

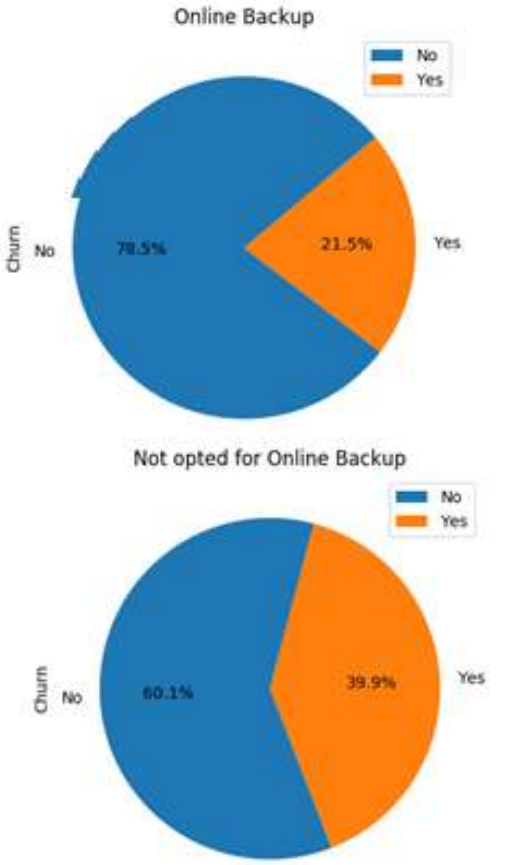


Figure: 1.11. Customers with Online backup vs Churn

1.12. Churn with Relationship details: Single customers churn more

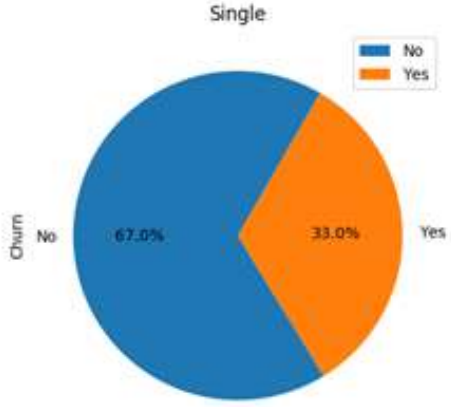


Figure: 1.12. customers relationship status with churn

1.13. Churn with Paperless Billing options details: Churn Rate is higher for the customers who opted for paperless billing

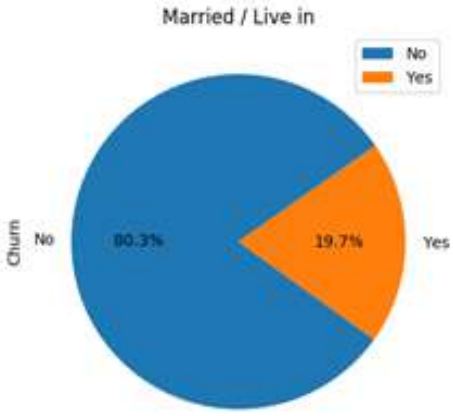


Figure 1.13. Type of billing by Customer vs Churn

1.14. Churn with Phone Service details: Customers who opted for phone service churn more

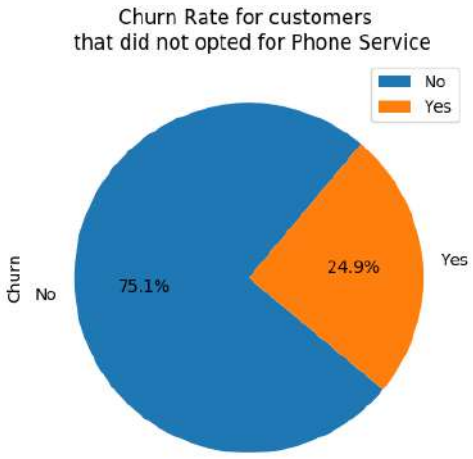


Figure: 1.14. Customers with phone service

1.15. Churn with Senior or Non Senior citizen details: Senior Citizens tends to churn more

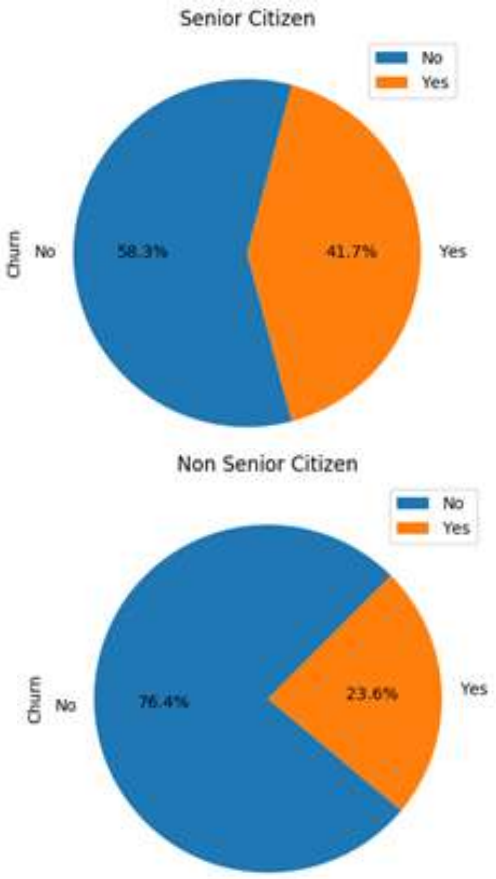


Figure 1.15: Senior or Non Senior citizen vs Churn

1.16. Churn with Streaming movies details: Streaming Movies doesn't make such impact on churning

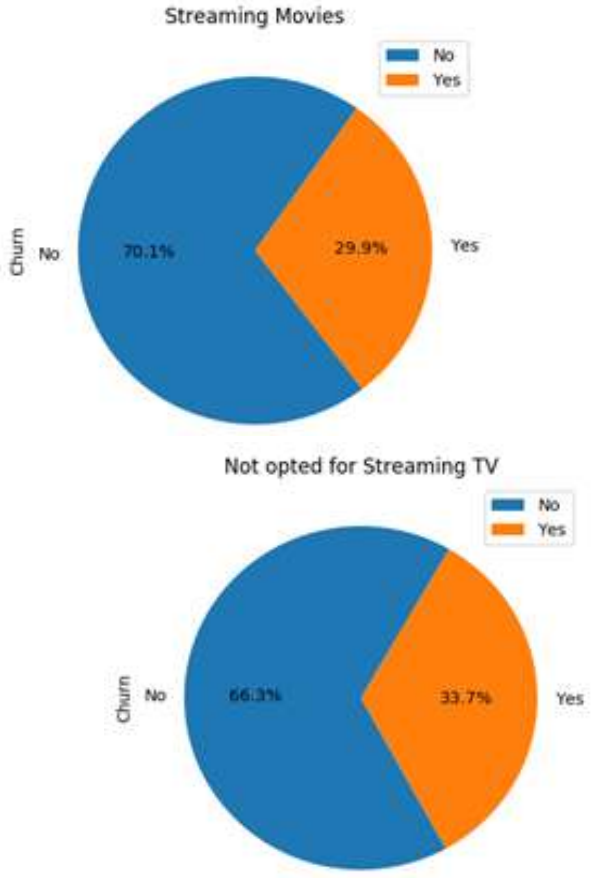


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Figure: 1.16 : Customers streaming movies vs Chur

1.17. Churn with Streaming Tv details: Streaming TV doesn't make such impact on churning.

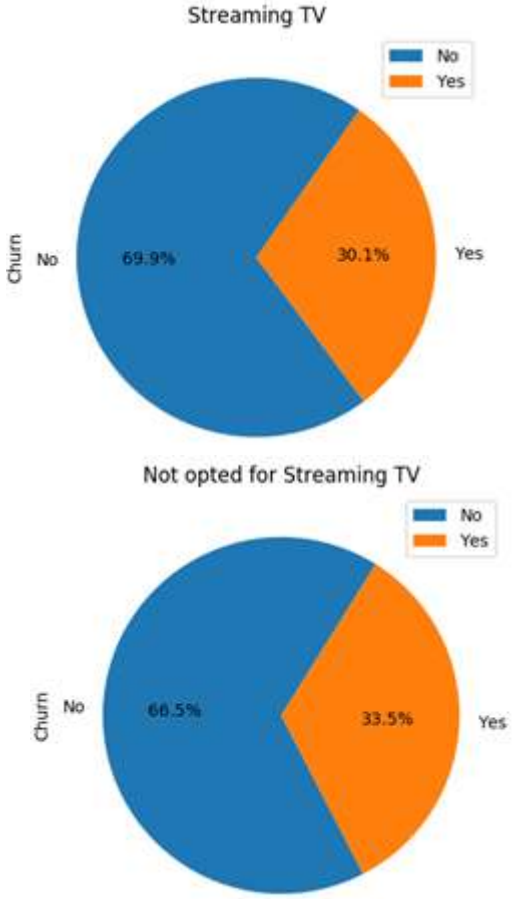

Figure: 1.17 : Customers streaming TV vs Churn

2. Data Analysis and results

2.1 Checking Null values: There were no null values in the dataset

Table: 2.1. Missing values Table:

After analysis of null values checking we did not find any null values. So no null values present in our dataset.

2.2 Variable Mapping:

Sl. No.	CustomerID	Tenure	PhoneService	Contract	Paperless Billing
0	7590-VHVEG	1	0	Month-to-month	1

1	5575-GNVDE	34	1	One year	0
2	3668-QPYBK	2	1	Month-to-month	1
3	7795-CFOCW	45	0	One year	0
4	9237-HQITU	2	1	Month-to-month	1

Table: 2.1. Variable Mapping Table

- **List of variables to map:**
  'PhoneService', 'PaperlessBilling', 'Churn', 'Partner', 'Dependents'.
- **Defining the map function:**
  Here I have defined the binary map function on the variables on the basis of Yes and No

Table: 2.3. Outlier Treatment Table

➢ Checking for outliers in the continuous variables : We have checked all the outliers in all the continuous variables in the dataset. The variables are checked on the basis of the percentiles of 25%,50%,75%,90%,95%,99% numerical parameters.

Creating a dummy variable for some of the categorical variables :

We have created dummy variables for all the categorical variables 'MultipleLines', 'OnlineSecurity','OnlineBackup','DeviceProtection','TechSupport','StreamingTV','StreamingMovies', 'Contract', 'PaymentMethod', 'gender', 'InternetService'

Feature Scaling using Standard scaler:

If data is not normally distributed, this is not the best scaler to use. Variables on which we apply standard scaler are: 'tenure','MonthlyCharges','TotalCharges'.

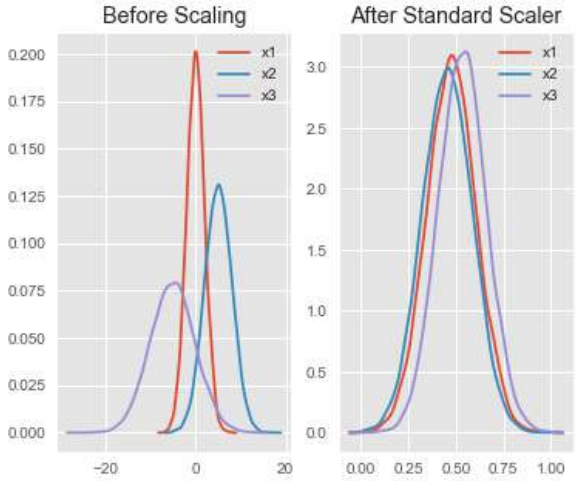

Figure 2.3.1. Standard scalar

The variable Tenure is shown in this figure showing before and after scaling of the variable using Stand Scaler.

Correlation Matrix:

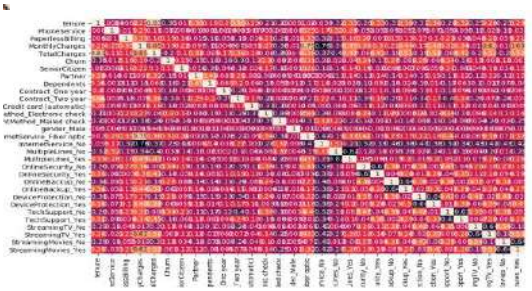

Figure: 2.3.2. Correlation Matrix

Heat map after dropping of some variables:

We have shown another heat map of the matrix after we dropped the redundant variables that were detected from the last heat map correlation matrix. We dropped variables 'MultipleLines_No', 'OnlineSecurity_No', 'OnlineBackup_No', 'DeviceProtection_No', 'TechSupport_No', 'StreamingTV_No', 'StreamingMovies_No' from the test dataset and train dataset and then again shown the heat map of the variables.

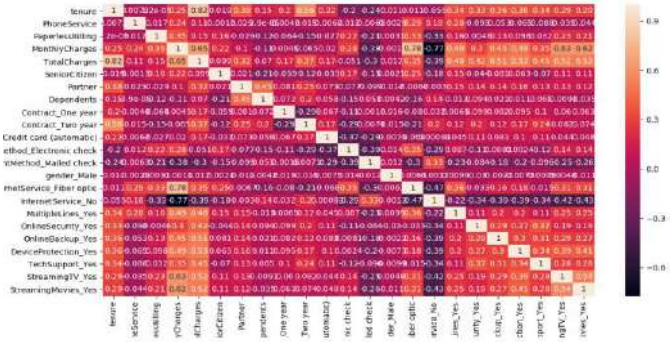

Figure: 2.3.1. Correlation matrix after dropping variables

Model Information :

This is the information gathered from running the GLM model on our dataset.

1	Dep. Variable:	Churn
2	Model:	GLM
3	Model Family:	Binomial
4	Link Function:	logit
5	Method:	IRLS
6	Date:	Tue, 25 Aug

		2020
7	Time:	13:15:22
8	No. Iterations:	7
9	Covariance Type:	nonrobust
10	No. Observations:	4922
11	Df Residuals:	4906
12	Df Model:	15
13	Scale:	1.0000
14	Log-Likelihood:	-2011.8
15	Deviance:	4023.5
16	Pearson chi2:	6.22e+03

Table:. Model Information

Feature Selection using RFE :

We have used Recursive feature elimination function on 13 variables as output

3. Interpretation of results:

Generalized Linear Model Regression Results:
This is our model result on running and fitting our model on our telecom dataset.

Sl. No		coef	std err	z	P>|z|	[0.025	0.975]
1	const	-1.0343	0.171	-6.053	0.000	-1.369	-0.699
2	tenure	-1.5386	0.184	-8.381	0.000	-1.898	-1.179
3	PhoneService	-0.5231	0.161	-3.256	0.001	-0.838	-0.208
4	PaperlessBilling	0.3397	0.090	3.789	0.000	0.164	0.515
5	TotalCharges	0.7116	0.188	3.794	0.000	0.344	1.079
6	SeniorCitizen	0.4294	0.100	4.312	0.000	0.234	0.625
7	Contract_(One year)	-0.6813	0.128	-5.334	0.000	-0.932	-0.431
8	Contract_(Two year)	-1.2680	0.211	-6.011	0.000	-1.681	-0.855
9	PaymentMethod_Credit card (automatic)	-0.3775	0.113	-3.352	0.001	-0.598	-0.157
10	PaymentMethod_Mailed check	-0.3760	0.111	-3.389	0.001	-0.594	-0.159
11	InternetService_Fiber optic	0.7421	0.117	6.317	0.000	0.512	0.972
12	InternetService_No	-0.9385	0.166	-5.650	0.000	-1.264	-0.613
13	MultipleLines_Yes	0.2086	0.096	2.181	0.029	0.021	0.396
14	OnlineSecurity_Yes	-0.4049	0.102	-3.968	0.000	-0.605	-0.205
15	TechSupport_Yes	-0.3967	0.102	-3.902	0.000	-0.596	-0.197
16	StreamingTV_Yes	0.2747	0.094	2.911	0.004	0.090	0.460

Table: 3.1 GLM results after modelling
Confusion matrix:

Results from the Model:

Overall Sensitivity of our logistic regression model:0.7793317793317793
Accuracy: 0.8082080455099553
Overall Specificity: 0.7639614855570839

Receiver Operating Characteristic Curve:

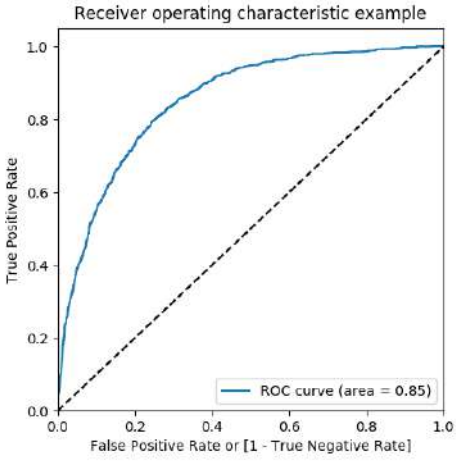

Figure 5.2.3.5. ROC of GLM model on telecom dataset

After training the Model:
Overall accuracy:0.7679804957334417
Sensitivity of the regression model :0.5501165501165501

Precision Score:
0.6598322460391426

Pre

Sl. No.	CustID	Churn	Churn_Prob	final_predicted
1	942	0	0.398978	0
2	3730	1	0.316800	0
3	1761	0	0.004331	0
4	2283	1	0.606035	1
5	1872	0	0.008464	0

The recall is the ratio tp / (tp + fn) where tp is the number of true positives and fn the number of false negatives. The recall is intuitively the ability of the classifier to find all the positive samples.

The last precision and recall values are 1. and 0. respectively and do not have a corresponding threshold. This ensures that the graph starts on the y axis.

Score

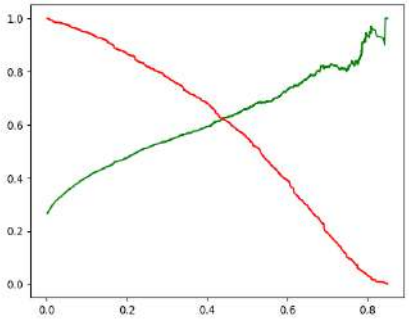

Figure 5.2.3.6. Precision and Recall Threshold Curve

After the modelling on the train dataset then we apply the model on the test dataset and then calculate the accuracy and specificity of the model and predict the churn of the customers based on the predictive model that we have created. The predicted data has been provided with the figure below.

Predicted Head of the Test Data:

Recall Score:
0.5501165501165501

Figure 5.2.3.7. Predicted Churn over test data.

Observation after the modelling on the test dataset:
Sensitivity:
0.6374570446735395
Specificity :0.8370418848167539

Confussion Matrix	
1279	249
211	371

Overall accuracy:
0.7819905213270142

CONCLUSIONS

Through all this observation we can come to a certain conclusion through our results. Here we have performed a churn prediction on market secondary data. Now a company may use a huge amount of data with many more parameters to be taken into consideration. Now with more parameters coming into the scenario we may see the model may change its accuracy and specificity after training and then after testing the model over the test data we may see a different accuracy value after checking the precision and recall values. The more number of data and more number of parameters being taken into consideration we may find better results. Here the data is secondary data, now if we use primary data by collecting information through questionnaires then the data thus collected may give more variations. Maybe, the data collected can give us a different perspective and we may use a different modelling technique like deep learning which may occur to be more efficient than other machine learning techniques.

RECOMMENDATIONS AND LIMITATIONS

1. Guidelines for the implementation based on conclusions:

Here we have applied a machine learning algorithm to predict churn in a telecommunication market data. Now if we need to compare the results with other machine learning algorithms like decision tree, random forest, svm or using deep learning then we can provide a different conclusion based on the result and can also observe which machine learning algorithm is best suited for this type of the dataset.

Inference & Limitation:

From **modelling** perspective, we observed:

- The accuracy of the model is 78% after testing the data.
- We have considered 20 parameters in this modelling, so the accuracy may depend if more parameters are added.
- The data is secondary data, so the modelling can change in case of primary data.

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A STUDY ON FINDING THE MOST EFFECTIVE SOCIAL MEDIA PLATFORM FOR E-RECRUITMENT PROCESS

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Abstract: ***According to Edwin Flippo recruitment is the process of searching the candidates for employment and inspiring them to apply for jobs in the organisation. Recruitment is the process which creates linkage between employers and the job seekers. This paper focuses on the effectiveness of social media usage on e-recruitment process. As both the job seekers and the recruiters are looking for a platform which creates a connecting link between them. This paper focuses on how social media is using by recruiters for recruitment process. Recruiters are using social networking sites for connecting with the hard working candidates to ease out the process.***

This paper includes the research conducted on the recruitment process which held throughout the social media networking sites. In the research paper we have taken only Naukri, LinkedIn, Twitter, indeed because other social media sites were not giving relevant results. After collecting data from various social media websites, Statistical Package for the Social Science (SPSS) & Friedman Test was applied to find out the effectiveness of social media usage for e-recruitment.

Keywords: E-recruitment process, Social Networking sites, recruitment through Social Media, LinkedIn recruitment, Twitter recruitment, Indeed recruitment, Naukri recruitment.

I.INTRODUCTION

With the improved and advanced technology, social media plays a vital role in communication among peoples It engages various communities and build the true relationship among them (Narvey 2009). Some examples of social media include Facebook, LinkedIn, Twitter, Indeed, Naukri. There are large differences between the sites but the basic concept, which is networking through social contacts (Smith 2010). LinkedIn and Twitter have features to represent themselves as a recruiting tool because they both have job posting features for recruiters and job search options for job seekers. LinkedIn and Twitter are more popular among young generation, so recruiters who use Twitter and LinkedIn for recruitment have higher chance of reaching to young professionals in the workplace (Schroeder 2010). LinkedIn is specially used for business and networking reasons and can be described as digital contact book (Bulik 2008).

With the advancement of technologies, both recruiters and job seekers are using these social media platforms such as Facebook, LinkedIn, Naukri, Twitter to find jobs, hidden talents and to communicate with potential recruiters of the company (Maldia 2011).

E-recruitment is also called as online recruitment which means using of web based technologies for various

processes of attaching, accessing, selecting, recruiting and on-board job candidates. Through e-recruitment employers can reach to larger number of potential and hardworking candidates. E-recruitment process is now a trend within the recruitment process and it has been adopted by many large and tiny organisations because the role of Human Resource Manager is changing day by day.

Elements:

- **Job boards:** website used by the recruiters to advertise their jobs.
- **E-testing:** Some relevant online evolution of candidates.
- **Social media:** Quick reach staunch potential candidates.

E-recruitment includes similar steps like normal recruitment process. Some important e-recruitment steps are -

I. Post job ads in online job boards.
II. Evaluating by online pre-employment test.
III. Interview candidates using video interviewing software.
IV. Background verification by using a provided that your Application Tracking System (ATS) combine with.

The concept of e-recruitment encircles various recruiting tools, technologies and platforms.

II.NEED FOR THE STUDY

E-recruitment through social media is considered to be fruitful because it saves time, effort and moreover it can confirm that suitable person is hired/appointed for a selected position. Therefore, the most important motive of our study is to compare the effectiveness of different social media platforms in e-recruitment.

III.OBJECTIVES

I. To find out the effectivity of e-recruitment through social media.
II. Compare the effectiveness of different social media platforms in e-recruitment.
III. Recommend a way for future managers how to attract good candidature.

IV.SCOPE OF THE STUDY

The scope of the study is to emerge the e-recruitment process acquired by the corporate through different social media platforms.

V.SURVEY OF LITERATURE

- **Social Media (SM)**

"Social media is a web-based technology that it eases the dividing of ideas thoughts and knowledge through the creating of virtual networks and communities. By design, social media is internet based and provides users quick transmission content. Content includes personal documents, videos and photos. Users engage which social media via computer, tablet or Smartphone via an internet based software or web applications, often using it for messaging" - **BY MAYA E DOLLARHIDE**

Social Networking Sites (SNSs)

A Social Networking Site or social service is a web based platform which individuals use to create social networks or social relationships with people who share similar distinctive or professional interests, activities, backgrounds or real-life connections.

- **Recruitment**

Recruitment is a process of finding the candidates for employment and restorative them to use for jobs within the organization.

The process of locating and appointing the best capable candidate (*from the outside or within an organization*) for an opening of job, in a convenient and worthwhile manner. This process includes scrutinizing the needs of a job position, enchanting employees to that job, screening and selecting applicants, hiring and amalgamating the new employee to the organization.

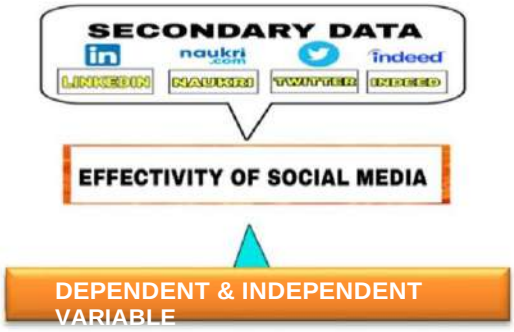
- **E-recruitment**

Online recruitment is known as e-recruitment, this is the procedure of appointing capable candidates for vacant job positions, using the resources of electronics, particularly internet. Usage of internet is so effective to reach a large number of job seekers and appoint the best capable employee for the organization at a reduced cost, as contrasted to the physical recruitment process.

Various social media available in market which are used for e-recruitment:

Naukri, Indeed, LinkedIn, Facebook, Twitter etc.

VI.METHODOLOGY



Data Collection

We have collected all the data through social media like Naukri.com, LinkedIn, Indeed, Facebook, Twitter etc. From the Google search for the period we have collected only the details of these 26 companies as mentioned below -

Reliance Jio	Fortis	Flipkart	Cognizant	Amazon
Vedantu	Muthoot Finance	HDFC	Cipla	PWC
Siemens India	Bharat Matrimony	Walmart	Myntra	Accenture

Period Covered:
The present study covers a period of the time from 2018-2020.

Tools and Techniques:
We have used SPSS (Statistical Package for the Social Science), Friedman's Test and MS Excel as our tools for analysis.

Construct of measurement:
The various variables in the study was optionalized below :

Age	**18-60**
Sex	**Male and Female**

VII.ANALYSIS

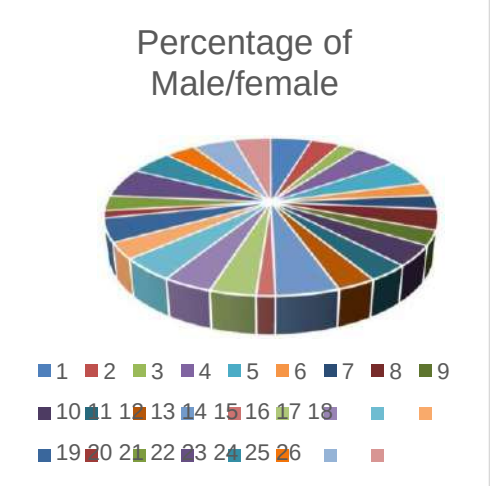
For the above study, we have collected the secondary data and done the analysis in two parts.

a. Descriptive statistics used to describe and summarise date.
b. Freidman test

Descriptive:

	Minimum	Maximum	Mean	Median	Std. Deviation
Naukri % Out of Good CV	8.61	42.55	25.77	25.08	9.11
LinkedIn % Out of Good CV	13.29	58.31	36.11	35.54	9.87
Indeed % Out of Good CV	3.19	32.99	19.32	20.05	8.73
Twitter % Out of Good CV	2.15	28.11	14.03	14.79	5.98
p Value	0.000				
Significance	Significant				

1. **Minimum-** This is the data value that is less than or equal to all other values in our data set. Here we can see that the minimum value of Twitter is 2.15 and the minimum value of LinkedIn is 13.29. Here we can see that the percentage of male and female ratio comes under 1-26.



2. **Maximum-** This is the data value that is greater than or equal to all other values in our set of data**.** Here we can clearly observe that the maximum number of good CVs is in LinkedIn 58.31 and maximum number in twitter is28.11. That means the maximum number of job applicants applies through LinkedIn is more than Twitter.

3. **Mean-** Statistical mean is a measure of central tendency and gives us an idea about where the data seems to cluster around. Here the highest mean value (the data are more spread out) is 36.11 which is the mean value of LinkedIn and lowest mean value (the data are less spread out) is 14.13 which is the value of twitter. As we can see that the highest value of mean is of LinkedIn we can say that the total number of good CVs are more than twitter.

4. **Median-** The median is the value separating the higher half of a data sample, a population, PR a probability distribution, from the lower half. Here the highest median value is 35.54 which is the value of LinkedIn and the lowest value is 14.79 which is the value of Twitter. So LinkedIn received more number of good CVs Than Twitter.

5. **Standard Deviation-** In Statistics, SD is a measure that is used to qualify the amount of variation or dispersion of a set of data values. SD of LinkedIn is highest which is 9.81 and lowest is of twitter which is 5.98.

Friedman Test:

	Minimum	Maximum	Mean	Median	Std. Deviation
Naukri % Out of Total CV	0.25	20.00	5.95	5.19	4.84
LinkedIn % Out of Total CV	0.19	28.37	8.28	7.37	6.72
Indeed % Out of Total CV	0.09	21.28	4.76	3.42	5.06
Twitter % Out of Total CV	0.13	14.18	3.04	2.35	3.09
p Value	0.000				
Significance	Significant				

Friedman Test is a non-parametric alternative to Anova with repeated measures. We used Friedman Test because we have attempt to compare with multiple variables, but our data set does not have standard deviation to compare with variables. Here we can see that the mean deviation of LinkedIn is Highest which is 8.28 and the 2nd list is 0f Naukri is 5.95. Then followed by Indeed and twitter 4.76 and 3.04 respectively. So, CVs collected from LinkedIn are more in number then the other social sites and Twitter comes at the end.

VIII.FINDINGS

With the help of this analysis, the findings of the project are as follows:

1. There is a positive relationship between the CVs collect from the social sites with the variables. The research establishes that social sites does help in recruitment process as the p values of variables is 0.000 and it signifies the relationship.

2. On the average good CVs obtained from LinkedIn which is significantly higher than Naukri/Indeed and Twitter. LinkedIn is the most effective followed by Naukri and Indeed. And we have noticed that Twitter is least effective.
3. In future it can be use more in the recruitment process, as recruitment via social sites gives recruiter to collect a proper database of good CVs for current and future use.

IX.SUGGESTION

E-Recruitment process depends on social media. The company can give more job offers to the employees through different website of social media and the employees can easily apply to their desired level of companies and the recruiter can increase the information about the job vacancy and position about their companies to the employees. The job sites are very trustworthy to the employees. The job seekers can always update their resumes and CVs to the website and they can also update themselves to the website properly. The personal information of the employee should not show to the others by the job sites. The company can give internet service to take the edge off the charge and cost of internet connection to the employee's. These things can take the selection process of the company to the advanced level.

X.LIMITATION

- Every employee has different types of opinions, so it is difficult to understand their opinions and a miscommunication can be created in an organization.

- The recruiter cannot understand the situation where employees honestly answer all the questions without any anxiety.

- We were not able to collect a huge amount of data in our research due to lack of time.

- We have taken only Naukri, LinkedIn, twitter, indeed because other social media sites were not giving relevant data.

- E –recruitment is a technological based process. In an organization, HR may not have the high- tech knowledge to select any candidate for a particular job position.

XI.CONCLUSION

With the above analysis we have concluded that now a day's social media has a great impact in the recruitment process of companies. We have also seen that if we implement this process in future for recruitment process it will be beneficial for the companies and will be a time saviour. From our analysis, we can conclude that LinkedIn is the more effective website and twitter is least effective website of social media for E-recruitment process

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Assessment & Management of Language and Technology Literacy Barriers to accessing E-learning Services in India

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Abstract

Proficient assessment of language and technology literacy barriers to accessing E-learning services has been a topic of interest for the last two decades. Especially in the context of a multi-lingual country like India, these issues must be researched well for better service delivery. Cost-effective and readily accessible technology and electronic devices have broadened the scope of facilities for the citizens of India. Several parameters like socio-economic conditions, economic status, and access to internet facilities have been considered to analyze the data. Lack of understanding of foreign language and technology create differences among the students and misconceptions. National Education Policy, 2020 has focused to mend the language and technology literacy barrier between students and educators by popularizing language education. Students and teachers can access information from digital libraries. The Indian government is trying to popularize coding in the course curriculum of primary and secondary education.

The paper intends to explain how language and technology literacy are creating obstacles for students and teachers in India. The paper presents research aimed at overcoming obstruction to citizens' capability to access the e-learning services. Implication of Natural language processing (NLP) advancements in other languages has become pertinent as technology benefits non-English speaking communities and businesses can develop localized applications to reach customers in their preferred languages. Although educational applications are unable to reach up to the expectations of the students, teachers, and parents, it has been observed that many mobile applications have become popular as a learning medium.

Key Words

Natural language processing (NLP)

STEM (Science, technology, engineering, and mathematics) Learning

Artificial intelligence (AI)

National Educational Technology Forum (NETF)

Educational technology (EdTech)

New Education Policy 2020 (NEP 2020)

Introduction

A. Background of the study

The profound implications of language and technology literacy barriers in E-learning services have been analyzed in this study. `Digital India' campaign, initiated by the Government of India is a leading example for other developing countries. Several educational mobile applications have become very much popular among the millennial in this 21st century. This study outlines the potential of e-learning facilities in the Indian subcontinent and delineates language and technology literacy as barriers in the path of success.

Socio-cultural background, level of technical understanding, literacy, and language are certain ‘non-connectivity' barriers to electronic service delivery to the education sector. The EdTech startups are fostering an ecosystem of regional languages in India.

B. Overview of learning apps and its applicability through Natural language Processor (NLP)

EdTech startups like WhiteHat Jr, Pesto, Playshifu, Class plus and many more have seen in the surge in the number of users and subscribers during the COVID situation. As students, as well as teachers, unable to get to the academic institutions, they prefer to look out for better alternatives and start to learn using these EdTech applications. It has been observed that formerly EdTech startups focused on implementing innovations in learning techniques.

C. Barriers to access E-learning Services in India

From several Government initiatives, it can be understood that the Government of India is trying to bring all the students and teacher under the e-learning program. But there are certain constraints which are responsible for lowering the E-learning opportunities in regional languages [1].

Digital Illiteracy

A large number of rural populations in India are unaware of the internet and its usage. Additionally, rural population falls short of the infrastructural facilities. There are certain rural areas where the unstable flow of electricity and internet bandwidth are not enough to avail the services over the gadgets [2].

Cost to access data over proper devices

It is not always possible for the individuals who reside in village areas to make a usual investment towards initial development and purchase of E-learning products [3]. Unavailability of appropriate gadgets like laptops, computers and mobiles generate hindrances to avail digital content. Most of the parents of the children are not capable to bare the internet and other costs. Moreover, the phone screens are not big enough for teaching and learning in a classroom.

Insufficient skills

Educators and teachers across rural areas are not provided with proper training to operate over digital platforms. Inadequate technical know-how is an essential factor that discourages the teachers to practice online learning and teaching through digital platforms [4].

Language barrier

According to the Census report of 2011, India has more than 19,000 dialects which are spoken by over 96 % of the population and have 23 official languages including English. Still, India denotes the position of second highest internet user base across the globe [5].

Gender inequalities

As per the reports, most of the female populations are unable to gain access to learning after a certain age.

Females are more encouraged to stay in the house and do household routine jobs [6].

I. Research objective

To review language and technology literacy barriers to accessing E-learning Services in India

To comprehend ways of managing of language and technology literacy barriers through technology-based interventions

To understand ways to mend the existing gaps between physical learning and E-learning through artificial intelligence (AI)

II. Literature Review

Digitalization, globalization and technological advancement have reshaped the conventional methods of teaching and studying across the globe. India has also become an essential part of global educational culture and the emergence of the internet has enabled the citizens to become digitally literate. Presently online-teaching and learning have become the new mode of education and several startups have emerged to provide e-Learning services to the learners. But lack of technological understanding and operating language has digitally divided the learners by generating barriers.

Evolution of Educational startups

When EdTech startups came into the market, they formerly targeted the segment of students who belonged to upper economic classes and studied in English medium schools. Moreover, the startups were more concerned with setting up of technologically advanced virtual learning ecosystems [6].

Apart from this textual content, children were facilitated with assisted learning tools so that they can learn coding, robotics and basic AI. Learning applications has been offering the students key opportunities to enhance their analytical and problem-solving skills through STEM learning. In the year 2019, the COVID situation made the government stop the convention way of teaching in the classrooms. Rather schools and colleges focused to continue the classes over the virtual medium [7].

EdTech startups took this as an opportunity to expand their market among the masses by providing continuous education and meeting the requisite demands. Bur language divide and technology literacy intervene in the digital expansion of E-learning services in India. India is a multi-lingual nation of vivid traditions, cultures, and heritage.

As per the study by Google and KPMG, it has been found that the English internet user base has 2.5 to 3% growth compared to the Indian language internet user base. It has been found that at a CAGR of 18% Indian language internet user base is growing [8].

In contrast, there are reports states that Hindi internet users along with Bengali and Marathi being the other two Indian regional languages are going to outgrow the English internet user base by the end of 2021. Also, it has been predicted in the report that more than 70% of active internet users of India are going to exceed the English internet users [9].

Adoption of AI in E-learning services in India

There are various challenges in terms of AI in learning that are also recognized by the MHRD. Based on innovation, emergent technologies have been categorized into potential and estimated timeframe for disruption. Widespread use of Artificial Intelligence (“**AI**”) requires general awareness among the citizens including the educators. Moreover, issues like data breaching and data security are major concerns that must be handled properly while adopting AI across the educational domain.

But still, there were several potential e-learning barriers identified which seeks to pay much-needed attention as e-learning can raise the level of

education, literacy and economic development. In bits and pieces, steps were taken across India to combat barriers in e-learning [11].

One of the problems with e-learning in India is the lack of course content, especially outside the mainstream focus areas of IT education, English-language content and tutorial-like courses. There will be a high demand for people who can develop multi-lingual courseware that addresses various topics [12]. The social implications of online learning centre around one primary requirement that students need to feel a part of the class, regardless of where they are located physically or geographically. If there is a problem in appointing regional teacher for them another alternative is to go for NLP which can be effective for both student and teacher's welfare [13]. Technical support is indispensable both for the teachers and students. For teachers, technical support is needed to ensure that teacher has the resources and skills necessary for technology-integration into the class practices. For students, technical support helps in the acquisition of knowledge and skills necessary to fulfil their unique curriculum requirements [14].

Natural language processing (NLP) in E-learning

NLP refers to the evolving set of computer and AI-based technologies that allow computers to learn, understand, and produce content in human languages. The technology works closely with speech recognition and text recognition engines [15]. While text/character recognition and speech/voice recognition allows computers to input the information, NLP allows making sense of this information [16]. NLP-based systems are augmenting both human-human communication (e.g., with language translation) as well as human-machine communication (e.g., virtual assistants). This is because the model can understand the semantics – the grammatical structure and rules of the language along with the context – the general understanding of words in different contexts [18]. There is a dire need for NLP advancements in other languages to ensure that the technology benefits non-English speaking communities and businesses can develop localized applications to reach customers in their preferred languages.

Digital India

The National Education Policy, 2020 has put grave importance over the strengthening of digital infrastructure and the good amount has been invested towards the sustainable development of online teaching platforms. The policy has encouraged the EdTech startups to set up virtual labs and digital libraries for students.

Additionally, educators have been provided with training so that standard quality contents are created over the virtual medium and more number of students will be able to gain knowledge through online teaching and learning methods. Online teaching-learning and assessments in regional languages are envisaged to redesign the meaning of pedagogy across the Indian states.

Several telecom operators and service providers are providing data service at cost-effective data packages to contain both teachers and students in online classes. It is recommended that telecom companies can subsidize data plans for learning purpose mending the existing gap between physical and E-learners.

Equitable multi-mode access to education can be provided to the children through an initiative called PM eVidya-started since the last year 2020. GOI has taken initiatives regarding online learning and established DIKSHA (Digital Infrastructure for Knowledge Sharing) that was launched in September 2017. GOI has mentioned in the report that the development of quality e-content in local languages as a long-term learning strategy.

Technology embedded learning services will help differently-able children to get greater access to learning through online mode. There is a pre-requisite of online teacher-training for the educators and academicians. In professional and higher education incorporation of standard-quality technology-based learning has been proven to be beneficial for the students. Incorporation of education and technology has been applied in various professional fields like medical science, engineering, architecture etc.

It is mentioned in the policy that the National Educational Technology Forum (“NETF") will widen the chances for the students of the school and higher education to exchange knowledge on training and assessment on the online platform. Four major entities of education sector in India (Higher Education Grants Council, National Accreditation Council, National Higher Education Regulatory Council, and the General Education Council) have put a strong focus on the implication of language and technology literacy in the education sector.

Ministry of Human Resource Development had released the National Education Policy, 2020 that had been revolutionized in terms of policy generation. Multiple aspects of academics including early childhood care and current curriculum of primary school education, professional and higher education, research and development have been revamped. India has reshaped itself into an 'information-intensive society' by embedding technology in the educational framework. It is believed that the National Education Policy, 2020 will be an important stepping stone towards extensive usage of technology in learning and teaching. Pandemic circumstances have broadened the scopes of virtual learning while replacing conventional classroom-based learning and teaching practices.

Significance of regional language in online learning

It has been found in several studies that students and teachers are more comfortable in exchanging knowledge in regional languages. Convenient data packs by the service providers have enabled many schools to provide remote access to learning through virtual classrooms. Besides technological aspects, availability of study materials in regional languages will be helpful for the students to boost up their learning experiences. More than 82% of Indian speaks in other languages than English. Lack of availability of standardized content in official language- Hindi and other regional languages have lowered the rate of digital learning adoption. Starting from nursery class to higher-doctorate level-standard material in regional languages across the states is not available.

III. Methodology

The deductive approach will be adopted in this study. Therefore, a hypothesis has been built and tested by both primary and secondary data. Primary data was collected through questionnaires, telephonic interviews and the secondary data was collected from internet resources, published articles and conference papers. The Non-Probability sampling method was used to identify barriers to using E-Learning.

Overview of Participants

The actual study consisted of 100 respondents, of whom 58% were female and 42% were male. Their ages ranged from 11 to over 40 years, with 4% being between 11 and 18 years of age; 44% aged between 18 and 25 years, 27% aged between 25 and 32 years, 11% aged between 33 and 40 years and 14% above 40 years of age. Of those who participated, 37% believed that India being a multilingual country but the learning apps offer services in a few native languages in India is one of the barriers in e-learning.

Research Method

Qualitative method

To conduct qualitative research method, prevalent conventional learning and opinions are considered while analyzing the data. Small numbers of respondents have been asked for providing open-ended responses in the form of interviews, surveys, and observations. Contextual and descriptive responses are studied to understand their motive.

Quantitative method

This method is particularly useful when a large number of sample size is taken for the study. Incidence of their views is measured through data validation tools. In this study, a set of the questionnaire has been prepared to survey 100 respondents.

Size

Total of 100 respondents from different psychographic, demographic and geographic segments was considered for this survey. Non-Probability sampling method has been considered in this study where random sampling practice is not abused.

Data collection

To analyze the information, primary and secondary data has been collected from 100 respondents.

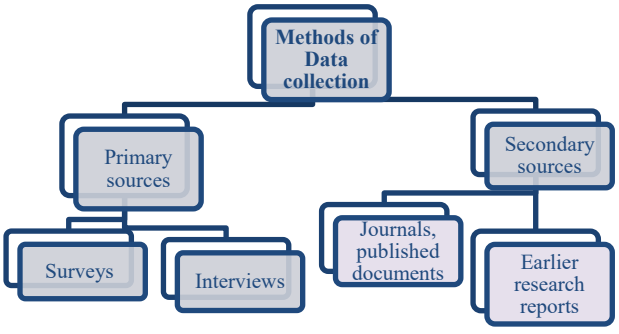


Figure: Methods of Data collection

A semi-structured validated survey questionnaire (8 closed-ended and 10 open-ended questions including feedback) has been prepared for gaining perception of individuals from various fields and domain about language and technology literacy barriers to accessing e-learning services in India. Total of 100 respondents was from different psychographic, demographic and geographic segments.

Data analysis

It was observed that most respondents suggested digital education in various regional languages will be more advantageous for the citizens of India. Quantitative survey-based data has been collected and evaluated from the graphs.

The demographic, geographic, psychographic details of the respondents are given below:

1. **Gender**

Respondents	Variable	Percentage(%)
Male	42	42
Female	58	58

2. **Age Group**

Respondents	Variable	Percentage (%)
11-18	4	4
19-25	44	44
26-32	27	27
33-40	11	11
Above 40	14	14

3. **Education level**

Respondents	Variable	Percentage (%)
Below 10	2	2

Class 10	3	3
Class 12	23	23
Under Graduation	42	42
Post-Graduation	29	29
Doctorate	0	0
Post-doctorate	1	1

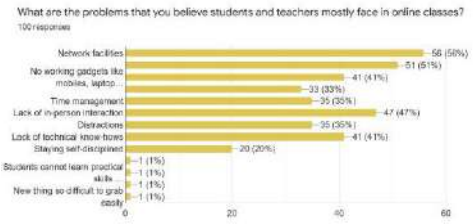
4. Mother Tongue

Respondents	Variable	Percentage (%)
Hindi	27	27
Bengali	74	74
English	0	0
Others	2	2

5. Place

Respondents	Variable	Percentage (%)
Kolkata	28	28
Howrah	49	49
Bihar	3	3
Other areas of West Bengal	12	12
Others	8	8

6. What are the problems that you believe students and teachers mostly face in online classes?



According to the chart 56%, people face network issue in their way of education, well this breaks the momentum of concentration on studies, while this barrier can be taken care of by the management department by giving access to the recorded class in case of network issue.

It is found that for 41% of the respondents one of the concern barriers for e-learning is Highlighting India's digital divide, poor connectivity and lack of smart gadgets is proving a hassle for many students. 47% of people find that learning isn't just an intellectual activity, but a social one – and that explains why several people feel that in-person interaction with their instructors is missing in online classes.

7. Have you come across someone who couldn't excel due to these barriers?

Respondents	Variable	Percentage (%)
Yes	43	43
No	12	12
May be	45	45

8. India is a multi-lingual country. But learning apps offer services in a few native languages in India. Do you think, it is creating problems for Indian students?

Respondents	Variable	Percentage (%)
Yes	37	37
No	12	12
May be	49	49

9. Do you think education management team should appoint regional language teachers of the core subjects that can help out students to have an in-depth better understanding of the subjects to build a base?

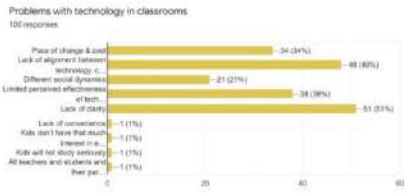
Respondents	Variable	Percentage (%)
Yes	51	51
No	7	7
May be	42	42

10. **Natural language processing (NLP) is a subfield of linguistics and artificial intelligence concerned with the interactions between computers and human language'. Do you think, NLP is an effective way to solve these problems?**

Respondents	Variable	Percentage (%)
Yes	37	37
No	9	9
May be	54	54

According to the chart, 37% of respondents believe that NLP that has enabled machines to understand and process human language and can be an effective way to minimize the barriers in e-learning, whereas 54% of the respondents were not aware of the concept of NLP.

11. **Problems with technology in classrooms**



The given chart depicts that 48 % of respondents support the fact that a lack of alignment between technology, curriculum, and instruction is one of the problems with technology in classrooms. And 51% of respondents believe that lack of clarity in technology stands as a barrier in the e-learning process.

IV. Conclusion

In conclusion, this paper is aimed to assess and manage the language literacy and technological interventions of E-learning services in India. Specifically, the hindrances that are created by 'non-connectivity' elements including socio-cultural background, level of technological skill, language, and literacy to online educational service have been investigated and solutions researched in the Indian context. Government initiatives including the recent National Education Policy 2020 support the technological development of the educational system. Another initiative, Digital India has set up a collaborative framework for the digital service providers such that data has become cost-effective in the rural areas.

An efficient and holistic ecosystem for e-learning must be set up so that more number of students and teachers can efficiently practice E-learning exclusive of further interventions. It can be comprehended from this study that personalized service delivery must be taken into account keeping in mind the distinctive conditions of each individual. Thus everyone will have equal access to E-learning services in the Indian context.

V. Recommendations

This research paper is aimed at overcoming language and technological intervention in the E-learning services in the Indian context. India is a multi-lingual developing nation. A promising necessity exists in terms of embracing regional languages and the usage of technology in the field of teaching and learning. It can be understood from the study that pandemic

situation of over the past few months has replaced in-person learning and embraced virtual learning as an efficient mode of education at home. This situation has induced new-edge online learning facilities across the globe. In this research, a major concern is to assess the barriers created by language and technology and analyze the managing of these constraints through artificial intelligence.

The revolutionary National Education Policy-2020 is considered as an ideal framework towards enhancing the learning opportunities for India. The new education policy-2020 has envisaged the scope of digitalization by ensuring the development of digital infrastructure across the states. Proper management and assessment of e-education needs of the children and educators is an essential part to sustain the uprising digital growth.

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A study on co-integrating relationship between inflation and its determinants in India

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Abstract—

*In the global economic forum, India has been always at the highlight due to its changing inflation patterns. In fact, the inflation rate in India during the fiscal year 2007-2008 was so alarming that, even though India had experienced an average growth rate of more than 9%, the global financial crunch squeezed the economy so hard that a few sectors experienced a slump. Though a number of research studies could be found related to inflation and its determinants in case of the European and Asian economies, but, in context of India, not many studies can be found in the literature. Against this backdrop, this paper seeks to empirically analyze some of the major determinants of inflation in India, by considering the newly constructed three Consumer Price Indices (CPI) inflation and a set of macroeconomic variables, namely, Gross Domestic Product (GDP), Index of Industrial Production (IIP), Broad Money (M3), Narrow Money (M1), Export (EXP), Import (IMP), Oil Export (Oil EXP), Oil Imports (Oil IMP), Gross Fiscal Deficit (GFD), and Foreign Exchange Reserves (FOREX). Time series data has been analyzed using ADF Unit root test, Granger Causality test, and Johansen Cointegration Test and Vector Error Correction Model. It was also found that CPI (Rural) is found to have bidirectional granger causality with the three macro variables i.e. IIP, Export and Import. Besides, CPI (Combined) is found to make short-run adjustment with changes in GDP, IIP, M3, Oil Imports and Oil Export products. GDP and IIP, no doubt, are used as measure of economic growth of a country by most of the researchers. The short-run relationship is supported by researchers like Patnaik (2010; p-*118-129*), and Sehrawat and Giri (2015*; pp.1-08*).*

Keywords: Forex, GDP, GFD, Indian Economy, IIP, M1, M3, Macroeconomics

I. Introduction (*Heading 1*)

The study regarding inflation would remain incomplete without analyzing the impact of inflation on macro-economic variables. The impact of inflation on growth, output and productivity has been one of the main issues examined in macroeconomics. Following Friedman's (1977) Nobel Lecture the empirical research on the relationship between inflation and macro variables has two distinct approaches .The first approach of research starting with Friedman's hypothesis that higher nominal inflation raises inflation uncertainty, has tended to investigate the relationships among inflation, inflation uncertainty, growth and growth uncertainty. The second approach tends to focus on the traditional macroeconomics and investigate the relationship between inflation and macro variables without reference to inflation uncertainty.

Many studies have taken place during the last three decades studying the link between money, output and inflation specially in developing economies. Sharma (1984; p-19) checked for causality between price level, M1 and M2 for the period 1962-1980 and found bidirectional causality between M1 and price level and M2 and price level. Nachane and Nadkarni (1985; p-13) found unidirectional causality from money stock to prices but the result had been inconclusive for money supply affecting real output. Lim and Papi (1997; p-1 − 32) in their study to identify the determinants of inflation in Turkey concluded that money, wages, prices of exports and prices of imports have positive influence on domestic price level whereas exchange rate has been found to have inverse effect on the domestic price level in Turkey. Ramachandran (2004; p-983-1001)'s study taking data from 1951to 2001, found an overall long term relationship between money, income and prices. Das (2003; p-35:10) working with money, price, and output of India over the period from April 1992 to March 2000 shows a negative relationship between price and output.

Accordingly, the following objective has been framed : To investigate causality and cointegrating relationship among inflation rate measured by CPI with ten macro-economic variables, namely GDP, IIP , M1,M3 , Export , Import, Oil Export, Oil Imports, Gross Fiscal Deficit , and Foreign Exchange Reserves .

II. Literature Review

The studies relating to Indian conditions have been discussed subsequently. Malhotra and Krishna (2015) attempted to understand the linkage between crude oil prices and two major macroeconomic variables i.e. inflation and interest rates, in India. A dynamic conditional correlation - GARCH (DCCGARCH) had been applied for analyzing monthly data of WPI, Oil prices and Repo rate for the period 2004-2014. The results from DCC-GARCH showed that the correlation between WPI and international crude oil prices remained positive and close to one for majority of period except during the subprime mortgage crisis of 2007-09 when these two became negatively correlated. The results from DCC-GARCH also suggested that global crude oil prices had significant effect on inflation, but no direct effect on interest rates. However, results from Granger Causality Test indicated that oil prices would be able to affect interest rates at appropriate lag levels. Saxena and Singh (2015; p-1-15) attempted to study the impact of selected macroeconomic variables on inflation in India. The paper considered CPI (Consumer Price Index) inflation as dependent variable and a set of independent macroeconomic variables like Gross Domestic Product, Money Supply, Deposit Rate, Prime Lending Rate, Exchange Rate, Trade Volume (Value of Imports and Exports) and Crude Oil Prices. The empirical analysis covered the quarterly data series for ten financial years from 2002Q1 to 2012Q1, and was analyzed using ADF Unit root test, Granger Causality test, and the Ordinary Least Square (OLS) technique. The results showed that the selected independent variables had significant impact on CPI. However, it was also

found that there were some other significant variables which might influence the variations in dependent variable. Thus, the study concluded with the note that though the identified independent variables had significant impact on the inflation; there were some other variables which might have impact on inflation. Singh, Das, and Baig (2015; p-497) stated that as the dynamics of the monetary system in India had been undergoing significant changes since long time, therefore in this context, the study investigated the causal relationship between money, output and prices for the post liberalization period in India. The Johansen test for Cointegration and Granger causality test were performed to test the relationship. The empirical finding indicates that the choice of variable was relevant in the understanding of relationship between money, output and prices. Narrow Money (M1) was found to be a better policy variable than reserve money (M0) or Broad Money (M3). It concluded that monetary variables had a causal relationship with prices. It also found that food prices were having a causal relationship with monthly growth in base money. Mohaddes and Raissi (2014; p-14/222) examined the long-run relationship between consumer price index industrial workers (CPI-IW) inflation and GDP growth in India. This study was based on a annual data of 14 Indian states over the period 1989–2013, and used the crosssectionally augmented distributed lag (CS-DL) approach of Chudik, Mohaddes, Pesaran, and Raissi (2013; p-13.23) as well as the standard panel ARDL method for estimation - to account for cross-state heterogeneity and dependence, dynamics and feedback effects. The study empirically tested the existence of a threshold level of inflation beyond which growth is severely undermined. The results indicated that the negative growth effects of inflation were more pronounced above an inflation threshold of about 5.5 percent. It found that inflation in India was a result of a number of factors, including: supply-driven food inflation feeding quickly into wages and core inflation; entrenched inflation expectations; binding sector-specific supply constraints (particularly in agriculture, energy, and transportation); and ongoing fuel prices increases. Saxena and Bhadauriya (2013; p-4-12.) attempted to shed some light on the determinants of inflation in India during April 2001-March 2011, and to estimate a more specific relationship between inflation and its determinants using Johansen Co-integration and Vector Error Correction Model (VECM). The Johansen Co-integration test applied on selected data indicated four long run equilibrium relationships for inflation with its determinants. The results of VECM indicated a positive relationship between GDP and the CPI, and a high degree of interdependence between money supply, crude oil prices and inflation in India. Sharma, Singh, Sharma, and Gupta (2012; p-95-99.), on the backdrop of increasing dependence on oil imports, along with the unprecedented rise in oil prices in the world market in 2008, had used an empirical analysis to compare the effects of crude oil price on Indian economy. The study found that though future oil prices were difficult to predict, it was expected to rise in future. This in turn would lead to a rise in the inflation rate, government would also have spend too much on subsidy, exports would become weaker, investment would fall and GDP also would get affected.

Nevertheless, high and persistent inflation, no matter how it was created, was a matter of concern and the Reserve Bank of India should strengthen its anti-inflation efforts in order to avoid any negative longrun effects of excessive inflation on growth. Kumar (2013; p-65-72) based on the monthly data between 1992 and 2012, was an endeavour to study the inflation dynamics in the Indian economy by employing co integrated autoregressive technique. Inflation variable has cointegrating relationship with other macro-economic variables. It has been established that money supply was the most important variable in explaining the variation in inflation overtime, i.e. Money supply determined the CPI; however the converse was not true. Besides, import index variable also matter for inflation in Indian economy but with considerably lesser strength. But, in case of IIP, negative and significant coefficient attached to the IIP suggested that it had a inflation discouraging effect. Besides, apart from the economic variables, moral suasion (i.e. people should be adequately educated towards their buying behaviour) factor has also been proved to be important in controlling Indian inflation. Cointegrating relationship among the variables has considerable bearing on the inflation dynamics. Moreover, inflation bears stable and correcting relationship with CPI and import index variables, however such relationship is unstable and explosive with money supply and IIP.

Mukherjee and Mukherjee (2012; p-363) analyzed the performance of India's exports and the various economic factors which had contributed to its growth. Since manufactured exports comprised a significant share of India's aggregate (merchandise) exports, the paper also provided an overview of the export performance of three important commodities; namely, gems and jewellery, cotton and electronic goods The paper concluded that India's export performance would be affected by macroeconomic variables such as inflation, world demand (or GDP), tariff and non-tariff barriers and also exchange rates, and therefore key policy changes could have a bearing on the current trends seen in these sectors. Tiwari, Tiwari, and Pandey, (2012; p-57-81) attempted to examine the direction of causality among the fiscal deficit, government expenditure, money supply, and inflation in India. This study had employed Dolado and Lutkepohl (DL) (1996; p-251-276) and standard Granger-causality approach to examine the direction of the causality among the test variables. However, some conflicting results for India were found. Causality analysis based on DL approach suggested that both government expenditure and money supply Granger-cause fiscal deficit while standard Granger-causality test indicates that only government expenditure Granger-cause fiscal deficit. And money supply Granger-cause government expenditure and fiscal deficit Granger-cause money supply. Further, it was found that inflation did not Granger-cause any of the test variable included in the model and no variable included in the model Granger-cause fiscal deficit. The last finding was that inflation in the Indian context had no impact on the fiscal deficit. Patnaik (2010; p-118-129) aimed at empirically identifying the determinants of inflation in India with the help of a Cointegrated Vector Autoregression (VAR) framework. The Error Correction Mechanism (ECM) of the cointegrated variables was also carried out. The variables used in the study were Consumer Price Index (CPI), the Index of Industrial Production (IIP), the Reserve Money (RM), and the Import Index (IMP). The study found that the CPI was influenced by the IIP, RM and IMP. It finally concluded that though inflation in India was a mix of demand and supply side factors, yet the Indian inflation was majorly demand pull inflation, because both the money supply (RM) and the IIP represented the existing demand in the economy. However, the supply side factors represented by the imports also influenced the inflation in the short run. Salian and Gopakumar (2008), sought to examine the relationship between inflation and GDP growth in IndiaThe result shows that there is a long-run negative relationship between inflation and GDP growth rate in India. Inflation is harmful rather than helpful to growth. The study explained that any increase in inflation from the previous period negatively affects growth. But, macroeconomic stability and the necessary infrastructure are among the preconditions for sustained growth. Jayathileke and Rathnayake (2013; p-87) investigated the short-run and the long-run relationship between the economic growth and the inflation of three Asian countries- India, China and Sri Lanka, over the period 1980-2010. The results revealed that there was a long run negative and significant relationship

between the economic growth and inflation in Sri Lanka. Whereas no statistically significant relationships were found between the variables in China and in India, a negative and significant short run relationship was found for China. The causality results revealed that there was a unidirectional causality that runs from the economic growth to the inflation in China. Behera (2014; p-145-154) investigated the impact of inflation on economic growth and established the existence of inflation growth relationship in the context of South Asian countries. In order to examine the impact of inflation (CPI) on economic growth (GDP), the study used the annual time series data for the period 1980-2013. The correlation analysis found that there was a high positive correlation between inflation and economic growth for all the countries. In order to test the time series properties, the study also employed unit root test which indicated that all the variables were stationary at their corresponding first difference for all the countries. The cointegration result suggested that a long run relationship between CPI and GDP existed for Maldives.

Review of the literatures have shown that variables like GDP, IIP , M1,M3, Export , Import , Oil prices , Fiscal Deficit , Agricultural Index and many others effect inflation. Inflation was positively correlated with IIP but negatively correlated with GDP. M1 and M3 were found to have causal relationship with prices (Singh et al 2015).Inflation in India is found to be the result of a number of factors including supply driven food inflation (Mohaddes 2014).High degree of interdependence has been found between money supply, crude oil prices and inflation in India (Saxena et al 2013).

Majority of these Indian studies have seen the effect of these variables on WPI and only a few with CPI. But since April , 2014, CPI has been used to measure the inflation rate in the Indian economy , hence this study is focused on identifying the relationships between macro variables and three new CPIs , namely CPI (Rural), CPI (Urban) and CPI (Combined) as constructed in 2014.

III. Methodology

This study is purely exploratory in nature. More precisely, the relationship between three new CPIs, namely CPI (Rural), CPI (Urban) and CPI (Combined) and macro indicators This study is mainly based on secondary sources of data. For this, the monthly data related to the different macro variables i.e. Index of Industrial production (IIP), Narrow Money (M1), Broad Money (M3), Gross Fiscal Deficit (GFD), Exports, Imports, Oil Exports, Oil Imports, and Foreign Exchange Reserves, and quarterly data of Gross Domestic Product (GDP), for a period of ten years (from 2006 to 2015) have been collected from the official website of the Reserve Bank of India, i.e. www.rbi.org.in. Past studies are found either to take GDP or IIP as a measure of economic growth in their studies. But, this study has taken both the GDP and IIP. Taking only IIP may give misleading results as around 18% GDP comes from the manufacturing sector only.

Tools for Analysis: Unit Root Test, Augmented Dickey Fuller test, Granger Causality test and Vector Error Correction Model have been employed to examine the extent of causation among the variables.

Till January 2012, in India there were only following three CPIs compiled and released on national level for Industrial Workers (IW), Agricultural Laborer (AL) /Rural Laborer (RL) and Urban Non-Manual Employees (UNME). The three CPIs mentioned above reflect the effect of price fluctuations of various goods and services consumed by specific segments of population in the country. These indices, however, do not encompass all the segments of the population in the country and as such do not reflect true picture of the price behavior in the country.

To overcome this problem, the Central Statistics Office (CSO) of the Ministry of Statistics and Programme Implementation started compiling a new series of CPI for the entire urban population, viz. CPI (Urban), and CPI for the entire rural population, viz. CPI (Rural), which would reflect the changes in the price levels of various goods and services consumed by the urban and rural population. These new indices are compiled at State/UT and all-India levels -CPI for the entire urban population, i.e. CPI (Urban); CPI for the entire rural population, i.e. CPI (Rural) and Consolidated CPI for Urban + Rural, i.e. CPI (Combined).

I. Unit Root Tests of Macroeconomic Variables:

Johansen Co-integration technique requires confirming the order of integration of all the variables used in the study. The Null-Hypothesis of non-stationarity is tested by using the t-statistic with critical values calculated by Mac Kinnon (1991). Table 1 and 2 reports the results of unit root tests and corroborate that all the variables are integrated at order one.

Table 1: Unit Root Tests for Macro-economic Variables

Unit Root Test of GDP (Rs Billion) for the period: Jan 2006 to Dec 2015								
At Level	ADF	R-Sq.	DW	AIC	SC	F	Prob(F)	1% CV* = -3.6289
	-0.1	0	1.92	18.3	18.44	0.07	0.927	5% CV = -2.9472
								10% CV= -2.6118
At 1st Diff	-6.2	0.57	1.87	18.1	18.24	21.08	2E-06	1% CV* = -3.6353
								5% CV = -2.9499
								10% CV = -2.6133
Unit Root Test of IIP growth rate (%) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq.	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	-1.9	0.26	1.99	5.38	5.526	7.82	3E-06	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-10	0.74	1.97	5.37	5.447	163.2	0	1% CV* = -3.4880
								5% CV = -2.8865
								10% CV = -2.5799

Unit Root Test of M3 (Rs Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq.	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	3.57	0.12	2.03	15.3	15.54	3.168	0.0104	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-5.3	0.54	2	15.5	15.66	25.57	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV = -2.5801
Unit Root Test of M1 (Rs. Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	1.31	0.037	1.99	14.2	14.44	0.84	0.5207	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-5.8	0.53	-810	14.3	14.45	25.29	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV = -2.5801
Unit Root Test of Exports (Rs. Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	-1.02	0.3	1.99	11.9	12.1	9.37	0	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-7.6	0.79	1.9	11.8	11.97	82.69	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV = -2.5801

Unit Root Test of Imports (Rs. Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	-1.5	0.21	1.99	12.8	13	5.97	6.3E-05	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-5.1	0.722	2.002	12.8	13.03	56.14	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV = -2.5801
Unit Root Test of Oil Exports (Rs. Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	-1.5	0.058	2.073	9.53	9.675	1.36	0.2431	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-6.8	0.571	1.92	9.51	9.65	28.77	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV = -2.5801
Unit Root Test of Oil Imports (Rs. Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	-1.5	0.265	2.02	11.1	11.22	7.87	2E-06	5% CV = -2.8865
								10% CV = -2.5799

At 1st Diff	-5.5	0.73	2.021	11.1	11.24	60.58	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV = -2.5801

Oil Exports	At Level	Non-Stationary
	At First Difference	Stationary
Oil Imports	At Level	Non-Stationary
	At First Difference	Stationary
Gross Fiscal Deficit	At Level	Non-Stationary
	At First Difference	Stationary
Foreign Exchange Reserves	At Level	Non-Stationary
	At First Difference	Stationary

Unit Root Test of GFD (Rs. Billion) for the period: April 2006 to March 2016								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	-4.5	0.49	1.97	14.7	14.82	21.78	0	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-8.6	0.81	2.005	14.8	14.9	94	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV= -2.5801

From Unit Root Analysis, it has been confirmed that the data series are non-stationary at levels and stationary at first difference, indicating same order of integration at I (1) for all the variables.
Considering integration of I (1), all the data series are amenable for Granger Causality Test and VECM.

Unit Root Test of FOREX in India (in Billion Rs) for the period: Jan 2006 to Dec 2015								
At Level	ADF	R-Sq	DW	AIC	SC	F	Prob(F)	1% CV* = -3.4880
	0.27	0.019	1.99	14.8	14.91	0.435	0.8231	5% CV = -2.8865
								10% CV = -2.5799
At 1st Diff	-5	0.5	1.99	14.8	14.91	21.62	0	1% CV* = -3.4885
								5% CV = -2.8868
								10% CV= -2.5801

Table: 2 Findings from Unit Root Tests of Macro Variables
(Levels of Stationary)

Macro Variables	Lag Period	Remarks
GDP	At Level	Non-Stationary
	At First Difference	Stationary
IIP	At Level	Non-Stationary
	At First Difference	Stationary
M1	At Level	Non-Stationary
	At First Difference	Stationary
M3	At Level	Non-Stationary
	At First Difference	Stationary
Exports	At Level	Non-Stationary
	At First Difference	Stationary
Imports	At Level	Non-Stationary
	At First Difference	Stationary

II. Granger Causality Tests between Macroeconomic Variables and CPI:

For Granger causality tests, it is required that the series are trend and mean stationary. The variables are first differenced to make the series trend stationary and the mean value of the transformed series is then deducted to make the series zero mean stationary. The maximum lag order considered is 2 lags.

Granger Causality Tests between CPI (Rural), CPI (Urban) and CPI (Combined) and the Macro variables have been carried out and the results have been given in the Appendix Tables I to V. The interpretations have been provided subsequently in Tables 3 to 6.

Table 3: Interpretation of the Granger Causality Test between CPI (Rural) and Macro Determinants

Variables	Level of Significance	Lag Period		Remarks
GDP & CPI (Rural)				
CPI (R) does not GDP	Significant at 10%	1	2	Unidirec 10% lev
IIP & CPI (Rural)				
IIP does not Granger Cause CPI (R)	Significant at 10%	1	2	Bidirect ional at lag 1 at 10% level of significa nce
CPI (R) does not Granger Cause IIP	Significant at 10%	1	2	
M3 & CPI (Rural)				
M3 does not Granger Cause CPI (R)	Insignificant	1	2	Insignifi cant at lag1 and lag2
CPI (R) does not Granger Cause M3				
M1 & CPI (Rural)				
M1 does not Granger Cause CPI (R)	Insignificant	1	2	Insignificant at lag1 and lag2
CPI (R) does not Granger Cause M1				
EXP & CPI (Rural)				
EXP does not Granger Cause CPI (R)	Significant at 5%	1	2	Bidirectiona l at lag 2 at 5% level of significance
CPI (R) does not Granger Cause EXP	Significant at 5%	1	2	
IMP & CPI (Rural)				
IMP does not Granger Cause CPI (R)	Significant at 5%	1	2	Bidirectiona l at lag 2 at 5% significance
CPI (R) does not Granger Cause IMP	Significant at 5%	1	2	
OIL EXP & CPI (Rural)				
CPI (R) does not Granger Cause OIL EXP	Significant at 5%	1	2	Unidirectio nal at lag 2 at 5% level of significance
OIL IMP & CPI (Rural)				
CPI (R) does not Granger Cause OIL IMP	Significant at 10%	1	2	Unidirectio nal at lag 2 at 5% significance
GFD & CPI (Rural)				
GFD does not Granger Cause CPI (R)	Insignificant	1	2	Insignificant at lag and lag2
CPI (R) does not Granger Cause GFD				
FOREX & CPI (Rural)				
FOREX does not Cause CPI (R)	Insignificant	1	2	Insignificant at lag1 and lag2
CPI (R) does not Granger Cause FOREX				

Table4: Interpretation of the Granger causality Test between CPI (Urban) and Macro Determinants

Variables	Level of significance	Lag period		Remarks
GDP & CPI (Urban)				
CPI (U) does not Granger Cause GDP	Significant at 10%	1	2	Unidirectional at lag 1 at10% level of significance
IIP &CPI (Urban)				
CPI (U) does not Granger Cause IIP	Significant at 10%	1	2	Unidirectional at lag 1 at10% level of significance
M3 &CPI (Urban)				

M3 does not Granger Cause CPI (U)	Insignificant	1	2	Insignificant at lag1 and lag 2
CPI (U) does not Granger Cause M3				
M1 &CPI (Urban)				
M1 does not Granger Cause CPI (U)	Insignificant	1	2	Insignificant at lag1 and lag 2
CPI (U) does not Granger Cause M1				
EXP &CPI (Urban)				
CPI (U) does not Granger Cause EXPORTS	Significant at 5%	1	2	Unidirectional at lag 1 and lag 2 at5% level of significance
IMP &CPI (Urban)				
CPI (U) does not Granger Cause IMPORTS	Significant at 5%	1	2	Unidirectional at lag 1 and lag 2 at5% level of significance
OIL EXP & CPI (Urban)				
CPI (U) does not Granger Cause OIL EXPORTS	Significant at 5%	1	2	Unidirectional at lag 1 at5% significance
OIL IMP&CPI(Urban)				
CPI (U) does not Granger Cause OIL IMPORTS	Significant at 5%	1	2	Unidirectional at lag 1 at5% significance
GFD &CPI (Urban)				
CPI (U) does not Granger Cause GFD	Insignificant	1	2	Insignificant at lag1 and lag2
FOREX &CPI (Urban)				
CPI (U) does not Granger Cause FOREX	Insignificant	1	2	Insignificant at lag1 and lag2

Table 5: Interpretation of the Granger causality Test between CPI (Combined) and Macro Determinants

Variables	Level significance	Lag period		Remarks
GDP & CPI (Combined)				
CPI (C) does not Granger Cause GDP	Significant at 10%	1	2	Unidirectional at lag 1 at10% level of significance
IIP & CPI (Combined)				
CPI (C) does not Granger Cause IIP	Significant at 10%	1	2	Unidirectional at lag 1 at10% level of significance
M3 & CPI (Combined)				
M3 does not Granger Cause CPI (C)	Insignificant	1	2	Insignificant at lag1 and lag2
CPI (C) does not Granger Cause M3	Insignificant	1	2	
M1 & CPI (Combined)				
M1 does not Granger Cause CPI (C)	Insignificant	1	2	Insignificant at lag1 and lag2
CPI (C) does not Granger Cause M1	Insignificant	1	2	
EXP & CPI (Combined)				
CPI (C) does not Granger Cause EXP	Significant at 5%	1	2	Unidirectional at lag 1 and lag 2 at 5 % level of significance
IMP & CPI (Combined)				
CPI (C) does not Granger Cause IMP	Significant at 5%	1	2	Unidirectional at lag 1 and lag 2 at 5 % level of significance
OIL EXP & CPI (Combined)				
CPI (C) does not Granger Cause OIL EXP	Significant at 5%	1	2	Unidirectional at lag 2 at 5 % level of significance

OIL IMP & CPI (Combined)				
CPI (C) does not Granger Cause OIL IMP	Significant at 5%	1	2	Unidirectional at lag 2 at 5 % level of significance
GFD & CPI (Combined)				
GFD does not Granger Cause CPI (C)	Insignificant	1	2	Insignificant at lag1 and lag2
CPI (C) does not Granger Cause GFD	Insignificant			
FOREX & CPI (Combined)				
FOREX does not Granger Cause CPI (C)	Insignificant	1	2	Insignificant at lag 1 and lag 2
CPI (C) does not Granger Cause FOREX	Insignificant	1	2	

Table 6: Findings from Granger Causality Test between the CPIs and Macro Variables

Findings from Granger Causality Test between the CPI (R,U, C) and Macro Variables			
Sl No.	Direction of Causality between the Variables		Remarks
1	CPI (R) → GDP		Unidirectional at 10% significance level for lag 2
2	CPI (U)→ GDP		Unidirectional at 10% significance level for lag 1
3	CPI (C) → GDP		Unidirectional at 10% significance level for lag 1
4	CPI (R) ↔ IIP		Bidirectional at 10% significance level for lag 1
5	CPI (U)→ IIP		Unidirectional at 10% level of significance for lag 1
6	CPI (C) → IIP		Unidirectional at 10% significance level for lag 1
7	CPI (R)	M3	Insignificant
8	CPI (U)	M3	Insignificant
9	CPI (C)	M3	Insignificant
10	CPI (R)	M1	Insignificant
11	CPI (U)	M1	Insignificant
12	CPI (C)	M1	Insignificant
13	CPI (R) ↔ EXP		Bidirectional at 5% significance level for lag 2
14	CPI (U)→EXP		Unidirectional at 5% level of significance for both lags 1 and 2
15	CPI (C) →EXP		Unidirectional at 5% level of significance for both lags 1 and 2
16	CPI (R) ↔ IMP		Bidirectional at 5% significance level for lag 2
17	CPI (U)→ IMP		Unidirectional at 5% level of significance for both lags 1 and 2
18	CPI (C) → IMP		Unidirectional at 5% level of significance for both lags 1 and 2
19	CPI (R)→ OIL EXP		Unidirectional at 5% significance level for lag 2
20	CPI (U)→ OIL EXP		Unidirectional at 5% level of significance for lag 1
21	CPI (C)→ OIL EXP		Unidirectional at 5% significance level for lag 2
22	CPI (R)→ OIL IMP		Unidirectional at 5% significance level for lag 2
23	CPI (U)→ OIL IMP		Unidirectional at 5% level of significance for lag 1
24	CPI (C)→ OIL IMP		Unidirectional at 5% significance level for lag 2
25	CPI (R)	GFD	Insignificant
26	CPI (U)	GFD	Insignificant
27	CPI (C)	GFD	Insignificant
28	CPI (R)	FOREX	Insignificant
29	CPI (U)	FOREX	Insignificant
30	CPI (C)	FOREX	Insignificant

IV. Summary of Findings

The analysis of the causal relationship between inflation rate as measured by CPI and different macroeconomic variables suggest that there exists a bidirectional (two-way) relationship between the CPI-Rural and the following macroeconomic variables:

- CPI (R) and IIP
- CPI (R) and Export
- CPI (R) and Import

Bidirectional relationship implies that both the CPI (Rural) index and the macroeconomic variables IIP, Exports and Imports influence each other.

On the other hand, the relationship between CPI (Rural), CPI (Urban) and CPI (Combined) with the rest of the macro economic variables i.e. GDP, IIP, Oil Export, Oil and imports has been found to be Unidirectional. These inflation measures are found to granger cause the aforesaid macro variables in the short run.

Macro variables M1, M3, Gross Fiscal Deficit and Foreign Exchange Reserves are not found to have any short run relationship with CPI (Rural), CPI (Urban) and CPI (Combined).

III. Johansen Cointegration Test (Long-run estimates) and Vector Error Correction Model (Short-run estimates)

The findings from the Co-integration test (i.e. whether there is a long-run relationship between the variables) and VECM model have been presented in the following table:

Table7: Johansen Long Run Results for CPI (Combined)

Variables	Coefficient	Standard Error	t-statistics	Conclusion
CPI Combined	1			
GDP	0.001	0.001	1.185	Significant *
IIP	-1.678	0.956	1.755	Significant *
M3	0.002	0.001	2.055	Significant*
M1	0.009	0.006	1.405	Significant *
EXP	0.042	0.026	1.639	Significant *
IMP	0.02	0.013	1.544	Significant *
OIL EXP	0.026	0.062	0.416	Significant *
OIL IMP	-0.133	0.046	2.000	Significant *
GFD	-0.073	0.024	3.027	Insignificant
FOREX	-0.0025	0.0015	3.666	Insignificant

(* indicates significant at 5% level of significance)

The Table 7 shows the long run relationship of important macro variables with the CPI (Combined). The results are given below:

- GDP is found to have a positive significant relationship with CPI Combined. With 1% increase in GDP, there is expected to be only 0.001 % rise in inflation (CPI (C)). Though this is in contradictory to the traditional theory of Fischer (1993) that states that inflation falls with a rise in GDP. This finding has been supported by the research works of Behera (2014), Saxena et al (2013), and Bashir et al (2011).
- IIP is found to have a significant relationship with CPI Combined; however the negative coefficient indicates that CPI Combined would fall 1.678 percent with 1percent rise in IIP. This may be due to higher supply leading to lower price level.
- The significant relationship of M3 with CPI Combined indicates that 1 percent increase in M3 may lead to 0.02 percent increase in price level.
- The significant relationship of M1 with CPI Combined indicates that 1 percent increase in M1 would lead to 0.09 percent increase in price level.
- Exports (EXP) are found to have significant relationship with CPI Combined and indicate that 1 percent increase in Export would lead to rise in 4.2 percent in price level. Looking into the nature of exports, like rice, oil products etc. the domestic supply may be reduced, whereas the aggregate demand may be high, resulting in increase in price level.
- Imports (IMP) are found to have significant relationship with CPI Combined and indicate that 1 percent increase in import would lead to rise in 2 percent in price level on the average in the long run. Imports mostly consist of raw-materials, semi-processed materials which are used as inputs in Indian manufacturing industries (mentioned in the section (a)), and we can conclude that because of imports, cost of production may rise, which in turn lead to increase in general price level. Another reason may be that income level of the manufacturing houses and importers may decline leading to lesser investments in production of goods and services which may more reduce the supply thereby increasing inflation. This finding has been supported by researcher Kumar (2013), Sharma et al (2012) and Arif et al (2012).

Table 8: Johansen Long Run Results for CPI (Urban) and CPI (Rural)

Variables	Coefficient	Standard Error	t-statistics	Conclusion
CPI Urban	1			
GDP	0.001	0.0014	0.965	Significant *
IIP	-1.76	0.97	1.8	Significant *
M3	0.003	0.001	2.06	Significant*
M1	0.01	0.007	1.59	Significant *
EXP	0.05	0.02	1.85	Significant *
IMP	0.02	0.01	1.84	Significant *
OIL EXP	0.02	0.06	0.42	Significant *
OIL IMP	-0.14	0.04	3.02	Significant *
GFD	-0.07	0.02	3.03	Insignificant
FOREX	0.0016	0.002	3.75	Insignificant
CPI Rural	1			
GDP	0.001	0.001	1.09	Significant *
IIP	-1.78	0.98	1.81	Significant *
M3	0.003	0.001	2.08	Significant*
M1	0.01	0.007	1.67	Significant *
EXP	0.05	0.02	1.99	Significant *
IMP	0.03	0.01	2.08	Significant *
OIL EXP	0.02	0.06	0.42	Significant *
OIL IMP	-0.15	0.05	3.13	Insignificant
GFD	-0.08	0.02	3.06	Insignificant
FOREX	0.003	0.001	2.98	Insignificant

(* indicates significant at 5% level of significance)

The Table 8 shows the long run relationship of important macro variables with the CPI (Urban) and CPI (Rural). The results are given below:

- GDP is found to have a significant relationship with both CPI (Urban) and CPI (Rural), indicating that both CPI (Urban) and CPI (Rural) would increase by approximately 0.001% percent for 1 percent rise in GDP. This may be due to the rising disposable income of the people.
- IIP is found to have a significant relationship with both CPI (Urban) and CPI (Rural). However the negative coefficients indicate that CPI (Urban) and CPI (Rural) would fall approximately 1.7 percent for both with 1percent rise in IIP. This may be due to higher supply leading to lower price levels.
- The significant relationship of M3 with CPI (Urban) and CPI (Rural) indicate that 1 percent increase in M3 may lead to 0.03 percent increase in price levels for both.
- The significant relationship of M1 with CPI (Urban) and CPI (Rural) indicate that 1 percent increase in M1 would lead to 1 percent increase in price levels for both.
- Exports (EXP) is found to have significant relationship with CPI (Urban) and CPI (Rural) indicating that 1 percent increase in Export would lead to rise in 5 percent in price level.
- Imports (IMP) are found to have significant relationship with CPI (Urban) and indicate that 1 percent increase in import would lead to rise in 2 percent in price level on the average in the long run. The significant relationship with CPI (Rural) indicates that 1

percent increase in import would lead to rise in 3 percent in price level .It may be because of imports, income level may decline leading to lesser investments in production of goods and services which may more reduce the supply of goods and services thereby increasing inflation.

Table 9: Vector Error Correction Model (Short run results)

Error Correction	D(CPI Combined)	D(CPI Rural)	D(CPI Urban)
(Speed of Adj) CointEq	-0.019	-0.02	-0.02
	0.039	0.03	0.03
	-0.484	-0.65	-0.56
D(GDP(-1))	0.002	0.00	0.00
	0.00	0.00	0.00
	1.63	2.45	1.24
D(GDP(-2))	0.00	9.20	0.00
	0.00	0.00	0.00
	1.02	0.16	1.64
D(IIP(-1))	-0.219	-0.26	-0.24
	0.146	0.15	0.15
	-1.496	-1.67	-1.6
D(IIP (-2))	0.0448	0.05	0.49
	0.181	0.19	0.19
	0.247 *	0.27 *	0.25 *
D(M3(-1))	0.001	0.001	0.001
	0.001	0.001	0.001
	1.121 *	1.33 *	1.23 *
D(M3 (-2))	-0.001	-0.001	-0.001
	0.001	0.001	0.001
	-1.199	-1.11	-1.14
D(M1(-1))	-0.002	-0.002	-0.002
	0.003	0.004	0.004
	-0.538	-0.64	-0.64
D(M1(-2))	-0.002	0.002	0.002
	0.002	0.002	0.002
	0.995	0.72	0.72

Error Correction	D(CPI Combined)	D(CPI Rural)	D(CPI Urban)
D(EXPORT (-1))	-0.005	-0.005	-0.005
	0.006	0.007	0.007
	-0.832	-0.74	-0.74
D(EXPORT (-2))	-0.006	-0.005	-0.005
	0.007	0.007	0.007
	-0.952	-0.74	-0.74
D(IMPORT (-1))	-0.005	-0.007	-0.007
	0.005	0.005	0.005
	-1.05	-1.24	-1.24
D(IMPORT (-2))	-0.004	-0.004	-0.004
	0.004	0.005	0.005
	0.888	0.84	0.84
D(OIL EXP (-1))	0.046	0.04	0.04
	0.021	0.02	0.02
	2.141 *	2.15 *	2.15 *
D(OIL EXP (-2))	0.004	0.008	0.008
	0.022	0.02	0.02
	0.209 *	0.33 *	0.33 *
D(OIL IMP (-1))	0.008	0.009	0.009
	0.01	0.01	0.01
	0.746 *	0.83 *	0.83 *
D(OIL IMP (-2))	-0.003	-0.005	-0.005
	0.011	0.01	0.01
	-0.294	-0.47	-0.47
D(GFD (-1))	-0.001	-0.002	-0.002
	0.002	0.002	0.002
	-0.698	-0.88	-0.88
D(GFD (-2))	-0.0005	-0.0006	-0.0006
	0.001	0.001	0.001
	-0.355	-0.37	-0.37
D(FOREX (-1))	-0.001	-0.00	-0.00
	0.001	0.002	0.001

	-0.521	-0.781	-0.88
D(FOREX (-2))	-0.00	-0.00	-0.00
	0.00	0.001	0.001
	-0.45	-0.27	-0.97
C	0.487	0.3	0.3
	1.49	1.6	1.6
	0.32	0.18	0.18

The short run results from Vector Error Correction Model have been given in Table 9. The values in the first row are short run coefficients, values in the second row are showing standard errors and those in the third row are denoting t-statistics.

The most important thing in the short run results is the speed of adjustment term. It is expected to show how much time would be taken by the economy to reach at long run equilibrium.

- The Table 9 reveals that CPI (Combined) has a negative sign with a value of 0.019 as speed of adjustment, indicating that economy will converge towards long run equilibrium after taking 1.9 percent annual adjustments in the short run.
- CPI (Rural) and CPI (Urban) also have negative sign with a of 0.02 each indicating that economy will converge towards long run equilibrium after taking 2 percent annual adjustments in the short run .
- The VECM analysis further reveals that GDP (Lag 1), IIP (Lag 2), M3 (Lag 1), Oil Imports (Lag 1) and Oil Exports (Lag 1 and Lag2) are found to have a positive effect on CPI(Combined), CPI (Rural) and CPI (Urban) in the short run.

V. Conclusions

i. All the ten macro variables and CPI (Rural), CPI (Urban) and CPI (Combined) are found to be non-stationary at levels and stationary at first difference, indicating same order of integration at I (1) for all the variables.

ii. CPI (Rural) is found to have bidirectional granger causality with the three macro variables i.e. IIP, Export and Import.

iii. India's present main inflation indicator CPI (Combined) is found to make short-run adjustment with changes in GDP, IIP, M3, Oil Imports and Oil Export products. GDP and IIP, no doubt, are used as measure of economic growth of a country by most of the researchers. The short-run relationship is supported by researchers like Patnaik (2010), and Madhu and Giri (2013).

iv. GDP is found to have a positive significant relationship with CPI (Combined). With 1% increase in GDP, there is expected to be only 0.001 % rise in inflation CPI inflation. This may be due to the rising disposable income of the people. Though this finding is in contradictory to the traditional theory of Fischer (1993) that states that inflation falls with a rise in GDP, but it has been supported by recent research works on inflation dynamics like Behera (2014), Saxena et al (2013) and Arif et al (2012).

v. IIP is found to have a significant relationship with CPI Combined; however the negative coefficient indicates that CPI Combined would fall 1.678 percent with 1percent rise in IIP. This may be due to higher supply leading to lower price level.

vi. The significant relationship of M3 with CPI Combined indicates that 1 percent increase in M3 may lead to 0.02 percent increase in price level. vii. The significant relationship of M1 with CPI Combined indicates that 1 percent increase in M1 would lead to 0.09 percent increase in price level.

viii. Exports (EXP) are also found to have significant relationship with CPI Combined and indicate that 1 percent increase in Export would lead to rise in 4.2 percent in price level. Looking into the nature of exports (like rice, jewellery, drugs, textiles, electronic goods among many others), the domestic supply may be reduced, whereas the aggregate demand may be high, resulting in increase in price level.

ix. Imports (IMP) are found to have significant relationship with CPI Combined and indicate that 1 percent increase in import would lead to rise in 2 percent in price level on the average in the long run. Imports mostly consist of raw-materials, semiprocessed materials which are used as inputs in Indian manufacturing industries. Hence it may be concluded that because of imports, cost of production may rise, which in turn lead to increase in general price level. Another reason may be that income level of the manufacturing houses and importers may decline leading to lesser investments in production of goods and services which may more reduce the supply thereby increasing inflation. This finding has been supported by researcher Kumar (2013).

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APPENDIX

Table A1: Granger Causality Test between the Macro Variables and CPI (Rural)

Granger Causality between GDP and CPI (R)		F-Statistic	Prob
Lag 1	GDP does not Granger Cause CPI (R)	2.34649	0.1451
	CPI (R) does not Granger Cause GDP	2.56275	0.12897
Lag 2	GDP does not Granger Cause CPI (R)	1.18309	0.33725
	CPI (R) does not Granger Cause GDP	3.74185	0.07095 **
Granger Causality between IIP and CPI (R)			

	IIP does not Granger Cause CPI (R)	2.81172	0.09915
Lag 1	CPI (R) does not Granger Cause IIP	3.03658	0.0869 **
	IIP does not Granger Cause CPI (R)	2.00439	0.14483
Lag 2	CPI (R) does not Granger Cause IIP	0.56975	0.5691
Granger Causality between M3 and CPI (R)			
	M3 does not Granger Cause CPI (R)	0.00119	0.97261
Lag 1	CPI (R) does not Granger Cause M3	0.01724	0.89599
	M3 does not Granger Cause CPI (R)	0.13245	0.87624
Lag 2	CPI (R)does not Granger Cause M3	0.03449	0.96612
Granger Causality between M1 and CPI (R)			
	M1 does not Granger Cause CPI (R)	0.00029	0.98645
Lag 1	CPI (R) does not Granger Cause M1	0.03249	0.8576
	M1 does not Granger Cause CPI (R)	0.16962	0.84444
Lag 2	CPI (R) does not Granger Cause M1	0.03127	0.96923
Granger Causality between Exports and CPI (R)			
	Exports does not Granger Cause CPI (R)	0.61307	0.43693
Lag 1	CPI (R) does not Granger Cause Exports	32.2857	5.00E-07 *
	Exports does not Granger Cause CPI (R)	1.13296	0.32975
Lag 2	CPI (R) does not Granger Cause Exports	9.99935	0.00021 *
Granger Causality between Imports and CPI (R)			
	Imports does not Granger Cause CPI (R)	0.39807	0.53065
Lag 1	CPI (R) does not Granger Cause Imports	17.9962	8.40E-05 *
	Imports does not Granger Cause CPI (R)	0.50527	0.60622
Lag 2	CPI (R) does not Granger Cause Imports	7.01549	0.00198 *
Granger Causality between Oil Exports and CPI (R)			
	Oil Exports does not Granger Cause CPI (R)	2.19045	0.14447
Lag 1	CPI (R) does not Granger Cause Oil Exports	1.58407	0.2134
	Oil Exports does not Granger Cause CPI (R)	2.00915	0.14419
Lag 2	CPI (R) does not Granger Cause Oil Exports	4.94849	0.01071 *
Granger Causality between Oil Imports and CPI (R)			
	Oil Imports does not Granger Cause CPI (R)	2.96199	0.09076 **
Lag 1	CPI (R) does not Granger Cause Oil Imports	0.35678	0.5527
Lag 2	Oil Imports does not	1.32841	0.27357

	Granger Cause CPI (R)		
	CPI (R) does not Granger Cause Oil Imports	2.90625	0.06344 **
Granger Causality between GFD and CPI (R)			
	GFD does not Granger Cause CPI (R)	0.06334	0.80221
Lag 1	CPI (R) does not Granger Cause GFD	0.42407	0.51758
	GFD does not Granger Cause CPI (R)	0.26394	0.76902
Lag 2	CPI (R) does not Granger Cause GFD	0.38582	0.68179
Granger Causality between Forex and CPI (R)			
	Forex does not Granger Cause CPI (R)	0.00028	0.98674
Lag 1	CPI (R) does not Granger Cause Forex	0.04829	0.82686
	Forex does not Granger Cause CPI (R)	0.01752	0.98264
Lag 2	CPI (R) does not Granger Cause Forex	0.11064	0.89547

(Where * indicates significant at 5% level of significance, and ** indicates significant at 10% level of significance)

Design optimization of heat exchanger by old and new generations metaheuristic optimization algorithms: Insights and comparisons

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Abstract— **This study compares the performance of 3 old generation algorithms namely Genetic Algorithm, Particle Swarm Optimization, and Differential Evolution with two new generation algorithms namely Firefly Algorithm and Symbiotic Organism Search in the optimization of the heat exchanger. The optimization procedure involves the selection of the major geometric parameters such as tube diameters, tube length, baffle spacing, a number of tube passes, tube layout, head type, baffle cut, etc., as per TEMA standard and minimization of total annual cost is considered as the design target. The methodology takes into account the geometric and operational constraints typically recommended by design codes. Three different case studies are presented to demonstrate the comparative effectiveness and accuracy of the proposed five algorithms. From the results of all the three case studies, it is concluded that DE performed the best in terms of capturing the lowest value of total cost and minimum execution time. The new generation algorithm, SOS performed the second-best as it captures the lowest values of total cost every time, honors the constraints every time in reasonably low execution time. The final optimized heat exchanger complies with the TEMA standard, having the lowest cost, and obeys all geometry, velocity, and service constraints.**

Keywords— ***Heat Transfer; Mathematical Modelling; Heat Exchanger Design; Firefly Algorithm (FA); Symbiotic Organism Search (SOS); Differential Evolution (DE); Constrained Optimization***

INTRODUCTION

Heat exchanger (HE) remains as the most widely used heat transfer equipment in chemical process industries. Major chemical industries around the globe are facing unprecedented challenges due to shrinking profit margin and cut-throat global competition. Chemical industries are now looking for new ways to reduce their capital and operating expenditure (CAPEX and OPEX). Due to large numbers of HEs available in industries, a slight reduction of cost in heat exchanger (both CAPEX and OPEX) has multiplication effect. Hence, improvements in HE design methodology has attracted many researchers over the decades to minimize cost. HE design remains as potential area which can have a huge impact on the plant's profitability.

The traditional design of STHE involves heat transfer area and tube and shell side pressure drop calculations. Traditional design approaches does not take into account the cost of HE as main design target. It involves trial and error approach and does not guarantee the lowest cost HE. Detail design of HE involves thermodynamics, heat transfer and fluid dynamics calculations, strength calculations and last but not the least cost estimation. Various commercial software packages like HTRI, HTFS, ASPEN automates the thermal design and rating of STHE. In this software, designer needs to specify a priori various design decision variables like tube diameter, tube length, tube pitch, shell type, baffle spacing, baffle cut etc. from the standard values given in drop-down menu. Based on the user inputs, these software calculate various constraints like pressure drop, velocity through tubes etc. and check for any violation based on some industry-specific criteria. If any constraint gets violated, based on his experience, designer assumes new values of above geometric variables to explore the possibility of reducing the heat transfer area while obeying all the constraints. This type of trial and error approach is time-consuming and does not guarantee minimum cost design as cost minimization is not considered as design target.

Many gradient-based optimization techniques are tried in past by several researchers to minimize total cost. Researchers applying the gradient descent based traditional cost minimization techniques to STHE problem did not get encouraging results as most of the time, solution gets trapped in local optima. Hence, traditional optimization techniques are not proven to be very efficient and also, they have limited applications in complex heat exchanger optimization.

The second objective of the present study is to integrate the optimization algorithm of STHE with TEMA (Tubular Exchanger Manufacturers' Association) standard. TEMA standards are followed by industry all over world to design and fabricate heat exchanger. From the literature survey, it was found that TEMA standard is not considered in the majority of published papers during the optimization of STHE. Hence, the resultant optimum STHE found in the literature does not comply with TEMA standard sizes and thus makes the fabrication cost higher. This makes the lowest cost heat exchanger with standard dimensions and easy for fabrication.

The third objective of the paper is to incorporate the best practices followed by different industries in HE design. In the actual shop floor of the industry, the lowest cost HE may not be always the best exchanger. Maintainability, less fouling tendency, less flow-induced vibration, ease of cleaning of tubes and shell, less floor space requirement, compactness of design are some of the criteria which must be considered during design of STHE. In the present study, we have incorporated those geometric and hydraulic constraints during the design optimization phase and thus ensure all these constraints are obeyed.

I. *THE OPTIMALl HE DESIGN PROBLEM*

The calculation sequence of the optimum HE design has the following steps:

1) Assume a set of seven design variables like tube diameter, tube length, Ratio of baffle spacing to shell diameter, Number of tube pass, Type of pitch, Head type, Baffle cut %. These are the free optimization variables which need to be optimized to attain a lowest cost exchanger.

2) Estimate the heat transfer area based on required duty and assuming the values of design variables in Step 1.

3) Evaluate the shell and tube side pressure drop.

4) Based on the heat transfer area and pressure drop, calculate the capital cost, operating cost, and total cost.

5) Evaluate different constraints like velocity constraint, pressure drop constraint, geometric constraint, hydraulic constraint, and see whether all constraints are obeyed.

6) Iterate and select new set of values for design variables within their upper and lower bounds to minimize the cost.

Continue iteration until total cost is minimized and all the constraints are obeyed. An attempt has been made in this work to apply different optimization techniques such as GA, PSO, DE, FA and SOS to design the lowest cost heat exchanger with TEMA dimensions (Table 1) and satisfying all of the constraints.

TABLE I
(TITLE: Design variables and their options)

Optimization variable	Variable Notation	Optimization variable	Options Available
x_1	d_0	Tube diameter	[0.00635, 0.009525, 0.0127,0.01905, 0.022225, 0.0254, 0.03175,0.0381, 0.04445, 0.0508, 0.05715, 0.0635]
x_2	L	Tube length	[1.2192 1.8288 2.4384 3.048 3.6576 4.8768 6.096 6.7056 7.3152]
x_3	R_b	Ratio of baffle spacing to shell diameter	[0.2 ,0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6 ,0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1]
x_4	N_{pass}	Number of tube pass	[1, 2, 4, 6, 8]
x_5	P_t	Type of pitch	Triangular or Square
x_6	Head type	Head type	Fixed tube sheet or U tube, outside packed head, split ring floating head, and pull through floating head
x_7	Baffle Cut	Baffle cut, %	[15, 25, 35, 45]

II. *OBJECTIVE FUNCTION*

The capital investment (C_i) can be obtained from Hall's correlation, which involves the C_i as the function of the HE surface area. The expression is as follows [21]:

$$C_i = a_1 + a_2 S^{a_3}$$

If the material of construction of the HE is stainless steel, the values of a_1, a_2 and a_3 are 8000, 259.2, and 0.93, respectively.

The total discounted operating cost (C_{od}) can be computed by the following expression:

$$C_{od} = \sum_{x=1}^{ny} \frac{C_o}{(1+i)^x}$$

C_o is the annual operating cost formulated as below:

$$C_o = PC_eH$$

Where C_e is the energy cost and P is the pumping cost which can be expressed as below:

$$P = \frac{1}{\eta}\left(\frac{m_t}{\rho_t}\Delta P_t + \frac{m_s}{\rho_s}\Delta P_s\right)$$

The total cost (C_{tot}) is the summation of C_i and C_{od} and thus formulated as follows: $C_{tot} = C_i + C_{od}$

III. CONSTRAINTS

TABLE 2
(TITLE: Geometric, Velocity and Service constraints)

Constraints description	Remarks
Geometric Constraints	
$3 \le L/D_s \le 5$	-
$0.2 \le R_b \le 1$	-
Velocity Constraints	
$v_t^{min} \le v_t \le v_t^{max}$ $1 \le v_t \le 2$ **(in this case study)**	Process fluids: 1 to 2 m/s, maximum of 4 m/s if it is required to reduce fouling; water: 1.5 to 2.5 m/s
$v_s^{min} \le v_s \le v_s^{max}$ $0.3 \le v_s \le 1$ **(in this case study)**	shell-side: 0.3 to 1 m/s
Service Constraints	
$\Delta P_t \le \Delta P_t^{max}$ $\Delta P_t \le 35000Pa$ **(in this case study)**	For fluids having viscosity less than 1 mNs/m^2 maximum pressure drop is 35 kN/m^2 and for fluids having viscosity 1 to 10 mNs/m^2 maximum pressure drop is 50-70 kN/m^2
$\Delta P_s \le \Delta P_s^{max}$ $\Delta P_s \le 35000Pa$ **(in this case study)**	Shell side also has the same conditions as the tube side.

IV. *OPTIMIZATION ALGORITHM*

Symbiotic organisms search (SOS), Firefly algorithm and Differential evolution is given to understand their working principle. GA and PSO algorithm are also used in the present study but their working principle are not given here for the sake of brevity. More details of all the algorithms can be found in reference Yang [10].

Symbiotic Organisms Search (SOS): SOS is a nature-inspired metaheuristic optimization technique proposed by Cheng and Prayogo [11]. This method basically imitates the relationship among different organisms.

Firefly optimization (FA): Firefly optimization algorithm (FA), proposed by Yang [13] mimics the periodic flashing behaviour of fireflies.

Differential Evolution (DE): DE is one of the old metaheuristic optimization methods and has been proved to be very effective in solving many real-life optimization problems.

V. *TESTING OF ALGORITHM AGAINST HEAT EXCHANGER OPTIMIZATION THEOUGH A CASE STUDY:*

The data as shown in Table 3 were supplied as input to the different optimization algorithm. This case study is taken from Kern [6]. Each optimization algorithm was run 100 times due to the stochastic nature of such algorithm and the best out of 100 runs was taken as the final optimum value for that algorithm. One distinctive feature of the present study, which differs from the earlier research work, is that in the present study, the optimization algorithm is forced to take discrete standard values as per TEMA standard. It cannot take any other values, which are not standard. This ensures that the final design obtained after optimization complies with TEMA standard. For other optimization variables also discrete values as per TEMA standards are taken, and those values are given in Table 1. All the values of discounted operating cost are computed with *ny* = 10 years, annual discounted rate *i* = 10 %, energy cost (C_e) = 0.12 €/kW h. Annual amount of work hours (*H*) = 7000 h/year.

TABLE 3
(TITLE: Process parameters and physical properties of the case study)

Condition	*Mass flow* (kg/s)	T_{in} (ºC)	T_{out} (ºC)	ρ (kg/ m^3)	C_p (kJ/ kg K)	μ (Pa.s)	*K* (W/ m K)	$R_{fouling}$ (m^2 K/W)
Shell side: methanol	27.8	95	40	750	2.84	0.00034	0.19	0.0003
Tube side: sea water	68.9	25	40	995	4.20	0.0008	0.59	0.0002

Table 4 shows the optimum HE results of 5 metaheuristic algorithms, namely GA, PSO, DE, SOS, and FA, along with their original design solutions given by the referenced authors.

Based on the performance to capture the minimum value and execution time, the following sequence can be made:

1) DE (Capture the lowest value and the lowest execution time)
2) SOS (Capture the lowest value and the second-best execution time)
3) PSO (Capture the lowest value, execution time is very high)
4) FA (Did not capture the lowest value, however reasonably low execution time)
5) GA (Did not capture the lowest value and reasonably low execution time)

We also observed that the total cost has increased from 37064.04 € to 38687.15 € when the constraints are imposed. Therefore, the difference of 1623.11 € is due to the imposing constraints mentioned in Table 2 but it ensures the best performing HE.

TABLE 4
(TITLE: Results of Optimization)

Parameter	**Literature**	**GA**	**PSO**	**DE**	**SOS**	**FA**
d_0 **(m)**	0.02	0.0191	0.0191	0.0191	0.0191	0.0127
L **(m)**	4.83	3.658	3.658	3.658	3.658	2.438
R_b	0.39	0.8	1	1	1	1
N_{pass}	2	2	2	2	2	2
P_{type}	-	Square	Square	Square	Square	Square
Head Type	-	Split Ring Floating head	Outside packed head	Outside packed head	Outside packed head	Outside packed head
Baffle Cut	-	35%	15%	15%	15%	35%
N_t	918	694	677	677	677	1528
D_s **(m)**	0.894	0.8101	0.7754	0.7754	0.7754	0.7392
v_t **(m/s)**	0.75	1.0936	1.1210	1.1210	1.1210	1.1180
v_s **(m/s)**	0.58	0.3530	0.3083	0.3083	0.3083	0.3392
h_t **(W/m² K)**	3812	5297.47	5403.56	5403.56	5403.56	5847.42
h_s **(W/m² K)**	1573	15863.2	22025.9	22025.9	22025.9	15300.02
U_{calc} **(W/m² K)**	615	1143.37	1172.06	1172.06	1172.06	1168.91
S **(m^2)**	278.6	151.89	148.17	148.17	148.17	148.57
ΔP_t **(Pa)**	6251	10366	10844	10844	10844	11646.37
ΔP_s **(Pa)**	35789	3866.01	2407.19	2407.19	2407.19	3053.07
C_1 **(€)**	51507	33051.1	32492.4	32492.4	32492.4	32552.42
C_{od}**(€)**	12973	6349.34	6194.71	6194.71	6194.71	6780.90

C_{tot} (€)	64480	39400.4	38687.2	38687.2	38687.2	39333.32
Run Time (s)	-	1.89062	57.2031	1.89062	2.3125	2.84375
Constraints						
L/D_s	*5.403	4.5149	4.7173	4.7173	4.7173	4.5149
v_t (m/s)	*0.75	1.0936	1.1210	1.1210	1.1210	1.1180
v_s (m/s)	0.58	0.3530	0.3083	0.3083	0.3083	0.3392
ΔP_t (Pa)	6251	10366	10844	10844	10844	11646.37
ΔP_s (Pa)	*35789	3866.01	2407.2	2407.2	2407.2	3053.07

*Did not obey the constraints

VI. *OBSERVATIONS*

The optimization algorithms are able to reduce the total cost from 64480 € (literature) to 37064€ i.e., 43 % decrease in total cost when no constraints were imposed. However, when constraints were imposed, minimum total cost was achieved 38687 € i.e., equivalent to 40% reduction in total cost. In other words, the cost of imposing constraints is around 1623 €.

From the results, we can conclude that DE performed the best among all algorithms in terms of capturing the lowest value of total cost and minimum execution time. The new generation algorithm, SOS performed the second-best as it captures the lowest values of total cost every time, honors the constraints every time in reasonably low execution time. PSO captures the lowest values every time, but its execution time is excessively high as compared to DE and SOS. FA has reasonably well execution time, but it fails to attend the lowest values of total cost in all three cases. Therefore, as observed from the results of three case studies, SOS is the most promising new generation algorithm, and DE being old generation classical algorithm, still performs the best among all the five algorithms.

The major advantages of these type of case studies are as follows:

a)It helps the designer to locate the minimum cost HE very quickly without trial and error.

b)Use of different algorithms enables the designer to validate the final optimum results as the most of the algorithms converge to same minimum value. Agreement of final results buy five different algorithms increase the confidence of designer about his calculations

c)The imposition of different constraints in optimization algorithms enables the HE maintainable, robust, and compact.

Use of discrete decision variables ensures that the final optimized HE would comply with TEMA standard, which is followed by the industry globally.

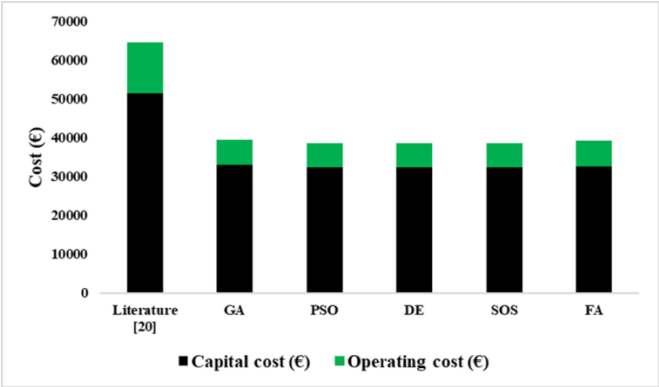

Fig 1: Comparisons of total cost, capital cost and operating cost obtained from different algorithms for case study

VII. *CONCLUSIONS*

This study applies 5 metaheuristic algorithms on heat exchanger optimization problems and able to find out the lowest cost heat exchanger automatically. From the comparative study results, it is concluded that SOS has great potential among new generation algorithms. However, DE performs best in heat exchanger optimization problem. Instead of picking up any random value between lower and higher bound, this study enforced picking up only TEMA specified discrete values for tube diameter, tube length etc and thus ensure that the resultant heat exchanger coming out from algorithms comply with TEMA standard. Also, various best practices in heat exchanger design followed by industry is incorporated in the design algorithm in terms of geometry and hydraulic constraints so that optimum heat exchanger performs best in the shop floor in spite of its lowest cost.

NOMENCLATURE

a_1 = numerical constant (€)
a_2 = numerical constant (€/m^2)
a_3 = numerical constant
Baffle-cut = Baffle cut
C_e = energy cost (€/kWh)
C_i = capital investment (€)
C_o = annual operating cost (€/yr)
C_{od} = total discounted operating cost (€)
C_{ps} = Cp of shell side fluid (kJ/Kg K)
C_{pt} = Cp of tube side fluid (kJ/Kg K)
C_{tot} = total annual cost (€)
D_s = shell inside diameter (m)
d_i = tube inside diameter (m)
d_o = tube outside diameter (m)
ΔP_s = shell side pressure drop (Pa)
ΔP_t = tube side pressure drop (Pa)
F = temperature difference correction factor
H = annual operating time (h/yr)
h_s = convective coefficient shell side (W/m^{2}K)
h_t = convective coefficient tube side (W/m^{2}K)
i = annual discount rate
j_h = Parameter for Baffle Cut
$K1$ = numerical constant

K_s = thermal conductivity shell side (W/m K)
K_t = thermal conductivity tube side (W/m K)
L = tube length (m)
LMTD = mean logarithmic temperature difference (°C)
m_s = shell side mass flow rate (kg/s)
m_t = tube side mass flow rate (kg/s)
μ_t = viscosity at tube wall temperature (Pa s)
n_1 = numerical constant
n = Number of passes
N_t = tubes number
η = overall pumping efficiency
ny = equipment life (yr)
P = pumping power (W)
P_t = tube pitch (m)
Ptype = Pitch type
Q = heat duty (W)
R_b = Baffle Spacing / Shell Diameter Ratio
R_{fs} = conductive fouling resistance shell side (m^2K/W)
R_{ft} = conductive fouling resistance tube side (m^2K/W)
ρ_s = fluid density shell side (kg/m^3)
ρ_{ts} = fluid density tube side (kg/m^3)
S = heat exchange surface area (m^2)
S_a = Cross sectional area normal to flow direction
T_{hi} = inlet fluid temperature shell side (K)
T_{ci} = inlet fluid temperature tube side (K)
T_{ho} = outlet fluid temperature shell side (K)
T_{co} = outlet fluid temperature tube side (K)
U = overall heat transfer coefficient (W/m^2K)
v_s = fluid velocity shell side (m/s)
v_t = fluid velocity tube side (m/s)

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