

# Stochastic Modeling & Applications

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# **S<sub>t</sub>ochastic M<sub>o</sub>odeling**

&

# **A<sub>p</sub>plications**

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# **S<sub>t</sub>ochastic M<sub>o</sub>odeling & A<sub>p</sub>plications**

**Special Issue**

**on**

**Innovative Research in Management, Applied Science and  
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**DEVELOPMENT AND GROWTH OF MICROFINANCE IN INDIAN FINANCIAL SECTOR****SAMUEL PAUL ISAAC\*, MANJUNATH AND NIKESH V VALAPPIL****ABSTRACT**

*Microfinance has developed as a resource of providing support to the financially weaker section of the public and the unbanked poor. The ultimate goal is to alleviate poverty via fiscal and public inclusion. The present article focuses on the development and purpose of microfinance organisations in the economic growth of Indian finance sector. The study showed that the quantity of MFIs receiving banks credits grew in 2017-18 and 2018-19. In 2019-2020 and 2020-2021, overall bank loans to MFIs fell over the previous year. The share of loans generated by income stayed the same throughout 2017, rising to 94% in 2021. Indicators linked to the general financing structure such as 'return of interest' have risen throughout the time, as well as the capital adequacy ratio, while the total MFI assets have fallen sharply.*

**Keywords:** Growth of Microfinance, MFI's, Poverty, Microfinance

**INTRODUCTION**

After Indian independence in 1947, several administrations stressed the relationship between better access to money and poverty reduction. In the 1950s, a national network of rural cooperative banks was created to help the financially weaker sections of India. Around 75% of the underprivileged in India are located in country side. This was followed by other steps designed to increase access to finances, nationalise commercial banks towards the end of the 1960s and provide a strong effort to grow rural banks during the 1970s and 1980s. In developing countries like India, micro-finance is considered to be a vital means of socio-economic upgrading (Meenu et al., 2021; Govindasamy and Viswanathan, 2020; Rajiv, 2020; Dwivedi, 2016; Sangeetha and Chitra, 2021; Anita, 2020; Sharma A and Sharma J K, 2020; Carlo, and Arvind, 2020; Joyeeta and Ram, 2021; Mayakkannan, 2020). It will play a crucial role in alleviating poverty. India has been an agro-based economy and agriculture has played a key role in the country's national revenue. There's nothing new about microfinance; it's been around for years. In the 19th century, moneylenders played the job of financial organisations informally. In the last two decades, politicians, international agencies, non-governmental groups, and others have created numerous development initiatives targeted at reducing poverty in developing nations. A microfinance programme is one of these techniques, which has grown more widespread since the early 1990s.

Globally, India is characterized as a low-income nation, according to the World Bank's data. Rural areas are home to roughly 70% of the population. Agriculture accounts for the occupation of about 60% of the populace, resulting in a major percentage of underemployment. People in rural areas have limited access to formal finance (from commercial banks). Priority has been given to reducing poverty at the national and international development levels since the 1990s. The government has adopted a number of measures within this framework. Because of its effectiveness in poverty reduction and socioeconomic development, microfinance has attracted a lot of interest. The impoverished can benefit greatly from microfinance by enhancing their quality of life.

The Self Help Group (SHG) – Bank Linkage Program (SBLP), launched as an experimental initiative by NABARD in 1992, was the beginning of the microfinance movement in India. As a result of the program's great performance, it has become the most prevalent microfinance concept in India. The microfinance monitoring structure in India is not uniform. In addition to commercial banks, microfinance is also provided through SHGs and cooperative societies as well as non-profit organisations and non-banking financial institutions (NBFIs). The RBI regulates banks and non-banking financial institutions (NBFIs), NABARD regulates self-help groups, and the Registrar of Cooperative Societies (RCS) regulates cooperatives, etc. The NBFIs, the self-help groups, the cooperative societies together constitute the microfinance institutions in India. Overall there are thousands of such organizations which provide credit to the poor. Some of the top such institutions are namely, Equitas Small Finance, ESAF Microfinance and Investments, Fusion Microfinance, Annapurna Microfinance, Arohan Financial Services, BSS Microfinance, Bandhan Financial Services, etc.

**LITERATURE REVIEW**

MFI's and SHG's play a key role in delivering microfinance services in India, according to a study by Kumar Vipin et al., (2015). Slow graduation rates of SHG members, poor group functioning, dropouts, etc., have also been recorded in different regions of the nation, and should be taken into account while creating the plan for SHG's second stage. For the first time in the years 2012-13, following the launch of SHG BLP, the number of

SHGs with bank-linked savings decreased (Nikita, 2014). Also shown in the research was an increase in the number of loans outstanding at SHG, which contributed to the rise in non-performing assets. Finally, it is shown that commercial banks hold the majority of the MFI agency's loans. There should be ongoing efforts to enhance the performance of Microfinance initiatives. Researchers found that providing loans to the underprivileged through microcredit does not solve the problem, but rather marks the start of a new age (Mahanta, 2012). It has the potential to be a game changer in the fight against poverty if it is managed correctly. A capacity building programme must accompany it, though. There is no way for governments to shirk their duty to provide social and economic growth for the disadvantaged. Lacking any specific expertise with microcredit customers, the funds are utilised for non-productive asset use and purchase.

Because of this, it is vital to give training in areas such as handicrafts and weaving as well as poultry, goat raising and masonry as well as beekeeping and vegetable gardening. As a result, the government must take the initiative. Priority should be given to those with unique abilities when it comes to microcredit. They should also have access to post-loan technical and professional assistance to ensure their microenterprises are successful. A larger role for microcredit may be played in poverty reduction if the government and microfinance institutions work cooperatively. The impact of micro-finance in India was the subject of research by Maruthi et al., (2011). Despite the pioneering efforts of the government, banks, and non-profit organisations in India, microfinance has only just begun to take off in the country. To accelerate the spread of MFIs and relieve poverty, a new generation of microcredit leaders might be created. In each state, a multiparty working committee may be created to discuss how the political atmosphere may be improved and misconceptions can be resolved. A successful model that is being set by one state needs to be adopted and built upon. We shall gently but definitely alter India by releasing the entrepreneurial genius of the underprivileged.

An investigation was performed in Nigeria by Christopher et al. in 2010 to ascertain the impact of microfinance on small and medium-sized enterprises (SMEs). The 100 SMEs that comprised the size of the research sample were selected using a simple random sampling approach. A structured questionnaire has been developed to ease the collection of pertinent data for analysis. To display data, descriptive statistics, which use basic percentage charts and visuals, were strategically used. Although just a few SMEs were able to acquire the requisite amount, the study's findings show that a substantial number of SMEs benefited from MFI loans. Interestingly, the majority of SMEs believe that MFI loans have helped them increase their overall competitive advantage, product innovation and market share. SMEs in Nigeria should be supported with more than just tax advantages and financial assistance.

A working model for assessing the financial performance of microfinance organisations does not appear to exist, at least in India. Furthermore, microfinance institutions do not have any specific regulation that governs how they operate and are managed. Because microfinance institutions lack a regulated framework for financial disclosures, the situation gets worse. An attempt has been made in the current study to determine its significance and to evaluate the achievement of such institutions functioning in India. Due to the fact that they rely on marginal and scarce capital to function effectively, and that their intended benefactors are the most disadvantaged parts of society, it is vital that these institutions operate efficiently. So that they may continue to pursue their ambitious goals, MFIs must be able to preserve their financial health.

People who lack access to conventional banking can create assets, diversify their livelihood alternatives, improve their earnings, and minimise their exposure to economic stress through microfinance. Because they can pay their complete expenses through sufficient interest rates, MFIs have proven that they can provide financial goods and services to the poor in an efficient and sustainable manner in the past.

Not all the users accessing credit through these institutions will be able to alleviate their poverty through microfinance. However, a number of studies have shown that impoverished families benefit from such programmes (Rosenberg and Littlefield, 2004). For the Asian Development Bank (2000), microfinance is a service that provides a wide variety of facilities to low-income families and microenterprises, which comprises loans, money transfers, payment services, deposits, savings, insurance, etc. This concept of microfinance does not just apply to those who live below the poverty line, but also to low-income households. When it comes to microfinance, NABARD's taskforce on a legislative and regulatory framework that is supportive defines it as "the provision of thrift, saving and credit services to the poor in rural or semi-urban and urban areas in order to enable them to raise their income level in order to improve their standard of living" (Sen 2008).

In order to help the very or exceptionally poor build or start their companies, microfinance is a progress instrument that offers monetary products and facilities such as modest loans, microleasing, microinsurance, savings, and money transfer (Robinson 1998). Others provide social services such as group creation, confidence

building, and financial literacy and management training to their members in addition to financial intermediation, according to MFIs (Ledgerwood 1999). Commercial banks, government banks, credit unions, savings and loan cooperatives, etc. are some of the providers of microfinance (MF) services. As a result, MFIs target self-employed low-income businesses such as small farmers and shopkeepers as well as hairdressers and rickshaw drivers.

Microcredit falls within the umbrella of microfinance, which is a large group of services. Microcredit is a means of providing credit facilities to individuals earning low wages. Neither microcredit nor microfinance are the same thing. Banks and other legally recognised institutions provide micro credit loans to impoverished individuals, whereas micro-finance comprises an extensive array of amenities like insurance, loans, and savings, as well as money transfers and other micro credit services.

Microfinance in India may be classified into four phases in general: Phase 1: The Movement of Cooperative Organizations (1900-1960). Through this period, cooperative organisations served as platforms for providing discounted loans to communities through government patronage. Phase 2: Nationalization and Social Banking (1960s - 1990). As the functioning of cooperatives started deteriorating, the administration concentrated on steps like banking nationalisation, networking of rural branches, the creation of RRBs, and the formation of top organisations like NABARD and SIDBI, and the launch of a government funded IRDP. Although these measures resulted in covering a huge populace, the time was characterised by widespread credit abuse, producing a poor image of the reliability of micro borrowers among bankers, further impeding low-income people's access to banking services. Phase 3: NGO-MFIs and SHG-Bank Linkage Program (1990 - 2000). An exemplary change in rural credit provision has resulted in NABARD's failure to provide subsidised social banking, with the view of connecting informal groups of women with banks by setting up SBLP. The programme's work contributed to increasing banking system coverage for non-attached individuals and changing the banking view of families earning low wages from "beneficiaries" to "consumers." The expansion of loans to market rates thereby defined this time. In order to work with NABARD in this initiative, the MFI, primarily non-profit, created great enthusiasm among newly developing micro-financial institutions. The early 1990s balance-of-payments problem prompted the implementation of substantial economic reforms in 1991, which gave the banking sector greater autonomy. This led to the creation of a large number of new generation private sector banks, which a decade later would play a significant role in the microfinance industry. Phase 4: Commercialization of Microfinance. Rural markets emerged as a new business opportunity in the first decade of the recent Millennium reforms and became the new drivers of MFI's and banks' expansion. Non-bank financing firms (NBFCs) are gradually beginning to be regulated, attracting trade investments. The microfinance industry as it exists now comprises mostly of the SBLP and MFIs. Women are the main beneficiaries of these schemes, as five out of four customers in India are women.

India has long been a great concern over the lack of access for poor and disadvantaged sections of society to credit and banking institutions. Many actions have from time to time been taken by the government and the central bank, including bank nationalisation, specified priority lending requirements for the sector, and the applicable concessional rate of interest for the weakest part of the community. It was nonetheless recognised that a more direct approach was necessary to comply with the credit criteria of poor individuals. The microfinance movement in India began in the early 1990s with the implementation of the banking connection programme (SBLP) for the SHG banking industry. There are now basically two Microfinance delivery options in India, namely SHG-Bank Linkage Program (SBLP) and Microfinance Institutions (MFI)

In SBLP a group of 10-20 people from rural and urban populations can form an SHG, whose members promote savings and use their resources to meet their loan obligations. The organisation is made up of an elected democratic group. The SHGs are members of the same community or company with the same financial goal. Informal credit-based SHGs are the formal financial institutions in this model. The SBLP model has become the main example of the outstanding loans and debtors'. This approach is adaptable, creates autonomy and provides the option to save and borrow according to group members' requirements. The SHG-BLP is well suited to the Indian setting because of the broad network of rural bank branches. The microfinance movement has begun in India by implementing the SHG-bank linkage programme (SHG BLP). SHGs are used to connect banks with rural, impoverished people in an endeavour to help reduce both the operating costs for rural consumers and banks. While officials/NGOs/agencies of the government are organising the poor into SHGs, banks are providing the aid. The loans to the SHGs using three distinct techniques are offered under this programme: (1) the banks create and nurture the SHG organizations, issue savings accounts, and make bank loans. (2) The SHGs are established by organisations outside of banks but financed by banks. (3) SHGs are financed by banks via financial intermediaries to other agencies.

The SBLP concept is an indigenous idea. The concept of the MFI is found across the world. MFI models lend significant amounts of cash to people or groups of people from financial institutions like banks. These MFIs serve people or groups, like SHGs, with financial services. The Joint Liability Group (JLG) idea is used by these institutions. An informal group of 5 to 10 members that collects bank loans either individually or against mutual guarantee through a group method is a JLG. There are MFIs in India which are available in a range of formats.

According to World Bank data, India has around one-third of the world's impoverished population (enduring on an equivalent of a dollar a day). Although various efforts are currently underway in India to relieve poverty, microfinance represents an important addition to financial inclusion. In recent decades, it has greatly contributed to eliminating poverty. Reports indicate that people who get microfinance might increase their remunerations. Therefore, microfinance is an essential factor in the stimulation of the Indian economy.

- Rural Poor Credit: Often, the rural sector depends on the financial requirements of non-institutional entities. Micro-financing has successfully taken institutionalised loans to impoverished people's doors and has made them sound economically and socially.
- Poverty alleviation: Poor people obtain jobs because of micro-finances. It also enables you to develop your business abilities and motivate you to take advantage of your business possibilities. Employment improves income, reducing poverty in turn.
- Empowerment of women: In general, women constitute more than half the SHG's, who have improved accessibility to financial and economic resources. This is a step towards improving financial security. Thus, economically and socially, micro financing enables impoverished women.
- Economic growth: To boost sustainable economic growth, finance plays a vital role. Due to microfinance, product and service output are rising, GDP is increasing, and this contributes to the country's economic growth.
- Savings mobilization: Microfinance creates people's saving habits. Poor individuals with poor incomes may now also save and be bankable. The money created by savings and micro-credits derived from banks is used to offer their members loans and advances. Microfinance thus supports savings mobilisation.
- Skills Development: Microfinance was a benefit to potential rural businesses. SHGs urge their members to collectively or individually build up business units. They are trained and gain leadership characteristics from supportive institutions. This indirectly causes micro-finance to improve skills.
- Mutual assistance and cooperation: Microfinance fosters mutual support and cooperation amongst members. The group's joint work encourages economic awareness and contributes to socio-economic transformation.
- Social welfare: As more jobs are created, individuals' earnings increase. They may be used for improved education, health, welfare etc. This contributes to the improvement of the community via microfinance.

## **METHODOLOGY AND DATA**

There are descriptive and exploratory components to the research design. The data for the current work was gathered from a variety of databases, including the Internet. Microfinance institutions in India were evaluated for their performance. Yearly reports on the micro finance status in India from NABARD, and other appropriate databases were used to compile the necessary data for the period 2017-18 to 2020-21. Modest statistical methods like averages and percentiles were used to generate the study's conclusions.

## **RESULTS AND DISCUSSION**

The progress in the MFI-Bank links initiative was shown in Table 1. In 2017–18, there was a 17% reduction in the number of MFIs receiving credits from banks over the last year. Over the year of 2017-18, the number of MFIs that received bank loans in 2018-19 significantly grew by 355%. But the number of MFIs that received bank loans in 2019-20 and 2020-21 has increased somewhat compared with the previous year. In 2017-18, 2018-19, 2019-20 and 2021-21, the Banks' total credit to MFIs declined in comparison to the previous year. It has fallen by around 32.2, 5.24, -22.3 and -26.6%.

**Table 1:** Yearly Development under bank and MFI linkage Programme (Amount in INR in crore)\*

Year	2017-18		2018-19		2019-20		2020-21	
Particular	MFI No.	Amount						
Loans made to	1922	25515	8,750	26,852	20,744	20,876	28,601	15,322

MFIs by FIs/banks	(-17)	(32.2)	(355)	(5.24)	(137)	(-22.3)	(38)	(-26.6)
Loans owed to MFOs/MFIs as of March 31	5073 (-5.3)	32306 (10.54)	34,982 (589.6)	27,159 (-16)	52,288 (49.5)	29,897 (10)	61,259 (17.2)	24,494 (-18)
New debts made as a percentage of loans due		78.97		98.86		69.82		62.55

\*Source: NABARD, India Report, 2017 to 2021.

MFIs' outstanding loans increased by 589.6 percent in 2018–19 and then increased modestly in subsequent years. The new loan as proportion to loan unpaid has been raised in the years consecutive to the prior year. Therefore, it is obvious that the confidence of customers and credit institutions is increasing.

The major findings from this study can be summarized as follows. (1) Over the course of the year 2018-19, MFIs that have accessed loans from banks rose 355% over 2017-18. However, the number of MFIs receiving loans from banks in 2019-20 and 2020-21 has significantly decreased in comparison to the previous year. It fell from 137 percent to 38 percent. (2) Total banks' MFI loans rose over the prior year correspondingly during 2017-18, 2018-19. It increased by approximately 32.2 and 5.24 percent. Overall bank loans to MFIs fell by 22.3 and 26.6 percent in 2019-20 and 2020-21, respectively, compared to the previous year. (3) The outstanding credit to MFIs has risen over the last few years. It increased by 10% in 2019-20 and fell by 18% in 2020-21 compared to the previous year. The new loan has been increased as a percentage for the remaining loan in the following years in the prior year.

The drop in the number of MFIs receiving loans in 2019-20 and 2020-21 can be attributed to the global pandemic caused by Covid-19. Due to the pandemic economic activity all over the country dropped significantly which led to a lower demand for credit. Before the pandemic there has been a steady growth in the number of MFI loans and the amount of loans over the years. A significant increase in the demand for credit from individuals and small businesses is expected in the coming years as normalcy returns, which will in turn increase the number of MFI loans and the amount of loans in the upcoming years.

## **CONCLUSION**

In developing nations like India, the relevance of microfinance cannot be ignored since it plays a key part in increasing the socioeconomic status of the poor and those with low incomes. Since the 1990s, both domestic and international development have been prioritising poverty alleviation. In this context, the government has taken several steps. Microfinance has garnered consideration as an instrument for the alleviation of poverty and economic development.

Hence, Microfinance may have a significant role in enhancing the living standards of the impoverished. Any country's economic progress is heavily impacted by financial service accessibility. A well-developed financial system supports economic investment prospects. To guarantee sustainable and inclusive growth, the governments of India should focus on offering financial services to both rural and urban areas. In rural areas during the past two decades, the operations of micro financial institutions in India have played an important role. In order to continue the Indian microfinance sector's growth, the Central Government and RBI should take the required actions. State governments also take the required measures to sensitise individuals to utilise microfinance services to increase their economic position and to better their livelihoods.

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**A BRIEF REVIEW ON DIGITAL PLATFORM IN COLLABORATIVE ECONOMY****SAMUEL PAUL ISAAC\*, NIKESH V VALAPPIL AND MANJUNATH****ABSTRACT**

Over the last several years, major changes in consumer behaviour were observed due to the new digital platforms for the sharing economy. Few academic studies have examined probable logistical variables that may have played a role in the rapid rise of the sharing economy in the last few years. Specific digital methods tailored to the sharing economy must guide these new consumption modes in the online world. In this article we Review the literary gap and organise the major strategies, approaches and tactics of digital marketing. Foremost a structure for the shared economy is established, which includes a debate on defining the SE model, aims, relevance and consequences for consumer behaviour. The two essential concepts - "sharing economy" and "digital marketing" - are used to construct a technique of literature review on the basis of prior literature collected from databases such as the Web of Science and Scopus. Digital marketing strategy and approaches may be identified on collaborative platform via the interpretation and analysis of the outcomes. In conclusion a description of the relevance of digital marketing and an enhancement of user produced information on these platforms in the online environment.

**Keywords:** User Experience, User Generated Content, Digital Marketing Strategies, Sharing Economy.

**INTRODUCTION**

New technological developments, especially ICTs, have produced major social and economic shifts in recent developments in the new technologies (Pourri & Hilty, 2018). New business concepts, such as Sharing Economy (SE) or new management project aid techniques, created by Crowdfunding owing to ICTs, were developed to tackle current challenges as alternatives. The SE, alternatively known as peer-to-peer or collaborative economy (Chappelow, 2020), are largely distinguished by the facilitation, via the promotion of socially and sustainably used exchanges of products and services among consumers. This is done through interacting with people who freely share their views, suggestions and online experiences.

The digital age is defined by broad usage of new technology and persistent Internet access, all leading to important consumer behaviour changes (Labrecque et al., 2013). As endless sources of knowledge are available, consumers are becoming more and more informed. Reyes et al., (2020) said the users are currently looking for their own knowledge, creating material, which is also referred as UGC (user generated content), and altruistic sharing on Social Media so that anonymous users may communicate and collaborate. Electronic word-of-mouth (e-WoM) is also a notion of crucial relevance to digital marketers (Saura et al., 2019). Those new trends stress that traditional communications methods for marketing have to be adapted to a digital environment, as the proper execution of DM techniques indicates tremendous advantages for e-business (Saura et al., 2017).

As technology and innovation have progressed, marketing channels have evolved drastically. Increasingly, marketers are looking for more efficiency, effectiveness, relevance, and persuasion power when it comes to reaching value partners, such as customers. With the digital revolution, marketing channels have undergone their most fundamental transformation yet. Since its inception and broad adoption of the Internet, supply chain management has been re-conceptualized as a marketing channel (Garca-Dastugue & Lambert, 2003), as well as social relationships and word-of-mouth (Kozlenkova et al., 2015; Berger & Milkman, 2012). Koetsier (2015) has reported that 17 organisations in the sharing economy are worth more than \$1 billion. We must investigate a digital marketing plan that can simultaneously reach, expand, and maintain a large customer base in record-setting time frames.

By organising distribution of items and services from their origination point to clients via a certain form of supply chain, digital marketing channels function much like traditional marketing channels (Pride & Ferrell, 2017). Unique technologies and procedures are used to ensure that products and services are delivered predominantly via online digital connections via the Internet in the supply chain in question.

As a result, digital marketing channels are Internet systems that may concurrently develop, promote, and transmit value from producers to consumers via digital networks. Value chain transactions can be completed totally online in some cases. When it comes to delivering software to users via the Internet, the term "software as a service" (also known as SaaS) is commonly used. A well-designed mobile application can facilitate

research, customization, purchase, review, and post-purchase communications for physical objects that do not originate or travel in digital environments (also referred to as mobile apps or apps).

On the other hand, the Internet has created new efficiency in the commodification of information by allowing consumers and businesses alike to exchange information via e-mail subscriptions for the price of a customer's e-mail address, which can be used to keep them informed of promotions and/or download relevant material. Sharing economy businesses can take advantage of the built-in control and efficiency that comes with the use of digital marketing platforms as well as the low cost.

Numerous service providers in the sharing economy have seen rapid expansion over short periods of time. Aside from Facebook and Google, the sharing economy has risen more quickly than all three (Matofska, 2015). During the first seven years of the sharing economy, a total of \$15 billion has been generated, compared to the previous power trio's \$11 billion in the first seven years of their existences. According to certain predictions, the global sharing economy might achieve a total value of US\$335 billion by 2025. (Carson, 2014).

As a result of the 2008 financial crisis and the digital platform business model (Parker et al., 2016), such quick growth can be attributed to these factors (Roose, 2014). However, a less well-known factor in the success of the sharing economy is a major shift in marketing methods. These developments, when paired with a truly creative product or service, allow for unprecedented growth levels in history.

The novelty of this research adds to the useful understanding of the key DM tactics in SE companies. In addition, there are no previous research that have clearly structured these techniques. The study goal is thus on the review by its goals of the key DM strategies, methods or tactics used by collaborative business models; the obstacles connected with implementing these strategies are also discussed.

The SE is a business concept which originated in the later part of the 1990s and in the 21st century it became sustainable. According to Rodríguez et al. (2017) (1) Internet and digital culture (2) social and cultural transformations; (3) economic crises; and (4) environmental issues are the major drivers of the collaborative economy.

Collaborative economics companies are fully digital platforms. These enterprises rely on the basis of products and services between users and the promotion of a more viable way of living. These platforms have resulted in new ways for customers to trade, share or rent second-hand items. This activity has significant effects of digital media on consumer behaviour.

The SE model has been used in several industries, especially in transport and hostel industries (e.g. Uber, Ola or Airbnb), but also in consumer goods, media and entertainment companies (e.g., Craigslist, Wallapop, or Olx) (i.e. Spotify or SoundCloud). Each sector adopts this collaborative economic model, modifying its business activities and consumer relationships and utilises DM tactics which enable it to recruit users and promote their involvement and consumption.

As SE business models evolve as basically digital platforms, the user's consumer behaviours and motives in this context are vital to comprehend. The Internet provides the customers with a wide range of information which can influence their buying decisions. Users review the experience and opinions of other consumers in social networks, created via e-WoM and UGC. The following five features of collaborative economy are underlined: (1) peace of mind, (2) transparency, (3) community, where users are interactive among the equal peers, which reinforces the ties of belonging to the same community, (4) no uncertainty, and (5) freedom of choice.

Communication and engagement amongst peers is one of the major reasons why youthful consumer activity in new digital settings is particularly important. Younger consumers tend to establish groups of similar interests and inclinations, enhancing cooperation and trade amongst the cohort of products and services. Other population groups, however, are more worried about utilising digital platforms because they fear interaction or feel uneasy while talking on digital platforms. Another key motivation in this sector is the simplicity of usage and immediate transactions. More and more people are searching for relaxed, instinctive and consumers-focused platforms, and these features are all crucial to building a successful consumer experience. The impact of the e-WoM and UGC in the collaborative economy is in the enhanced engagement of the user in the consumption of the products and services and the response of the digital platforms in the needs of the users.

The engagement of users in SE is essential for its operational activity. Their engagement might take place in numerous ways: the users themselves who sell, lend, share or talk with others (e.g. review) and boost their confidence in utilising these types of digital platforms. The users are part of the performance of the company. The users no longer have a passive mentality.

However, they are becoming increasingly demanding and are looking for greater quality and better service. This makes it more difficult for digital marketers to achieve their loyalty. Therefore it is important not to overlook the importance of establishing efficient DM tactics.

In cooperative economy enterprises, social trends in the direction of a sustainable lifestyle and rising environmental awareness are other key features of customers. However, there may be inconsistencies between views and actual behaviour among the customer according to Hamari et al. (2016).

First of all, the advantage of the adoption of DM techniques in e-businesses is taken into account in the creation of research questions. Since certain DM methods are utilised more widely than others, and some of them depend on the business concepts more effectively. The RQ1 responds to the resulting question: What exactly are the primary digital marketing techniques for economic platforms sharing.

Secondly, it would be fascinating to pursue further and evaluate the way digital marketing is applied to encourage consumer involvement, knowing that user engagement is vital in the SE. RQ2 is then the following address: In what ways can digital marketing contribute to the sharing economy and promote consumer participation.

In DM platforms the engagement of the user and catering to the needs of the user is very crucial for the success of the digital platform. Collecting, storing and analysing the user data to assess the user behaviour and provide the appropriate service to the consumer is needed. Security and privacy of the stored data is of concern to the users. Data privacy and security related matters in a digital marketing platforms is a complex and vast topic and needs to be discussed in more detail and which is beyond the scope of this article.

## **METHODOLOGY**

The approach of a Systematic Literature Review (SLR) to address the questions posed in this study was utilized. The objective of SLRs is to discover and summarise past results of research (Snyder, 2019). This technique enables a thorough knowledge of a particular issue and the acquisition of key concepts and consequences. The possible contributions of the SLR to both academics and industry are essential to emphasise. Any approach has to be analysed and interpreted using some past data. In the case of an SLR, the procedure includes a qualitative method to gather and assess articles. In this work, the methodological development was directed by Brocke et al., (2015) methodical sequential approach. Likewise, PRISMA Statement was utilised to ease the drafting of the SLR (Moher et al., 2015).

In this study, two main worldwide academic databases were used as research methods: Web of Science and Scopus (Chadegani, 2013). The databases have been scanned by significant keywords. The following procedure was followed. First identify the appropriate terms for SE and DM. The next item was a total of three queries in each database, fixing the terms "share economy" or "collaborative economy" and alternating between the terms "digital marketing" or "internet marketing" and the other three key terms associated with marketing strategy in the on-line environment. We were able to broaden the result by searching for related keywords. Moreover, it was stipulated that the title, abstract or keywords should contain these terms.

From a total of 81 papers, the PRISMA technique was followed to select key articles according to the review objectives. First, the double results were removed and the results where the terminology used in the titles, abstracts and keywords were not in line with the study goal. A total of 40 items were kept in the dataset as a consequence of this filtering. Second, a more comprehensive assessment was conducted, focusing in particular on the implementation in models, findings and consequences of sharing the digital marketing strategies. As a consequence of this filtering procedure over three stages, the dataset was reduced to 13 items in total.

## **RESULTS**

Digital platforms are DM tactics in the collaborative economy enterprises. In this part, we examine important DM tactics in this business model, how they are implemented and how they might impact their users. Furthermore, numerous other major ideas are also being defined.

A review of the articles chosen (N=13) showed that these digital platforms are successful in building on the user experience (UX) of DM strategy. The associated UX methods must be created to enable users in online ecosystems to self-story (Pera et al., 2016). This allows customers to offer their views and to demonstrate pleasure or discontent with SE companies' operations. This conduct is commonly referred to as e-WoM. It is one of the key elements that impact consumer loyalty and the reputation of firms in digital ecosystems.

The link between quality of service (SQ) and client loyalty was proven by Lalicic and Weismayer (2018). This investigation was nevertheless concentrated on an offline setting.

Innovative business templates like the collaborative economy have been built on their tactics to foster user and company involvement (Pisano et al., 2015). Accordingly, such firms are often employed for social media marketing techniques (SMM). Social networks provide an essential communication route for e-commerce, enabling them to gain more awareness and foster deeper and more informal consumer relationships.

Collaborative economic companies build accounts on main social networks like Twitter, Facebook or Instagram to connect with their followers and produce content. One of the major goals is to establish an online community of users, to inspire people to engage, exchange experiences, views and even demonstrate contentment or happiness with a merchandise or service (Rowe, 2017). The wisdom of community and relationships are the support of cooperative economic stages (Lee, 2016).

In addition, the findings imply that the mistrust of the consumers of digital platforms is one of the key issues in the online world. One method, as indicated above, is to support UGCs via social networks or on your own platforms by incentivising the user trust. UGC is the way to build the brand or company that has been produced on digital platforms or social networks by users in a fully altruistic way; people communicate their experiences and views freely (Reyes, 2020). There is evidence that UGC has more effect than platform generated content on customer behaviour and online confidence (Zloteanu et al., 2018). Positive evaluations are a result of increased sales and involvement in the companies concerned according to Camacho-Otero et al. (2019). The quality of the created material is another decisive element here.

The study of user searches data offers a rich amount of information and insights for collaborative commercial enterprises as suggested by Palos-Sanchez et al. (Palos-Sanchez et al., 2018). This study's findings also suggest that the words Internet access, social networks and technology use are interconnected. All of this underlines the necessity of employing tactics such as SEO and SEM (Search Engine Marketing).

In addition, numerous other studies revealed that creation of blog material – especially in hospitality and tourism – is a very effective and affordable approach to promote the image of the company (Sabou et al., 2014). Evidence also exists that it has a favourable effect on customer decisions in the internet world, to use ambassadors or prominent opinion leaders (Lee and Chow, 2020). Such study, however, remained exploratory.

Dellaert (2018) states that cooperative economies have made consumers an integral component of the digital platform manufacturing and operational procedures including consumer strategies creation. This user participation is known as customer co-production. But in order to do this, it is crucial to build beforehand methods that provide an information and emotional experience to win consumers' confidence (Nadeem et al., 2020). DM's tactics employ comprehensive data analysis to discover customers with these successful co-productions and customise promoting measures for users, provide them with more assistance and data so that they endure to create value (Dellaert, 2018). Online relationship marketing promotes customised connection with people that is crucial to get feedback (Casais et al., 2020). In addition, intimate and individualised connection decreases scepticism and credibility issues about the regular usage of the digital environment. Online Marketing Relations (ORM) methods to include consumers in co-production of customers (Casais et al., 2020). We have shown that the use of data management and exploration tools as well as corresponding mechanisms are very beneficial in this respect for customer-based initiatives (Dellaert, 2018).

Finally, the findings indicated that Freemium models may be used to differentiate across SE platforms. This impact is caused by the heterogeneity of consumers in which prices are an essential consumer behaviour component (Querbes, 2017). Furthermore, this sort of model enables user data to be exchanged, a benefit for digital marketers since the data may be used for development of customised strategy, searching or buying history by users, thus making the relevant offers or content of value to their clients. This results in more trust, happiness and customer loyalty on digital platforms.

## **DISCUSSION**

The SLR technique was utilised in this study to discover key DM tactics for SE business models. We were able to respond to the issues raised in this research based on the findings of the evaluation.

Firstly it was found that the deployment of UX, SMM, SEO and SEM-driven tactics in order to produce profitable outcomes in this business type was important in RQ1 on key DM techniques used in collaborative economic companies. The incorporation of object-relational mapping (ORM) methods and analysis of qualitative (e-WoM or UGC) and quantifiable data is another successful strategy for increasing loyalty for current consumers and for attracting new consumers.

Secondly, in relation to the RQ2, it was observed that implementing SMM strategies, together with supporting the progress of UX through the websites, or on-line platforms, can successfully inspire consumer involvement and collaboration with digital marketing to help the shared economies to enhance consumer involvement in their platforms. The positive UGC and e-WOM, which promote consumer loyalty and e-confidence, play an especially significant function. DM methods are beneficial when applied in order to collect user information for improving user involvement. Analysis of user data left in digital surroundings. This material gives ideas on how to properly develop DM tactics. For instance, tracking heat maps in UX methods to learn how users move online can assist to enhance usability and subsequently consumers' involvement in the SE business. Alternatively, as per the results collected, SMM and social networks are crucial in engaging users in creating discussion and in implementing social networks and SMM strategy in these media outlets that are relevant and attractive for users' interaction. Data analysis is essential to knowing what material is more suitable.

For business and customers, UGC and e-WOM are highly important information sources. Our results therefore suggest that collaborative businesses create areas within digital platforms that foster user-to-user contact. Accordingly, more investment in UX is recommended because this is a key base for developing DM strategies.

According to Reyes et al., (2020) SE firms are able to have a better understanding of their audiences and to adopt customer interests and needs policy through SMM strategies by analysing the information from e-WOM and UGC. The use of methods such as sentiment analysis (SA) in social networks like Twitter is a significant example in this regard. SA can be beneficial to determine the user sentiments about a business or whether subjects are better suitable for content production that engages with social networking networks (Reyes et al., 2020). An improper application of SMM tactics, however, may severely affect the reputation of the firm online. Overall, UGC analysis is essential to find information and insights on consumption behaviour, in order to build best suited business success strategies (Saura et al., 2019).

In order to analyse user data from your platforms and social networks firms should also be able to employ the resources and capabilities needed. The integration of ORM techniques is therefore crucial. In addition, the inclusion of software for customer management might give a firm with more benefit over its competitors in order to facilitate the development of DM tactics, such more tailored e-mail markets or direct marketing techniques. Search marketing strategies should, on the other hand, be properly developed in order to obtain a higher organic and paid positioning of search monitors. SEO strategy is the most efficient way of rating blogs in the top search engine position. There is evidence that the websites with initial results tend to produce more user confidence and are the first to visit. In addition, utilising search-based analysis techniques (for example, Google Trends), decision makers and co-operative economic managers can assist forecast customer preferences (Palos-Sanchez et al., 2018).

A last proposal is that Freemium models should be used for consumers who are drawn to more exclusive services. In this way, information will be collected from these users. There should also be use of direct tailored approaches centred on user interests and promoting user reliability and co-creation.

There were very few relevant research on SE and DM methods, leading to quite a restricted set of data that were evaluated. Secondly, we chose a limited example to be evaluated according to our study aims owing to the intrinsic content present in our databases. Finally, certain marketing methods have been identified that do not focus on the online environment that is crucial to develop loyalty and consumer confidence.

In this respect there is no significant difference with regard to e-companies based on B2B or B2C as SE enterprises are established in a digital environment in terms of the implementation of DM strategies (Saura et al., 2019). However, given the vacuum in information in this area, future study ought to emphasize on the distinction between businesses and companies based on B2B or B2C relationships in the collaborative economy. Evidence shows that mobile apps (MAP) are the major way to participate in this business model in the later kind of companies due to their quick accessibility to consumers (Kannan and Li, 2017). Consequently, there is no discussion of methods which may be applied in applications that attract or promote consumer engagement with the experience and efficiency of mobile users or application search optimizations.

Our contribution, on the other hand, is the following, given the findings of Lalicic and Weismayer (2018) on SQ in an off-line firm and its impact on consumer loyalty. In terms of web design, easy usage of the platform, user privacy, responsiveness and the development of rooms which foster interaction between users, SQ may be built from a digital viewpoint and stimulate content generation among users. Digital spaces in SE companies are a typical technique in assessing or reviewing the services/products supplied.

**CONCLUSION**

In short, we may come to the following conclusions from the outcomes of the present study. First, the substantial effects of UGC and eWoM on consumers are strongly demonstrated in our findings. Collaborative enterprises therefore should search for solutions in their platforms to enhance UGC and e-WoM volumes. Second, our results highlight the significance to further analysis and interpretation of both the qualitative and quantitative consumer data gathering. For this purpose, DM techniques are crucial that allow user information gathering and software integration capable of organising and evaluating such information. DM techniques may then be utilised to build relevant measures that would best fit every customer on the basis of the insights that are gained.

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**FINANCE TECHNOLOGIES IN INDIA: A NEW PERSPECTIVE****SAMUEL PAUL ISAAC\*, MANJUNATH AND NIKESH V VALAPPIL****ABSTRACT**

Fintech denotes the innovative procedures and services that are provided by digital technology for financial services. Fintech comprises financial innovation technologically equipped to produce novel business structures, applications, procedures or related goods with a substantial impact on the financing markets, establishments and financial services. The newest Fintech trends in the financial industry are significant for regulators and market players alike; the recent developments of Fintech leads to difficulties, in particular by balancing the advantages of advances with the potential hazards of new methods to investment. FinTech is an expression used to characterise increased financial-sector technology advancements. Fintech shapes the financial industry more and more. India is becoming a dynamic environment that gives Fintech companies a platform to become billion dollar unicorns. Fintech in India has many objectives, ranging from new segments to overseas markets exploration. India's cash-centred economy has reacted excellently to the promise of Fintech, owing mostly to a rise in e-commerce and smartphone device usage. The growth of India remains unlike its global rivals, though, but is stacked well thanks to the robust pipeline of skilled innovators.

**Keywords:** Finance, Fintech, Fintech Adoption, Fintech Startup, Fintech Industry Structure.

**INTRODUCTION**

Financial technologies or ‘Fintech’ is a sector made up of enterprises that utilise technology to improve the efficiency of financial systems and financial services. Fintech refers to new procedures and products which, owing to digital technology developments, are accessible in financial services. The Fintech industry has numerous aspects that may be roughly classified into three primary segments, including financing, administration of assets, and payments (Dorfleitner et al., 2017). According to PricewaterhouseCoopers, 83% of financial establishments think Fintech start-ups are at danger from different elements of their business (PwC., 2016). Global investment in Fintech businesses reached 5.3 billion dollars during the first four months of 2016, up 67% from the same period of the year before, while Fintech's investment proportion for European and Asia-Pacific firms almost doubled to 62% (Accenture, 2016).

India has transformed to a dynamic environment that offers start-ups by Fintech companies an opportunity to develop into billion dollar unicorns. Fintech's start-ups in India pursue different ambitions, ranging from new sectors to exploring overseas markets. The historically cash-based Indian financial sector has adapted effectively to Fintech, which is mainly due to the rise in e-commerce and the prevalence of smartphones. The Indian Fintech sector is projected to grow by 22% in 2020 over a five year period from 2016. But India's wave of growth, when contrasted with its worldwide equivalents, still may not be of size, but is well-stacked thanks in large part to a solid talented pipeline of cheap technology employees. Fintech's services altered the way companies and individuals do regular activities, from wallets to loans to insurance. The growing acceptance of these trends places India as a global market appealing to firms in the Fintech industry in general, and especially to develop, expand and gain competitive edge in the global financial market.

Like e-commerce, many of these innovations have reduced the number of banking companies in physical locations. In the financial business, the influence of Internet technology is particularly clear. Almost all elements in the value chain of the banking company profit from a novel use of internet based technologies (Baporikar, 2019a, Baporikar, N. 2019b]. For the banking industry, possible advantages of on-line banking comprise of lower operative costs, shorter turnarounds, real-world information for managers, smoother organisational communication, more convenient interaction and supply of added value services like access to professional knowledge in financial management, and better interaction with current and prospective customers (Nielsen, 2002; Sathye, 1999). Another instance of e-finance is online stock trading. By executing every stock transaction electronically, it lowers operational costs. By offering unique services at the lower fees for transactions, it obtain a competitive edge. In the mid-2000s, the rise of the user base on smartphones allowed mobile financing growth, including mobile payments and mobile banks, which represent an increase in e-financing. Fintech is seen as an invention that changes and disrupts established financial markets (Lee et al., 2018). But, there is still no standard definition of Fintech and it is yet to be fully understood and many new innovations are being developed on a regular basis (Schueffel, 2016).

We first need to examine the ecosystem in order to comprehend the competitive and collaborative dynamics within Fintech. The Fintech industry's development is driven by a robust symbiotic Fintech environment. The Fintech ecosystem consist of the companies, the financial establishments, and the Government. The ecosystem contribute symbiotically to innovation, boost the economy, enable financial industry collaboration and competition and eventually benefit financial industry customers. Since 2010, an investment of US\$50 billion and above has been made in almost 2500 businesses, redefining the ways individuals borrow, transfer, spend, save, invest, and safeguard money (Accenture, 2016). Fintech's stipulations include mobile wallets, mobile payment (P2P), exchange and transfers, digital currency solutions, and payment in real-time to customer and reseller payments. The services enhance consumers' experience for a faster, convenient and multi-channel access to a streamlined payment experience. Fintech's predominant business models in India now include crowd-funding, wealth management, payment, crediting, insurance services and capital markets, as well as the rising number of Fintech companies and startups. Business model for payment in comparison to other financial goods and services payments are very straightforward. Fintech-based payments firms may quickly gain consumers at a reduced cost and are the most rapid move for innovation and the introduction of new payments. Fintech's two payment markets are (1) retail and customer payments and (2) business and wholesale payments. Payment for services and goods is one of the most common day-to-day retail financial services and one of the less properly regulated.

Due to the ongoing growth in information technology, that rivalry between Fintech and conventional banking services grows more each year (Webster, and Pizalla, 2015). Simultaneously, progressive financial institutions have shown interest in Fintech in contemporary finance services, aimed at maintaining and enforcing their leadership in the sector and providing modern, high-quality services to their clients everywhere, in a convenient and efficient way. The cooperation between the new Fintech sections and the traditional financial institutions have grown recently as potential ways forward for both sides. Table 1 provides an overview of the sectors in which Fintech delivers new technologies and conventional financial sector institutions to which Fintech companies wish to compete and describes the pros and downsides of Fintech technology.

#### **ADVANTAGES AND DISADVANTAGES OF FINTECH**

As seen in table 1, Fintech businesses provide its technology and services actively and successfully in all fields in which conventional financial institutions like insurance, banks, and other organisations function. Banks had already begun to actively recognise Fintech at that time, despite their inherent conservatism and caution, realising that, in conjunction with their large banking clientele, the new technologies they offered could lay the foundations for a new generation of digital financial agencies, attract low-cost resources, and a robust regulatory system to ensure clients' reliance. Therefore, the more Fintech businesses develop, the more conventional financial organisations have overlapped. In certain situations it can really be impossible to differentiate between a Fintech firm and a regular bank. For instance, the so-called low-cost banks, or "internet-based retail banking". Such banks quickly got customers and were profitable in the Czech Republic (Hes and Jilkova, 2016).

**Table 1:** Advantages and Disadvantages of Fintech Services with respect to traditional services

<b>Application Areas</b>	<b>Traditional Services and Fintech Services: Advantages and Disadvantages</b>
Management of assets and investments	Fintech companies have a highly competitive value proposal by providing the customers an investment portfolio based on their investment profile and risk profile by using appropriate algorithms; the annual maintenance costs are lower than those in banks (1-2%). Fintech companies now provide services to the general public and SMEs that were earlier accessible exclusively to the rich (Baporikar, 2020).
Banks Digital	On the basis of existing banking infrastructure and creation of an infrastructure from scratch, digital banks may offer convenient mobile services.
Support services and infrastructure	Security-related technology; big data, borrowers scoring methods, platforms such as credit arrangements or mobile payments.
Insurance	Instead of the distribution of products, Fintech companies may provide innovative technologies in the insurance industry via offline agent networks, charge fees in the form of commissions up to 20 percent and, as a consequence, services become cheaper.
Lending	After the crisis of 2008, Fintech businesses began to compete successfully

	with banks, due to banks' unwillingness to lend because of their high risk to specific loan groups such as SMEs. Bank competitors may nevertheless charge loans and commissions significantly more and credibility is still a problem.
E-commerce, On-line payments and transfers.	A high volume of trade in close coordination with the major trading platforms in the world shows the successful competitiveness of Fintech firms with banks. However, the transaction costs of bank competitors are significantly lower.
Planning, analysis and Personal finances	Fintech businesses offer online platforms for the administration of the budgets, invoices and reports to let users access their credit rating and credit history, as well as retain records of all financial clients.

There are enormous changes taking place in the financial business. Innovative Fintech solutions are challenging a variety of conventional banking goods ranging from investment advice to payments. With a higher transaction security and speedier exchange of money, blockchain technology is changing many conventional banking services at reduced domestic and worldwide prices. In the next few years, Fintech innovation is capable of shaking the whole financial landscape. Like every interruptive invention, Fintech's disturbing power is evident as the industry develops. In these times of global economic disorder, the Fintech sector faces some specific challenges. These are namely, disruptive technologies, technology integration, security and privacy, investment management, customer management, risk management, etc.

### **FINTECH IN INDIA**

Numerous startup companies have joined the Indian fintech market in recent years. The sector has now developed considerably with each company and makes its name worldwide. The newest studies from CB Insights show that the 20 Indian start-ups are included among the 250 global startups and many new customer friendly services like digital bank, Payment Wallet, BHIM and UPI (Wilson, 2020). India is one of the world's rapidly developing marketplaces for FinTech. In FinTech's adoption rate India is rated the highest internationally along with China. The value of digital payments of 65 billion dollars in 2019 could increase at CAGR of 20% to 2023. FinTech is definitely becoming a major player in all assessed areas with worldwide FinTech adoption reaching 64%. This indicates a continuous growth curve over the last five years, compared to adopted rates in earlier polls in 2015 and 2017. In the 6 studied markets throughout this period, adoption rates increased by over 100% every two years from 16% in 2015, to 31% in 2017, and by 60% in 2019 (Hatch et al., 2019).

Fintech is promoted in India by several governmental efforts, including Jan Dhan Yojana, Aadhaar and the creation of UPI, which offer a strong basis for fostering financial inclusion in India. Demographically, the Fintech apps were adopted by men & women at 88% & 84%, while the age-specific Fintech users between 25 and 44 years are at approximately 94%, while Fintech adoption generally is at around 73% in the same age bracket. India is one of the world's rapidly developing marketplaces for FinTech. Indian market for FinTech has its own difficulties and possibilities. Accessibility of most Fintech services in India is mainly through smartphone based apps. To increase the adoption of most basic financial services banks are providing SMS based services which can be accessed by customers who do not have a smartphone and use only the basic feature phones.

### **FINTECH STARTUP IN INDIA**

The development in FinTech is still growing in India, largely because new FinTech firms are emerging and a strong wave of technical progress is being made. FinTech has witnessed a financing boom in India over the previous five years and funding increased by 98% over the last six year. Nowadays, the number of active Fintech businesses is rising regularly and India has the second largest fintech centre in the world with 2565 startups in operation in 2020, while in 2014 there were just 737. The greatest percentage of Fintech start-ups in India consists of 'payments', loans, wealth technology, personal finance, regulations and more (Ashwini, 2020). The Indian FinTech sector is split into 34% for payments handling, 32% for banks and 12% for the open and private trade marketplaces. Visakhapatnam was promoted as FinTech Valley by the Andhra Pradesh government (Shrivastava, 2020).

In Fintech, the number of investments in the country has grown. India has witnessed 23 new investments and China 15 in the same time in the second quarter of 2019. Some of the major Indian Fintech investments in 2019 were made by Sequoia and Ribbit Capital and digital insurance, which raised USD 75 million by payment provider RazorPay in June. The first six months of 2020 six fintech companies in India were funded over

US\$1.7 billion compared to US\$726.6 million in the previous year. The KPMG research shows that India is to contribute 2.2 percent to the world digital payments industry by 2023. The creation of a favourable framework of collaboration and consolidation for financing institutions, startups, government, venture capitalists, the regulators. The study provides the insights into three growing sectors, with 10000 start-ups: open banking, artificial intellectuals and blockchain, which will be capable of transforming the financial services industry in India.

The Indian Government is aggressively pursuing this approach, both at policy and at implementation level, to encourage the development of a cash-free Digital Economy with a strong fintech ecosystem in India. The following are the key actions that the GOI has done together with other regulatory organisations such as RBI (Reserve Bank of India) and SEBI (Security and Exchange Board of India): Artificial Intelligence in Fintech, Blockchain in Fintech, Cloud computing in Fintech and NLP based chatbots.

Financial companies are also likely to focus on their capacity to shape the shared economy and consumer intelligence and address technological advancements, such as blockchain, robots, artificial intelligence (AI), and more. The financial sector was transformed by artificial intelligence (Hill, 2020). Just few industrial giants had the bandwidth to deal with the magnitude naturally inherent in the technologically skilled environment before AI and FinTech's emergence (Buttice, 2020). FinTech firms and financial institutions utilise AI and machine learning to improve productivity and to give consumers with financial services and solutions that are more relevant, inexpensive, and intuitive to suit their bank requirements (Darcy, 2020). Fintech disrupts the financial system and the blockchain firms in the development field have a big advantage (Shah, 2019). Recently, a study released by the Fintech Steering Committee, Ministry of Finance, the Government of India, underlined Blockchain's relevance with a specific mention of four blockchain applications in Fintech (Jacob, 2020) [21]. Blockchain technology revamps the financial sector in a variety of ways, including removing third parties, lowering operating time and costs, increasing identification checks and so on (Srivastav, 2020). FinTech firms may quickly scale up and down with complete control while keeping the regulatory standards using Cloud infrastructure (Naser, 2020). FinTech decreases the budgets of CAPEX and OPEX, enhances the portfolio of services and user experience (Ray, 2020). With NLP based chatbots and an innovative conversation user interface for mobile banking, Fintech will generate a whole new sensation (PwC, 2016). These chatbots may address client difficulties and give real-time solutions, which enhance customer experience.

## **FUTURE DIRECTIONS**

Fintech is still an emerging field from the academic perspective. Therefore, we can see several new research threads. The connection between Fintech companies and incumbent companies is certainly one of the most pressing. Does one consider each other to be supplements or competitors? Is it meaningful for fusions and acquisitions or would strategic partnerships give more value? Another industry-level research matter might be what distinguishes Fintech companies from incumbents. In general, however, Fintech startups and incumbents are fundamentally different. They often service same clientele. How are their vision and strategy, organisational structure, procedures and culture different? Further research issues come from marketing and sales moving down the value chain. How are Fintech companies approaching customers? What are the generally target segments of customers? What is the price model of the company? The investigation of the support services of Fintech companies might potentially provide valuable insights: How is funding guaranteed? What type of HR approach are Fintech companies pursuing?

Fintech is set to continue to expand. Individual start-up companies from Fintech which have only started capturing and optimising particular sections of the value chain of financial services. This puts current participants in a tough position when sections of their frequently most valuable companies split up while the regulatory burden and related expenses are left to them. Fintech nevertheless has to demonstrate at the same time that it isn't only a fleeting star. Despite its amazing rise in recent years, Fintech needs to show that even in downturning economies it is sustainable.

## **CONCLUSION**

Business innovation is certainly driving micro- and macro-economic development (Harrison et al., 2014). The use of IT in the financial industry is an area with enormous innovative potential, which is why businesses are keenly interested in it. Fintech influences the experiences of its customers and all of the customers' interactions with the service provider. It will also influence corporate economics, i.e. income, expenses and margins. Finally, the sector specialists forecast that Fintech would completely disrupt industry dynamics, which will affect the competitive structure and financial services ecosystem (Deloitte, 2016). In addition, Fintech will change all kinds of banks, asset managers, asset management and payment providers, brokers, trade and

insurance alike. No other financial service provider will go undisturbed (PwC, 2016; Kauffman and Ma, 2015; and Mackenzie, 2015).

Fintech is the new paradigm that uses innovation and technology required for the provision of financial services through new apps, products as end-to-end Internet processes. Fintech is particularly favourable in India since it offers financial services to a constantly expanding unrivalled young generation. India's financial services industry is mainly unexplored, with 40 per cent of the population unrelated to banks and more than 80 per cent of cash transactions. This offers Fintech start-ups the potential to expand their wings significantly across many sectors. In conclusion, this study gave an outline of the Indian Fintech sector and governmental backing of fintech industry efforts and its performance in today's context. Fintech provides consumers with speedier financial and product services. For the global and Indian financial sectors, it is therefore vital to grow the fintech industry. Fintech innovations in the financial industry which are being developed in the near future.

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**ANALYTICAL STUDY OF HIMACHAL PRADESH STATE COOPERATIVE BANK LTD. (HPStCB)  
IN COVID-19 PANDEMIC SITUATION**

**VISHAL THAKUR AND DR. NEEL KUMAR SINGH**

**ABSTRACT**

*Indian banking is the lifeline of the nation and its people. The sector has translated the hopes and aspirations of millions of people into reality. A cooperative bank is a financial entity which belongs to its members, who are at the same time the owners and the customers of their bank. Surprisingly economy has witnessed unprecedented situation of Lockdown due to spread of Covid-19 and this has resulted into contraction of economy and have effected the banking industry. The present study attempts to review the impact of COVID-19 in the working of Himachal Pradesh State Co-operative Bank Ltd. and to explore the area for performance improvement.*

**Keywords:** COVID-19, Himachal Pradesh Co operative Bank Ltd., pandemic and performance.

**1. INTRODUCTION**

Indian Banking system is continuously framing reforms to minimize the effect of COVID-19. As world is suffering from COVID-19 Pandemic and resultantly it has changed the way the world works. The Corona virus disease first time identified in Wuhan, the capital of Hubai China in December 2019 and spread to the overall world. After observing its infection and increase the rate of death World Health Organization declares COVID-19 as Pandemic on 11<sup>th</sup> March 2020. In India the first case of COVID-19 was identified as early as January 2020. Slowly, the pandemic spread to various states and union territories including the state of Himachal Pradesh. The first case was recorded in this region on 20 March 2020. Even after advisories by the Central and State Government and after adopting various preventive measures the cases of COVID-19 were rising in India day by day and to minimize the further spread the prime minister of India had declared Janta Curfew on 22<sup>nd</sup> March 2020 followed by complete lockdown of 21 days from 24<sup>th</sup> March 2020. The lockdown was extended from time to time and restrictions were becoming new normal thereafter. India is widely affected from Corona virus. Due to this pandemic situation the economy of the country has shattered and many industries have collapsed due to which recession, rise in unemployment and stress on demand and supply chain management have arisen.

Human Resource Management played a crucial role in helping organisation to navigate in the situation of dramatic changes caused by the pandemic lockdown. In banking sector, the dedicated Human Resource has provided their continuous/ uninterrupted services to their customer amidst serious situations due to COVID-19 pandemic.

**Organization and Function of Himachal Pradesh State Cooperative Bank Ltd. (HPStCB)**

Himachal Pradesh State Co-operative Bank Ltd. (HPStCB) came into existence in the year 1954 and has been progressive since then. HPStCB is the apex institution in the three-tier cooperative credit structure, operating in state of Himachal Pradesh (India). It lead with Branch network of 218 branches and 23 Extension Counters and occupy a unique position in the cooperative credit structure in H.P because of its three important functions:

- (a) HPStCB provide a link, through which the Reserve Bank of India provides credit to the cooperatives and thus participates in the rural finance,
- (b) HPStCB function as balancing centers for the central cooperative banks (Kangra Central Cooperative Bank Ltd. & Jogindra Central Cooperative Bank Ltd.) in H.P by making available the surplus funds for these central cooperative banks. The central cooperative banks are not permitted to borrow or lend among themselves,
- (c) At present the HPStCB is performing dual function viz. that of Apex Co-operative Bank in Himachal Pradesh to play lead role in development in Co-operative in the State and that of a Co-operative Bank in 6 districts viz. Bilaspur, Chamba, Kinnaur, Mandi, Shimla and Sirmour.

**Capital:**

HPStCB obtain their working capital from own funds, deposits, borrowings and other sources:

- (i) Own funds include share capital and various types of reserves and surplus. Major portion of the share capital is raised from member cooperative societies and the central cooperative banks, and the rest is contributed by the state government. Individual contribution to the share capital is very small;

(ii) The main source of deposits is also the cooperative societies and central cooperative banks. The remaining deposits come from individuals, local, board's corporations and others.

(iii) Borrowings of the HPStCB are mainly from the other Banks and other institutions and agencies.

**Loans and Advances:**

HPStCB is mainly formed for the purpose to providing loans for agricultural purposes and advances to the cooperative societies. However, this trend is changing and now HPStCB is giving competition to other nationalized banks in other sector also.

**2. REVIEW OF LITERATURE**

1. **Dr. Asif Perwej (October 2020)**, in his research the impact of pandemic COVID-19 on the Indian banking system Said that the COVID - 19 badly impacted the Indian banking sector and affected the regular banking operations. It ultimately affects the financial sector of the globe to face this challenge banks need to adopt some new and innovative strategies. It's the time to adopt new technology and flexibility in infrastructure including each and every operation. As per the researcher there is need to expedite the online processing system with in the bank and should digitalized all the banking transaction as soon as the can. All the processes functions and systems should be get digitalized.
2. **Dr. Asif Pervej (2020)**, the worldwide spreads of COVID have been hampered. The COVID impacted every industry across the globe in recent months. As industries attempt to recover, there is a need for new strategic initiatives and higher preparation. Banks and the wider financial services sector are facing multiple challenges from the ongoing global impact of COVID-19 pandemic is an u economy. Banks must continue to leverage technology and build flexibility in their infrastructure to navigate these challenges.
3. **Mayank Jindal et. al. (2020)**, "It has found that online banking playing an important role in the Covid-19 period to protect the people. All type of people using online banking feeling safe in the online payment from Covid-19 virus. As per the sampling and response, people feel 89.12% safe in using online banking. People felt completely safe from the Covid-19 virus in the online payment of bills, fund transfer and other banking transactions.
4. **Nicola, et. al. (2020)**, after studying the impact of covid-19 on Economy estimated about the economic crisis and recession. They focused on socio-economic effects of covid-19 on the world economy in paper.
5. **Dr. Priyanka Bobade et. al. ( Dec 2020 )**, Concluded in their research on study the effect of COVID 19 in Indian banking sector that, there is need to change some ways as well as style of working by maintaining healthy environment and by reskilling the employees towards the system and processes. Customer centric approach should get focused first by adopting digital channels For this RBI should take initiative by framing policy for enhancing business continuity. To cope up with the situation government should take the initiative to encourage the people to design innovative model for business and focusing on digital system with latest technology.
6. **Peterson K Ozili et. al. (2020)**, study highlights how spread of virus has created uncertainty in behaviour of consumers, investors and international partners. The fast policy making decisions by the Government of the country for responding to virus have led many countries to recession.
7. **Mr. Rambabu Cherukur et. al. (2020)**, In this pandemic, there is a need to create more awareness among the public. Digital platform usage by the public can become a greater solution to the non-flexibility problems. To study the changes happening in the field of banking due to covid19.To analyze customer perception towards the usage online banking during pandemic in.To know their satisfaction and opinion about banking services.
8. **S. Mahendra Dev et. al. (2020)**, The paper of Mahendra and Rajeshwari studies impact of Lockdown and various covid guidelines introduced by the Government. The authors have studied the outcome of various schemes introduced by the Government and fund release to deal with damage caused by virus. The authors also focus on the financial position of major banks in India and also fall in demand of oil, petrol, diesel, electricity and impact of demand crops of companies and various stakeholders.
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companies and various stakeholders.

10. **Vikas kumar et. al. (Jan 2021)**, Impact of COVID - 19 on Indian Economy with Special Reference to Banking Sector: An Indian Perspective Said that this COVID 19 strongly affected the Indian banking sector and economy and it still impossible to find out its depth and span. The government and RBI are involve in taking some initiative to minimize the effects of COVID - 19 on economy. It is concluded that this pandemic situation need a strong and flexible leadership to protect the long term damage on Indian economy.

### **3. OBJECTIVES OF THE STUDY**

The main objective of the research is to study the overall performance of Himachal Pradesh State Cooperative Bank Ltd. in covid-19 pandemic situation. In this research primary and secondary data is considered. Following are the objective of this research:-

1. To study the impact of COVID-19 pandemic situation on Himachal Pradesh State Co-operative Bank Ltd. (HPStCB).
2. To find out solution for HPStCB to face COVID-19 Pandemic situation.
3. To know the potential of HPStCB functioning in Himachal Pradesh.
4. To explore the future strategies and suggest measures to improve the efficiency of the HPStCB in COVID-19 pandemic situation.

### **4. RESEARCH METHODOLOGY**

#### **Research Design and Sampling:**

The research design of the study is descriptive and analytical in nature. For the study work data of Himachal Pradesh State Cooperative Bank Ltd. are presented in condensed form and research is limited for the period of four years from fiscal year 2016-17 to 2019-20. In this research primary and secondary data is considered:-

1. **Primary data:** Primary data collection was restricted to six districts of the state of H.P, where the H.P State co-operative bank is functioning viz. Bilaspur, Chamba, Kinnaur, Mandi, Shimla and Sirmour. A multistage random sampling technique is used to choose the sample responders.
2. **Secondary data:** The majority of study is based on secondary data collected through various sources like audit reports of HPStCB and published reports of the IBA (Indian Banks Association), annual reports, NAFCB (National Federation of co-operative Bank) are the sources of collected data. The profit and loss accounts and Balance sheets of selected bank i.e. HPStCB are presented in condensed forms.

**Table 1: Performance of H.P State Co-operative Bank Ltd. since 2016-17 to 2019-20**

<b>Upto</b>	<b>Share capital (Rs. in crore)</b>	<b>Over the year growth (%)</b>	<b>Aggregate deposit (Rs. in crore)</b>	<b>Over the year growth (%)</b>	<b>Aggregate Advances (Rs. in crore)</b>	<b>Over the year growth (%)</b>	<b>CD Ratio</b>	<b>Net Profit (Rs. in crore)</b>	<b>Over the year growth (%)</b>
2016-17	8.74		9092.84		4758.26		52.33	93.2	
2017-18	8.77	0.34	9954.56	9.48	5162.01	8.49	51.86	49.78	-46.59
2018-19	8.9	1.48	11030.65	10.81	5620.26	8.88	50.95	41.09	-17.46
2019-20	8.92	0.22	11844.21	7.38	6850.83	21.9	57.84	50.48	22.85

**(Source: Data taken from annual reports and compiled in MS-Excel)**

### **5. HYPOTHESIS**

The hypothesis relating to the study for co-operative bank issues and challenges are:-

1. There is no significant relationship between performances of HPStCB with COVID-19 pandemic situation.
2. There is no significant relationship between COVID-19 pandemic situation and future strategies of HPStCB.

## 6. ANALYSIS

**Analysis of data:** Secondary data for the study is analyzed using ratios. Bank performance in each ratio is assessed over a four years from fiscal year 2016-17 to 2019-20. Banks performance averages are calculated and compared using the banks' mean ratios.

Table 2: Growth of H.P State Co-operative Bank Ltd. since 2016-17 to 2019-20

Sr. No	Particular	2017-2020				%age growth last 4 years
		2017	2018	2019	2020	
1	Owned Funds (Total)	984.6	1054.76	1133.56	1226.46	25%
2	Share capital	8.73	8.77	8.90	8.92	
3	Deposits (Total)	9092.83	9954.56	11030.7	11844.2	30%
4	Borrowings o/s (Total)	1785.19	1735.9	1603.76	2055.49	15%
5	Investments (Total)	6552.66	6890.59	7394.89	7757.82	18%
6	SLR	2290.05	2598.25	2551.35	2219.83	
7	Non SLR	4262.61	4292.34	4843.54	5537.99	
8	Loans & Adv. (O/S)	4758.27	5162.00	5620.27	6850.83	44%
9	Short Term (SAO)	755.81	855.96	966.31	1061.66	40%
14	Total working capital	12082.87	12384.85	13206.04	14409.06	19%
15	CRAR	16.92%	13.98%	13.56%	16.06%	
16	NPA Amount	273.44	412.52	517.85	547.52	
17	Gross NPA %age	8.62%	7.99%	9.21%	7.99%	
18	Operational Profit(+)	158.20	111.19	125.45	145.67	
19	CD Ratio	52.33	51.86	50.95	57.84	11%
20	Branches	199	218	218	218	10%
21	Extension Counters	21	23	23	23	
22	ATMs				100	
	POS	4	60	100	150	

(Source: Data taken from annual reports and compiled in MS-Excel)

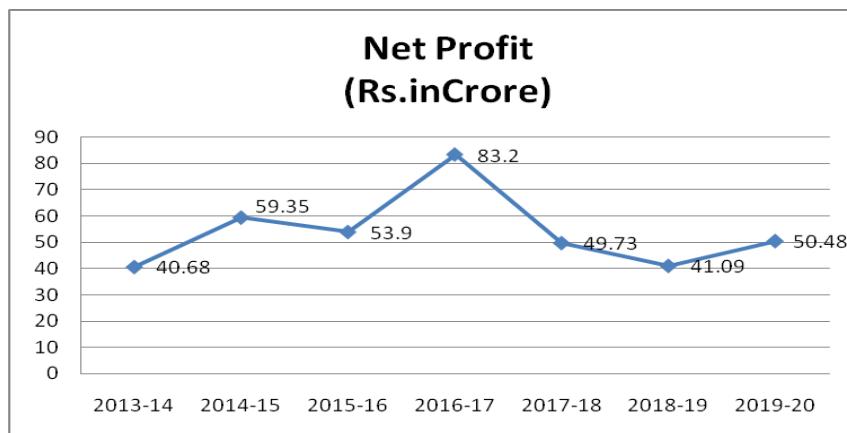
Table 3: Performance of the HPStCB as Compared to National Parameter

Parameters	National Level	HPStCB Achievements 2019-20
CD ratio	60%	57.84%
Priority Sector advances	40%	43.10%
Agri. Advances	18%	18.49%
Weaker Section	10%	26.77%
Micro enterprises	7.5%	7.96%

(Source: Data taken from annual reports and compiled in MS-Excel)

- a) **Performance of the Bank as Compared to National Parameter:-** The table revealed that in COVID-19 pandemic situation performance of HPStCB is on higher side as compared to national level parameters. In COVID-19 pandemic situation HPStCB has undertaken the programme for the development of weaker section, women and agriculture advances.

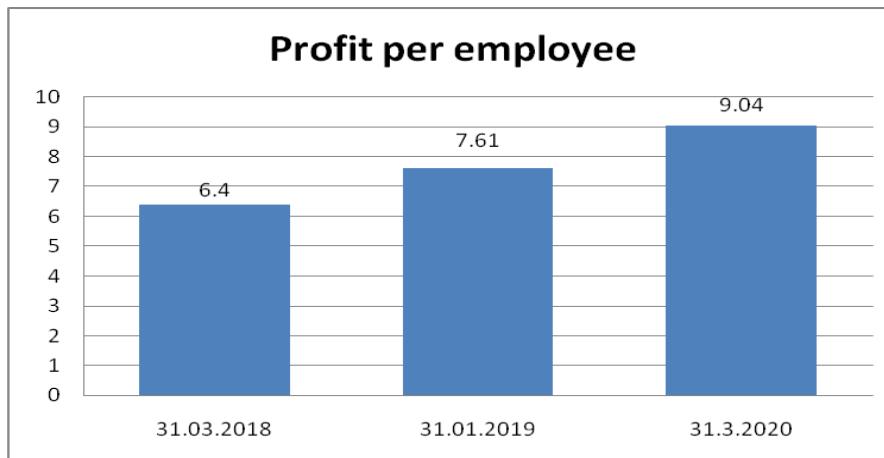
**Fig. 1: Net Profit**



(Source: Data taken from annual reports and compiled in MS-Excel)

**b) Net Profit:** The net profit of the bank was Rs.40.68 crore in the year 2013-14 which increased to Rs.59.35 crore in 2014-15. The net profit of the bank reflects the volatility. It was Rs.41.09 crore in 2018-19 and during COVID-19 pandemic period i.e. in 2019-20 it has increased to Rs.50.48 crore.

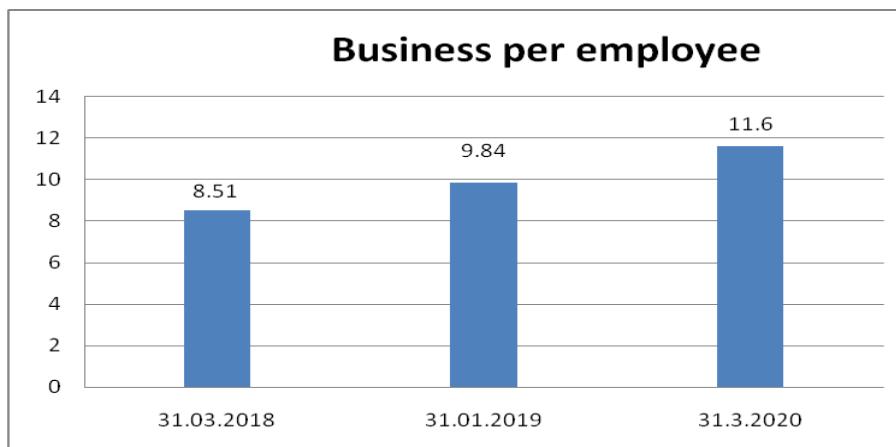
**Fig. 2: Profit per employee**



(Source: Data taken from annual reports and compiled in MS-Excel)

**c) Profit per employee:** Gross profit per employee has increased from Rs 6.40 lakh as on March 31, 2018, to Rs 7.61 lakh as on March 31, 2019 and during COVID-19 pandemic situation HPStCB has shown increasing trend and gross profit per employee has increased to Rs 9.04 lakh as on March 31, 2020.

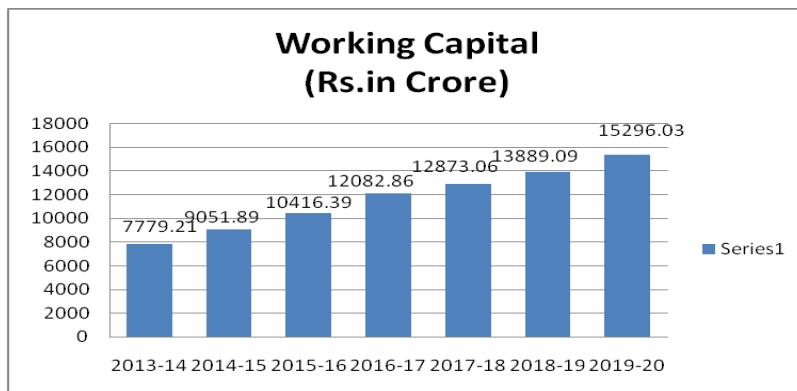
**Fig. 3: Business per employee**



(Source: Data taken from annual reports and compiled in MS-Excel)

**d) Business per employee:** The turnover per employee was Rs. 8.51 crore as on March 31, 2018 and increased from Rs.9.84 crore as on March 31, 2019 to Rs.11.60 crore as on March 31, 2020, showing an increase of Rs.1.76 crore shows that HPStCB has performed well in COVID-19 pandemic situation.

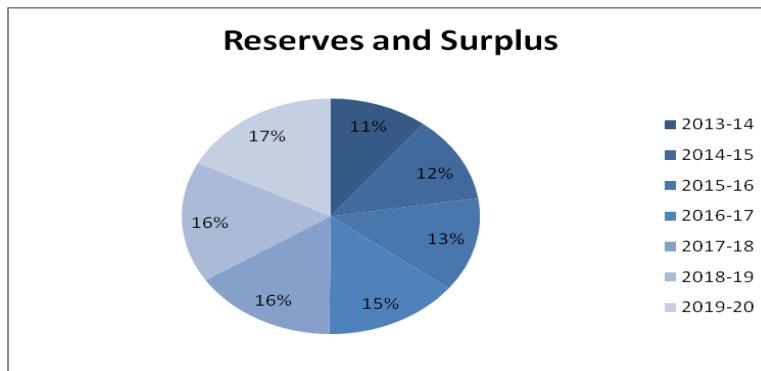
**Fig.4: Working Capital**



(Source: Data taken from annual reports and compiled in MS-Excel)

**e) Working Capital:** The working capital of HPStCB is Rs.7779.21 crore as on 31.03.2014 has grown to Rs.15296.03 crore as on 31st March, 2020 against Rs.13889.19 crore as on 31st March, 2019 which shows an enhancement of Rs.1406.84 crore during COVID-19 period i.e.2019-20.

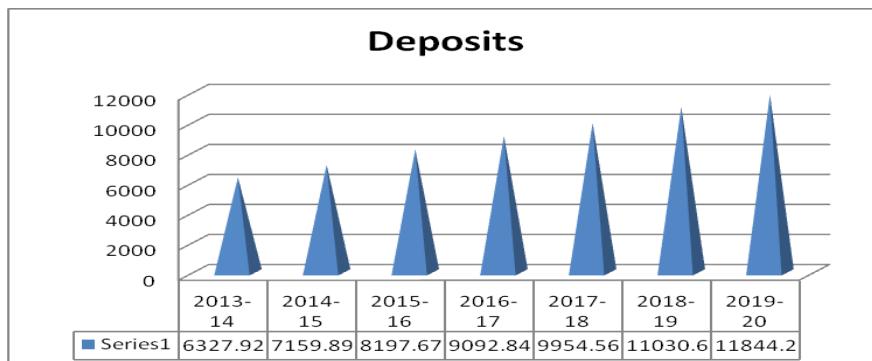
**Fig. 5: Reserves and Surplus**



(Source: Data taken from annual reports and compiled in MS-Excel)

**f) Reserves and Surplus:** The Reserve Fund and other funds of HPStCB are being strengthened every year by appropriating the Net Profit of the Bank. The Reserves and Surplus of the bank is increasing every year as shown in the graph. It has increased from Rs.924.07 crore as on 31st March 2019 to Rs.981.09 crore as on 31st March, 2020.

**Fig. 6: Deposits**



(Source: Data taken from annual reports)

**g) Deposits:** Deposits of HPStCB was Rs.6327.92 Crore in 2013-14 which has grown to Rs.7159.59 in 2014-15, Rs.8197.67 Crore in 2015-16, Rs.9092.84 crore in 2016-17, Rs.9954.56 crore in 2017-18 and has shown continues growth. Deposits have escalated from Rs. 11030.65 crore as on 31st March, 2019 to Rs.11844.20 crore as on 31st March, 2020 recording a growth of 7.38% during COVID-19 period.

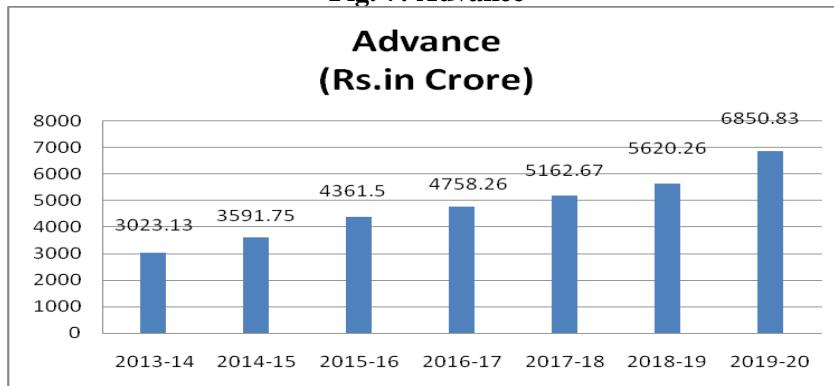
**h) Borrowing:** The borrowing portfolio mainly consists of refinance from NABARD which is 97.76% of the total borrowings as on 31st March, 2020. The rest 2.24% consists of borrowing from ICDP and NCDC. Borrowing as on 31st March, 2020 was 2055.49 crores, while as on 31st March, 2019 it was Rs 1603.76 crores.

**Table:4** **Uses of Funds during COVID-19 period** (Rs. in crore)

Particulars	2019-20
Cash and Bank Balances	453.02
Balances with Bank and Money at Call	5476.06
Investments	2343.51
• SLR	2219.82
• Non-SLR	123.69
Loan and Advances	6850.83
• Short Term	1548.47
• Medium Term	2215.73
• Long Term	3086.63
Fixed Assets	30.7
Other Assets	141.89

(Source: Data taken from annual reports)

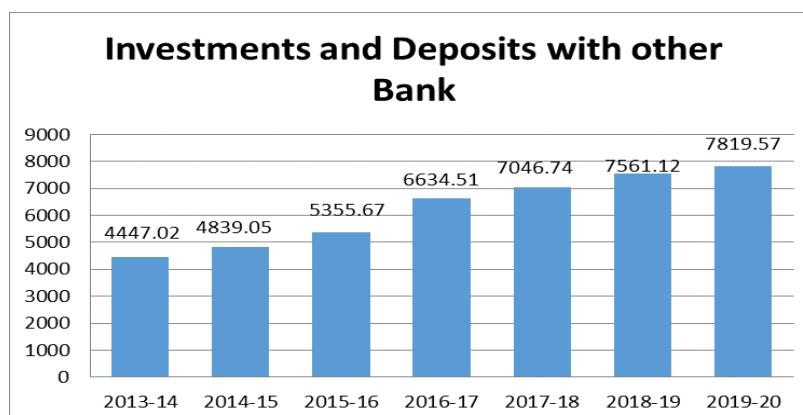
**Fig. 7: Advance**



(Source: Data taken from annual reports)

**i) Advance:** The total advance of banks in the year 2013-14 was Rs.3023.13 crore which is increasing continuously. There has been an increase from Rs.5620.26 crore as on March 31, 2019 to Rs.6850.83 crore as on March 31, 2020 with tremendous growth of 21.90% during COVID-19 phase.

**Fig. 8: Investments and Deposits with other Bank**



(Source: Data taken from annual reports)

**j) Investments and Deposits with other Bank**

The investment and deposits with other banks was Rs. 4447.02 Crore in 2013-14 and grown to Rs. 7819.57 crore in 2019-20. Whereas Investment portfolio stand at Rs.2343.51 crore as on 31st March, 2020 which was 2715.91 crore as on 31st March, 2019. The major part of investments includes Government securities.

**k) Other Findings**

The paid up share capital of the bank has increased from Rs. 8.90 crore by March 31, 2019 to Rs. 8.92 crore by next year. From above tables and figures it is revealed that in covid-19 pandemic situation performance of the bank is excellent as compared to national level parameters.

**7. SUGGESTIONS**

- HPStCB should focus on implementation of digital banking facilities in Bank.
- RBI should relax their norms to give licence for net banking facilitie to cooperative banks.
- The HPStCB should transparently express the availability of the loans and documents demanded by its customers. This would help the customers to avail the loans without any procedural delays.
- To remain competitive in market HPStCB should explore other possibilities for lending their loans viz. door to door facilities, online loan facilities etc. shall be adopted.

**8. CONCLUSION**

1. The research attempted to analyze the overall position of HPStCB in COVID-19 pandemic situation. After reviewing all of the above criteria, it is determined that HPStCB, instead of COVID-19 situation has performed and recovered exceptionally well in year 2019-20. Instead of bank's low infrastructure in term of digital banking (viz. internet banking facilities, online loaning etc. which are not presently functional in HPStCB), the bank has succeeded to increase its overall performance in comparison to national level. In the research it is found that in fiscal year 2016-17 to 2019-20 HPStCB financial position have shown growth of 30% in respect of deposit, 44% in advances and 19% growth in total working capital. It is discovered that HPStCB has sufficient quantity of liquid assets to deal with any situation however due to less administrative thinking net profit of this bank has shown fluctuation.
2. In this research it is concluded that due to non-availability of digital banking, the HPStCB are facing challenges and are not able to formulate their full potential for investment (which has shown marginal growth of 18% in fiscal year 2016-17 to 2019-20) with their available funds (owned fund 25% growth).
3. Finally, the research finds that HPStCB have high degree of potential and has performed well in this COVID-19 pandemic situation. But profitability is a major issue for the bank as the net profit of the bank reflects the volatility in couple of past years. Bank must reduce their operational costs and seek other revenue streams since their non-interest income is low. Some initiative from administration of the bank regarding adopting digital banking is required.

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**TOTAL SPLIT DOUBLE GEODETIC NUMBER OF A GRAPH****DR. T. JEBARAJ AND SAJITHA. D****ABSTRACT**

For a connected graph  $G$  of order  $n$ , a set  $S$  of vertices is called a double geodetic set of  $G$  if for each pair of vertices  $x, y$  in  $G$  there exist vertices  $u, v \in S$  such that  $x, y \in I[u, v]$ . The double geodetic number  $dg(G)$  is the minimum cardinality of a double geodetic set. A set  $S \subseteq V(G)$  is a split double geodetic set of  $G$ , if  $S$  is a double geodetic set and  $\langle V - S \rangle$  is disconnected. The split double geodetic number of a graph  $G$ , is denoted by  $dg_s(G)$ , is the minimum cardinality of a split double geodetic set of  $G$ . A total split double geodetic set of a graph  $G$  is a split double geodetic set  $S$  such that the subgraph  $G[S]$  induced by  $S$  has no isolated vertices. The minimum cardinality of a total split dg-set of  $G$  is the total split double geodetic number of  $G$  and is denoted by  $dgt_s(G)$ . The total split double geodetic number of some standard graphs are obtained. In this paper we shown the relationship between split double geodetic number and total split double geodetic number of  $G$ .

**Keywords:** split geodetic set, double geodetic number, total double geodetic number, split double geodetic set, total split double geodetic number. **AMS Subject Classification:** 05C12

**INTRODUCTION**

By a graph  $G = (V, E)$  we mean a finite undirected connected graph without loops or multiple edge. The order and size of  $G$  are denoted by  $n$  and  $m$  respectively. The distance  $d(u, v)$  between two vertices  $u$  and  $v$  in a connected graph  $G$  is the length of a shortest  $u - v$  path in  $G$ . It is well known that this distance is a metric on the vertex set  $V(G)$ . For a vertex  $v$  of  $G$ , the eccentricity  $e(v)$  is the distance between  $v$  and a vertex farthest from  $v$ . The minimum eccentricity among the vertices of  $G$  is radius,  $\text{rad } G$ , and the maximum eccentricity is the diameter,  $\text{diam } G$ . A  $u - v$  path of length  $d(u, v)$  is called a  $u - v$  geodesic. We define  $I[u, v]$  to the set of all vertices lying on some  $u, v$  geodesic of  $G$  and for a non empty subset  $S$  of  $V(G)$ ,  $I[S] = \cup_{u, v \in S} I[u, v]$ . A set  $S$  of vertices of  $G$  is called a geodesic set in  $G$  if  $I[S] = V(G)$  and a geodetic set of minimum cardinality is a minimum geodetic set. The cardinality of a minimum geodetic set in  $G$  is called the geodetic number of  $G$ , and we denote it by  $g(G)$ . Double geodetic number of a graph was studied by in [4]. A set of vertices of  $G$  is called a double geodetic set of  $G$  if for each pair of vertices  $x, y$  in  $G$  there exist vertices  $u, v$  in  $S$  such that  $x, y \in I[u, v]$ . The double geodetic number  $dg(G)$  of  $G$  is the minimum cardinality of double geodetic set. Any double geodetic set of cardinality  $dg(G)$  is called dg-set of  $G$ . Total double geodetic number of a graph was studied by in [12]. A total double geodetic set of a graph  $G$  is a double geodetic set  $S$  such that the subgraph  $G[S]$  induced by  $S$  has no isolated vertices. The minimum cardinality of a total dg-set of  $G$  is the total double geodetic number of  $G$  and is denoted by  $dgt(G)$ .

Split double geodetic number of a graph was studied by in [14]. A double geodetic set  $S$  of a graph  $G = (V, E)$  is a split double geodetic set if the induced subgraph  $\langle V - S \rangle$  is disconnected. The split double geodetic number  $dg_s(G)$  of  $G$  is the minimum cardinality of a split dg-set. A vertex  $v$  is an extreme vertex a graph  $G$ , if the subgraph induced by its neighborhood is complete. The neighborhood of a vertex  $v$  in a graph  $G$ , is the subgraph of  $G$  induced by all vertices adjacent to  $v$ . A vertex  $v$  is a weak extreme vertex of  $G$  if there exists a vertex  $u$  in  $G$  such that  $u, v \in I[x, y]$  for a pair of vertices  $x, y$  in  $G$ , then  $v = x$  or  $v = y$ . A vertex cover in a graph  $G$  is a set of vertices that covers all edges of  $G$ . The minimum number of vertices in a vertex cover of  $G$  is the vertex covering number  $\alpha_0(G)$  of  $G$ . If  $e = uv$  is an edge of graph  $G$  with  $\deg(u) = 1$  and  $\deg(v) > 1$ , then we call ' $e$ ' a pendent edge or end edge, ' $u$ ' a leaf or end vertex and ' $v$ ' a support vertex of  $u$ . The minimum degree of  $G$ ,  $\delta(G)$ , is the smallest of the degree of vertices in  $G$  and the maximum degree  $\Delta(G)$  of  $G$  is the largest of the degrees of the vertices in  $G$ . The following results definitions will be used in the sequel.

Theorem 1.1 [12] Every total double geodetic set of a connected graph  $G$  contains all the weak extreme vertices and the support vertices of  $G$ . In particular, if the set  $S$  of all weak extreme vertices and support vertices is a total dg-set then  $S$  is the unique  $dgt$ -set of  $G$ .

Theorem 1.2 [14] For the Gear graph  $G_n$  ( $n \geq 3$ ),  $dg_s(G_n) = \begin{cases} n & \text{if } n = 3 \\ n-1 & \text{if } n = 4 \\ n+1 & \text{if } n > 4 \end{cases}$

Definition 1.3 [3] An armed crown is a graph in which path  $P_n$  is attached at each vertex of cycle  $C_n$  by an edge.

Theorem 1. 4 [14] Let  $G$  be a connected graph of order  $n$ , such that  $G$  has a split dg-set  $S$  then  $2 \leq dg(G) \leq dg_s(G) \leq n - 2$ .

Theorem 1.5 [4] Each extreme vertex of a connected graph  $G$  belongs to every double geodetic set of  $G$ . In particular, if the set of all end vertices of  $G$  is a double geodetic set, then it is the unique dg-set of  $G$ .

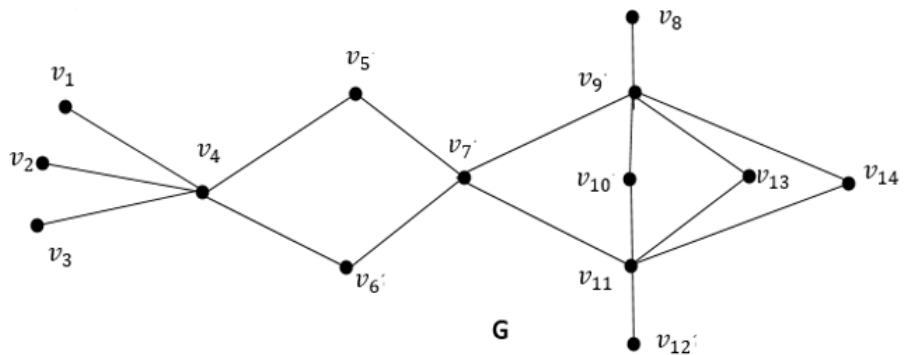
### Total Split Double Geodetic Number of a Graph

#### Definition 2.1

Let  $G$  be a connected graph with atleast 5 vertices. A total split double geodetic set of a graph  $G$  is a split double geodetic set  $S$  such that the subgraph  $G[S]$  induced by  $S$  has no isolated vertices. The minimum cardinality of a total split dg-set of  $G$  is the total split double geodetic number of  $G$  and is denoted by  $dgt_s(G)$ .

#### Example 2.2

For the graph  $G$  given in Figure 2.1,  $S = \{v_1, v_2, v_3, v_8, v_{12}, v_{10}, v_{13}, v_{14}, v_7\}$  is the minimum split dg-set of  $G$ , so that  $dgs(G) = 9$ . Note that the subgraph induced by  $S$  has isolated vertices so that  $S$  is not a total split dg-set of  $G$ . Clearly  $S' = \{v_1, v_2, v_3, v_8, v_{12}, v_{10}, v_{13}, v_{14}, v_7, v_4, v_9, v_{11}\}$  is a minimum total split dg-set of  $G$  and so  $dgt_s(G) = 12$ . Thus the total split dg-number and the split dg-number of a graph can be different.



**Figure 2.1**

#### Theorem 2.3

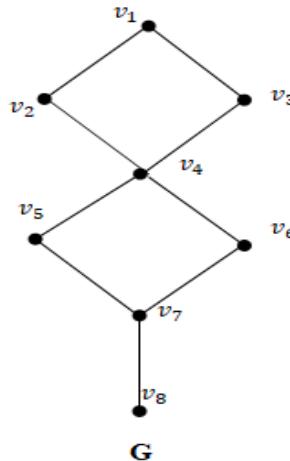
Let  $G$  be a connected graph of order  $n$ , such that  $G$  has a total split dg-set  $S$  then  $2 \leq dgs(G) \leq dgt_s(G) \leq n - 2$ .

#### Proof:

A split dg-set needs atleast two vertices and therefore  $dgs(G) \geq 2$ . It is clear that every total split dg-set is also a split dg-set and so  $dgs(G) \leq dgt_s(G)$ . Since by Theorem [1.4],  $dgt_s(G) \leq n - 2$ .

#### Remark 2. 4

The bounds in Theorem 2.3 are sharp. For any even cycle  $C_{2n}$ ,  $dgs(C_{2n}) = 2$  and for path  $P_8$ ,  $dgt_s(P_8) = n - 2$ . Also for the graph  $G = P_n \odot k_2$ ,  $dgs(G) = dgt_s(G)$ . Further all the inequalities in Theorem 2.3 are strict, for the graph  $G$  in Figure 2.2,  $dgs(G) = 3$ ,  $dgt_s(G) = 5$  and  $n - 2 = 6$ . So that  $2 < dgs(G) < dgt_s(G) < n - 2$ .



**Figure 2.2**

**Theorem 2.5**

For the cycle  $C_{2n}$  ( $n \geq 3$ ),  $dgt_s(C_{2n}) = 4$ .

**Proof:**

Let  $S = \{p, q\}$  be a split dg-set of  $C_{2n} = G$  and  $d(p, q) = diam(G)$ . Further, it is not a total split dg-set, since the subgraph  $G[S]$  induced by  $S$  has isolated vertices. Therefore to form a total split dg-set of  $G$  from  $S$ , the corresponding neighborhood of each vertex in  $S$  is to be added. Clearly  $S' = \{p, q, r, s\}$  forms a minimum total split dg-set of  $G$ . It follows that  $dgt_s(G) = dgt_s(C_{2n}) = 4$ .

**Theorem 2.6**

For the path  $P_n$  ( $n \geq 8$ ),  $dgt_s(P_n) = 6$ .

**Proof:**

Let  $\{v_1, v_2, \dots, v_{n-1}, v_n\}$  be the vertices of the path  $P_n$ . Consider  $H = \{v_1, v_n\}$  and let  $H' = H \cup \{v_i\}$  be a split dg-set of path  $P_n$ . Since  $v_1 - v_n$  path covers all the pair of vertices of path  $P_n$  and the induced subgraph  $<V - H'>$  is disconnected. Here  $v_1, v_n$  are the end vertices of  $P_n$  and  $v_i$  is a cut vertex in  $V - H'$ , which is not adjacent with the end vertex of  $V - H$ . Moreover the subgraph induced by  $H'$  has isolated vertices, so it is not a total split dg-set of  $P_n$ . Therefore to form a total split dg-set of  $P_n$  from  $H'$ , the appropriate neighborhood of each vertex in  $H'$  is to be added. It follows that  $H'' = \{v_1, v_{n-1}, v_{i+1}, v_2, v_i, v_n\}$ , forms a minimum total split dg-set of  $P_n$ . Hence  $dgt_s(P_n) = 6$ .

**Theorem 2.7**

For the graph  $C_{2n} \odot pk_1$  ( $n \geq 3, p \geq 1$ ),  $dgt_s(C_{2n} \odot pk_1) = p + 3$ .

**Proof:**

Consider  $G = C_{2n} \odot pk_1$ . Let  $\{u_1, u_2, \dots, u_{2n}, u_1\}$  be a cycle with  $2n$  vertices and  $v_1, v_2, \dots, v_p$  be the p-end vertices of  $G$ . Now  $V(G) = \{u_1, u_2, \dots, u_{2n}, v_1, v_2, \dots, v_p\}$ . First we prove that  $\{u_1, v_1, v_2, \dots, v_p\}$  are the weak extreme vertices of  $G$ . Let  $u_1$  be a vertex of  $C_{2n}$  and  $u_1 - v_1$  be a diametral path of  $G$ . Obviously, the pair  $u_1, v_1$  lie only on  $I[u_1, v_1]$ , as a result  $u_1, v_1$  are the weak extreme vertices of  $G$ . Similarly  $(u_1, v_2), (u_1, v_3), \dots, (u_1, v_p)$  are the weak extreme vertices of  $G$ . Suppose  $H' = \{u_1, u_k, v_1, v_2, \dots, v_p\}$  is a total split dg-set of  $G$ , where  $u_k$  is a support vertex of  $v_1, v_2, \dots, v_p$  and  $d(u_1, v_i) = diam(G)$ ,  $1 \leq i \leq p$ . It follows that  $<V - H'>$  is disconnected and the subgraph  $G[H']$  induced by  $H'$  has one isolated vertex, which is a contradiction. Further  $H'' = \{u_1, u_2, u_k, v_1, v_2, \dots, v_p\}$  forms a minimum total split dg-set of  $G$  and hence  $dgt_s(C_{2n} \odot pk_1) = p + 3$ .

**Theorem 2.8**

$$\text{For the Gear graph } G_n, (n \geq 3), dgt_s(G_n) = \begin{cases} 4 & \text{if } n = 3, 4 \\ \frac{3(n+1)}{2} & \text{if } n \text{ is odd and } n \geq 5 \\ \frac{3n+2}{2} & \text{if } n \text{ is even and } n \geq 6 \end{cases}$$

**Proof:**

Let the Gear graph  $G_n$  has  $2n + 1$  vertices and  $3n$  edges and let

$V(G_n) = \{v_1, v_2, \dots, v_{2n}, x\}$ , where  $\deg(x) = n$ ,  $n \geq 3$ . In  $G_n$ , the  $n$  alternate vertices of  $C_{2n}$  are connected with a central vertex 'x' which is named as major vertices and the other  $n$  alternate vertices of  $C_{2n}$  are not connected with 'x' which is named as minor vertices. We have the following cases.

Case (i) When  $n = 3, 4$

Let  $S = \{p, q, r, s\}$  be a total split dg-set of  $G_n$  and  $d(p, q) = diam(G_n)$ ;  $r, s$  are the appropriate neighborhoods of  $p$  and  $q$ . Deleting any one vertex from  $S$ , it doesn't form a total split dg-set. So  $S$  is the minimum total split dg-set of  $G_n$ . Thus  $dgt_s(G_n) = 4$ .

Case (ii)  $n$  is odd and  $n \geq 5$

By Theorem [1.2],  $dgt_s(G_n) = n + 1 = \{u_1, u_2, \dots, u_n, x\} = Q$

Where x is the central vertex and  $u_1, u_2, \dots, u_n$  is the set of minor vertices of  $G_n$  with  $\deg(u_j) = 2, 1 \leq j \leq n$ . Also the subgraph induced by  $Q$  has  $n+1$  isolated vertices, therefore to form a total split dg-set of  $G_n$ , add

$\binom{n+1}{2}$  major vertices of  $G_n$  to  $Q$ . It follows that  $Q$  is a minimum total split dg-set of  $G_n$ . Thus  $dgt_s(G_n) = n + 1 + \binom{n+1}{2} = \frac{3n+3}{2} = \frac{3(n+1)}{2}$

Case (iii)  $n$  is even and  $n \geq 6$

Proof follows from the above case,  $dgt_s(G_n) = n + 1$ . Since the subgraph induced by  $Q$  has  $n+1$  isolated vertices. Then to find a total split dg-set of  $G_n$ , add  $\frac{n}{2}$  major vertices of  $G_n$  to  $Q$ . It follows that  $Q$  is a minimum total split dg-set of  $G_n$ .

Thus  $dgt_s(G_n) = (n + 1) + \frac{n}{2}$

$$= \frac{2n + 2 + n}{2} = \frac{3n + 2}{2}$$

### Theorem 2.9

For the graph  $P_n \odot K_2$ , ( $n \geq 3$ ),  $dgt_s(P_n \odot K_2) = 2n + 1$ .

**Proof:**

Let  $X = \{u_1, u_2, \dots, u_n\}$  be the vertices of path  $P_n$  and  $Y = \{v_1, v_2, \dots, v_{2n}\}$  be the vertices of  $n$ - copies of  $K_2$ . Consider  $V(P_n \odot K_2) = \{u_1, u_2, \dots, u_n, v_1, v_2, \dots, v_{2n}\}$ . First we prove that  $\{v_1, v_2, \dots, v_{2n}\}$  are the weak extreme vertices of  $P_n \odot K_2$ . Let  $v_x \in Y$  and  $v_y$  be a extreme vertex of  $P_n \odot K_2$ . Then  $v_x \neq u$ , and the pair  $v_x, v_y$  lie only on  $I[v_x, v_y]$ , as a result  $v_x, v_y$  are the weak extreme vertices of  $P_n \odot K_2$ . It follows that the set of all vertices of  $Y$  is a weak extreme vertices of  $P_n \odot K_2$ . Also  $\langle V - Y \rangle$  is a path, so that  $Y$  is not a split dg-set of  $P_n \odot K_2$ . Consider  $Z = \{v_1, v_2, \dots, v_{2n}, u_k\}$  be a split dg-set of  $P_n \odot K_2$ , where  $u_k$  is a cut vertex of  $V - Y$ . Also the subgraph  $G[Z]$  induced by  $Z$  has no isolated vertices and  $\langle V - Z \rangle$  is disconnected. Thus  $Z$  is the minimum total split dg-set of  $P_n \odot K_2$ . Therefore  $dgt_s(P_n \odot K_2) = |Z| = 2n + 1$ .

### Theorem 2.10

For the graph  $P_n \odot K_2$ , ( $n \geq 3$ ),

$$dgt_s(P_n \odot K_2) = \begin{cases} \frac{\Delta(2l+1)-\delta}{2} & \text{if } n \text{ is even and } l = \frac{n}{2} \\ \frac{\Delta(2l+1)+\delta}{2} & \text{if } n \text{ is odd and } l = \frac{n-1}{2} \end{cases}$$

**Proof:**

Let  $V(P_n \odot K_2) = \{u_1, u_2, \dots, u_n, v_1, v_2, \dots, v_{2n}\}$  where  $u_1, u_2, \dots, u_n$  are the vertices of path  $P_n$  and  $v_1, v_2, \dots, v_{2n}$  are the vertices of  $n$  copies  $K_2$ . Now  $\deg(v_i) = 2$  for each  $i \in \{1, 2, \dots, 2n\}$ ;  $\deg(u_1) = \deg(u_n) = 3$  and  $\deg(u_j) = 4$ ,  $j \in \{2, \dots, n-1\}$ . Maximum degree ( $\Delta$ ) of  $P_n \odot K_2$  is 4 and minimum degree ( $\delta$ ) of  $P_n \odot K_2$  is 2. We have the following cases.

Case (i) Let  $n$  be even.

By Theorem [2.9],  $dgt_s(P_n \odot K_2) = 2n + 1$

$$\begin{aligned} &= l\Delta + 1 \text{ where } l = \frac{n}{2} \\ &= l\Delta + \frac{\Delta - \delta}{2} \\ &= \frac{2l\Delta + \Delta - \delta}{2} \\ &= \frac{\Delta(2l + 1) - \delta}{2}, l = \frac{n}{2} \end{aligned}$$

Case (ii) Let  $n$  be odd.

By Theorem [2.9],  $dgt_s(P_n \odot K_2) = 2n + 1$

$$= l\Delta + \delta + 1, \text{ where } l = \frac{n-1}{2}$$

$$\begin{aligned}
 &= l\Delta + \delta + \frac{\Delta - \delta}{2} \\
 &= \frac{2l\Delta + 2\delta + \Delta - \delta}{2} \\
 &= \frac{2l\Delta + \Delta + \delta}{2} \\
 &= \frac{\Delta(2l + 1) + \delta}{2}, l = \frac{n-1}{2}
 \end{aligned}$$

**Theorem 2.11**

If  $dg(G) = n$  or  $n-1$  in a graph  $G$  of order  $n$ , then  $G$  has no total split dg-set.

**Proof:**

Let  $G$  be a connected graph with  $n$  vertices

Case (i) If  $dg(G) = n$

Let  $S = \{u_1, u_2, \dots, u_n\}$  be a dg-set of a graph  $G$ . We claim that  $S$  does not form a total split dg-set. Suppose not, it is clear that  $G[S]$  has no isolated vertices and  $V - S$  is a null set, which is a contradiction. Therefore,  $S$  is not a total split dg-set of  $G$ .

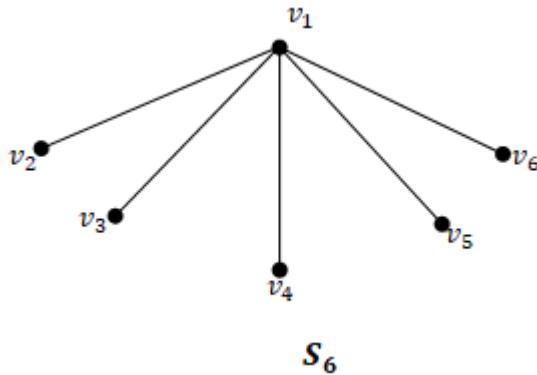
Case (ii) If  $dg(G) = n - 1$

Let  $S' = \{u_1, u_2, \dots, u_{n-1}\}$  be a dg-set of a graph  $G$ . Proceeding as in above case,  $S'$  doesn't form a total split dg-set of  $G$ . Thus  $dg(G) = n$  or  $n - 1$ ,  $G$  has no total split dg-set.

**Corollary 2.12**

If  $dg_t(G) = n$  or  $n - 1$  in a graph  $G$  of order  $n$  then  $G$  has no total split dg-set.

**Example 2.13**



**Figure 2.3**

From the graph  $S_6$  in Figure 2.3,  $dg(G) = \{v_2, v_3, v_4, v_5, v_6\}$  and  $dg_t(G) = \{v_1, v_2, v_3, v_4, v_5, v_6\}$ . It is clear that  $S_6$  has no total split dg-set.

**Theorem 2.14**

For the triangular Ladder graph

$$dgt_s(TL_n) = \begin{cases} 4 & \text{if } n = 3 \\ 5 & \text{if } n \geq 4 \end{cases}$$

**Proof:**

Let  $\{w_1, w_2, \dots, w_{2n}\}$  be the vertices of triangular ladder graph  $TL_n = G$ . We have the following cases to prove the result.

Case (i) when  $n = 3$ .

Suppose  $H = \{w_i, w_j\}$  is a split dg-set of  $G$ . Since  $w_i, w_j$  are the extreme vertices of  $G$  and the induced subgraph  $V - H$  has only one component, which is a contradiction. Consequently define another set  $H' = \{w_i, w_j, w_k, w_l\}$  where  $w_k, w_l$  are the appropriate neighborhoods of  $w_i, w_j$  respectively. Now conspicuously

know  $\langle V - H' \rangle$  is disconnected and the subgraph  $G[H']$  induced by  $H'$  has no isolated vertices so that  $H'$  is a minimum total split dg-set of  $G$ . Hence  $dgt_s(TL_n) = 4$

Case (ii) when  $n \geq 4$

Suppose  $P = \{w_i, w_j, w_k, w_l\}$  is a total split dg-set of  $G$ . Since by Theorem [1.5],  $w_i, w_j \in P$  and  $w_k, w_l$  are the appropriate neighborhoods of  $w_i, w_j$ . Further, the induced subgraph  $\langle V - P \rangle$  has only one component, which is a contradiction. Consequently  $P' = \{w_i, w_j, w_k, w_l, w_m\}$ , where  $w_m$  is the cut vertex in  $V - P$ . Thus the subgraph  $G[P']$  induced by  $P'$  has no isolated vertices and  $\langle V - P' \rangle$  is disconnected. It is clear that  $P'$  forms a minimum total split dg-set of  $G$ , so  $dgt_s(TL_n) = 5$

**Corollary 2.15**

For the Ladder graph,  $dgt_s(L_n) = \begin{cases} 4 & \text{if } n = 3, 4 \\ 5 & \text{if } n \geq 5 \end{cases}$

**Theorem 2.16**

For any armed crown graph  $AC_n$ ,  $dgt_s(AC_n) = 2n+2$ ,  $n \geq 4$ .

**Proof:**

Let  $\{\alpha_1, \alpha_2, \dots, \alpha_n\}$  be the end vertices of  $AC_n$ ,  $\{\beta_1, \beta_2, \dots, \beta_n\}$  be the vertices of cycle  $C_n$ . Consider  $M = \{\alpha_1, \alpha_2, \dots, \alpha_n, \beta_1\}$  be a split dg-set of  $AC_n$ . Since for each pair of vertices  $\alpha, \beta$  in  $AC_n$  lie on some geodesic of a pair of vertices from  $M$  such that  $x, y \in I[M]$  and the induced subgraph  $V - M$  has two components. Moreover the subgraph  $G[M]$  induced by  $M$  has  $n+1$  isolated vertices, so that the appropriate neighborhood of each vertex in  $M$  is to be included. Now  $M' = \{\alpha_1, \alpha_2, \dots, \alpha_n, \beta_1, \alpha_{11}, \alpha_{12}, \dots, \alpha_{1n}, \beta_l\}$  is a minimum total split dg-set of  $AC_n$ , where  $\alpha_{11}, \alpha_{12}, \dots, \alpha_{1n}$  are the support vertices of  $\alpha_1, \alpha_2, \dots, \alpha_n$  and  $\beta_l$  is a neighborhood of  $\beta_l$  for all  $P_n$  except  $P_2$  in  $AC_n$  respectively. Thus  $dgt_s(AC_n) = |M'|$

$$= 2n + 2.$$

**Corollary 2.17**

For any armed crown graph  $AC_n$ ,

$$dgt_s(AC_n) = 2(\Delta + \delta + h), \text{ where } h = n - \Delta$$

**Proof:**

Consider an armed crown graph  $AC_n$  ( $n \geq 4$ ) consists of  $n[n(P_m) + 1]$  vertices. Clearly maximum degree ( $\Delta$ ) of  $AC_n$  is 3 and minimum degree ( $\delta$ ) of  $AC_n$  is 1. We have by Theorem [2.16],  $dgt_s(AC_n) = 2n + 2$ ,  $n \geq 4$

$$= 2[\Delta + h] + 2\delta$$

$$= 2[\Delta + h + \delta], h = n - \Delta.$$

**CONCLUSION**

In this paper, the concept of the total split double geodetic number of a graph was presented and we determined the total split double geodetic number of certain graphs. Also it is shown the relationship between split double geodetic number and total split double geodetic number of  $G$ .

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***AN OVERVIEW ON WORKFORCE RETENTION IN FAST FOOD RESTAURANTS****RUBY JOHN, MANJUNATH AND SAMUEL PAUL ISAAC\*****ABSTRACT**

A company's long-term sustainability and competitive edge in today's economic world are heavily reliant on the quality of its staff. The fast food industry is a labour-intensive business, and employee work satisfaction is critical to its success. In this context, the need for skilled human resources is not only met, but also the need for a long-term workforce is taken into consideration. In order to sustain a high level of employee contentment and loyalty, effective management strategies are required. Fast-food workers' job happiness and career dissatisfaction are reviewed. Fast food business employee retention is influenced by a number of crucial elements, which have been identified in this review. Some of the aspects such as supervisor support, and job security is discussed in this review. Rotation of workers across various departments on the shop floor will reduce the monotonous nature of the work. Motivational practises in these companies must also be rethought to keep workers on the ground level.

*Keywords:* *Fast food industry, Job satisfaction, Employee retention, Human resources, Job security.*

**INTRODUCTION**

The importance of the labour in all businesses cannot be overstated; nevertheless, the service industry is particularly dependent on the existence of its employees. On the basis of employee motivation and organisational dependency, industrial quality is established [1]. Employee productivity, absenteeism, retention, and turnover are all influenced by how happy they are in their jobs and how likely they are to stay there. Employers and other employees will benefit from knowing the contentment level of their superiors. As a result of the decrease in production during new employee training and the increase in expenditures as a result of new employee replacement, employers should pay attention to work satisfaction. Employer's job satisfaction levels can be determined, and company objectives can be evaluated, for a more effective and peaceful working environment, as well as to avert many difficulties in organisations.

In emerging countries, the fast food industry, a component of the food and beverage industry, is on the increase in the service sector. Because this industry provides a wide range of employment prospects for people, one of the most pressing issues facing businesses in this sector has to do with a lack of workforce efficiency and a high turnover rate. When it comes to both cost and availability, personnel is the most critical issue for fast food businesses. Fast-food companies' profitability is heavily reliant on the quality of their employees. Employees must be satisfied, motivated, and committed to the company's goals in order for the workforce to be sufficient and efficient [2]. Workers who are dissatisfied with their jobs tend to be less loyal to their employers. As a result, they either look for a more satisfying career or work inefficiently. This is why the efficiency is so low. The efficacy of the company will rise with the increase in work satisfaction of the workers.

It is important for employers to keep in mind that their employees are more than just a source of revenue; they are also part of the society and family and are working to fulfil their individual wants and requirements. He argued that ensuring the well-being of employees is also a company's social responsibility. The qualities of the organisation itself, as well as the many personal traits of its employees, will support employee welfare and work contentment [3]. So companies should be aware how the workers feel about the work culture and how they're doing there.

It's a rapidly expanding industry. Due to the strong demand for food and beverage items, it is always evolving. Having individuals who are gifted, skilled, and knowledgeable is critical in this field. As a result, this industry places a high value on ensuring the happiness of its personnel. Food and beverages can be purchased and consumed at restaurants or can be delivered at the consumer's place of work or residence. Fast food is ready to eat or can be prepared in a very short time and can be served at the restaurant or packed and delivered at a convenient location for the consumer. It is usually a self-service type restaurant where the product is paid for at the counter and collected from the serving counter to be consumed by the customer [4].

In the fast food industry, turnover is extremely high. Because of the importance placed on customer service in this market, retaining top talent is crucial [5]. Identifying and understanding the essential aspects that influence employee retention in fast food is critical. Training and development, work happiness, reward systems, and a

variety of other factors all contribute to employee retention around the world [6]. However, its significance to the entire fast food sector cannot be overstated, and it necessitates both strong HR involvement and a comprehensive employee retention programme. A thorough knowledge of the important elements affecting employee retention is also necessary [7].

## **LITERATURE REVIEW**

Fast food is served at a fast food establishment. When a customer pays at the counter, he or she generally serves oneself and consumes the merchandise rapidly. Payment is done before the food is served [4]. Usually bakery items like Burgers, Sandwiches, Donuts, or beverages like Coffee, tea, cappuccino, sodas or fried items like French Fries, and other snack products make up the bulk of the merchandise. The company offers a variety of beverages. Pizza isn't fast cuisine, but rather a high-end dining option. Specialty items are served at some quick service restaurants [4].

Management of an organization's human resources (HRM) relies heavily on employee retention. Regardless of the industry, high employee turnover can have a significant financial impact, regardless of whether it is a newer industry like IT services or a traditional manufacturing industry. Different industries have different methods for keeping their best workers happy. All aspects of employee happiness are considered, including training and development, salary, and work culture [8]. Some factors are more important in some industries than others. Maintaining a healthy equilibrium between work and personal life is the most crucial issue in the hospitality industry [9]. Regular training of the staff on the new developments in the fast food industry is the most common reason for employee retention. As with hourly workers in fast food chains, factors such as ease of travel, restaurant location, and flexible hours are critical [5]. This study examines factors other than the most common ones in the fast food sector to see if they have an impact on staff retention. Support from the supervisor, feeling content about the work, progress in the career, assurance about retention of the job are all factors that contribute to these outcomes.

Job satisfaction, is "how people feel about their work and the numerous facets of their work." More than 11,000 studies on job satisfaction have been conducted since the 1930s [10]. Employee retention depends on their level of job satisfaction. Which in turn will reflect in customer satisfaction on the service provided. Organizational training programmes and reward systems also have a direct impact on employee satisfaction at work [11]. Compensation, career advancement, supervisor support, and the nature of the task all contribute to job satisfaction [12]. Job empowerment has been shown to improve employee contentment and dedication to the company [13]. The five elements of Work Features — a demanding work, a feeling of realization, significance of work, nice colleagues, and job security – all affect new employee's levels of job satisfaction [14]. The Herzberg's motivation-hygiene theory is the most widely accepted explanation of job contentment. Job happiness and job discontent are both generated by various circumstances in the workplace, according to psychologist Frederick Herzberg. These components are not interdependent. Dissatisfaction is caused by the absence of Motivators, whereas positive satisfaction is caused by the presence of Hygiene elements.

Young people's future employment prospects are enhanced by working in fast food outlets, where they gain communication skills, self-confidence, teamwork abilities, and routine work practices [15]. Internal raises, succession planning, frequent practise and progress are just some of the ways in which an employee's career can progress. Some fast food workers are looking for a long-term career and switch restaurants frequently. A solid upgradation programme as well as strong job security policies will entice them to invest in their own futures [5]. The quality of an employee's training has a direct correlation with their retention, according to studies. It is six times more likely that employees who have gotten proper training will be retained than those who have not [6]. Employees will not switch their jobs for an extended period of time if they have more opportunity to advance their careers [8].

Employees are motivated to grow professionally in a way that will benefit them in the long run, as we discovered while investigating the final element, career development. As a result, the fast food restaurant has a competitive advantage. However, the manager/role supervisor's is crucial in maximising the potential of the individual [16]. Another study found that 51.5 percent of fast food workers are driven by mentorship, which also found that people are motivated when they are informed they have a specific gift. In order to cultivate talent, supervisors might use a variety of methods, including counselling, mentoring, inspiration, and delegation [16]. The direct subordinate should be given the freedom to make their own decisions and be empowered by their boss. For young employees, this strategy is very effective [17].

Employer branding has been increasingly important in recent years as a means of building a strong firm brand image. In 1996, the term "employer branding" was used to describe the practise of tying the advantages supplied

by an employer to its name. Employer branding can be achieved by making promises to future and present employees about what the firm has to offer and how they can benefit from working for the company [18]. Employees are more likely to stay with a company that has a strong brand. You may attract high-potential individuals by promoting your workplace as a “great place to work”. According to [19] Workplace commitment and contentment are directly impacted by the five core values of staff branding: economic, reputational, developmental, social, and diversity-related [20]. To replace a retiring employee's annual wage with a new hire, an organisation must spend more than it did to keep the existing staff. Employer branding is currently being utilised for recruiting, training, and retaining employees [20].

Corporate social responsibility (CSR), work-life balance (WLC), training and development, and the workplace environment (WE) are all included in this model's definition of employer branding. Workplace happiness, a sense of belonging, increased productivity and employee advocacy are all possible results of effective employer branding. Job satisfaction and psychological contract are directly influenced by the employer's brand, which in turn affects employee retention. Employee morale has an effect on productivity as well. Secondly, employer branding adds to the building of brand advocacy through the dedication of the organisation. While work satisfaction and the psychological contract have a role to play, there is evidence to suggest that employer branding has a direct impact on both productivity and brand advocacy.

It's possible that job security has an effect on employee retention [21]. Promotions from inside have been shown to boost employee retention in a survey of 100 organisations. Employers like McDonald's and KFC use this approach to keep their workers safe. Research has also confirmed this [7]. Job security was shown to be the most important element in retaining employees in another survey. It was cited as a motivator for staff to remain with the business [22]. When employees are confident in their jobs and their futures, they would stay for a long period in the same company. It is more likely that employees will stay with a company if their jobs are not in danger and if they perceive that advancement is possible through personal development. Employee morale improves when a firm has a culture of compassion and generosity [21].

## **RESEARCH FINDINGS**

Job happiness has a direct impact on both corporate and individual productivity and efficiency. Employees who are not happy with their jobs are more likely to leave their positions. Dissatisfaction in the workplace can have far-reaching consequences for the company's long-term success. Job satisfaction has a substantial impact on people's plans to leave their existing positions. As a result of this research, fast-food workers' job happiness and their intents to leave the company are shown to be linked.

According to research, unsatisfied employees are more inclined to quit their jobs [23,24,25]. Research is being done by food and beverage companies. Studying kitchen workers in Korea, researchers found an association between low degree of job satisfaction and the desire to quit [26]. As O'Neill and Davis [27] observed in their study, workers who were dissatisfied with their jobs had a greater tendency to resign.

## **DISCUSSION**

According to the findings of the research, there was a strong connection between employees' feelings of job approval and their intent to leave. According to this study, work satisfaction has an impact on a person's desire to leave their current position. Increased employee commitment to the company will lead to bigger throughput and a lower want to leave the company. In this setting, businesses should first look for strategies to ensure employee happiness and strive for long-term stability. To put it another way, those workers who are content with their occupation are more likely to make sacrifices for their employer's benefit. There can be no long-term success in a firm if individuals are continuously thinking about quitting, which is the most crucial aspect of an organisation, and it has a detrimental impact on other employees' performance.

The majority of fast-food workers are thought to be young and unmarried. Many countries, including Germany and the United Kingdom, have a higher percentage of fast-food workers who are older than their peers [28]. Whereas, according to Giezen [29], fast-food workers tend to be young and unmarried.

A study by Zopiatis et al. [30] found a connection between work fulfilment and employees' intentions to leave their positions in Cyprus's lodging facilities. Researchers Kim and colleagues [31] showed that employees at chain restaurants had a lower level of job satisfaction and a greater desire for a new job if they were more satisfied with their current position.

According to Carbery and colleagues [32], the association between work fulfilment and job objective of 280 hotel leaders in Ireland was explored. Worker satisfaction and willingness to leave the company are said to be affected by these findings. Choi and Sneed [33] found the outcomes of his investigation on 133 persons

employed in various sections of an American institution in parallel with this work. Researchers in Malaysia surveyed 1224 hospitality workers about their job satisfaction and desire to leave their jobs [34].

102 participants from the public and commercial sectors were interviewed for Hellman [35], who then compiled the findings into a single report. There is a correlation between job fulfilment and plan to leave, as well as a number of other characteristics such as gender, age, education, and employment duration.

Analysis shows that there is a negative association between internal happiness, outward satisfaction, and overall job satisfaction and a desire to leave. Intention to depart was negatively correlated with external contentment, while interior contentment was not statistically significant. People who are content with their jobs have a lower desire to leave, and this is supported by the findings of a new study.

One can infer that plans to leave will have a significant influence on corporate goals from statements made. This is the time at which characteristics like work satisfaction may improve or reduce the possibility of a decision to leave the company.

## **CONCLUSION**

Academia studies employee turnover intention as a popular issue. There are a variety of articles on this topic in journals and databases. However, we believe that focusing on staff retention is a more direct, positive, and constructive approach. Companies should focus on keeping employees rather than just finding out why and how many plan to quit. When it comes to fast food restaurants, research shows that a loss of staff can have a significant financial and cultural impact on an organisation. However, Job Satisfaction, Brand Image, and Job Security all play a significant role in employee retention in the fast food industry. Businesses and organisations interested in learning more about what factors contribute to fast food workers' job satisfaction and what they can do to improve those factors might take advantage of the findings of this study. Fast-food workers' willingness to leave their jobs was found to be influenced by their level of job satisfaction or dissatisfaction.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***DATA ON INDIAN WOMEN ENTREPRENEURS: AN ANALYSIS OF INFORMATION SOUGHT  
THROUGH RTI****BHAVANA RAO****ABSTRACT**

*Indian women's entrepreneurial ventures as well as their participation in the economy should be documented through data. It would significantly increase not only the women's income and societal well being, but also it would alleviate poverty. Trade, and more specifically international trade, can expand women's role in the economy, decrease inequality, and improve women's access to skills and education. However keeping a gender-disintegrated data only would give a real picture of women's participation in international trade. This would enable clear policy changes to accommodate women in this field.*

**Keywords:** Women, Entrepreneurs, Data, RTI, Gender Equality, International Trade, Exporter

**INTRODUCTION**

Women have not been properly representing Indian Exporters for various socio cultural factors. The cultural set up being one and limitations of access to credit and ownership in family properties being another example. "Investing in women's economic empowerment sets a direct path towards gender equality, poverty eradication, and inclusive economic growth." A lot of women are left out or are not economically empowered. There are both direct and indirect reasons why women are not economically well. Much has been said and little done on this front.

It is therefore pertinent to enquire into the reasons why women are not participating in certain vocations and in particular international trade as an exporter of goods and services. Women owned businesses are very few in number and there is a need to achieve parity on this front on an urgent basis. The first step towards gender mainstreaming in businesses is managing data on women entrepreneurs. The researcher did a study as part of a larger study to find out if the aspect related to managing data of women entrepreneurs is taken care of by the institutions responsible for it.

**RESEARCH DESIGN****1. Type of Research**

The Research is Exploratory in nature and employed quantitative methods. The purpose of the study was to find if institutions responsible for holding data are keeping records of gender segmented data. So this part was a quantitative research as part of a larger study which is both quantitative and qualitative.

**2. Universe of Study**

Institutions of the government of India who train women in business and holding women exporters related data were chosen. The reason why this was chosen is that these are institutions specifically mandated under different schemes and policies of the government to hold gender data. If these institutions fail to hold separate data for all the genders, there is bound to be difficulty in implementing the schemes and thereby improve gender figures, which also effect the participation of women in trade and exports. Not only this, this segregation itself is important to adjudge the skewed ratio of participation of women vis a vis men.

**3. Sampling Technique**

The researcher visited Ministerial Websites and found and made a list of all 100 institutions responsible for implementing various schemes and then using **systematic** sampling technique, made a list of fifty institutions. So first was **purposive sampling**. For selecting the institutions from the first list a **randomiser** was used to select 50 institutions.

**4. Tools Used**

**Close ended questionnaire** was sent to the selected commissions and institutions. The first set of questionnaires was in the form of RTIs for the commissions like Central Tool Design Institute and National Skill Development Agency responsible for training and facilitating women entrepreneurship. These questionnaires had two segments. One segment was common to all institutions and totalled 7 questions. For the SEZs a separate set was framed.

**5. Statistical Tools Used**

1. SPSS

2. Microsoft EXCEL

**6. Data Collection and Analysis**

The researcher sought information through RTI from the following for receiving gender disintegrated data on women who are trained or with potential to be trained in the field of entrepreneurship.

RTI replies were received from the following in **TABLE A**.

**TABLE A**

1.	KVIC
2.	UDAAN
3.	Central institute of hand tools, Jalandhar
4.	Indo German Tool Room, Indore
5.	Central footwear training institute, Agra
6.	Central tool room and training centre, kolkatta
7.	Statistics and Data Bank Division, MSME Ministry
8.	International Cooperation Section, MSME
9.	Development Commissioner,Delhi, MSME
10.	Coir Board Kochi, MSME
11.	Skill Development Section, MSME
12.	EDI Section, MSME
13.	Central institute of Tool Design, Hyderabad
14.	Indo Danish Tool Room, Jamshedpur
15.	Central Tool Room, Ludhiana
16.	Entrepreneur Development Scheme, MSME Skill Development Section
17.	Rashritya Mahila Kosh
18.	Electronics Service and Training Center, Nainital, Ministry of MSME
19.	Entrepreneur Development Scheme, MSME Skill Development Section

Replies were also received from SEZs in **TABLE B**:

**TABLE B**

1.	KASEZ
2.	FALTA SEZ
3.	Vishakhapatnam SEZ
4.	MEPZ SEZ
5.	NEPZ
6.	Kandla SEZ
7.	SEEPZ SEZ

The researcher through the Office of the Development Commissioner(s) sought replies from six SEZs through RTIs. These SEZs are set up by the central government.

She received replies from two state notified SEZs including Vishakhapatnam and Dahej. She is awaiting replies from other state notified SEZs. One Scheme called UDAAN on Women Entrepreneurs was also selected for an RTI to find if the scheme implementors have data segregated gender wise.

Reasons for choosing the above mentioned are various for each. For example, the khadi and village industries commission is India's leading cottage industry commission which trains and facilitates micro industries like textiles, handicrafts, gems and jewellery. The researcher posed the following questions to the commission through an RTI of which the questions are herein asunder. The Skill Development Agencies have to keep data related to those skilled in the specific domains.

**ANALYSIS OF DATA RECEIVED**

Questions related to women put to all these Institutions were seven. They were:

- How many women have been trained for setting up businesses?

2. What is the Yearly data on the total number of women trained ?
3. Are there any schemes or concessions for women?
4. How many women are from rural background?
5. How many women are from urban background?
6. What is the total number of exporters in all three genders?
7. What is the yearly data on the total number of women exporters.

**Total Questions posed to these institutions = 7**

**Table 1**

Sno	Institution	Questions Answered	Questions Not Answered
1.	Khadi and Village Industries Commission	3	4
2.	Indo Danish Tool Room Jamshedpur	2	5
3.	NER Cell Development Commissioner MSME	0	7
4.	Indo German Tool Room Aurangabad	1	6
5.	Development Commissioner NER cell	0	7
6.	National Small Industries Corporation	5	2
7.	Central Institute Of Hand Tools Jalandhar	5	2
8.	MSME Tool Room Indore	4	2
9.	Central Footwear Training Institute Agra	4	3
10.	Central Tool Room and Training Center Kolkatta	5	2
11.	National Productivity Council(LMCS)	4	3
12.	MSME EDI Section	0	7
13.	Central Institute of Tool Design Hyderabad	0	7
14.	Central Tool Room Ludhiana	0	7
15.	NSIC Okhla	3	4
16.	Department of Agriculture, Cooperation and Farmers Welfare	0	7
17.	Entrepreneur Development Scheme, MSME Skill Development Section	4	7
18.	Rashritya Mahila Kosh	1	6
19.	Electronics Service and Training Center, Nainital, Ministry of MSME	7	0

After the collection of data, the following tables were generated.

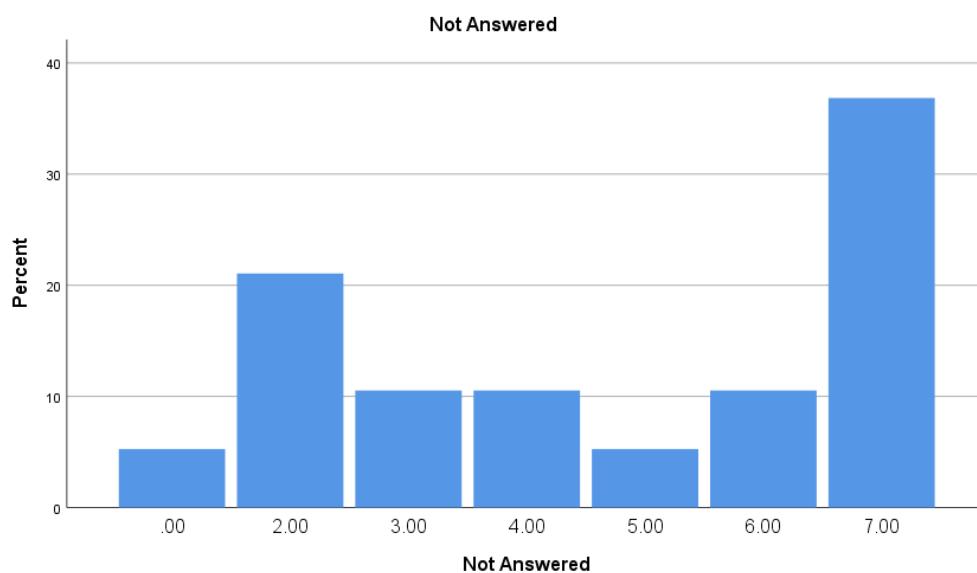
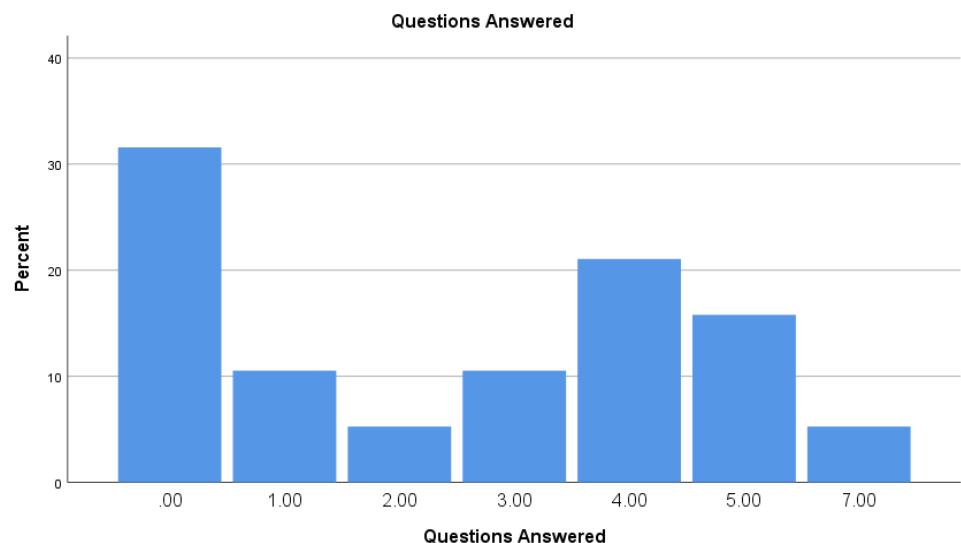
#### Frequency Tables

Questions Answered					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	6	31.6	31.6	31.6
	1.00	2	10.5	10.5	42.1
	2.00	1	5.3	5.3	47.4
	3.00	2	10.5	10.5	57.9
	4.00	4	21.1	21.1	78.9
	5.00	3	15.8	15.8	94.7
	7.00	1	5.3	5.3	100.0
	Total	19	100.0	100.0	

Not Answered				
		Frequency	Percent	Cumulative Percent
Valid	.00	1	5.3	5.3

2.00	4	21.1	21.1	26.3
3.00	2	10.5	10.5	36.8
4.00	2	10.5	10.5	47.4
5.00	1	5.3	5.3	52.6
6.00	2	10.5	10.5	63.2
7.00	7	36.8	36.8	100.0
Total	19	100.0	100.0	



### Data on SEZs

**Table 2**

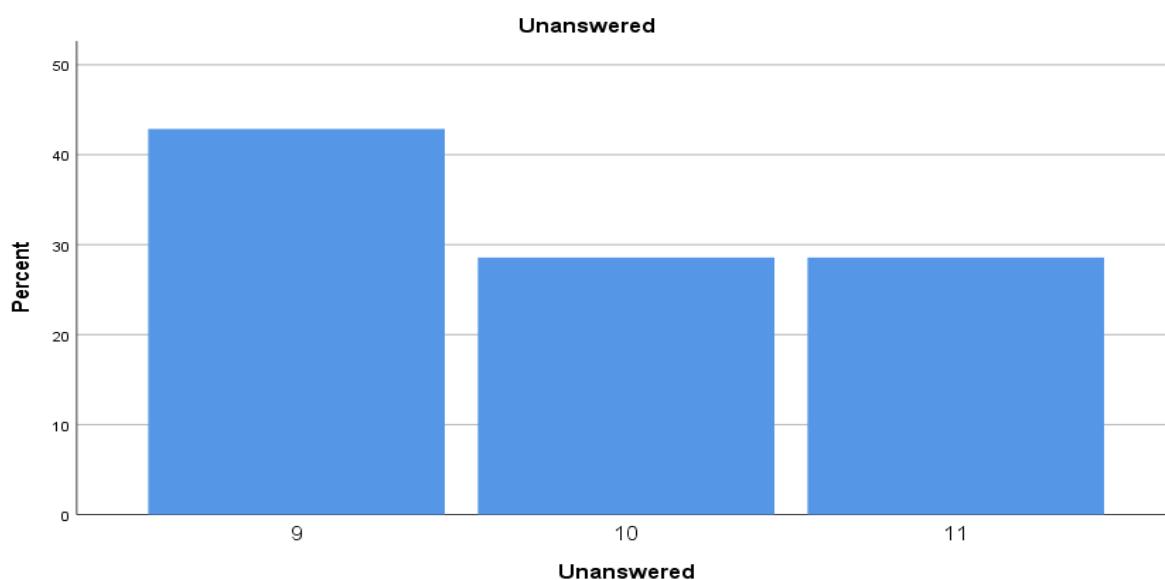
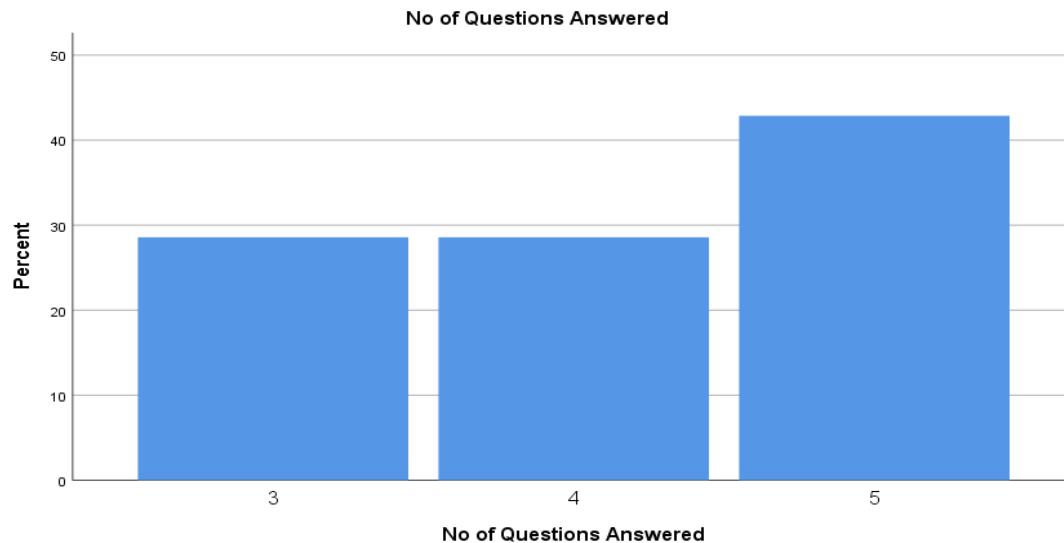
SEZ NAME	No of Questions Answered	Unanswered
KASEZ	4	10
FALTA SEZ	3	11
Vishakhapatnam SEZ	5	9
MEPZ SEZ	4	10
NEPZ	5	9
Kandla SEZ	5	9
SEEPZ SEZ	3	11

After recording the above table, frequency tables were generated as following.

### Frequency Tables

No of Questions Answered					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	28.6	28.6	28.6
	4	2	28.6	28.6	57.1
	5	3	42.9	42.9	100.0
	Total	7	100.0	100.0	

Unanswered					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	9	3	42.9	42.9	42.9
	10	2	28.6	28.6	71.4
	11	2	28.6	28.6	100.0
	Total	7	100.0	100.0	



**FINDING :**

**Institutions responsible to hold gender data do not keep a record of gender disintegrated data in India.**

**CONCLUSION**

The following suggestions are made among others presented in a similar study. However, empirical evidences should be collected through field studies to corroborate the effect of the suggestions.

1. Keeping a record of the adult population who are entrepreneurs, by sex, should be a high priority in India.
2. Removing barriers to trade by improving access to finances, skill training, promoting gender based entrepreneurship.
3. Working on the societal barriers like ownership of property in women's name and having a hold on the finances.
4. Partnering with the corporates to facilitate female entrepreneurship, start-ups and keep data.
5. Adding gender provisions in the trade legislations like FEMA and FTA to facilitate women.
6. Adding gender provisions in the clauses including exception clause of the GATT 1994 Agreement.

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Selection Grade, School of Law, University of Petroleum and Energy Studies; PhD Scholar, Faculty of Law, University of Delhi

*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***RESEARCH – SOCIAL AND INDIVIDUAL –A CONCEPTUAL STUDY****PROF. (DR.) DHANANJAY AWASARIKAR****ABSTRACT**

Any kind of Research; whether conducted by an Institution or an Individual; that confers the benefits on the Society; at large; can roughly and broadly be called as a Social Research. Individual Research is conducted by an Individual primarily for personal benefit; incidentally or indirectly it may confer the benefits to the members of the society.

For Comparison; first and the foremost; the concerned factors should be capable of being compared. The Parameters or Yardsticks or Benchmarks meant for the measurement of the concerned constructs must necessarily be determined well in advance. In this Research Paper; the Researcher has covered the Concepts of Social as well as individual Research in depth. Also; there is a distinction or differentiation between the two.

Some Researchers or Subject Experts; in general; comment quite loudly; in several seminars; webinars; conferences; workshops; or lectures that the Social Research is superior to an Individual Research. However; there does not seem to be any substance in such a criticism called upon on Individual Research unless and until it is crystal clear whether the Research conducted confers or does not confer the benefits on the Society; as a whole and in the long run. Moreover; conferring Social Benefits is indeed one of the parameters to test the quality or superiority of the Research.

**Keywords:** Research Orientation, Research Knowledge, Commonality and Contextual Subjective Accuracy

**INTRODUCTION**

As a matter of fact; Research is an integral; thus inevitable part not only of the Technology but also of the Human Society. Had the Research not resulted over a period; the human society would; no doubt; have still remained in the primitive or traditional stage. In other words; any Research irrespective of its nature; kind or character; whether individual; social or otherwise is always welcome by the society; at large; because it is beneficial.

Furthermore; Research is a sign of Progress of Society. It keeps the society vibrant and dynamic. It may not be an exaggeration of a fact that a society (Human Habitation) not encouraging Research may be interpreted as a Dead Society; consisting no doubt of human bodies; but of dead human bodies having no life. There are some rural regions besides India; in some other foreign countries where the Research; as a concept; has yet to evolve. The villagers in such areas really live a very miserable life. Therefore; there can be no controversy at all; whether to promote the Research or not; at the most it can be in respect of its Methodology and the sphere of practical Application.

**RESEARCH PAPER OBJECTIVES**

The following are the Objectives of the Research Paper.

1. To Study the Concepts of Social and Individual Research
2. To Compare Social Research with Individual Research

**RESEARCH PAPER SCOPE**

The Scope of the Research Paper extends to the experiences of the Researcher himself and also to the number of other Researchers; Social and Individual; who have been interviewed for the purpose of this Research.

**RESEARCH PAPER METHODOLOGY**

Primary Data for the Research is collected through *informal or unofficial (Mobile) interactions* with the Researchers; both Social and Individual; with *unstructured disguised questionnaire*.

**SAMPLING PLAN FOR THE MOBILE SURVEY****(I) Population**

- (a) The Researchers who have conducted Individual Research (with their own Cost)
- (b) The Research Officers who have conducted Social Research (with the Cost of the [Research] Organization)

**(II) Sample Unit –**

- (a) The Research Executive in Pune who has conducted Individual Research
- (b) The Research Officer in Pune who has conducted Social Research

**(III) Total Sample Size – 100****Sampling Methodology for the Mobile Survey -**

The Sampling Methodology adopted for the Mobile Survey was ***Non Probability – Stratified (Demographic resulting into Purposive and Convenience Sampling.***

**Sample Category –**

The sample consisted of the following four different categories.

Sr. No	Category	Population	The Sample Unit	Sample Size
1	Individual Research Executive	Individual Researchers	Select Researcher in Pune	50
2	Social-Research Officer	Social-Research Officers	Select Social-Research Officer in Pune	50
			<b>Total Sample Size</b>	<b>100</b>

**Concept of Social Research**

As a matter of fact; any kind of Research; whether conducted by an Institution or an Individual; that confers the benefits on the Society; at large; can roughly and broadly be called as a **Social Research**. When the Researcher referred to various Text Books and Reference Books; he ended up in getting a number of definitions and lengthy descriptions of the word ‘Social Research’; its Concept in depth and its process in detail. Indeed; it is simply not; at all; necessary to put forward over here in the Research Paper; entire narration as it stands; of course; for want of its length. However; at the same time; some significant pieces of pertinent literature are retrieved; in the following lines.

In the words of **P. V. Young** it means Scientific undertaking which by means of Logical and Systematized Techniques;

- (a) Aims to discover a New Factor
- (b) Verify or test old Facts
- (c) Analyze their Sequence; Interrelationship and Casual Explanation derived within an appropriate Theoretical Framework of Reference and
- (d) Develop new Scientific Tools; Concepts and Theories which will facilitate reliable and valid study of human behavior.

It is based on logic and empirical observations. **Charles C. Ragin**, a Social Researcher, had written in his book titled; ‘**Constructing Social Research**’ that Social Research involves the Interaction between Ideas and Evidence. These ideas help the Social Researchers to make real sense of the Evidence and Researchers use the Evidence to extend, revise, and test the Ideas. It attempts to create or validate different Theories through Data collection and its intelligent Analysis as its primary goal is Exploration, Description, Explanation, and Prediction related to Social Happenings. It never ever develops neither Social Philosophy to be practiced nor any Social Belief. It simply aims at finding out several Social Patterns of Regularity in Social Life and usually deals with social groups (aggregates of individuals), not individuals themselves. The Researcher’s Primary Goal; distant and immediate; is to explore and gain an understanding of Human Behavior and Social Life; thereby gain a greater control over time.

**Stevenson** said; it is a Systematic Method of Exploring; Analyzing and Conceptualizing Social life in order to extend; correct or verify Knowledge; whether that aids in the Construction of a Theory or in the practice of an Art. It is the Scientific Analysis of the Nature and the Trends of Social Phenomena of Groups or in general of Human Behavior so as to formulate broad Principles and Scientific Concepts; **M. H. Gopal** Commented.

**Rummel** stated that it is devoted to the Study of Mankind in his Social Environment and is concerned with improving his understanding of Social Orders; Groups; Institutes and Ethics. **Prof. C. A. Moser** described it as Systematized Investigation to give new Knowledge about Social Phenomena and Surveys.

It is a Method utilized by the Social Scientists and other Researchers in order to learn about People in general and different Human Societies in particular. The different Methodologies used to conduct the Social Research can conveniently and comfortably be classified into two distinct categories; namely; **Quantitative** and **Qualitative**. Moreover; as the name suggests; the Quantitative Methods deal with several Social Phenomena through quantifiable and convincible evidence. Furthermore; it relies; more often than not; on the Statistical Analysis of a number of relevant and significant cases or on the intentionally designed treatments in an experiment in order to create valid and reliable Generalizations.

Furthermore; the Qualitative Designs emphasize the overall understanding of Social Phenomena through Direct Observation and active Communication with various participants or through Analysis of Texts. They may additionally emphasize on the Contextual Subjective Accuracy over Generality. Although the Research Methods are classified as aforesaid; many Researches really reveal the elements of both the Methods; namely; Quantitative and Qualitative. For instance, Qualitative Data Analysis involves; quite often; a fairly structured approach for Data Coding and thereafter its convenient conversion into Systematic Information in order to quantify Data Reliability. Thus, there exists a more Complex Relationship between Qualitative and Quantitative Social Research Methods.

Further; it is necessary to understand the present society properly and correctly especially on the background of dynamic Social Norms; Practices; Styles and Fashions. Whenever the Sociologists all over the world develop considerable confusion; doubt or dispute about Social Behavior; they initiate the Research with the pure objective to investigate as to why people belonging to a particular society behave in the manner or the way they do and try their best to predict their future Social Behavior in order to control the same; if it is possible. In general; the Social Research is conducted with several Objectives to develop novel knowledge through Scientific Study; Study the Social Life; Classify or Categorize the Social Facts; Control and Predict the Social Consequences; undertake Social Planning; formulate new Laws for Social Governance; improve the tools and techniques to conduct Social Research; Resolve emerging Social Problems; etc.

Social research is an inquiry to identify, explore, describe, understand, explain, evaluate, and predict social phenomena involving human behavior. As it is implicit in the definition, social research involves the application of scientific methods through data collection, for understanding, studying, and analyzing the social life in order to modify, correct, or verify the existing knowledge as a system. The information contained in the data would benefit society either through the direct application of findings to the amelioration of social ills or through the use of the findings to test theoretical issues in social sciences.

### **Concept of Individual Research**

As the name suggests; Individual Research is conducted by an Individual. It may incidentally confer the benefits on the Society; at large. However; its fundamental objective is not the same as that of Social Research. In other words; it may be conducted for Personal or Official benefits. For example; an Assistant Professor or an Associate Professor may conduct it to fulfill the University or Statutory Requirements in order to get promoted to the Post of Associate Professor or Professor respectively.

If Cost Benefit Analysis would be undertaken; naturally the overall Cost Estimate of the Social Research would really be more; naturally because of its relatively vast or broad Scope. But the Institute can certainly afford the huge Cost; involved in the Social Research; which an Individual may hesitate to utilize. In-spite of this fact; it does not mean that the quality of the Social Research is superior as compared to that of the Individual Research simply because the Research Quality depends upon the Systematic and Scientific Research Methodology adopted and not on the amount used to conduct the Research.

Moreover; an Individual Researcher may possess an adequate class and caliber to conduct the Research of an Excellent Quality through adoption of High Grade Research Methodology; yet; he may turn handicap because of Cost involved in conducting the Research for his own that is personal or Official Benefit; forget; the conduct of Social Research.

### **Comparison between Social Research and Individual Research**

For the purpose of Comparison between the factors; the following few Conditions should be fulfilled.

First and the foremost; the concerned factors are capable of being compared with each other. This means that there should be some sort of similarity or a special kind of commonality; between the factors; which will act as the connecting link between them or sound; logical and rational basis to compare them. On the other hand; if there is neither similarity nor commonality even to the minute extent; between the factors; comparison between them just cannot result.

The Parameters or Yardsticks or Benchmarks meant for the measurement of the concerned constructs must necessarily be determined well in advance. Otherwise there may result the measurement of a wrong construct or of an irrelevant and insignificant construct and at the same time; no measurement of a relevant and significant construct.

In the instant case; the two factors namely Social Research and Individual Research are; no doubt; capable of being compared with each other. 'Research' as an activity does act as some sort of similarity or a special kind of commonality or sound; logical and rational basis of comparison between the two factors. However; on the basis of the parameters such as 'Cost' or 'Benefit'; the comparison between these two factors seems quite relevant and significant only when the costs incurred for conducting both the kinds of Research are reasonable or research-need based; otherwise naturally the benefits received by the beneficiaries would definitely be drastically different.

Furthermore; the comparison between the factors is incomplete until the similarities too along with the differences existing between the two are pointed out; quite clearly. Whether it is a Social research or an Individual Research; the Methodology adopted and Costs incurred to conduct both may be the same and reasonable respectively; but the classes those would receive the benefits of the Research would be different in the sense that the benefits of Social Research; as the name indicates; would be received by the Society; at large while the benefits of an Individual Research; as the name indicates; would be primarily enjoyed by the Individual Researcher; at the same time; they may be incidentally or unknowingly received by the Society.

### **Criticism on Individual Research**

Some Researchers or Subject Experts; in general; comment quite loudly; in several seminars; webinars; conferences; workshops; or lectures that the Social Research is superior to an Individual Research.

However; there does not seem to be any substance in such a criticism called upon an Individual Research unless and until it is crystal clear whether the Research conducted confers or does not confer the benefits on the Society; as a whole and in the long run.

It seems to be the outcome of

- (a) Absence or lack of Conceptual Clarity as regards 'Research' (overall) or
- (b) Illiteracy or Ignorance of Research Orientation (whether Social or Individual) or
- (c) Lack of in depth Research Knowledge (Existence of Superfluous Research Knowledge)

Thus; such kind of ***Comparison between Social Research and Individual Research is; in itself; insignificant and irrelevant or out of question in practical character.***

Furthermore; there is neither superior nor inferior in Research or anything such as right or wrong or correct or incorrect or vicariously ethical or unethical because all such factors depend upon the Application or Interpretation of the Findings in any kind of Research; whether Social or otherwise. It is needless to point out over here that the Research Findings; in turn; depend upon a number of factors such as Sample Selection; Research Methodology adopted; Researcher's Analytical Skills applied to interpret the data collected; etc.

At the same time; an interesting; unanswered; yet; inevitable question crops up as to what can be the probable reasons for initiation of this kind of comparison between Social Research and Individual Research. In this connection; as mentioned in the section of Research Methodology above; the Researcher had an active interaction with the number of eminent Researchers; both Individual as well as Social. However; he could really not ascertain even a single convincing or logical reason for the said comparison; thus; criticism on Individual Research. In simple words; indeed this discussion confirmed beyond a shadow of reasonable doubt that ***one can not apply logic to a person; who himself is illogical; irrational or non-considerate.***

### **RESEARCH PAPER LIMITATIONS**

Full intellectual concurrence with all the Views as well as Opinions; of the Researcher; expressed in the Research Paper and also of the other Respondents; interviewed for the purpose of the Research; is certainly not possible; thus; expected.

### **SCOPE FOR FUTURE RESEARCH**

During the Course of the Study of this Research Paper, the Researcher found out that there is an ample Scope and Potential for Research in future for the following topic.

(I) Factors Raising the Research Level – A Study

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**HARDWARE IMPLEMENTATION OF CNN BASED SPEECH ENHANCEMENT TECHNIQUE****ABHIGHNA MAHETA, DR. NIRALI A. KOTAK, DR. BHAVIN S. SEDANI, MAHARSHI K. BHATT  
AND KOMAL R. BORISAGAR****ABSTRACT**

Speech is the foremost noteworthy way of communication among human creatures and a potential strategy for Human-Computer Interaction (HCI) by employing various sensors. This experimental research article suggests an innovative learning platform to develop complete convolutional neural network (CNN) for speech signal enhancement. The System which enhances the speech along with de-noises and resound distorted signals, are usually optimized based on signal reconstruction objectives. The impact of this investigation is how a system optimized based on the Automatic Speech Recognition (ASR). The objective of this research work is to improve the speech enhancement quality on various signal level metric along with ASR and word error rate. In this research paper, the major contributions for; (i) improving the accuracy of speech Command recognition (SCR) with reference to state of the art and (ii) decreasing the computational complexity are offered. This research paper proposes plain net strategy based artificial intelligence-assisted convolutional neural network architecture to learn important and discriminative features from spectrogram of speech signals that are improved in previous steps to execute superior. Local hidden patterns are learned in convolutional layers with specific strides to down-sample the feature maps instead of pooling layer and global discriminative features are learned in fully connected layers. A SoftMax classifier is utilized for the classification of Command in speech. The proposed procedure is assessed on Future Extraction Strategy, Mel -Frequency Cepstral Coefficient (MFCC), LPC and Google Discourse Database of speech recognition to improve accuracy. It demonstrates the adequacy and noteworthiness of the proposed technique and reveals its applicability in real-world applications.

**Keywords:** Convolutional neural network, Deep learning, Automatic speech Recognition, Feature Extraction, Mel-FrequencyCepstral Coefficients (MFCC)

**1. INTRODUCTION**

The major purpose of speech enhancement is to take the audio signal, clean it and forward clean audio to multiple clients such as a speech-recognition software, archival databases and speakers and etc. The main problem with any speech processing experiment is the background noise. So, the goal of speech enhancement system is to enhance the quality of system which gets corrupted by the noisy background environment so that the clean speech can be recognized. In general enhancement of speech works by presuming noise is as an answer to find the most favourable estimation of signals from a noisy atmosphere. Echo suppression is another important area which requires to be addressed during the processing of speech. The key idea is to use a frequency domain loss to train the Convolution Neural Network. Part of Machine learning i.e. Deep learning researches have been used in variety of speech processing design and train a Neural Network to get Speech Enhancement. Artificial intelligence is a fastgrowing area of Machine Learning various researches related to machine learning and deep learning. In this research work speech enhancement method basis on deep learning model is projected to aid hearing-impaired listeners by enhancing speech intelligibility and precision.

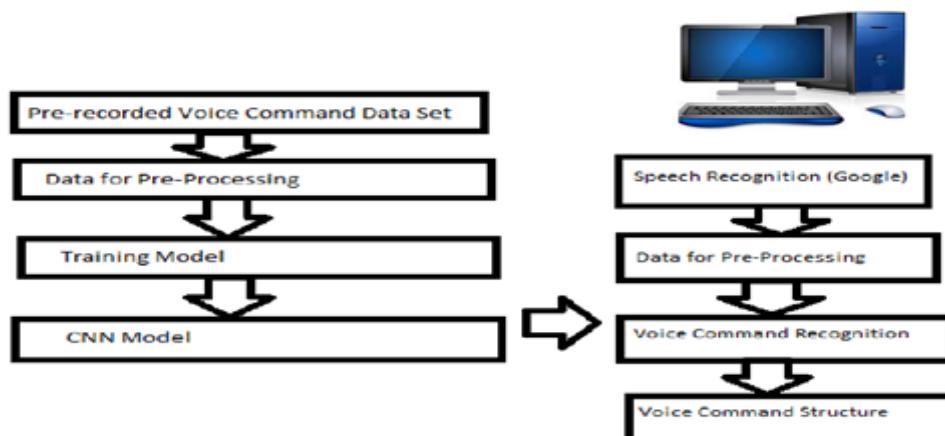


Figure1. Basic Speech Recognition System

Information processing machines have become ubiquitous. Be that as it may, the present ways of human machine communiqué are tailored more towards living with the confinements of computer input/output gadgets instead of the comfort of human speech is the essential mode of communication among human creatures. On the other hand, predominant implies of input to computers is through keypad or a mouse [8]. It would be pleasant on the off chance that computers might tune in to human speech and carry out their commands. Automatic Speech Recognition (ASR) is the method of obtaining the transcription of a speech, specified in the speech waveforms.

Speech understanding set off one step advance, and gathers the meaning of the speech in arranges to take speaker's command. Speech recognition could be an uncommon crate of pattern recognition. There are mainly two phases in administered pattern recognition, viz., preparing and testing. Figure 1 shows the basic speech recognition system.

The method of extraction of highlights important for classification is similar to both stages. Amid the preparing stage, the strictures of the classification model are assessed employing high number of lesson models (preparing information). Amid the testing or acknowledgment stage, the highlights of a test design (test speech information) are coordinated with the prepared show of each and each course. The objective of speech acknowledgment is to create the ideal word grouping subject to phonetic imperatives. The sentence is composed of phonetic components such as words, syllables, phonemes. The acoustic prove given by the acoustic models of this type of units are combined with the rules of building substantial and significant sentences within the language to hypothesis the sentence. Subsequently, in casing of speech acknowledgment, design coordinating arranges can be seen as taking put in various domains: acoustic and symbolic. Within the acoustic space, a include vector comparing to a little portion of test speech (called a outline of speech) is coordinated with the acoustic demonstrate of each and each course. The section is relegated a set of well matching class names beside their matching scores.

This prepare of name errand is repeated foreach include vector inside the highlight vector gathering analyzed from the test data. The final lattice of title hypotheses is taken care of in conjunction with the language appears to yield the perceived verdict.

## **2. OVERVIEW OF SPEECH FEATURE EXTRACTION TECHNIQUES**

Speech includes extraction which changes over the speech waveform into a few valuable parametric representations. These parameters are at that point utilized for assist examination in different speech associated functions such as speaker recognition, speaker acknowledgment, speech synthesis and speech coding. It plays a critical part to partitioned speech patterns from one another. Since each speech and speaker has diverse person characteristics implanted in their speech expressions. But extricated include ought to meet a few criteria whereas managing with the speech signal such as:

- Easy to measure extricated speech highlights
- Not be susceptible to mimicry
- Idealize in appearing environment variation
- Stability over time

In common, the real time acostic waveforms are moderate changing time signals that are moreover known as quasi-stationary. Therefore it is superior to carry out feature extraction in short term interim that would decrease this changeability. Consequently, these signals are inspected over a short period of time (10-30 msec), where the descriptions of speech signal gets to be stationary. In common, a speech signal includes a few acoustic data which can be characterized b amplitude spectrum of short term. The inspiration behind this computation is the cochlea of the human ear carry out a quasi-frequency investigation. The resultant investigation within the cochlea on a nonlinear frequency scale gets to be the bark scale or the mel scale [11]. The future vectors can be extracted from these examinations. The following section clarifies the foremost well known include extraction techniques and the adopted strategies for this work.

## **3. COMPREHENSIVE ANALYSIS OF SPEECH FEATURE EXTRACTION TECHNIQUES**

One of the most dominant portions of the speech recognition framework is feature extraction. It is measured as the heart of the entire framework. Figure 2 shows the basic diagram of Feature extraction system. From one side speech signals with nature of persistent for the method of windowing are given as input. The disturbances which are accessible at the beginning as well as at the final portion of the frame are diminished within the prepare of windowing. After this handle, the ceaseless discourse flag is changed to

windowed delineates. After this handle, the natural speech signal is changed over into windowed outlines. These windowed outlines are passed into DFT which is Discrete Fourier Transform, which changes over the windowed outlines into magnitude range. With this, spectral observation is prepared with a fixed resolution which produces a Mel-spectrum. This range is then applied to Log and after that to IDFT i.e. inverse of discrete Fourier transform which produces the ultimate result as Mel-Cepstrum. The Mel-Cepstrum comprises of the highlights that are necessary for speaker identification.[6]

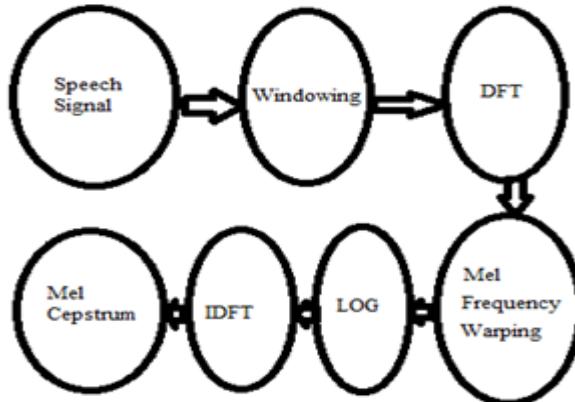


Figure2.Feature Extraction Diagram

The two sorts of features which are considered for any ASR framework are inactive and energetic features. These highlight vectors are utilized to classify or recognize the comparable patterns of speech appearance. In this research work, two static and dynamic features are extracted for implementations which are explained below.

### 3.1. Mel Frequency Cepstral Coefficients (MFCC)

These Coefficients are foundation on the known varieties of basic bandwidths (human ear's) with frequencies which are underneath a 1000 Hz. The most reason of the MFCC processor is to duplicate the conduct of human ears. The MFCC is the foremost apparent cepstral analysis-based feature extraction procedure for speech and speech recognition errands. It is famously utilized since it approximates the human framework response more closely than any other framework as the frequency groups are situated logarithmically [3]. Figure 3 shows the mechanism for deriving MFCC. Computing MFCC is standed on the short-term examination, and in this way from each outline a MFCC include vector is calculated.

To extricate the coefficients, the sample of speech is taken as the reference input and it is partitioned in various frames. After that, the hamming window is connected to minimize the discontinuities of the frames where Discrete Fourier Change (DFT) is exploiting to create the Mel filter bank.

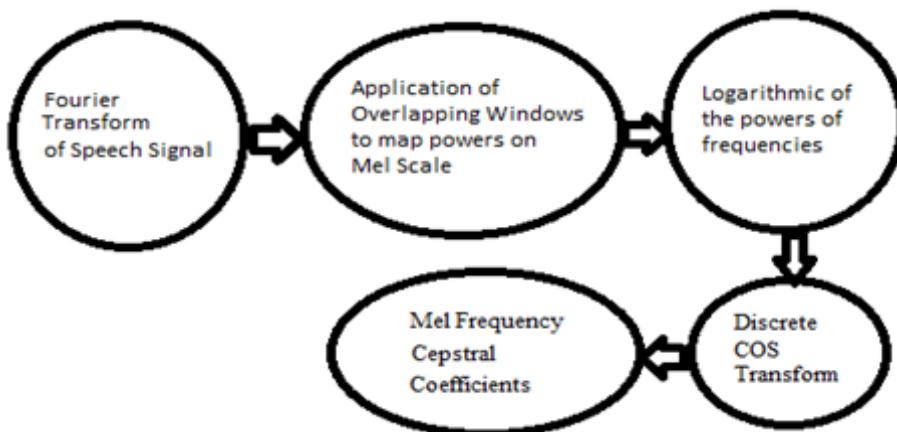


Figure3. MFCCs Derivation

Numbers of coefficients are obtained after warping. Finally, IDFT is exploiting for the cepstral coefficient calculation. MFCC can be computed by  $\text{Mel}(f) = 4000 * \log_{10}(1 + f/700)$ . In this work, 11 coefficients are

extracted and utilized for the experiments. The Fig.2 represents the various steps concerned in the MFCC feature extraction.

### 3.2. Linear Predictive Coding (LPC)

LPC is fundamentally device which is utilized for speech preparing. LPC is based on an presumption: In a course of action of speech samples, able to create a expectation of the nth test which can be appeared by summing up the target signal's past samples (k). The generation of an reverse filter have to be done so that compares to the formant regions of the speech tests. Subsequently, the application of these filters into the samples is the LPC process [6].

## 4. INTRODUCTION TO CONVOLUTIONAL NEURAL NETWORK

In a CNN, the reference may be a tensor with (number of images) x (image height) x (image width) x (input channels). When it is applied to convolutional layer, the picture gets to be abstracted to a highlight layout. The number of input channels and yield channels (hyper-parameter). Convolutional layers convolve the reference and pass its result. Each convolutional neuron forms data that is because it was for its responsive field as appeared in figure 4.

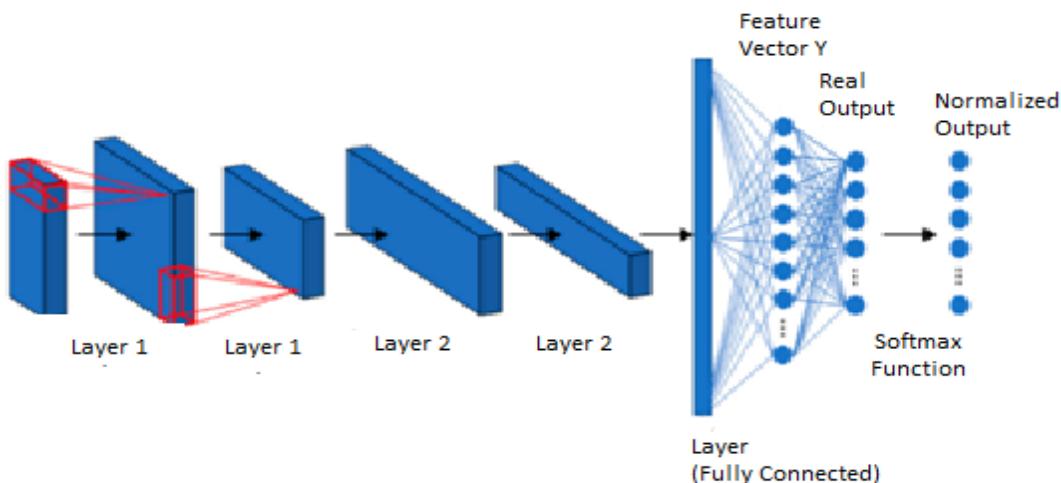


Figure4. Convolution Neural Network Diagram

## 5. MATERIAL & TOOLS AND PREREQUISITES

- Acoustic toolbox, Toolbox of Deep learning, Parallel computing toolbox, MATLAB support package for Raspberry pi hardware & Simulink
- MATLAB coder (Code Generation coder, Deep network designer)
- The MATLAB Encoder Interface needs for Deep Learning Support Package
- Xeon processor generally with duly support for Intel Advanced Vector Extensions 2 (Intel AVX2)
- Kernel Library of Intel Math for Deep Neural Networks
- Environment variables for Intel MKL-DNN
- ARM processor which supports the NEON extension
- Library version 19.05 (on the target ARM hardware)
- Environment variables for the compilers and libraries

This is the toolbox and prerequisites which are used for all process during the speech command recognition.

## 6. EXPERIMENTAL VIEW

### 6.1. Datasets:

The information here was collected, named, and packaged to permit the improvement of a framework that recognizes 10 vocal commands and tells them separated from other arbitrary words. Here thousands of

recordings with one second duration each were organized in a basic organizer pecking order, with each bottom-level organizer named after the word talked within the recordings inside. Once more, all recordings final one moment, with around 4000 records per each of approximately 30 person words, counting words that are not genuine commands. When we have such a huge sum of information and high number of files, it's critical to step out of the record dealing with subtle elements, as you do not want to be running the complete record taking care of code yourself. We as it were pass the root organizer of the information set to what a call an audio data store protest, which takes care of very a number of things itself. Characterize which subset of words we called commands. At that point we choose a random 20% of the remaining words, and we name all those as unknown.

These will be utilized to prepare the models to tell separated random words from actual commands. Based on those definitions, advanced subset of the primary data store is constructed. Presently cleared out with as it were 11 sets of named recordings with approximately 3000 Also records for each command and about three times as numerous within the obscure bucket. Once the information and the comments are arranged to go, they ought to be change the signals into a shape that the arrange can devour. As the title of the fragment prescribes, ordinarily where turn the raw recordings into a specific sort of two-dimensional time frequency representation. These go as often as possible beneath the non specific title of spectrograms.

## **6.2. Audio Analysis and Synthesis**

The Analysis Module obtains the wav files from database directory and extricates their spectrogram magnitudes and phases. The log-power spectrum is utilized as an input for the Neural Systems 20 models; whereas the phase will be utilized within the Amalgamation Module, in arrange to remake the wav signal. The Short Time Fourier Transform (STFT) is utilized for this specific errand. In arrange to execute the STFT the code given has been utilized. To windowing the signal, hamming window has been utilized, with a length of samples. The loop has been set up in samples, and the testing frequency. In Figure 5 it can be acknowledged the windowing impact over an audio input signal.

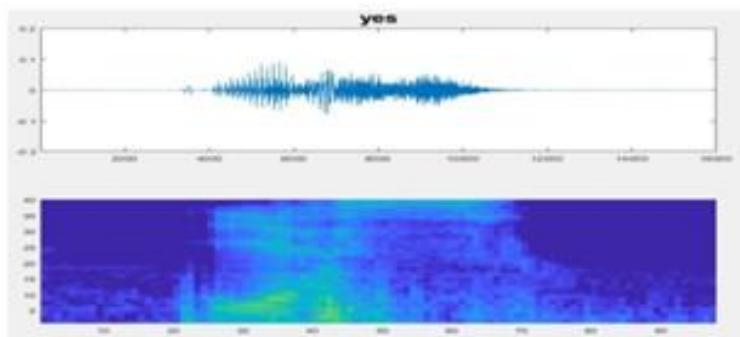


Figure 5.Windowing effect over the audio signal

## **7. PROPOSED METHODOLOGY REGARDING HARDWARE IMPLEMENTATION ON RASPBERRY Pi 4 B (RPi 4) Board**

The 2/3rd of the database has been consecrated for training, while the rest has been used for testing. We have tested the proposed model on English (UK) database containing 10 English (UK) spoken words of different directions (i.e., on, off, right, left, yes, no, up, down, background). These words have been repeated 10 times at different levels of SNR (ranging from -5 to 20 dB).

### **7.1. Hardware**

Raspberry Pi (RPi) can be defined as a single Linux board computer which has been extended to RPi 2 and RPi 3, etc versions. The general architecture of RPi 4 board model B is shown in Figure 6.



Figure 6. Raspberry Pi hardware Module

In this work, we have used RPi 4 since its major advantages, such as its high speed which can be 50% faster than RP4 in virtue of its processor (2.4/5 GHz), good memory capacity of RAM (4GB), and the memory of external SD card is 16GB. Compared to RPi 3, RPi 4 board includes wireless connections by integrating WIFI and Bluetooth, which makes it promised for the internet of Things (IoT) applications. An illustration about the main technical specifications of RPi 4 board is given in Table I.

Feature	Type
CPU	2.4/5GHz 64-bit quad core ARM Cortex-A53
Memory (SDRAM)	4 GB (shared with GPU)
USB 2.0 & 3.0 Ports	4 (5 with the on-board 5-port USB hub)
Video outputs	HDMI (rev 1.3), composite video (3.5 mm TRRS jack)
On-board storage	Micro SDHC slot
On-board network	10/100 Mbit/s Ethernet, 802.11n Wireless, Bluetooth 4.1
Power source	5 V with Micro USB or GPIO header
Audio port	4 pole stereo audio

Table 1. Technical Specifications of RPi 4 Board Model B

### [11] Software

Raspberry PI 4 Model B can support many coding languages, such as C++, Java, Python, and...so on. In this work, we have used MATLAB for the implementation of the proposed model since it makes the data processing faster than other programming language, as well as it contains rich toolbox. Figure 7 shows the CPU Time at user pi With Process id and Development Process

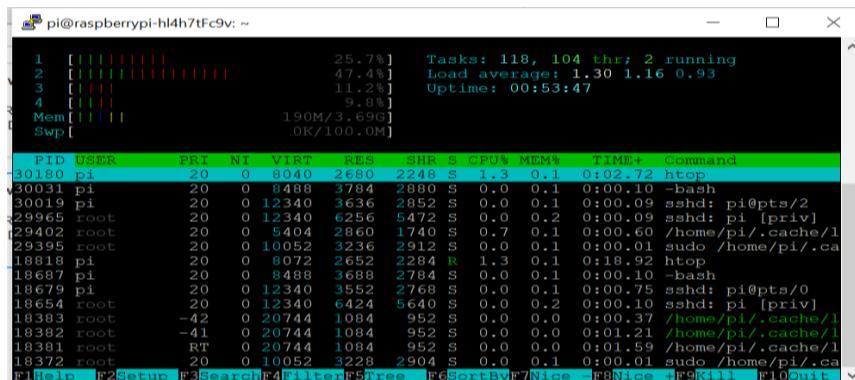


Figure 7. User Timing Result

### [12] Hardware Connection with Raspberry pi Module

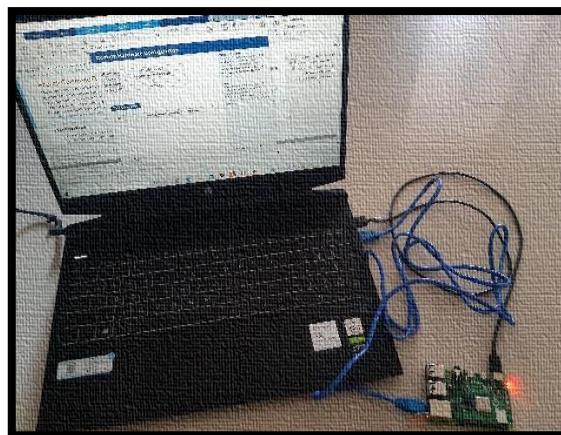


Figure 8. Connection between Host Computer and Raspberry Hardware Board

This system uses pre-recorded audio files to feed the speech command recognition system running on the raspberry. Figure 8 shows the interfacing between the Raspberry pi board and the host computer. The files are

read by MATLAB and sent to the raspberry pi board via UDP. The recognition runs on the board and the prediction results are sent back to MATLAB via UDP. In last MATLAB shows the Recognized commands.

### [13] EXPERIMENTAL RESULTS AND DISCUSSION

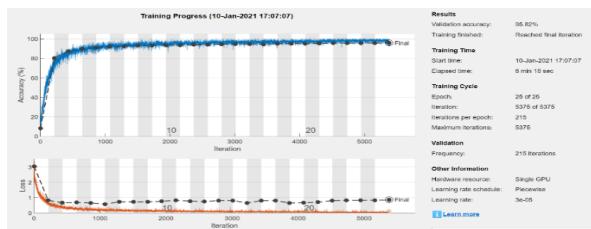


Figure 9. Training Progress

As shown in figure 9, the train for 25 epochs has been used and the learning rate is reduced by a factor of 10 after 20 epochs and finally the network I trained. Utilizaiton of the Adam optimizer with a mini-batch size of 128 is carried out. In this result Accuracy is increased.

Parameters	Value
output size	258
Dense1 Activation	RELU
Dropout 2 0.5	2 0.5
Mini-Batch size 128	128
Activationlinear Optimizer	ADAM
Activation	SoftMax
Learning rate	10
Epochs	20

Table 2. Network configuration

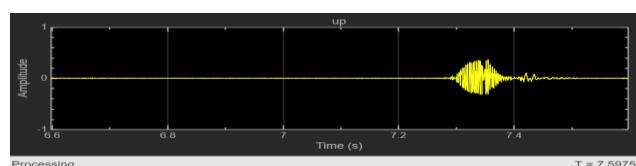
Figure 11 shows last precision of the network on the training set (without information expansion) and validation set. On this information set, the network is very exact In any case, the preparing, substantiation, and test data all have comparable disseminations that don't reflect real-world situations. This restriction primarily applies to the obscure category, which incorporates articulations of small number of words.



Figure 10. Matrix and Validation Data

### Final Output data:

- Error (Training) 1.9383%
- Error (Validation) 3.199%
- Size of Network 286.7402 kB
- Single-image prediction time on CPU 1.86 ms



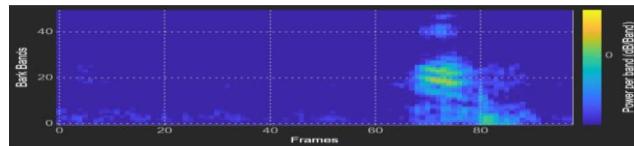


Figure11. Recognized Command Output with Spectrogram

Then the commands will be identified for utilizing the created MEX for as long as both the time scope and framework watcher are open or until the time constrain is come.. To halt the live detection before the time constrain is reached,

- SIM finishing time per 50 ms of audio = 6.6746 ms.
- MEX finishing time per 50 ms of audio = 1.5188 ms.

The performance gained by the use of MAX function will be measured. This execution trial is executed on a machine by using NVIDIA Quadro P620 (Adaptation 26) GPU and Intel(R) Xeon(R) W-2133 CPU operating at 3.60 GHz.

- Performance Gain = exe Time /exe Time Mex
- Performance Gain = 4.3945

## 9. CONCLUSION

The main aim of this research work is to recognize speech of a person using neural network. The natural environment gives more accuracy in the network. The system is tested against the speech Commands of around 4000 different background command data (i.e.: male, female, Marvin, Sheila, bed, house, cat, bird etc.) and system gives approximately 96%accuracy.

After that we performed two code generation report which is based on mkl and Arm compute library and deployed code for feature extraction and a Convolutional Neural Network for speech command recognition on Intel® processors and Raspberry Pi™. Finally, the system recognized commands on raspberry pi 4 GB hardware board and as a result, the speech commands have been recognized.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***OPTIMAL TEST CASE GENERATION USING G-GENETIC ALGORITHM VARIANT- PROPOSED METHOD****MR. VUDUMULA GOVINDA RAO DR K KOTESWARA RAO DR JITENDRA SHEETLANI****ABSTRACT**

*Project is a collection of similar activities that are going to be executed in certain order. Among the phases of project management software testing plays crucial role. The intention of the software testing is not to prove the correctness; it is the process of verifying and validation. Software Testing is the most challenging job among all the peers of the industry. Exhaustive software Testing is never possible only Optimized software testing is possible. Hence Software Testing can be viewed as optimization problem as it fall under NP complete.*

*Due to the large number of test cases that are required to perform sufficient testing of the desired software application; the diverse methods to reduce the test suite is needed. One of the common studied methods is removing the redundant test cases; the reason is minimal number of test cases and maximum number of errors isolation or uncovering.*

*In this research work study is conducted to address the utilization and effectiveness of Steady state genetic algorithm in order to diminish the number of test cases that do not add tangible value in the mean of test coverage or where the test cases can't isolate errors. GGA Genetic algorithm is utilized in this work to help in minimizing the test cases or optimizing the test cases , where the genetic algorithm generates the preliminary population randomly, calculates the fitness value using coverage metrics, and then selective the offspring in consecutive generations using genetic operations selection, cross over and mutation. The genetic modeling operations are specific and based on the operation may vary to normal Genetic algorithm. This process of generation is repeated until there is no change in the fitness values for two consecutive generations, when there is no change in the data generation for two iterations so convergence attained or a minimized test case is achieved. The results of study demonstrate that, genetic algorithms can significantly reduce the size of the test cases*

*Keywords:* GGA, Testing, Optimal.

**1. INTRODUCTION**

Testing is a movement of evaluating the framework or its segments with the resolved to discover whether it satisfies the measured necessities or not. This action outcome in the unmistakable likely and fluctuation between their outcomes. In humble words it is executing a framework with a specific end goal to find out mistakes or missing prerequisites in opposition to the real longing or necessities. In some cases it can be characterized as "movement of researching programming thing to recognize the contrasts amongst existing and required conditions and to assess the elements of the product thing".

**Importance of Testing**

Amid configuration and development programming is tried to reveal mistakes [40]. Testing is a fundamental part of any undertaking or process created to yield the wanted yield. Especially in programming in any upsetting environment, criticality develops with the unpredictability and size of the prerequisites. The IT world has seen numerous fiascos in light of the disappointment of programming items [32]. Presently a day in each industry, guaranteeing the quality and dependability of programming items has turned into a vital issue. Along these lines, to guarantee programming dependability testing is extraordinary and most requesting errands in programming progress. It finds issues and guarantees quality, agreeableness. The objective of testing is to discover issues, not to demonstrate rightness. And importance of the testing was explained in the article optimizing the Software testing efficiency by Using A Genetic Algorithm; A Design Methodology: ACM SIGSOFT Vol 38, Issue3, May 2013

**1.1 Testing Types:**

**Hands on Testing:** This write contains the testing of the Software physically i.e. without utilizing any modified device or any script. In this write the analyzer assumes control over the part of an end client and tests the Software to determine any un-expected execution or bug. There are diverse stages for industrial testing like unit, Integration, System and User Acceptance testing [32]. Analyzers use test arrangement, experiments or test

circumstances to test the Software to ensure the breadth of testing. Hands on testing likewise incorporate observational testing as analyzers find the product to distinguish blunders in it.

**Motorization Testing:** It is likewise outstanding as "Test Automation", here the analyzer engraves scripts and practices programming to test. This course includes computerization of a manual procedure, is utilized to re-run the test situations that were done physically, rapidly and more than once. Aside from relapse testing, Mechanization testing is additionally used to test the application from burden, execution and emphasize perspective. It accelerations the test scope; progress precision, spares time and spending plan than others.

**When to Automate:** It is best suited in the following:

- Hefty and acute projects.
- Chucks are stable.
- Retrieving the application with numerous users.
- Unchanging Software.
- Convenience of stint.

**Step by step instructions to Automate:** Mechanization is done by using a concerned computer language, lot of tools open for the purpose of automation cursives. The procedure is:

- Ascertaining regions.
- Appropriate tool assortment.
- Inscription of scripts.
- Test suits development.
- Accomplishment of scripts
- Creating outcome information.
- Recognizing impending bug or recital issue. Some of the tools used for Mechanization testing [33]:
- HP Quick Test Proficient
- SELINIUM
- RR serviceable Tester
- SILK Test
- Test Comprehensive
- Testing Anywhere
- WinRunner
- LoadRunner
- Visual Studio Professional
- WATIR

### **Testing Documentation**

It encompasses the credentials of relics which should be established throughout the testing of Software, helps in approximating the testing effort prerequisite, test coverage, requirement tracking/tracing etc. It contain

- Test Proposal
- Scenario
- Test Case
- Traceability Matrix

### **Test Proposal**

It skeletons the approach that will be used to test an application, Stereotypically the Eminence Guarantee Team Lead is accountable for writing a Test Plan. A test plan will contain

- Introduction of the proposal
- Assumption conditions
- List of Test cases
- The features to be tested
- Type of Approach
- What are the Deliverables
- Resource allocation
- Risks assessment
- Tasks and milestones

### **Test Scenario**

It clarifies what locale will be tried; guarantee that all method floats are tried from end to end. The term test situation and experiments are utilized. At the point when seen from this observation test situations are experiments.

### **Test case**

It includes the arrangement of steps, conditions and commitments which can be utilized while execution the testing undertakings [35]. There are various sorts of experiments alike Functional, undesirable, botch, sensible, lustful, UI experiments and so on. Moreover test cases are engraved to keep way of testing scope of Software. More often than not, there is no legitimate layout which is utilized through the experiment composing, the principle segments are:

- Test case ID.
- Invention Segment
- Merchandise variety
- Amendment antiquity
- Determination
- Molds
- Pre-Conditions.
- Stages.
- Predictable Outcome.
- Authentic Outcome.
- Pole Circumstances

### **.Test case Design Practices**

Following are the distinctive design practices

1. Test case generation form the requirements. This includes:
  - Frontier Rate Study
  - Sameness Apportioning
  - Pronouncement Stand Taxing
  - State Transition Diagrams
  - Use Case Testing
2. Test case derivation from structure:

- Declaration Exposure
  - Division Exposure
  - Track Exposure
3. Test case derivation based on experience:
- Fault Predicting
  - ProbingTesting

### 1.3 What is a Test Suite?

It is a container that has a set of tests which helps testers in executing and reporting the test execution status. It can take any of the three conditions namely Active, in progress and completed. A Test case can be added to multiple test suites and test plans. After generating a test plan, test suites are shaped which in turn can have any number of tests. Test suites are formed based on the sequence or based on the possibility. It can contain any type of tests, viz - functional or Non-Functional.

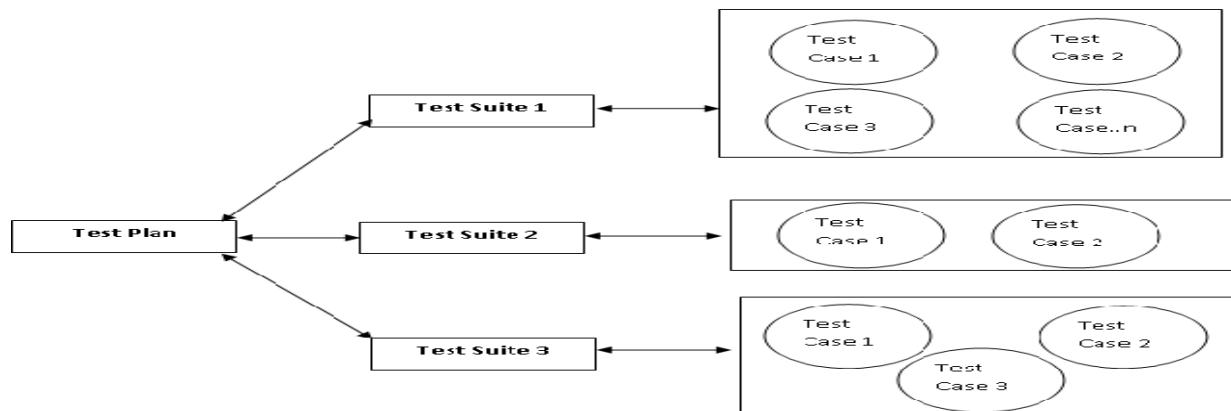
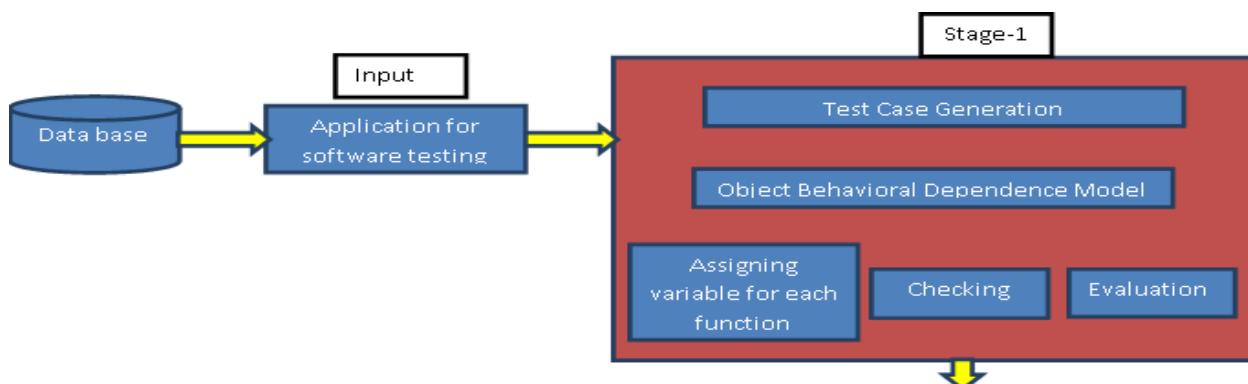


Figure 1. Test case execution with test suite

### Methodology:

#### Stage1: Generation of Test Cases

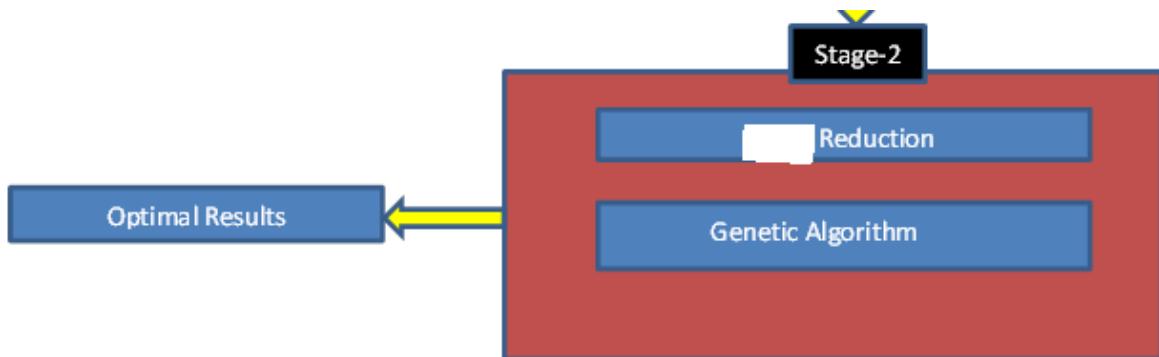
Programming testing is enormous and unmistakable field, reproducing the differing necessities that element ancient pieces must satisfy the various activities required in testing and the assorted levels at which programming can be checked. Self-assured testing makes test inputs subjectively from the information space of the item under test. The essential component of an unpredictable test time framework is that it produces test commitments at subjective from a language structure or some other formal relic clearing up the information space. The most basic explanation behind the proposed methodology is to assemble an effective system for decreasing natural imperfections in light of perfect test in direct self-assertive testing. For the period of examinations the proposed strategy is using Object Behavior Dependence Model The consequent data sources are supported to the GA; the foreordained method of executed methodology is discussed to in Figure The square framework of the prescribed methodology is discussed to in underneath



#### Stage2: Reduction of Test Cases

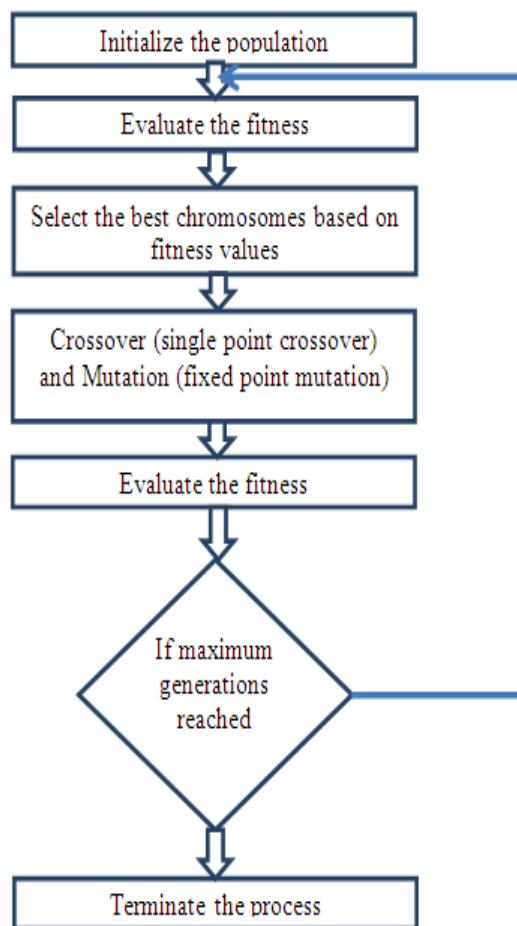
In our proposed method, we make enormous trials in which some of those investigations are not required for taking care of. In similar manner there may be equivalent investigations that are being made at each time break.

With a particular true objective to pick the concerned trials we require some compelling strategies. The accompanying period of the prescribed system is false diminishment by strategy for the GA. In this examination, the perfect data sources will be made in perspective of Genetic Algorithm (GA) which will decrease the unlawful information sources and relative wellsprings of information.



The simple form of GA

1. Start with randomly generated population
2. Calculate the fitness of each chromosome in the population
3. Repeat the following steps until n off springs have been created
  - Select a pair of parent chromosomes from current population
  - With probability  $P_c$  crossover the pair at randomly chosen point to form two offspring's
  - Mutate the two offspring's at each locus with probability  $P_m$
4. Replace the current population with the new population
5. Go to step 2



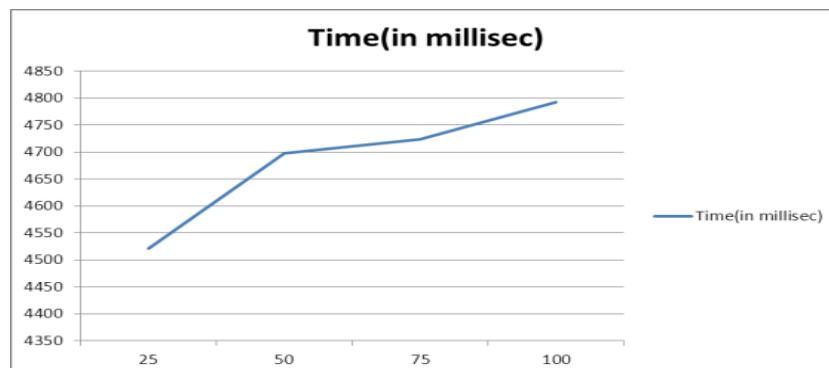
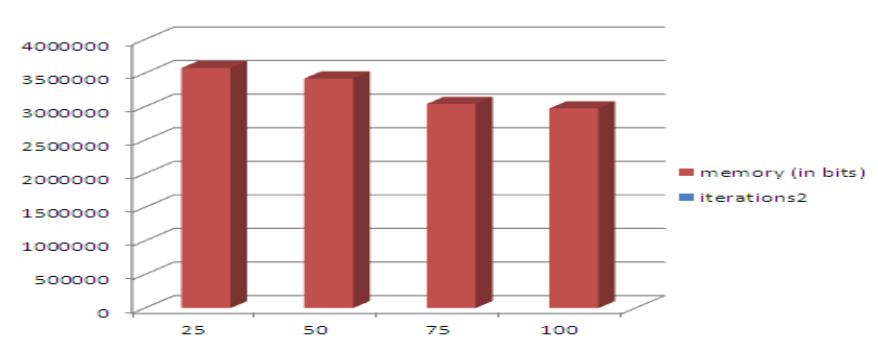
**Figure: Working of Genetic Algorithm.**

**Results and Future work.** In this section and Future implementation we will take the software application as input and for that we will generate the test cases in the phase one. In the phase two the generated test cases can be minimized using Genetic Algorithms by following the specified procedure. And results can be tabulated for the parameters 1. Fitness Value 2.Test case count 3.Time usage 4.Memory and any other parameter. Sample figures are As shown below

Iterations	Fitness Values using GA
25	X
50	Y
75	Z
100	Q

**Figure: Fitness comparison**

Iterations	Test case count	
	Without GA	With GA
25	X	Y
50	X	Z
75	X	Q
100	X	W

**Figure: Test case count comparison****Figure: Time utilization comparison****Figure: Memory utilization comparison**

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***STRESS MANAGEMENT –A NEED FOR ORGANIZATION****DR. PRAKASH V. PISE AND DR. CHARULATA M. KULKARNI****INTRODUCTION**

Stress is a large part of everyday life. Stress has many definitions and there are many ways to manage stress in organization. Most stress occurs at our busiest moments; school, work and home. Those are the most common places for stress to build. How do people know that they are stressed? The body responds to stress negatively. Many biological changes take place which include but are not limited to the following: muscles tensions, breathing heavily, dry mouth, sweats, tremors, dialating of pupils, response are not clear and there are many more. These changes can cause health problems if experienced to frequently. The body often becomes worn down making it more susceptible to becoming sick. Depending on how serious the stress, can determine the severity of its impact. Stress and stress management are directly related to personal well-being and specifically to workplace well-being. Employers should provide a stress-free work environment, recognize where stress is becoming a problem for staff, and take action to reduce stress. Stress in the workplace reduces productivity, increases management pressures, and makes people ill in many ways, evidence of which is still increasing. Workplace stress affects the performance of the brain, including functions of work performance; memory, concentration, and learning. Stress at work also provides a serious risk of litigation for all employers and organizations, carrying significant liabilities for damages, bad publicity and loss of reputation. Dealing with stress-related claims also consumes vast amounts of management time. So, there are clearly strong economic and financial reasons for organizations to manage and reduce stress at work, aside from the obvious humanitarian and ethical considerations. If you are suffering from stress yourself the stress management guidelines here are just as relevant.

**Keywords:** stress at work, stress management strategies, stress reduction and relief.

**REVIEW OF LITERATURE**

Research published in 2005 by Dr Michael Miller of the University of Maryland in Baltimore confirmed the positive and negative effect on blood vessels and their 'endothelium' lining, from respectively positive and negative viewing and listening experiences, and the resulting hormonal changes that result, producing stress, and adversely affecting blood vessel performance. Healthy blood vessels and endothelium are able to dilate (open) more freely and quickly, aiding blood flow and reducing propensity to clots and related blood flow problems such as heart risks. Basically, negative experiences reduce capability of blood vessels to dilate, and positive viewing experiences and laughter reduce stress and improve blood vessel dilation. Miller found that stress and reduced blood vessel performance resulting from negative experiences last for around 45 minutes, and suggested that unrelenting stress could permanently (adversely) alter blood vessels.

Professor Andrew Steptoe, British Heart Foundation Professor of Psychology at University College London, has previously shown associations between positive emotional states such as happiness and low levels of the stress hormone cortisol, (as well as finding that people with a more positive outlook appear to be less affected by stressful events).

Dr Margaret Stuber's US research has demonstrated that laughter is an effective pain reducer in children, and specifically that children's stress levels were reduced after laughing, and in UK hospitals 'clown doctors' are used in children's wards to improve patients' tolerance to stress and pain, including prior to anesthetic and operating theatre.

**OBJECTIVES OF RESEARCH**

- 1] To Study Symptoms of stress at workplace.
- 2] To Study the Strategies of stress management in organization development.

**Definition of Stress:** According to Spiellberger

"Stress is an interaction between coping skills of an individual and the demands of his environment"

A potential stress can become actual stress if there is uncertainty over the outcome and if outcome is important. Stress is highest for those individual who perceive that they are uncertain about their winning or losing and

stress is lowest for those individuals who think that they will certainly win or certainly lose. If outcome is unimportant, there is no stress.

### **What is Employee Stress?**



Employees stress is a growing concern for organizations today. Stress can be defined as a lively circumstance in which people face constraints, opportunities, or loss of something they desire and for which the consequence is both unpredictable as well as crucial. Stress is the response of people to the unreasonable/excessive pressure or demands placed on them.

Stress is not always negative. It may also bring out the best in individuals at times. It may induce an individual to discover innovative and smarter way of doing things. This positive dimension of stress is called as enstress. But usually, the term stress has a negative implication and this negative aspect of stress is termed as distress. For instance - When a subordinate is harassed or warned by his superior, unhappiness of unsuitable job, etc. We can say that "Stress causes some people to break, and other to break records."

### **SYMPTOMS OF STRESS:**

Symptoms of stress at workplace are as follows-

- Absenteeism, escaping from work responsibilities, arriving late, leaving early, etc.
- Deterioration in work performance, more of error prone work, memory loss, etc.
- Cribbing, over-reacting, arguing, getting irritated, anxiety, etc.
- Improper eating habits (over-eating or under-eating), excessive smoking and drinking, sleeplessness, etc.

Effective stress management strategies in an organization so that the detrimental repercussions of stress on the employees as well as their performance can be reduced and controlled.

### **SOURCES/CAUSES OF STRESS:**

The factors leading to stress among individual are called as stressors. Some of the factors/stressors acting on employees are-

1. Organizational factors- With the growth in organizational stress and complexity, there is increase in organizational factors also which cause stress among employees. Some of such factors are-
  - a. Discrimination in pay/salary structure
  - b. Strict rules and regulations
  - c. Ineffective communication
  - d. Peer pressure
  - e. Goals conflicts/goals ambiguity
  - f. More of centralized and formal organization structure
  - g. Less promotional opportunities
  - h. Lack of employees participation in decision-making
  - i. Excessive control over the employees by the managers
2. Individual factors- There are various expectations which the family members, peer, superior and subordinates have from the employee. Failure to understand such expectations or to convey such expectations lead to role ambiguity/role conflict which in turn causes employee stress. Other individual factors causing stress among employees are inherent personality traits such as being impatient, aggressive,

rigid, feeling time pressure always, etc. Similarly, the family issues, personal financial problems, sudden career changes all lead to stress.

3. Job concerning factors- Certain factors related to job which cause stress among employees are as follows-
  - a. Monotonous nature of job
  - b. Unsafe and unhealthy working conditions
  - c. Lack of confidentiality
  - d. Crowding
4. Extra-organizational factors- There are certain issues outside the organization which lead to stress among employees. In today's modern and technology savvy world, stress has increased. Inflation, technological change, social responsibilities and rapid social changes are other extra-organizational factors causing stress.

#### **STRESS MANAGEMENT:**



Stress management is a collection of skills, tools, and techniques that help you reduce, manage, and even counteract the negative side-effects of stress.

There are four main strategies for stress management:

- Change the stressors or environment causing your stress
- Change your direct response to these stressors
- Change your attitude and perceptions that affect your responses
- Take active steps to recover from stress

It is important to realize that the stress you experience is your unique response to a situation or event. For example, a change such as moving may not be stressful for you, but it could be stressful for your spouse, friend or coworker. It's actually not the stressor itself that's harmful, but rather how we respond to these stressors. Stress affects everyone differently. Some people are naturally good at stress management. Others, however, need a little help. The important thing to remember is that everyone needs to find positive ways to cope with stressors and the effects of stress.

#### **STRATEGIES FOR MANAGING STRESS**

Stress experienced by the employees in their job has negative impact on their health, performance and their behaviour in the organization. Thus, stress needs to be managed effectively so as to set off these harmful consequences. Strategies for managing stress are as follows-

#### **ORGANIZATIONAL STRATEGIES FOR MANAGING STRESS:**

1. Encouraging more of organizational communication with the employees so that there is no role ambiguity/conflict. Effective communication can also change employee views. Managers can use better signs and symbols which are not misinterpreted by the employees.
2. Encourage employees' participation in decision-making. This will reduce role stress.
3. Grant the employees greater independence, meaningful and timely feedback, and greater responsibility.
4. The organizational goals should be realistic, stimulating and particular. The employees must be given feedback on how well they are heading towards these goals.

5. Encourage decentralization.
6. Have a fair and just distribution of incentives and salary structure.
7. Promote job rotation and job enrichment.
8. Create a just and safe working environment.
9. Have effective hiring and orientation procedure.
10. Appreciate the employees on accomplishing and over-exceeding their targets.

**INDIVIDUAL STRATEGIES FOR MANAGING STRESS IN ORGANIZATION:**

- 1 Time Management If employee can understand and utilize the basic time management principals, He can better cope with tensions caused by job demand. These basic time management principles are making list of activities to be accomplished, Priorities by importance and urgency, Scheduling activities according to priorities set.
- 2 The employees should make a “to-do” list daily, prioritize the acts in the list and plan the acts accordingly. Take regular breaks during work to relax you. By effective time management, the employees can achieve their targets timely and can meet work pressures and, thus, avoid stress.
- 3 Do hard work. Strive to achieve your goals but do not do it to the harm of family, health, or peer.
- 4 Indulge in physical exercises. It helps in effective blood circulation, keeps you fit, diverts mind from work pressures.
- 5 Encourage a healthy lifestyle. Take a regular sleep, have plenty of water, have healthy eating habits. Promote relaxation techniques such as yoga, listening music and meditation.
- 6 The employees should have optimistic approach about their work. They should avoid connections with negative approach employees.
- 7 The employees should have emotional intelligence at workplace. They should have self-awareness, self-confidence and self-control at workplace.
- 8 The employees should build social support. They should have close connections with trustworthy peer who can listen to their problems and boost their confidence level. This social network will help the employees to overcome stress.
- 9 Employee counseling is a very good strategy to overcome employee stress. Through counseling, employees can become aware of their strengths and how to develop those strengths; their weaknesses and how to eliminate them; and they can develop strategies for changing their behaviour. Employees are also given career counseling which helps in reducing their ambiguities with regard to career.
- 10 Find a fun way to release stress, such as, cracking jokes, playing tennis, golf, etc.
- 11 Do not remain pre-occupied with yourself. Turn your focus outwards. Help others. This will release some stress.

**BENEFITS OF STRESS MANAGEMENT:**

1. Better immune function
2. Less illnesses and physical complaints
3. More energy
4. Feeling more relaxed
5. Sleeping better
6. Better digestion
7. Calmer mood
8. More focused, more positive
- 9 Increased Productivity
- 10 Increased Happiness

**CONCLUSION**

“Stress is an interaction between coping skills of an individual and the demands of his environment” **Stress** and stress management are directly related to personal well-being and specifically to workplace **well-being**. **Employers** should provide a stress-free work environment, **recognize** where stress is becoming a problem for staff, and take action to reduce stress. Stress in the workplace reduces productivity, increases management pressures, and makes people ill in many ways, evidence of which is still increasing. For organizational Development, management has to use stress management strategies to increase productivity and efficiency of organization and to run the organization smoothly.

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**PREDICTION OF POWER FROM PHOTOVOLTAIC PANELS SETUP USING MACHINE LEARNING TECHNIQUES BASED ON SOLAR IRRADIANCE IN INDIA**

**PRACHI SHARMA AND MEGHA KAMBLE\*****ABSTRACT**

*Most of the natural energy resources will get depleted within few years in near future. However solar irradiance is considered as one of the natural energy resources which will not get affected. It will continuously increase in upcoming years. Solar irradiance is the measure to determine the sun's radiation per square meter. People are getting to reuse everything in India and especially the energy sources are reused nowadays. Through the photovoltaic panels, the solar irradiance can be utilized to produce renewable energy. It can help to figure out how the photovoltaic panel setup is made. In this paper, solar irradiance from central Indian cities are collected, sorted from maximum to minimum with respect to cities are arranged in descending order. From NASA, the data is collected and to process the data various models, methods and algorithms have been applied. After the data is processed, the clear idea is obtained in which the PV panels setup is produces higher electricity and more economical than others through the solar irradiance as renewable energy. Three algorithms such as Artificial Neural Network- ANN, Linear regression and random forests are utilized. Among them random forest shows better results.*

**Keywords:** Solar irradiance, Power Prediction, PV Panel, ANN, Linear Regression and Random forest

**1. INTRODUCTION**

Solar irradiance is one of the natural resources used in and restore as the form of energy and electricity. It is more important like other natural resources. Solar irradiance depends on measure like temperature and humidity which are used again in an efficient manner(Al-Dahidi, Ayadi, Alrbai, & Adeeb, 2019). Solar power is totally depends on the weather condition of the given or selected cities and the forecasting of them is totally depends on the collection of data. A Statistical data and forecasting is very helpful in this era before calculation. Correct calculation gives better result and better result gives accurate information to plant Photo voltaic- PV panel(Dolara, Grimaccia, Leva, Mussetta, & Ogliari, 2018). Various solar power technologies through text mining are considered by taking 2280 international patents and 5610 literature reviews as thus was formed where initially this review resulted in the formation of a solar power knowledge oncology schema(Zhou, Zhou, Gong, & Jiang, 2020),Followed by non-supervised machine learning techniques finally applying word-embedding algorithm and cross-validation of results(Trappey, Chen, Trappey, & Ma, 2019). An improvement of energy efficiency of the construction sector has become necessary to reduce gas emission through machine learning- ML approaches including (Rana & Rahman, 2020)artificial neural network,support vector machine,Gaussian-based regressions and clustering(Miller, Nagy, & Schlueter, 2018).

From the existing researchers the problems identified and the major contributions of this study using machine learning algorithms are,

- In machine learning approach, which kind of algorithm is suitable for finding solar irradiance in particular set of places are difficult to determine. Further by applying these algorithms at set of places, solar irradiance determination in these places are expected to be identified and suggested where to identify in which place the PV plant can setup to produce highest energy compare to others.
- As the PV panels are highly expensive, it is significant to identify higher PV area with the better accuracy since placing an expensive PV panel with insufficient solar irradiance can lead to big financial disaster.
- Finally identifying the correct and suitable location to plant the panel and obtaining the maximum energy, and how to maintain the grid stability is very important and also maintaining the security of power management system.
- Various solar irradiance prediction has to be focused based on available data. Thus the core concept is to develop the clustering approach to group the data into respective attributes used for the further prediction process. Enhanced machine learning algorithms are employed considering the data availability.

### **1.1 Paper Organization**

The following section 2 deals with the discussion of existing researches. Further, section 3 describes the proposed methodology of this study and the results and discussion of the study explained in section 4. Finally the study is concluded in section 5.

### **2. LITERATURE REVIEW**

For all the solar power plants solar radiation is essential. The solar power plants' power output is time variant, and thus solar radiation forecasting is vital for the possible electricity generation prediction for the specific days in advance. It is beneficial for utility or ISO due to advance hourly forecasting(Yang, Kleissl, Gueymard, Pedro, & Coimbra, 2018). By using the CART, M5, random forest and MARS model the forecasting of hourly solar radiation is performed (1 day to 6 day ahead). Using the resource setup of solar radiation data is collected which is hired by Gorakhpur Government in India. From this study, the random forest model yielded better results whereas worst results obtained from CART model(Srivastava, Tiwari, & Giri, 2019). Better results obtained from double layer application and 16 percent power improvised(Ağbulut et al., 2020; Touati et al., 2017).

Global horizontal irradiance-GHI forecasting 5 to 20 min ahead with respect to convolution neural network-CNN model utilized from whole sky images(Dong, Chang, Wu, & Gao, 2020)(Sun, Szűcs, & Brandt, 2018). Through machine learning method based similarity metric weather analogs has developed. For weather analog search, trained neural networks are utilized. All variables are integrated in this new metric for weather analog search without weight optimization and prior feature selection requirement. This study has been performed at Shagaya Renewable energy park, Kuwait and studied the prediction of solar power related with machine learning models. The prediction errors in test dataset is minimized by the hyper-parameter and comprehensive parameter using the ANN models which is regime dependent(Pazikadin et al., 2020). For forecasting the intraday solar irradiance(Li, Pradhan, Gaur, & Thomas, 2019), two machine learning algorithms have been focused like multilayer perceptron- ANN and multigene genetic programming- MGPP.

The proposed study shows higher performance in stability and accuracy forecasting(Theocharides et al., 2020). Random forest and Adaboost technique are utilized and compared for the PV application study. Based on evolutionary algorithm of mathematical model, experimental setup of terminal current has augmented from fast changing environmental conditions dataset. For the multiple irradiance and temperature levels the mathematical model has investigated with respect of datasheet of manufacturer. Lesser standard deviation and mean resulted from Random forest absolute error distribution. Compared with Adaboost, random forest shows higher performance with respect to absolute error. Based on limits of larger quartiles, the distribution of absolute error is scattered b Adaboost technique. The error mean of Adaboost is 34.5 percent whereas random forest shows 0.27 percent, for standard deviation value the adaboost shows 15.8 percent and random forest shows 0.27 percent. Into the EML based MPPT mechanism accurate predictions are made(Omer & Shareef, 2019). Thus the existing work instances inside India and outside India has motivated this research work to be taken up to explore prediction.

### **3. PROPOSED METHODOLOGY**

In the solar irradiance field various work is performed. But only few researches are performed in India. In this study 8 cities are considered from central India. The significance is given to which cities possess higher solar irradiance and determining these cities and placing a PV panel for solving the electricity issue is the major goal of this study. The suggestion of placing PV panel is given to highest solar irradiance yielded city. For generating the PV, it can ensure the optimum use of solar irradiance. Also the energy should be used in an efficient manner.

#### **3.1 Data collection**

The proposed study's data consists of 28489 rows and every possible criteria is calculated after collecting data. The proposed research would not have completed if NASA would not provide the data. In this paper collect data from different cities of Madhya Pradesh state of INDIA is collected shown in table 1 and process data through different algorithm on different scale .by processing data of solar irradiance,solar energy become easier to calculate.

**Table 1: Significant data collection for the prediction of solar irradiance MAX**

City :	Bhopal ,Betul, Indore, Jabalpur ,Ratlam ,Seoni, Rewa ,Gwalior.
Date:	Dates (MM/DD/YY):01/01/2011 through 01/11/2020
T2m :	Temperatures at 2 meters
T2M_Max:	Maximum temperature at 2 meter
T2M_Min:	Minimum temperature at 2 meter

Earth skin temperature :	Earth surface temperature
T2MDEW:	Dew/Frost Point at 2 Meters
PRECTOT:	Precipitation
Relative humidity:	Relative humidity at 2 Meters
Surface pressure :	Surface pressure
Wind speed :	wind speed at 10 Meters(m/s)
Radiation:	Radiation
Clear_index:	Insolation clearness Index(dimensionless)

### 3.2 Data analysis and processing

By applying the filters for all these outliers, duplicate values or missing value, the data is prepared to make the model more suitable.

The dataset pre-processing involves,

- Firstly ignore the missing values
- Removing instances having missing values from the dataset
- Estimate the missing values of instances using mean ,median or mode
- Removing duplicate instances from the dataset
- Normalizing the data in the dataset

### 3.3 Feature selection

Here are some of the best features which are the best for data considered are, T2M,T2M\_Min,T2M\_Max,Earth\_Skin\_Tem,T2MDEW, Precipitation, Relative humidity, Surface pressure, wind \_speed, Radiation, Clear\_Index,Year ,day, month.And the radiation column in which there is prediction. This is the feature that can do the best work for the model and can provide less error.

### 3.4 Learning algorithm

In this process three algorithms are used for the process and they are linear regression, ANN, and random forest. The one which gives the best result is considered as the best algorithm.

The model is being trained from the dataset. This data set is divided into two parts, 80%:20%, training and testing data.

### 3.5 Proposed algorithm

The data provided by NASA is not only beneficial for this research but also it will be the base and stepping stone for future research in future in this field. In this research 8 cities such as Bhopal, ,Betul, Indore, Jabalpur,Ratlam,Seoni, Rewa and Gwalior from the central Indian state(Madhya Pradesh) were selected and result was concluded after applying different criteria on data provided by NASA approximately data past 10 years. The relation among the variables are shown in correlation matrix in fig.1.

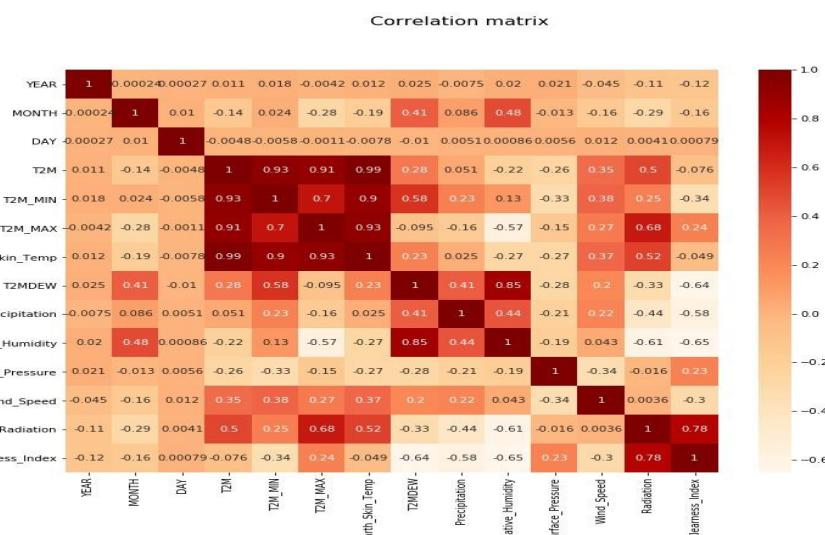


Fig.1. Correlation matrix- relation among two variables

The correlation matrix is in the form of a table that tells the relation between different variables. This reduces the large dataset to a smaller form. The given data is visible in visual form. In correlation matrix, the row and column represent the variables. Each cell in the table represents the correlation coefficient. This graph shows the correlation which feature have correlation in between. The darker the color the highest the correlation will be and vice versa. It also has values with better visuals, 1 means positive correlation, -1 means negative correlation. Correlation in radiation and temperature from this graph shows in the proposed research, if the temperature increases then radiation will also increase. So by this graph we can say radiation is directly proportion to the temperature.

$$\text{Radiation} \propto \text{Temperature} \quad (1)$$

At radiation and humidity, it shows negative correlation. If the radiation increases then humidity will decreases and on the other hand if the humidity is increase then radiation will decreases.

$$\text{Radiation} \propto 1/\text{Humidity} \quad (2)$$

Clear\_Index shows how clean the atmosphere is. Clear\_Index shows if the atmosphere is clean, solar energy will easily pass through the atmosphere. Correlation in radiation and clearness\_index in proposed research shows positive correlation, it means if the radiation increases then clear\_index will also increase. So the radiation is directly proportional to the clear\_index

$$\text{Radiation} \propto \text{Clear_Index} \quad (3)$$

Precipitation is the condensation of atmospheric water vapor present in the atmosphere. Water is present in the atmosphere the form of vapors or mini droplets, when these droplets meet together by the effect of gravity or by drop in temperature, these water droplets merge and appear in the form of precipitation. In the case of Radiation and precipitation, then it has negative correlation. If the radiation increases then Precipitation will decrease and in the same way, if the precipitation will increase radiation will decrease.

$$\text{Radiation} \propto \text{Precipitation} \quad (4)$$

From Eq. (1) and (2),

$$\text{Radiation} \propto \frac{\text{Temperature}}{\text{Humidity}} \quad (5)$$

From Eq. (3) and (4),

$$\text{Radiation} \propto \frac{\text{clear_index}}{\text{precipitation}} \quad (6)$$

From Eq.(5) & (6), the radiation is completely depends on all these parameters.

When solar radiation is discussed, it is generally around the unit of 4kw-h/m<sup>2</sup> on an average but solar radiation has a peak of 6-7kw hr/m<sup>2</sup> in Indian climate in summer months when the temperature is very high. According to proposed analysis of the dataset, temperature has a positive correlation with radiation so when the temperature increases radiation also increases and there is more solar irradiance at a particular point. In general temperature is normally distributed with some small peak points and in between these peak points are the one in which the value of temperature is very high. The high peak points are mostly in the months of May to June when the summer is mostly at its peak and the temperature is at its highest in most of central India.

### **3.5.1 Linear Regression (LR)**

It tries to model the association amongst two variable through linear equation fitting to the perceived data. A variable is taken into account as a descriptive variable. On the other hand, the other is taken into account as a dependant variable. For instance – a modeller might require to associate the individual weights to their corresponding heights through the use of a LR model. Before trying to fix a linear model for the perceived data, a modeller must initially find there exists an association or not amongst the variables. It does not inevitably imply that a variable leads the other (For instance – more SAT scores don't lead to high grades in college). However, there exists significant relationship amongst two variables

A LR line possess an equation having the form  $B = x + yA$ , where A indicates the descriptive variable and B denotes the dependant variable. The line slope is y and x indicates the intercept.

### **3.5.2 Random Forest (RF)**

It is the supervised learning algorithm. Forest it constructs indicates the decision tree ensemble typically trained through bagging technique. Typical concept behind bagging technique is that the integration of learning models

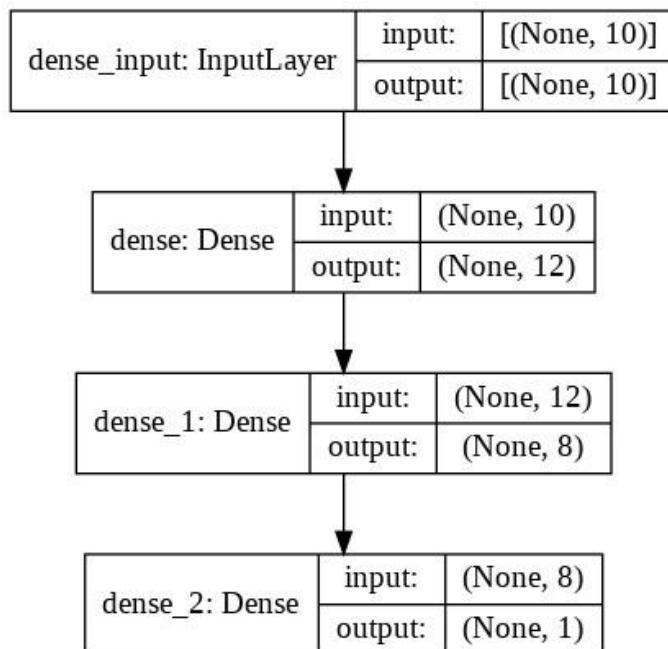
enhance the overall outcomes. RF is easy to implement and flexible machine learning (ML) algorithm that affords effective outcomes without even tuning the hyper parameters. It is a simple and diversified algorithm. It is also a handy algorithm as the hyper-parameters (default) used often generate effective prediction outcomes. The hyper-parameter understanding is also straightforward. In addition, RF algorithm possess various advantages as discussed here.

- It minimizes the overfitting issues in DTs and assists to enhance accuracy.
- It operates better with continuous and categorical values.
- Data normalisation is also not needed as it utilises a rule-based strategy.
- Flexibility to regression and classification issues.
- It automates all the missing values existing in the data.

Taking all these advantages into account, this study intends to predict power from Photo Voltaic Panels Setup by taking into account the above algorithms.

### **3.5.3 Artificial Neural Network (ANN)**

ANN is the element of AI (Artificial Intelligence) meant for simulating the operations of human brain. The processing units create the ANNs that comprise of input as well as the output. In addition, backpropagation comprise of set of rules for learning utilised to support ANNs. It possess several advantages. It learns events thereby making decisions through observation on identical events. It also has the ability to perform parallel processing that makes it effective. The architecture is represented in fig.3.



**Fig.3.** ANN architecture

#### Artificial Neural Network

Parameters = loss = mse" optimizer=adam, metrics = ['mse', 'mae']

Layer<sub>1</sub><sub>activation</sub> = relu

Layer<sub>2</sub><sub>activation</sub> = relu

Layer<sub>3</sub><sub>activation</sub> = linear

For instance, a location that gets 8kWh/m<sup>2</sup> per day could be stated to have acquired eight hours of sun per day at (1kW/m<sup>2</sup>)

A NN (Neural Network) possess neurons that operate in accordance with the bias, weight as well as their corresponding activation function. The activation layer introduces a non-linearity into this neuron output. In

addition, ReLU (Rectified Linear Activation Function) for miniature is the piecewise linear function which would output the corresponding input in a direct way if it's positive or else it tends to output zero. This ReLU function solves the vanishing-gradient issue permitting the models for faster learning and better performance. The main merit of utilising ReLU function upon supplementary activation function explores that is don't activate every neurons concurrently. This reason makes the back-propagation process, biases and weights for few neurons that have not been updated.

- In ratlam, radiation amount = 1822 kWh/m<sup>2</sup>on 2020.
- During peak sun hours, radiation = 1000 watt/m<sup>2</sup>.
- So, 6-7 hours of radiation is attained when average radiation range = 6kw/hm<sup>2</sup>.
- Thus, 2190 hrs of sunlight = 365 days
- However, in winter and rainy months, less sunlight is got.
- Hence, when 30 sun hrs are subtracted = 1533 hrs of radiation is attained.
- Typically, solar panels = 250 & 400 W of power.
- The actual outcomes will rely on certain factors like orientation, sun hours and shading.
- A 30 panel system = enough electricity for 365 days to counterpart all the electricity use.
- For a single panel, it is 1533 hrs of radiation,
- If panel is 290 W, then  $1533 * 290 \text{ W} = 400 \text{ to } 500 \text{ kwh}$  of energy for 365 days from a panel when 30 panels are used.
- Thus, thirty panel of 290 W = 8700W or 8.7kw.
- So,  $1533 * 8.7$ , there will exists around 13400kwh of produce of energy by 290W for thirty panels per year.

#### **4. PERFORMANCE ANALYSIS**

The proposed system is analysed with respect to various significant metrics to explore the extent to which the proposed ML models are better to predict the power from the Photovoltaic (PV) panels.

##### **4.1 Performance metrics**

The performance of the proposed system is analysed with respect to Root Mean Square Error (RMSE), Median Absolute Error (MAE), Mean Absolute Error, R<sup>2</sup>, Adjusted R<sup>2</sup> and Mean Square Error (MSE).

##### **A. RMSE-Root Mean Squared Error**

It is defined as the ideal computation of accuracy. It only performs comparison amongst the varied model's prediction errors or model configurations for a particular variable, however not between all variables which is due to its scale reliance. It is presented by equation.7.

$$\text{Root Mean Square Error (RMSE)} = \sqrt{\frac{\sum_{i=1}^N (\text{actual time series observation} - \text{predicted time series observation})^2}{N}} \quad (7)$$

Here i represents the variable and N indicates the counts of non-missing data points.

##### **B. MAE-Median Absolute Error**

It is specifically fascinating as it is found to be robust to the outliers. Loss is computed by considering the median of each absolute differences amongst the prediction and target. As assumption is made by considering  $\hat{x}_i$  is the ith sample's predicted value and  $x_i$  is the equivalent true-value, then estimation of MAE over n samples are defined by equation.8.

$$\text{MAE}(x, \hat{x}) = \text{median}(|x_1 - \hat{x}_1|, \dots, |x_n - \hat{x}_n|) \quad (8)$$

##### **C. MAE-Mean Absolute Error**

It is a model's assessment metric that is used with the regression models. A model's MAE with regard to a test set can be referred to as the mean of absolute values equivalent to the individual prediction errors over all test set cases and is given by equation.9.

$$\text{Mean Absolute Error (MAE)} = \frac{\sum_{i=1}^n |\text{predicted value} - \text{actual value}|}{n} \quad (9)$$

Here n indicates the total data point counts

#### D. $R^2$

It is the statistical computation that indicates the variance proportion for a dependant variable and is given by equation.10.

$$R^2 = 1 - \frac{\text{Sum (squares of residuals)}}{\text{overall sum (squares)}} \quad (10)$$

Here  $R^2$  indicates the determination coefficient.

#### E. Adjusted $R^2$

It is the modified version of  $R^2$  that is adjusted for the predictor counts in the model. This value enhances as the new term enhances the model than would be probable. On the other hand, it minimizes if a predictor enhances the model lesser than actually expected.

#### F. MSE-Mean Square Error

It exhibits the nearness of the set of points and regression lines and is given by equation.11.

$$\text{Mean Square Error (MSE)} = \frac{1}{n} \sum_{i=1}^n (\text{observed values} - \text{predicted values}) \quad (11)$$

Furthermore, the Machine learning techniquesplays an important role in research field and also very helpful in future prediction. Evaluating the model is very important throughout the development of model through various different methods. It is important to evaluate model successfully. While building the model, three different algorithms that learn from data and test the model are utilized shown in table 2.

**Table 2: Three proposed models and evaluating results**

S.no.	Algorithms	Root mean square	Mean absolute error	Median Absolute Error	$R^2$	MSE	Adjusted $R^2$
1	Linear regression	0.33	0.24	0.19	0.94	0.11	0.94
2	Random Forest	0.08	0.05	0.04	0.99	0.00	0.99
3	ANN	0.62	0.55	0.53	0.82	0.39	0.82

The following data are taken for the 8 cities ,the parameters are T2M,T2M\_Min,T2M\_Max,Earth\_Skin\_Tem,T2MDEW, Precipitation,Relative humidity,Surface\_pressure,wind\_speed,Radiation,Clearness Index.

From 0 to 8 scale solar irradiance is calculated by the above parameters so the proposed solar irradiance is 99% accurate from the given solar irradiance units upto the last 10 years. By this chart if these parameters are focused then the exact solar irradiance is predicted and plant P.V panel, getting better result. Better result is depends on the data accuracy, quality and quantity of data.

To create and redevelop the model every day, Solar Irradiation P.V panel, evaluate the solar energy based on result and solar panel installation increase solar irradiation daily. After evaluating and calculating algorithm from 2011 to 2012maximum solar irradiation was at Gwalior.After that in year 2012 to 2020 maximum solar irradiation wasin Ratlam.So according to the result in MP solar irradiance is maximum in Ratlam and if install PV plant more and more then PV panel in Ratlam get more solar energy.

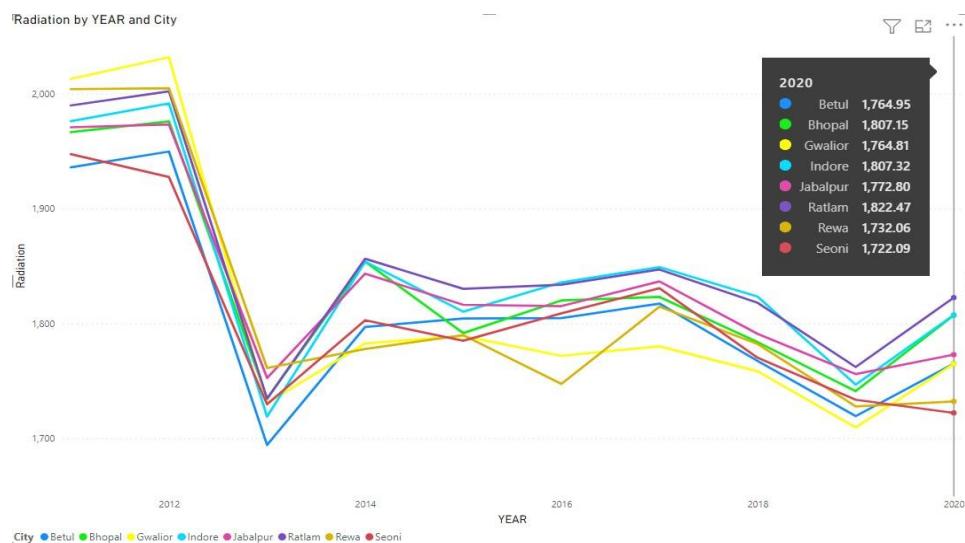


Fig.6. Solar irradiance in year 2012-2020

Above fig.6. Shows solar radiation from 2012-2020. According to the above figure solar radiation is maximum in RATLAM as well as minimum in SEONI so the total energy in a year is calculated here.

## 5. CONCLUSION

Solar irradiance depends on measures like temperature and humidity which are used in an efficient manner. Solar power is totally depends on the weather condition of the given or selected cities and the forecasting of them is totally depends on the collection of data. A Statistical data and forecasting is very helpful in this era before calculation. Through the PV the solar irradiance can be utilized to produce more renewable energy. It can help to figure out how the photovoltaic panel setup is made. In this paper, solar irradiance from central Indian cities are collected, sorted from maximum to minimum and process the data using various models like Artificial Neural Network- ANN, Linear regression and random forests. After the data is processed, the clear idea is obtained that in which cities the PV panels setup is produces higher electricity and more economical than others through the solar irradiance as renewable energy. Three algorithms such as are utilized. Random forest shows better results. Also, solar radiation is maximum in RATLAM as well as minimum in SEONI in Madhya Pradesh and thus more solar energy obtained in Ratlam.

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**REVIEW ON THE IMPACT OF ONLINE LEARNING ON STUDENTS****RAJKUMAR N\*, RUBY JOHN AND MANJUNATH****ABSTRACT**

Numerous educational institutions have been closed worldwide due to the pandemic caused by the COVID-19 virus. Most educational institutions are now using online learning platforms in order to continue their academic programmes. In poor countries like India, where issues like device compatibility and bandwidth availability make it difficult to implement successful e-learning programmes, many of these issues remain unresolved. A literature review was conducted to ascertain the public's perceptions about online learning. Our findings will help develop a successful online learning environment based on students' preferences for many aspects of online classes. For online study, most students opted to use their smart phones. Students prefer recorded sessions that culminate with a quiz in order to maximise their class time. Although students prefer online classes, the students in rural areas are unable to take full advantage of online classes due to internet access concerns. Since many science and technology courses are hands-on in nature, it may be unrealistic to completely shift the curriculum to an online format. A curriculum for the future beyond COVID-19 can benefit from the observations made in this review.

**Keywords:** Student perception, Online teaching, Preferences, Content analysis

**INTRODUCTION**

The pandemic caused by the corona virus, COVID-19, has led to the closure of educational institutes in many parts of the world. The everyday operations of educational institutions have been put on hold due to the necessity of protecting their students from viral exposure. Only schools in China and a few other nations affected by the spread of the disease were shuttered at the beginning of February 2020. However, as of mid-March, more than 70 countries had enacted or declared the shutdown of educational institutions. One out of every five pupils in the world was missing class as of the 10th of March as a result of the worldwide COVID-19 closures. Many kids have been hurt by the shutdown of schools, even though lockdown and social isolation are the only means to slow down COVID-19's spread by interrupting the transmission chain.

There are several methods that students and educational institutions alike are attempting to meet the academic calendar's deadlines while schools and colleges are closed indefinitely. New examples of educational innovation have arisen as a result of these efforts, but they have also caused some inconvenience. With millennia-old lecture-based teaching methods and out-of-date classrooms, academic institutions are still locked in the past. The COVID-19 pandemic has sparked a wave of innovative thinking in educational institutions around the world. When it comes to online education, new ways of classroom teaching like Google Meet, Microsoft Teams, Zoom, Blackboard or other similar systems have become the norm. Although some of these technologies existed before the pandemic, this mode of teaching was adopted due to the closure of the educational institutes.

Stop-gap measures are being sought by educational institutions in affected areas to keep classes running, but the quality of instruction depends on how well students can access and use technology. Students' enthusiasm, satisfaction, and involvement in online education are drastically different from those in traditional classrooms [1]. Social, cognitive and teaching presences all play a role in how students learn in an online setting similar to the traditional teaching methods. Students in online and in-person classes were equally satisfied, according to one survey. [2]. If they're properly organised, online classes can have the same impact on students as face-to-face ones. Research shows that online learning is a viable alternative to traditional classroom learning if it is properly planned and conducted.

**LITERATURE REVIEW**

As technology advances, we can use a variety of methods to create online content. Student's sensibilities and views must be considered when planning virtual courses. A student's preference is related to his or her willingness or capacity to participate in collaborative education and to the elements affecting the student's readiness for online education.

In Australia's vocational education division, Warner et al. [3] suggested the concept of preparing students for virtual learning. For online learning, they focused on three factors: (1) student preference for delivery mode

over face-to-face classroom instruction; (2) the learner's conviction in their own abilities to learn via computer-based communication and the Internet; and (3) the student's ability to take charge of their own education. A 13-item questionnaire designed by McVay, for example, investigated students' behaviour and attitude as determinants of achievement [4]. To test McVay's opinion poll, Smith et al. undertook an investigative study and developed a two-factor criteria called "Comfort with e-learning" and "Self-management of learning" [5]. Studies then attempted to operationalize the concept of online readiness by conducting research [6]. Self-directed learning [7,8], desire for learning [9], learner control [10,11], learner self-efficacy [12], and computer and internet self-efficacy [12,13,14] all had an impact on online learning readiness.

User perception is critical to any endeavour to improve online learning's effectiveness. Several studies have found that students have both positive and negative feelings about online learning. Online learning is viewed as more effective when the educator has a positive relationship with pupils. Student's rational thought and cognition abilities improve when they connect with their teachers [15,16]. This is especially true when students interact with their instructors in an online setting [17]. Students are encouraged to communicate with their educators and colleagues in online learning environments [18], as well as to have a strong social presence [19]. This means that in order to have a good online class, you need well-structured course content, well-prepared instructors, innovative technologies, and clear directions and feedback [20]. Although online learning has its advantages, it also has its drawbacks. Problems working with co-learners, technology challenges, and feelings of isolation or loneliness [21]. There are several issues that are considered to be weaknesses or barriers to online learning. Students should be self-motivated and disciplined for online classes to be successful, as well as be able to devote more time to their education [22].

Online or web-based tutorials have been compared to classroom training by several academics. Because of the vast differences between online and traditional classroom interactions, the views of students and instructors in one context can be profoundly influenced by how they communicate with one another. The research examined student's and faculty's awareness of virtual learning in comparison to traditional classroom settings and found conflicting results. Examining whether certain variables, such as the type of online interactions offered, the flexibility and accessibility of web-based instructions [23], the learner's skills, motivations, availability, as well as the instructor's perceptions [24,25], are linked to academic accomplishment is critical. Online learning and face-to-face classes had no substantial impact on students' enjoyment and academic achievement, according to the study [26]. Online classes, when designed appropriately, can be just as effective as face-to-face classes [27].

Koshaim et al studied the anxiety level and stress among University students in Saudi Arabia during the Covid - 19 pandemic [28]. In this study a survey using a questionnaire was carried out and analysed to measure the levels of anxiety in the students. Mheidly et al studied the stress and burnout among students due to technological and online learning [29]. Prolonged screen time and lack of social interaction leads to stress and burnout.

## **FINDINGS**

Most of the students preferred to attend online classes using a smartphone, laptop, tablet, or desktop computer, which shows that organisations developing online learning applications must ensure that the platform is compatible with these devices. Internet access was mostly using mobile data plans as the preference of mobile devices was higher. Information related to class changes etc. were communicated mostly through applications like WhatsApp. Most of the students preferred pre-recorded classes which are uploaded on the educational institute's websites or common platforms like YouTube. Whereas very few students preferred online classes which can be recorded or online classes without any recording. The preference for only reading material was negligible. Pre-recorded and live classes that can be recorded are preferred by the vast majority of respondents because they allow them to learn at their own pace. Most student's preferred video content combined with reading materials when compared to only reading materials. Usage of power point presentation by the instructor was the most preferred mode of learning.

Students preferred to submit their queries on a dedicated platform compared to live interaction or by email or other means and expected a reply within a day. Quizzes and assignments were the most popular ways for pupils to retain information. Online examinations were favoured compared to offline examinations and objective multiple choice questions were preferred compared to descriptive questions and answers. It is likely that the disparity in student's perspectives is due to a lack of internet access, ineffective teaching abilities, or a poor learning environment.

Flexibility and convenience were shown to be the most important advantages of online learning. Using online education, students can pursue their education at their own pace and at a time that suits them best.

Consequently, online education is becoming more popular because of characteristics like convenience and flexibility. The most common barrier to online learning was a lack of connectivity. A lack of equitable access to uninterrupted internet is a major problem for many students in India. The internet speed and data limit were the major constraints for students in rural areas. Additionally, a significant concern in online classes is the absence of direct communication between students and instructors.

It was widely agreed that the quality of content and infrastructure were critical factors in ensuring a successful online course. For a course instructor to commit the necessary time to the content, it must be well-structured, concise, interactive and relevant. If students have the ability to record their lectures, they will be able to review the material at any time. Additionally, students who are unable to see the sessions live because of internet connectivity issues would benefit from the recordings. Online lessons can only succeed if all students have access to the internet. Many different gadgets and software should be available for students, and they should be able to connect to the internet.

Technology constraints, distractions, teacher incompetence, learner inefficacy and health difficulties were frequently cited as barriers to online learning by study participants. The most common problem cited by participants was a lack of technology. Some students will be unable to take part in online classes due to a deficiency of internet connection. Accessing course platforms and resources can also be irritating if you have slow internet connections. In order to make online classrooms a success, the internet must be accessible and inexpensive to everyone. Instructors should make every effort to keep students interested in their classes by making them both fascinating and effective. Being able to use a computer and navigate the Internet is also vital.

Lack of socializing and interaction with their peers have a negative impact on the student community. Stress and anxiety level in students increased during the pandemic due to the imposition of the long lockdowns which restricted the movement of people. This also had an impact in the decreased productivity of the students.

## **DISCUSSION**

Student's life is not only just attending classes, the essential parts of every student's routine is visiting their campus, seeing friends in the cafeteria, discussing their ideas in the classroom and living in the dorms. This however, has drastically changed when the global pandemic has forced students to stay at home and accept the new form of studying online learning.

The major goal of this study to determine how students feel about online classes and what they think about them. As a result of lockdowns imposed due to the COVID-19 epidemic, the majority of students favoured online classes, while some proposed delaying or giving reading materials until the lockdown was removed. Early research has yielded a number of important discoveries about the possibilities of online learning [30,31,32]. The format of online classes was one of the most important criteria in determining the effectiveness of online classes. The findings of Dempsey and Van Eck [33]; Song et al. [34]; and Allen [35] support this conclusion. Long-term classes should be avoided, and students should be given a reasonable amount of time to rest between classes. For both mental and physical health, it is a good idea to limit the time spent using technological gadgets. Thompson's [36] formula of 52 minutes of effort and 17 minutes of rest backed it.

The level of computer and internet literacy of both instructors and students is critical to the success of an online course. Convenience and flexibility were considered to be the strengths of online classrooms as per some of the researchers [37,38]. It was observed that students found it convenient to interact in an online course without having to alter their schedules for everyone, as demonstrated by a study by Petrides [39]. Learners frequently used their home computers to obtain course materials [40]. In order to make online classes as convenient as possible for students, universities should make recorded videos readily available on their website so that students can watch them whenever they want. There is a great deal of emphasis on teaching students practical skills in science and technology courses. But it's tough to provide practical classes online. These 3D virtual labs are being developed as a means of adapting in light of the changing times. The capacity of a teacher to communicate effectively and use multimedia content is critical at this time. Incompetent teachers could be a major cause in the failure of an online class, and it also necessitates a closer assessment of current online practical class initiatives in order to better fulfil the needs of students.

In online classrooms, interactivity was discovered to be a main reason in their success. For online classes to be effective, students must be involved in a variety of interesting activities frequently. Other issues in online learning include a lack of immediate response time to students' questions. This means that the instructor should ensure that the student's queries are answered in a timely manner. If they provide relevant material and are backed by sufficient follow-ups, online courses can be just as effective as classroom courses. Reiterations of the

argument were made by a large majority of the attendees. Because online learning allows institutions and teachers to access learners remotely, it improves convenience and expands educational opportunities.

Before the current pandemic, even in countries with a smaller digital gap and greater internet connectivity than India, no one has ever gone completely online. The advantages of face-to-face engagement, immediate reaction, and a sense of community could be some of the reasons. It's also possible that the difficulty of imparting knowledge and skills, such as in lab classes, is a factor. As a result, it may not be possible to totally convert to an online style of instruction in science and technology education. Hybrid models may be used by colleges in the near future, in which online classes are supplemented by small-batch, and socially isolated practical sessions. The observations in this study can be used to develop the content and structure of online classes.

## **CONCLUSION**

An online education system is taking hold as a key mode of instruction in an effort to avoid spread of the new coronavirus. Universities and other educational institutions are increasingly relying on online resources to stay abreast of curricular changes. In spite of the fact that how students and teachers will adjust to online learning, this study is to document their attitudes about it and their readiness.

In the wake of the corona, this study found that most students had a positive outlook on online education. Students found online learning to be more convenient and flexible than face-to-face classes. Student interest was piqued by university websites featuring video recordings. Students wanted interactive sessions with quizzes and chores after each lecture to help them remember what they learned. A number of factors contribute to the difficulty of online instruction, including the instructor's inability to make effective use of information and communication technologies and the limitations of available technology. Technological improvement is needed to enhance the socialization and interaction among the students. This will not only improve the productivity of the students but also reduce the stress and anxiety levels in the students. When constructing an online course, all of these criteria should be taken into consideration to ensure that the learner gets the most out of it. A rise in school systems using online platforms for study aids may continue even after the COVID-19 pandemic is gone, but only in a hybrid mode with regular classrooms. As a result, this research will be valuable in rethinking and rebuilding higher education to include online components.

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**BENEFITS AND CHALLENGES OF OPEN INNOVATION IN INDIAN SMEs****DR. V KAVIDA, ARUN. R AND YUSAF HARUN K****ABSTRACT**

The purpose of this study is to expose the challenges that SMEs face as well as the benefits of adopting a more open approach to innovation. A structured questionnaire was employed to collect data from the manufacturing SMEs in India. A total of 335 Small, and Medium-sized businesses were surveyed. This study found that financial benefits, relationship building, improved strategy, improved knowledge, better management of resources, business development and increased recognition and values are the notable benefits of Open Innovation; while challenges are collaboration barriers, organisational barriers, knowledge barriers, human barriers, financial barriers, economic barriers, and market related barriers. It is recommended that, in view of the present challenges confronting small and medium-sized firms, the government may take necessary actions to help the industry flourish and contribute to the country's socio-economic growth.

**Keywords:** SMEs, Open Innovation, Benefits, Challenges

**1. INTRODUCTION**

Small and Medium Enterprises (SMEs) play an important role in a country's economy in terms of technology innovation, social inclusion, employment generation, and economic expansion. As a result, they have attracted more attention from policymakers and development organisations (Page and Soderbom, 2015). Over the last five decades, the Small, and Medium Enterprises (SME) sector has developed into a thriving and active sector of the Indian economy. It contributes significantly to the country's economic and social development by encouraging entrepreneurship and providing a high number of job openings at a lower initial capital investment. SMEs serve as support units for bigger companies, and this sector makes a significant contribution to the country's progressive economic growth. SMEs are increasing their economic sphere of influence, producing a diverse variety of goods and services to meet the demand of both domestic and international markets.

Despite their strong growth rates, however, SMEs face a variety of challenges. Particularly, in India, they are confronted with a suboptimal size of operation, technical obsolescence, supply chain problems, increased global and domestic competition, fund shortages, changes in industrial methods, and a chaotic and unstable business environment (Pricewater house Coopers Private Limited, 2011). Recent research has underlined the necessity for SMEs to capitalise on their innovative capabilities in order to gain and maintain a competitive edge (Cano-Kollmann et al., 2018; Parida et al., 2012). When it comes to innovation, SMEs confront a variety of difficulties. As a prominent innovation practice, closed innovation has become outmoded due to variables such as skilled worker mobility, the growing presence of risk capital. According to Chesbrough (2003) a centralised method of creating information for innovation known for closed innovation, has become ancient and obsolete in many industries. Thus Open Innovation model must fill that gap, in which extramural thoughts and expertise are tapped from and implemented in combination with internal resources. The adoption of the open innovation model has been linked to the success of companies like IBM, Apple, Cisco, Procter & Gamble, and Intel.

Early research focus primarily on the application of open innovation in giant high-tech companies such as IBM (Chesbrough 2003) and Procter & Gamble (Dodgson, Gann, and Salter 2006), while Small and Medium-sized Enterprises (SMEs) rarely have been studied. Very limited studies are found in Indian context. Thus, to address this research gap, the present study aims to explore the following research questions by considering evidence from India, an emerging market: What are the benefits that SMEs get while adopting open innovation and what are the key challenges that SMEs face while implementing open innovation. The subsequent part of the research paper is structured into four sections. The second section explains the review of the literature. Then, the research methodology is explained in detail. The fourth section comprises of the data analysis and results of the study and finally, the paper ends with the discussion and conclusion.

**2. LITERATURE REVIEW**

According to Chesbrough (2003), Open Innovation (OI) firm "commercializes both its own ideas, as well as innovations from other firms and seeks ways to bring its in-house ideas to market by deploying pathways outside its current businesses." He has defined OI as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the market for external use of innovation, respectively"(Chesbrough, 2006). Likewise, Lindegaard (2011) defines Open Innovation as "a two-way process

in which companies have an inbound process in which they bring in ideas, technologies, or other resources needed to develop their own business and an outbound process in which they out-license or sell their own ideas, technologies, and other resources".

Further Abouzeedan et al. (2013), state the challenges that SMEs face for innovation include lack of resources, the complexity of the scientific field, and access to up-to-date modern science and technology. Open Innovation can help SMEs overcome these obstacles, to gain outside knowledge and expand their technological expertise. SMEs face a range of bottlenecks while implementing open innovation, irrespective of its extensive engagement of open innovation and its derived advantages (Pullen et al., 2012). SMEs have been found to be more adaptive to open innovation, contributing significantly to challenges and perspectives related to their progress, such as products, process, and service innovation (OECD 2000a; De Jong and von Hippel 2005, 2009; IBM 2007; Hass and Hochrinner 2008; Maes 2009; Van de Vrande et al. 2009). It has been noticed that open innovation has provided SMEs with a variety of chances or options for growth. The key reasons for collaborating are to take advantage of new business opportunities, spread risk, combine complementary resources, and generate benefits (OECD 2008; Sousa 2008). Likewise Gassmann et al., (2010) have stated that Open Innovation has the potential to overcome problems and improve profitability for SMEs. Thus, SMEs can improve the performance by being exposed to open innovation which includes, obtaining knowledge from external sources, adopting OI techniques for internal growth, developing new business prospects, boosting access to markets, and enhancing business knowledge and capabilities.

Several studies have identified different hurdles to OI adaption. In a study Van de Vrande et al., (2009) argue that challenges faced by SMEs are still tied to organisational and cultural concerns which include venturing, customer involvement, external networking, R&D outsourcing, and external participation. Likewise Abouzeedan et al., (2013), state that lack of resources, the complexity of the scientific area, the coordination of the firm's operational functions, and access to up-to-date scientific expertise are obstacles for open innovation.

According to Spithoven et al., (2013), SMEs have a little influence from open innovation than large companies, because they lack the in-house ability to detect, assimilate, and integrate external knowledge. Likewise, Chesbrough (2010) suggested that SMEs, in comparison to large firms, lack the ability to both seek and absorb external information. However, SMEs lack sufficient number of skilled workers and internal knowledge base to incorporate and integrate externally acquired know-how (Vossen, 1998). Since very limited studies have been conducted in the light of Indian context, in order to fill in these research gaps, these studies aims to addresses the challenges of SMEs in adopting open innovation practices as well as identify its benefits.

### **3. METHODOLOGY**

The study gathered data from both primary and secondary sources. Secondary data was gathered from a variety of published sources. The Oslo Manual was utilised to design the questionnaire for this study (OECD, 2005). A structured questionnaire was employed to collect data from entrepreneurs of manufacturing SMEs using a five-point Likert scale in order to measure with a five-point scale ranging from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, and 5 = strongly agree). The data was gathered using the structured questionnaire from a sample of 335 manufacturing SMEs. Raosoft (2004) was used to calculate the sample size. Similarly, important topics ware captured from interviews. The topics discussed in the interview are: SMEs' perceptions on open innovation, their understandings of open innovation initiatives, the advantages and disadvantages of open innovation for businesses, the cost of these collaborative innovations for businesses, and what would be done to improve open innovations and avoid unnecessary violations of intellectual property while implementing open innovations practices. This study only focuses on quantitative outcomes from the survey using questionnaires. The data was collected between April and October 2021, and SPSS 20.0 was used for analysing a data for this study.

### **4. RESULTS**

#### **4.1 Characteristics of the Respondent Firms**

**Table: 1**

<b>Characteristics of respondents firms</b>	<b>N</b>	<b>%</b>
<b>Education level</b>		
Engineering Degree (BE/B.Tech.)	83	24.8
Engineering Diploma	31	9.3
PGPG Engineering Degree (ME/PhD) MBA/M.Com	110	32.8

<b>Any other</b>	<b>111</b>	<b>33.1</b>
<b>Year the business started</b>		
Below 5 Years	61	18.2
<b>5 to 15 Years</b>	<b>169</b>	<b>50.4</b>
16 to 40 Years	88	26.3
Above 40 Years	17	5.1
<b>Ownership Structure</b>		
<b>Sole proprietorship</b>	<b>237</b>	<b>70.7</b>
Limited Company	37	11.0
Family business	20	6.0
Partnership	41	12.2
<b>Type of Industry</b>		
Pharmaceuticals	12	3.6
Electrical and electronics	24	7.2
Food processing and Beverages	19	5.7
Rubber and Plastic products	34	10.1
Textiles and textile products	33	9.9
Leather and foot wares	5	1.5
<b>Iron and steel products</b>	<b>63</b>	<b>18.8</b>
Transport equipment's	4	1.2
Manufacturing of wood, pulp and Paper products	9	2.7
Chemicals excluding Pharmaceuticals	7	2.1
Refined petroleum products	2	.6
<b>Fabricated metal products</b>	<b>64</b>	<b>19.1</b>
Radio, TV and Communication machinery Office	1	.3
Accounting and computing Machinery	5	1.5
Others	53	15.8

Source: computed data

Table 1 shows that demographic profile of the participants from various firms. The result shows that education levels attained by majority of the respondents are related to engineering and management degree (33.1%). Most of the enterprises were sole proprietorship (70.7%) in ownership. The table also show that most of the enterprises have 5 to 15 years of experience. The results shows that majority of businesses operate in Iron and Steel segment (18.8%) and Fabricated metal products (19.1%).

#### 4.2 Benefits of the open innovation to the business

The benefits of Open Innovation to businesses were analysed based on the replies of firms to 22 proposed possibilities for potential advantages in terms of expansion of their business.

The Principal Component Analysis, a data reduction procedure, was applied to the replies in order to identify the factors that represent the advantages of Open Innovation in growing up businesses. Before proceeding to the Principal Component Analysis, in order to ensure the validity of sample size, the KMO test (0.765) was used to determine sampling adequacy, which was deemed acceptable. The P value is 0.000, which is less than 0.05, which indicates that the Bartlett's test was significantly in favour the questionnaire employed. These variables account for 71.54% of the total variance. As a result of the investigation, it was identified that factor analysis is an appropriate technique for data analysis. The computed results of component matrix for the statements relating to the benefits of Open Innovation have been extracted into seven factors identified with characterized new names which are related to benefits of Open Innovation.

Table: 2 Benefits of Open Innovation

Factors	Loading
<b>B1: Financial Benefits</b>	
Improved financial returns	.800
Adaptability to market changes more quickly	.846
Business-increased revenue	.856

Investment	.652
<b>B2: Building Relationship</b>	
Access to key networks	.593
Increased visibility and also enhanced publicity or reputation	.763
Expertise in scaling up	.772
Gaining entry to new markets	.677
<b>B3: Improved Strategy</b>	
Profit increase	.783
Market strategy has been enhanced	.847
New products and services	.699
<b>B4: Improved Knowledge</b>	
Provision of tools and training to staff	.755
Strategic plans are created.	.783
Collaborations with other companies or universities	.668
<b>B5: Better Management of Resources</b>	
Improved hiring process to take the business to next level	.832
Increasing the market knowledge	.536
<b>B6: Business Development</b>	
Business development	.583
Start-ups can help solve core business problems	.826
Increase in the number of skilled workers	.869
<b>B7: Increased Recognition and values</b>	
Achievement of rewards and recognition	.596
Effective Communication	.845
Employee motivation	.687

**Source:** computed data

Table 2 shows seven factors that are identified as factor that contribute to the benefits of OI to the sample firms discussed in detail below.

#### **Financial Benefits (B1)**

The first factor comprises of four variables which are: improvement in the financial returns, adaptability to market changes more quickly, business-increased revenue & Investment. This factor accounts for a higher variation of 29.33 per cent in the total variance. Hence the first factor represents financial benefits

#### **Building relationship (B2)**

The second factor comprises of four statements, which explains 9.45 % of the total variance which is related to access to key networks, increased visibility and also enhanced publicity or reputation, expertise in scaling up and gaining entry to new markets. These factors represent building relationship.

#### **Improved Strategy (B3)**

The third factor comprises of three items which includes increase in the profit, enhanced market strategy, new products and services and it explains 8.51% of total variance. This factor represents improved strategy.

#### **Improved Knowledge (B4)**

The forth factor includes three variables which explains 6.76% of the total variation and is related to provision of tools and training to staff, strategic plans are created, collaborations with other companies or universities. Hence this factor represents improved knowledge.

**Better Management of Resources (B5)**

The fifth component comprises of two statements, which explains 6.26% of the total variation and it is related to improved hiring process and increased market knowledge. These are related to better management of resources.

**Business Development (B6)**

The sixth factor, comprises of three items, which account for 5.96% of the overall variation and is related to business development, start-ups can help solve core business problems by bringing new thinking, increase in the number of skilled workers are in sixth factor. Hence it is named as business development.

**Increase Recognition & Values (B7)**

The seventh factor includes three items which explains 5.25% of the total variation and highly loaded on achievement of rewards and recognition, effective communication, employee motivation. This factor is named as increased recognition and values.

**4.3 Challenges faced by the SMEs in embracing open innovations.**

Respondents were asked to indicate how important each of the 26 characteristics which are hindering their innovation practices. The KMO test (0.841) was used to determine sampling adequacy, which was deemed acceptable. The P value is 0.000, which is less than 0.05, which indicates that the Bartlett's test was significantly in favour the questionnaire employed. These variables account for 69.72 percent of the total variance.

As a result of the investigation, it was found that factor analysis is an appropriate technique for data analysis. A Principal Component Analysis was performed on the variables to identify the most important factors impeding the adoption of open innovation, and seven factors were extracted as challenges to open innovation. These variables are responsible for 69.72 percent of the overall variation in the variables observed. All seven factors identified with characterized new names which related to challenges of the Open Innovation are discussed below.

**Table: 3 Challenges of Open Innovation**

Factors	Loading
<b>C1: Collaboration Barriers</b>	
Difficulty in finding co-operation partners for innovation	.714
Problems with administrative regulations	.631
Did not have any innovative plan	.787
Companies' fear of losing control over the innovation process	.761
Unwillingness to delegate essential employees	.658
<b>C2: Organisational Barriers</b>	
Organizational rigidities	.780
Problems with infrastructure	.807
Unpleasant working conditions	.844
Govt. Policy and regulations constraints	.779
<b>C3: Knowledge Barriers</b>	
Lack of information on technology	.644
Lack of information on markets	.767
Lack of knowledge about methods and tools of OI	.677
Lack of knowledge in implementing new form of technology	.713
<b>C4: Human Barriers</b>	
Lack of quality management personnel	.738
Higher education but improper knowledge of working field	.874
Absence of product specific manufacturing skill training	.811
Lack of qualified personnel	.517
<b>C5: Financial Barriers</b>	
High cost of these collaborative innovations to the enterprises	.598
Lack of finance from sources outside your enterprise	.764
Lack of funds within your enterprise or group	.805
Too expensive manpower	.634
<b>C6: Economic Barriers</b>	
Difficulties in managing joint open projects	.754
High economic risk	.787

<b>C7: Market related Barriers</b>		
Lack of market demand (Low purchasing power of customer)		.755
Market dominated by established enterprises		.828
Free-rider syndrome		.530

Sources: computed data

### **Collaboration Barriers (C1)**

The first factor was heavily loaded on five items which includes variables such as difficulty in finding co-operation partners for innovation, problems with administrative regulations, business do not have any innovative plan, companies' fear of losing control over the innovation process, unwillingness to delegate essential employees. The component explained 30.22% of the total variance. The factor is termed as collaboration barriers

### **Organisational Barriers (C2)**

The second factor was highly loaded on four variables: organizational rigidities, problems with infrastructure, unpleasant working conditions, and government policy & regulations constraints. This factor explains 10.08 % of total variance. This factor represents organisational barriers

### **Knowledge Barriers (C3)**

Four variables were highly loaded on this factor: lack of information on technology, lack of information on markets, lack of knowledge about methods and tools of open innovation, lack of knowledge in implementing new form of technology. These factors accounts for 7.89% of total variance, and are related to knowledge barriers.

### **Human Barriers (C4)**

Four items were strongly weighted in forth factor: lack of quality management personnel , higher education but improper knowledge of working field, absence of product specific manufacturing skill training, lack of qualified personnel. This variable accounts for 6.16% of total variance. This factor is related to human barriers

### **Financial Barriers (C5)**

The fifth factor was highly loaded on four variables: high cost of these collaborative innovations to the enterprises, lack of finance from sources outside your enterprise, lack of funds within your enterprise or group, too expensive of manpower. This factor explains 5.81% of total variance and named as financial barriers.

### **Economic Barriers (C6)**

The sixth factor comprises of two items which are, difficulties in managing joint open projects and high economic risk. These variable accounts for 5.05% of total variance. Hence, the sixth factor is related to economic barriers.

### **Market barriers (C7)**

This component was heavily influenced by three variables: a lack of market demand (low client purchasing power), a market dominated by established businesses, and the free-rider syndrome. This variable accounts for 4.50% of total variance. Hence, this factor is related to market related barriers.

## **5. DISCUSSION AND CONCLUSION**

This research investigates adoption of open innovation practices by SMEs in India, outlining the benefits and challenges that they face when adopting open innovations. The list of 22 variables highlighted through the review of the literature and after the execution of the factor analysis are organised into seven key factors on the benefits side that are: financial benefits, building relationship, improved strategy, improved knowledge, better management of resources, business development and increased recognition and values. So this study identified the above mentioned as the benefits of embracing a more open approach to innovation. On the other side resulting from the application of the factor analysis, the list of 26 variables obtained through the literature study was divided into seven primary factors considering as challenges for open innovation they are: collaboration barriers, organisational barriers, knowledge barriers, human barriers, financial barriers, economic barriers, and market related barriers. Thus this study identified factors the above seven factors as those that create barriers to adoption of open innovation in SMEs. Each component reflects a potential roadblock to SMEs that are adopting the open innovation model.

The main benefits of open innovation for SMEs identified by the study are financial benefits, building relationship, improved strategy, improved knowledge, better management of resources, business development and increased recognition & values. This result is consistent with the findings of (Ola ama,2017), where they

identified that open innovation can benefit in financial revenue, improved market strategy, and improved knowledge. This result is also in tune with (Lee et al. 2010) wherein they claimed that open innovation offers a lot of potential for SMEs to improve this performance.

Apart from the benefits, SMEs in India are facing some barriers specific to open innovation. They are, collaboration barriers, organisational barriers, knowledge barriers, human barriers, financial barriers, economic barriers, and market related barriers. The barriers are creating challenges to carry open innovation in SMEs. The results of this study is consistent with the observation of (Bigliardi,et al 2016), wherein identified knowledge, collaboration, organisational and financial factors are found to be hindering open innovation practices. Similarly, (Oduro, 2019) found that in Ghana, SMEs identified, economic and financial barriers, collaboration barrier, organisational barriers, knowledge barriers as hindrances for OI adaption. Thus, to overcome these challenges, business owners and managers require a proper training and education which encourage SMEs towards open innovation practises and network formation in order to increase business performance through innovation. The findings of this study may motivate researchers and practitioners to look into the issues that are preventing SMEs from adopting open innovation, for overcoming the same as this paradigm could be strategically important for their development.

## **RECOMMENDATIONS**

From the results of the study undertaken, it is suggested that the government should take the appropriate steps in the light of the current issues facing small and medium-sized businesses and endeavour to give a prominent role to them in the country's socio-economic growth. SMEs may be encouraged to adopt open innovation practices, by carefully devising plans to overcome the hindrances. The companies may be motivated to collaborate with universities in order to fill the gap in their R&D requirements for innovation caused by a scarcity of skilled research specialists with PhDs. Further policies that enable SMEs to access capital for their enterprises and protect businesses from the misuse are critical to intellectual property rights. Likewise policies must be implemented to shield Micro and Small Enterprises from unwarranted market competition from larger corporations. Similarly SMEs can use national innovation platforms, which are open to all SMEs, to launch innovation programmes and seek partners to collaborate on creative solutions. In this process, the platform may assist SMEs in quickly identifying innovation partners who share their vision and objectives. This can help the SMEs to overcome some of the barriers to collaboration with the above suggestions, the study concludes that, despite the challenges faces, the benefits of open innovation are promising for SMEs.

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**IMPACT OF VEHICULAR EMISSIONS (GAP ANALYSIS) ON URBAN AIR POLLUTION – STUDY OF AHMEDABAD****DR. NEELAM KSHATRIYA AND DR. DAISY KURIEN****ABSTRACT**

*Environmental sustainability is a topic of concern in light of the current scenario of rising population and urbanization. The pace at which urbanization is desired and implemented has had a major impact on the environment. Urbanization brought with it an increase in number of vehicles owned by households. One of India's most important drivers of economic growth is the automobile industry. On one hand the car manufacturing firms have been posting a consistent hike in the number of vehicle sold YOY(except for the marginal dip due to the impact of covid 19) while on the other pollution levels are increasing at an alarming rate. Pollution levels are rising at an alarming rate, wreaking havoc on citizens' health. During lockdown, when factories and manufacturing plants stopped operating and vehicles were not allowed on road, air quality had consistently improved. With life returning to normalcy in a few cities, communities are once again looking for transportation roadmaps to reduce the risk of ever-increasing greenhouse gas emissions.*

*The projected sales figure for the four wheeler segment on one hand and the increasing environmental drives of planting more trees, both have to be given equal importance. Despite the numerous and serious efforts to rescue the environment on a worldwide scale, much remains to be done. This paper makes an attempt to understand the increasing vehicular emissions on urban life. The government is leaving no stone unturned to reduce the impact of vehicular emissions on our environment. The researchers propose that the same seriousness in implementation has to be percolated down to the local level in all states. It is necessary to seek out new ways to cut pollution. The authors also suggest ways and interventions to curb air pollution in Ahmedabad and other Indian cities.*

**Keywords:** Environment, sustainability, vehicles, emission, pollution, urban

**1.1 INTRODUCTION**

Patricia Espinosa-Executive Secretary UN Climate Change recently said “We are not on track to achieve the Paris Agreement’s goal of limiting global warming to 1.5 C by the end of the century. In fact we are on opposite track heading for more than 3 C rise. We need to change course urgently and before it’s too late”. Positive actions from the society with a larger good in mind will definitely change things. This paper attempts to study the impact of vehicles on urban air pollutions in the city of Ahmedabad with an objective to increase awareness of the amount of air pollution being generated due to the love for driving big cars and owning multiple vehicles.

According to a report by Siam, India is one of the largest automobile markets in the world. However the vehicle penetration in India per 100 people is very low compared to our immediate neighbor China. Even the western countries like Europe have far more vehicle penetration. (August 26,2021 kalingatv.com/business/owning a car)

Indian government has been talking about reducing the taxes leading to a rise in sales of cars. The increasing fuel cost and the taxes both are been worked on to increase the operation of cars further. The crisis will increase. The increase in particulate matter (PM) like Carbon di oxide, Nitrogen oxides and ozone takes a toll over health of children, senior citizens and patients ailing from different respiratory diseases.

**1.2 RESEARCH METHODOLOGY****1.2.1 Research questions:**

Through this study, the researchers tried to understand many perspectives related to environment and its sustainability. Are the citizens aware of the environmental sustainability? Are they aware that they are responsible for carbon footprints? Are they ready to contribute to bring in a change? Are they ready to bring in behavioral change in their lifestyle to improve the current situation? Is the government concerned about the issue? Are government initiatives helpful?

**1.2.2 Research Objectives:**

1. To understand the role of the automobile Industry in the amount of Carbon being emitted in the atmosphere through vehicle
2. To build understanding of the impact of vehicular emissions on urban life and to suggest interventions/solution

**1.2.3 Data Collection Tools**

The researchers collected secondary data from reliable and authentic sources like government reports, research papers from national and international journals and websites.

**1.3 About Ahmedabad**

Ahmedabad located on the banks of river Sabarmati is Gujarat's largest city and its commercial capital. Gandhinagar the state's administrative capital is located 30 kilometres away. The urban cluster spans 465 square kilometres and has a population of almost 8 million people.

Ahmedabad was one of the cities chosen by the Indian government's Smart Cities Mission. Educational institutions, modern structures, residential areas, shopping malls, multiplexes, and new business districts may all be found in the city's western reaches. On the other hand, the old Ahmedabad on the Sabarmati's eastern bank has been designated as India's first UNESCO World Heritage Site.

Ahmedabad is the 7<sup>th</sup> largest city in India, it has a current population of 5.5 million and an area of 466 sq. km (180 sq. miles). It has gained the status of a commercial hub and a major industrial area. The city has been growing both in area and population (144% in area and 58% in population) since 2006. (Swamy, Pai and Kulshrestha 2015)

The growth in number of vehicles has also been exponential. The annual growth rate of motorized vehicles registered in the city is about five times higher than that of the city population (24% vs 4.7%). In 2011-2012, 206,749 vehicles were added to the existing vehicle population of 1.96 million. 71% of the newly registered vehicles were two-wheelers, followed by four-wheelers (25%), autorickshaws (2%) and buses/ trucks (0.1%). (Swamy, Pai and Kulshrestha)

According to the Central Pollution Control Board, Ahmedabad was ranked the fourth most polluted city in the country in terms of air pollution in 2001, prompting the Supreme Court to appoint the Bhure Lal committee to oversee pollution reduction efforts. The city is back on the nasty list over 18 years later, this time ranked third in particulate matter pollution for particles less than 10 millimeters in size, or PM10. These particles, which primarily consist of tiny dust and smoke particles, are big enough to become caught in the nose, mouth, and throat (Source: Times of India, Jul 14, 2019).

Manosalidis, I., Stavropoulou, et al. (2020) in their study to understand Environmental and Health Impacts of Air Pollution studied that Particulate matter (PM) is created in the atmosphere mostly as a result of chemical interactions between pollutants. The size of particles has a big impact on their penetration. Particulate matter (PM) pollution is made up of particles with a diameter of 10 micrometres (m) or less, known as PM10, and extremely fine particles with a diameter of 2.5 micrometres (m) or less, known as PM2.5. Particulate matter is made up of microscopic liquid or solid droplets that can cause major health problems if inhaled. After inhalation, particles with a diameter of less than 10 micrometres (PM10) can penetrate the lungs and potentially reach the bloodstream. PM2.5, or fine particles, provides a larger health risk.

The city has been on fast track growth on urban development process. However the government

**1.4 Government Initiatives**

Ahmedabad was one of the first cities in India to construct and run a bus rapid transit system (BRTS). The network, which first opened in October 2009, had grown to 89 kilometres by December 2015, with a daily ridership of 132,000 people. The public bus service in Ahmedabad is provided by the Ahmedabad Municipal Transport Service (AMTS), which has a fleet of less than 1000 vehicles. The government took the effort to encourage Amdavadis (citizens of Ahmedabad city) to use public transportation instead of driving their own cars for commuting. Also the use of public transport system would build a habit, long required for the city, resulting in less pollution.

The launch of Jawaharlal National Urban Renewal Mission (JNURM) in 2006 has aided to the same as a part of the national city modernization scheme. The road network became better, the public transport facilities also became better with AMTS (Ahmedabad Municipal Transport Service) bus fleets and BRTS (Bus Rapid Transit System). Auto rickshaws and buses resorted to CNG (Compressed Natural Gas) thereby adding to the efficiency of AMTS and BRTS.

The everyday increasing concern about excessive carbon being emitted into the atmosphere is generating curiosity among commuters about their exposure to air pollutants leading to increased number of diseases unheard of.

The Gujarat Pollution Control Board through its multiple initiatives has tried its level best to reduce the pollutant levels in Ahmedabad city.

A report by Society of Indian Automobiles Manufacturers (SIAM) march 2019 stated that the automobile market has been growing steadily in India and the next few years would get to see India as the world's 3rd largest automobile market. While on one hand this would be good for the economy as more employment opportunities would be created for the Indian consumer on the other hand it will put pressure on India's energy requirements to fuel the growth. It will also impact the contribution of transport sector towards CO<sub>2</sub> foot print.

The increased usage of fossil fuels is of great concern to the environment. The rising levels of air pollution, CO<sub>2</sub> emissions and depleting stocks of mineral oils like gasoline and diesel are matters of grave concern. The Government of India, therefore has mooted a roadmap for reduction of import of crude oil dependence by 10% by 2021-22 and reducing the energy emissions intensity by 33%-35% by 2030 as per the Nationally Determined Contribution (NDC) targets agreed in COP21 at Paris, by increasing production of natural gas; promoting energy efficiency and conservation measures; giving thrust on demand substitution; capitalizing untapped potential in biofuels and other alternative fuels/renewables; and implementing measures for refinery process improvements.

According to Report on 'Low Carbon Strategies for Inclusive Growth', Kirit Parikh, 2014, in 2007-08, the transportation sector produced 138 TMT of CO<sub>2</sub>, accounting for almost 7% of India's total CO<sub>2</sub>. With future fuel demand likely to increase, the contribution might rise to 346 TMT by 2022 in a business-as-usual scenario, representing a 150 percent increase. This could lead to an increase in the transportation sector's overall CO<sub>2</sub> contribution, which is now about 7% compared to global averages of 20%.

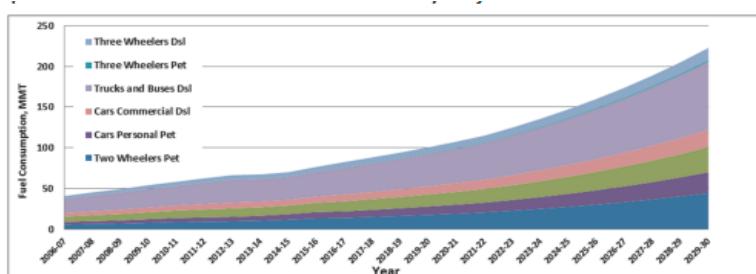
As a result of its rapid economic expansion and modernization, the country's energy need continues to rise. India's consumption of petroleum products climbed by 5.3 percent year on year to over 200 MMT, resulting in a major increase in oil import costs. With the rising demand for fossil fuels and a fast expanding motor vehicle fleet in India, the Indian government has set a goal of reducing imports by 10% by 2022. Bureau of Energy Efficiency is working on developing fuel efficiency standards for vehicles that would help to limit the escalating fuel consumption

The Government has announced fuel efficiency norms for different categories of vehicles. These efforts to improve the fuel efficiency of all modes of transport are definitely going to help reduce the new fleet fuel consumption and in the long run will also have a positive impact on the reduction of growth rate of fuel imports, considering already enormous dependence on fuel imports. However the sustainability of these efforts is important however at the same time many complementary efforts need to be taken to protect the environment.

Under the air and water pollution control acts, the state pollution control board gives a no objection certificate (NOC). As emission rules and fuel economy requirements have become stricter, automakers have been looking for ways to make vehicles lighter. This has increased demand for lighter materials like aluminium and copper for sheet fabrication, putting a strain on steel's market share. As a result, aluminium automotive body sheets (ABS) are becoming increasingly popular, with demand expected to climb by double digits globally over the next five years.(Source: [www.vibrantgujarat.com](http://www.vibrantgujarat.com))

Diversification of the fuel usage within the transport sector is the hope to reduce the CO<sub>2</sub> foot print from vehicle fleet. The policy landscape of alternative fuels in India is in a nascent stage and debates are on for enhancing and optimizing the blending of biofuels. The automobile industry is major stakeholder in policy formulation and implementation of alternative fuels.

India as a major importer of oil, has 80 % of its oil being imported.



Source: SIAM, Data based on PPAC estimate and future projects at a Year on Year increase in demand by 7 %

Chennai has recently been declared the first city in India where ground water is completely over and Ahmedabad is in top 10 cities where ground water is going down rapidly.

### **1.5 LITERATURE REVIEW**

Gajjar, V., Sharma, U., & Shah, M. H. (2021), in their paper on a study of deliverables to improve air quality in Ahmedabad city, opined that in terms of urbanisation, the city's development plan does not take into account the necessity and obligation to preserve the natural habitat. Furthermore, it benefits human activity, which has a huge impact on the environment. It also poses a constant threat to the residents of Ahmedabad's current and future quality of life.

Misra, P., Imasu, R., & Takeuchi, W. (2019) in their research on understanding impact of urban growth on air quality in Indian cities concluded that residential, commercial, and industrial units, agricultural crop fires, and brick kilns were all evaluated as land-use emission sources. Long-term R concentrations and contributions from various emission sources were calculated using this model. The most major contributors to urban air pollution were unaccounted sources and transportation, residential area emissions, and brick kilns.

Bhaskar, B. V., et al (2010) in their research to understand particles pollutants in Ahmedabad city, opined that the primary contributors of particle pollution in Ahmedabad's atmosphere are automobiles and factories. Apart from automobiles, other significant sources of particulate matter include diesel-powered generators (which are used in business establishments during power outages), emissions from paved roads, and background concentrations from the city's industrial and semi-industrial districts.

Srivastava, S., Lal et al (2010) in their study analyzed the impact of lockdown during Covid-19 on water and air quality to assess the short-term environmental changes. It was observed that the average Suspended particulate matter (SPM) has significantly decreased by about 36.48% when compared with the pre-lockdown period; and a drop of 16.79% was observed from the previous year's average SPM.

Data from the System of Air Quality and Weather Forecasting and Research (SAFAR) revealed that the near-complete suspension of everyday traffic has resulted in a significant reduction in particulate matter levels (PM). After April 6, the pollution levels in Delhi, Mumbai, Pune, and Ahmedabad declined by 62 percent, 45 percent, 31 percent, and 57 percent, respectively (Source: Times of India, April 12, 2020)

### **1.6 DISCUSSION**

- Government is making policies and has a stringent attitude to face the issue. However, now the citizens need to bring in behavioral change and change the lifestyle to match the environmental needs. Purchase of cars should not be considered as a status issue and citizens should be sensitive to the harm being caused to the environment by them and their family.
- Public transport system should be encouraged and more and more people should start making use of modes like BRTS and AMTS. This would curb pollution, increase fossil fuels, cause less harm to health of public suffering from lung diseases, asthma, and other respiratory problems. Thus mass public transportation should be promoted and enhanced to attract the users.
- Old vehicles which do not conform to the emission laws should be upgraded or discarded. This would help in sustaining the environment for longer period.
- Continuous research and development work would facilitate better understanding of the grave issue and help in finding solutions to save the environment from extreme peril.
- The youth and children of Ahmedabad should be involved in handling the crisis. This would spread awareness among the millennial and generation Z which will make them involved, and be ready to bring in the much needed change required at societal level.
- Adherence to law of the land should be put to practice. Defaulters should be suitably punished so that the seriousness of the issue can be understood by one and all.
- Innovative ideas should be appreciated and suitably awarded. The ideas should be promoted so that more and more citizens contribute and learn.
- Electric vehicles (EVs) are the car of the future. The government of India is putting in all efforts to promote electric vehicles, the truth remains that a lot still needs to be done at the ground level where operational complexity need to be addressed and resolved.

- Diversifying fuel usage in the transportation industry will be one such important initiative. This has the ability to utilize our domestic resources and hence support the Government of India's "Make in India" drive, while also lowering CO<sub>2</sub> emissions from the vehicle fleet(SIAM data)

### **1.7 LIMITATIONS OF THE STUDY:**

Urban air pollution has increasingly become a global environmental concern which needs to be addressed by all. However, this study is limited to the city of Ahmedabad. The researchers do not take into account emission due to other sources like fuels, domestic purposes, usage of kerosene, use of generators, waste burning, burning of chaff of wheat. The study is restricted to vehicular emissions in Ahmedabad City. This study is on vehicular emissions and its impact on urban areas. The researchers collected only secondary data to understand impact of vehicular emissions on urban life.

### **1.8 FUTURE SCOPE OF THE STUDY**

Similar study can be done for other cities of Gujarat and in other Indian states. Researchers can also study the impact of other sources of pollution impacting the environment. Also the impact of emissions on rural areas could be studied. A comparison on impact of pollution on rural and urban areas can also be studied further. Future researchers can collect primary data to facilitate better understanding of the study.

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**NEXUS BETWEEN INNOVATION AND CSR: DRAWING IMPLICATIONS ON FIRM PERFORMANCE**

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**ABSTRACT**

The prominence of CSR has been prevailing for ages. It is only now that the practices related to CSR have changed as per the demands and requirements asked by both external and internal stakeholders. Here, the main aim of the study is to assess the connection between practices of CSR and the factor of innovation. It also aims at detailing how both factors can improve a company's performance. It has taken the three factors under key consideration to identify the connection with each other. Discussion of CSR covers a broader perspective. It has to detail different CSR-based dimensions to observe its impact on the main stakeholders. This way it is possible to draw the link between Firm performance and CSR. Moreover, the study has also discussed the current trends of CSR like green CSR, strategic CSR, responsive CSR, and others. The approach that the present paper has taken seemed to be appropriate to validate the connection between the performance of a business entity, CSR practices, and innovation within organizations.

*Index Terms—Innovation, CSR, Firm, Performance, Sustainability, Socially Responsible.*

**INTRODUCTION**

In the contemporary world, where different socio-environmental concerns are making humanity vulnerable, corporate social responsibility (CSR) is emerging to be a crucial aspect in the study of management. Its importance within society is increasing consistently. CSR refers to the social responsibility of business enterprises including the economic, ethical, philanthropic, and legal expectations that people of society have from businesses at a given period (Shahzad et al., 2020). Four key components are related to CSR namely legal, economic, ethical, and philanthropic. Besides, there are five significant aspects related to CSR namely economic, environmental, voluntariness, social, and stakeholder. CSR responsibilities that multi-stakeholder need to follow is for the welfare of employees, customers, and government. Moreover, the responsibilities of stakeholders regarding CSR compliance are categorized into CSREM (CSR to employees), CSREN (CSR to the environment), CSRCS (CSR to consumer), and CSRCO (CSR to the community). CSREN considers the responsibilities of business enterprises towards climate and natural changes, environment protection, reduction in the emission of wastes, and responsible handling of industrial wastes. As per the compliance of CSR organization needs to provide an effective work environment, make way for the respect of employees, promote employee participation in policy and decision making, provide training and additional education, avoid discrimination of gender, and ensure wellbeing, safety, and health of its employees (Abbas & Sağsan, 2019). Further CSRCO stresses the initiatives of organizations towards the welfare and wellbeing of external communities such as financial aid to NGOs and society. CSRCS highlights the responsibility of business enterprises towards the customers. It includes customer satisfaction and care, ethical commercial undertakings such as eco-compatible services and products, ecological labels, and enforcing environmental and social standards on the key suppliers. In developing nations, CSR is at the core phase of adoption and is regarded as social and environmental responsibility and not humanitarian (Ikram et al., 2019). Moreover, assessing the requirements of CSR is not that easy. It is complicated and requires a proper strategy to comply with the CSR approach. In this competitive environment across the globe, innovation is the main component to ensure survival in this ever-changing business environment. Among the different fields of economic development, CI (corporate innovation) is considered to be the most appropriate way to attain the key objectives of a business enterprise. It is the increasing competition in the market that has demanded the firms to be innovative by channelizing new paths for attaining subside competitors and competitive advantage (De Roeck & Farooq, 2018). Firms can gain benefits from the basis of CSR in the context of achieving market access, reducing financial constraints, gaining stakeholders' trust and commitment, and retaining and attracting a better workforce (Lopes et al., 2017). These attributes and factors are majorly important for achieving innovation. In recent years, the idea of CSR, CSP (corporate social performance), environmental management, and corporate sustainability have acquired increasing attention from both practitioners and academics. Given that practices associated with sustainability are crucial for a company's existence, sustainable actions within an enterprise's strategy are probable to be the source of attaining competitive advantage (Zhu et al., 2019). Although the association between innovation and CSR has been identified as positive in various papers, the true nature of the

relationship between innovation and CSR is yet to be transparent (Ashrafi et al., 2018; Fu et al., 2020; Mattingly, 2017). Thus it is necessary to explore the connection between CSR and innovation to assess the dual-direction and approach that CSR and innovation can take. In certain companies, an innovation trajectory of CSR has been followed based on the fact that companies are primarily driven by values. These organizations consider the major impact of the business activities on the community and environment. However, the other innovation trajectory of CSR is prevailing in companies conducted primarily by the value creation criteria (Wang et al., 2016). Moreover, the association between innovation and CSR holds a crucial position in firms where CSR is a significant part of the enterprise's strategy. In a study corporate sustainability is shown as a key framework to determine the entire array of challenges related to sustainability (Martinez-Conesa et al., 2017). From a theoretical approach, a link between innovation performance and CSR is supported, particularly when the impact of CSR activities on innovation is considered. There is an increasing likelihood of the fact that firms who have been active in their CSR undertakings can emerge to be the most efficient performing enterprises; however with better strategies and most importantly taking the matter of innovation under consideration (Schaltegger & Wagner, 2017). In the competitive business circumstances, with increasing significance on a firm's intangible asset, innovation may support the sustainability of a responsible approach towards business, making way for system-level solutions that are regarded to be profitable and responsible (Cai & Li, 2018). Thus the main focus needs to be on creating a bond between distinctive activities within the company strategy since this is the approach to generating value. CSR can be used as an important mechanism for enterprises to be more effective, efficient, and innovative. For instance, the EO (European Observatory) of SMEs indicates that the implementation of CSR in the majority of small companies is undertaken for an occasional purpose (Grimstad et al., 2020). It is not linked with the strategies of the business. The real benefits can be experienced by SMEs if the matter of CSR is considered in the main decision-making technique (Pacheco-Blanco et al., 2020). In this regard, the matter of social intrapreneurship is prioritized which includes companies that have no social agenda or approach as a crucial part of their charter (Huque et al., 2019). However, they later implemented a visible agenda for the development of society. Social intrapreneurs take initiation from within enterprises for advocating social programming that intends to address environmental or social challenges. Organizations that consider these categories include Microsoft, Timberland, Patagonia, Starbucks, and others (Carroll, 2015). Through risk-taking criteria and innovation, organizations have emerged to be high-profile instances of sustainability and CSR. In this current study, the connection between CSR and innovation has been discussed to determine whether a firm can perform well considering the aspects of innovation in strategizing CSR compliance and regulations of the organization. It will also detail the impact on firm performance due to the integrated consideration of the CSR approach and innovation.

## **LITERATURE REVIEW**

### **Introduction**

CSR is a multidimensional approach that complicates the connection between CSR and innovation. If the term 'innovation' and 'CSR' is individually linked with the performance of a firm, the relation can be easily validated. However, the integrated consideration of CSR and innovation needs to be thoroughly evaluated. At the ground level, consideration of innovation while ramming CSR policies can enhance the performance of business entities. In this note, there is a necessity to observe the association between each of the key factors namely form performance, innovation, and CSR. As per the research of Al-Malkawi & Javaid (2018), companies that prioritize strategic CSR attain growth via their process and product innovations. Complying with CSR can allow organizations to gain the confidence and trust of stakeholders; thereby improving their brand prominence. The connection of CSR with a company is drawn to measure the degree of the firm in the context of social responsibility.

Here, a review paper has been formulated regarding the relationship between CSR and innovations and its collaborative impact on firm performance considering information from the existing literature or research. Here, the researchers surveyed the conference proceedings, relevant publications, abstracted journals, books, and technical reports to review and analyze the secondary source of literature.

### **Comprehending the concept and importance of CSR**

Activists, media, and governments have considered companies accountable for the social outcomes of their business activities. CSR has emerged to be an inescapable aspect of prioritization for business leaders and managers in every nation (Aust et al., 2018). Many organizations have taken initiatives to improve the environmental and social outcomes of their actions. However, there needs much improvement regarding the compliance of CSR from the end of organizations. DeTienne et al., (2021) stated that CSR is framed within the ethics of business operations as an attempt to assess the moral responsibilities and duties of firms and

corporations. Without strategic validation to CSR policies, it is argued that executives or corporations must follow certain social obligations even if these criteria stand in the path of profits. Lampert (2016) suggested while implementing CSR policies, one can consider the ethical duties of human beings and attempt to demonstrate how the responsibilities make moral claims in the approach of business executives. On the other hand, one can look into corporate citizenship as an ethical subject while conducting business operations (Jago & Laurin, 2017). Thus, CSR is a requirement that every business enterprise needs to adhere to be known as a responsible firm. The concept indicates that if an organization is ethical and moral, then it is possible to make certain extra-economic efforts to fulfil the moral social responsibilities (Riano & Yakovleva, 2019). An engaged and committed organization is always seen to be responsible for meeting environmental and consumer concerns. Thus it is necessary to understand the criteria of staying engaged through following CSR principles. Overall, organizations are required to map their responsibilities to get a broader picture of the public demands (Ko et al., 2018). In the third aspect of CSR engagement enterprises while operating their operations required to be provided clear information and knowledge about the outcomes and processes. Moreover, transparency needs to be maintained with the stakeholders since it is a component in the stakeholder dialogue (Johnston & Taylor, 2018). This implies closing the cycle or loop and is a vital part of engagement in the CSR approach since it lets stakeholders aware of how the firm has considered their views into account. On the contrary, Ahmad et al., (2020) opined that CSR is significant since it has a strong relationship with the level of organizational commitment (OC) and OCB (Organizational citizenship behaviour). CSR is such a tool that is considered to be strategic for business that intends to positively impact stakeholders via organizational activities that goes beyond the financial interest. Besides, socially responsible efforts of enterprises strengthen employees' pride and identification with it (Voegtlind & Greenwood, 2016; Newman et al., 2015). This in hand, positively influences the work behaviours and attitudes; thereby enhancing the extent of OCB and OC.

### **Unveiling the concatenation between CSR and Innovation**

Although the concept of CSR has been familiar for ages, the process in which CSR is practiced by modern business enterprises has changed with effective innovation. The activities of CSR are introduced to attain the standards and needs of stakeholders. Mithani (2017) stated that engagement of a firm's manager in the CSR criteria weakens the initiatives towards innovation investment. Social investment and corporate innovation influence economic growth. Bocquet et al., (2017) identified that strategic CSR facilitates different types of corporate innovation whereas responsive CSR reduces them. However, Bocquet et al., (2019) validated a positive impact of the RCSR (Responsive CSR) on the tech-based innovation for SMEs. Companies that do not take the requirements of stakeholders into account suffer from major destruction and inquiries about its existence in the market. Innovation is held to be the connection between a company's financial and social performance and CSR. Besides, CSR may enhance the competitive potential of corporations and ensure sustainable development through stimulating innovation. Szutkowski & Ratajczak (2016) argued that innovation and CSR are the basis of corporate competencies. Modern business enterprises operate in an ever-changing environment which insists them to evolve and look for advanced solutions to deal with any future uncertainties and can guarantee competitiveness for the organization. In this regard, innovation is inevitable and crucial for each entity. The innovative approach within the organization supports them to implement new and positive ideas into the operational practice. In consideration of the demands of stakeholders in current days, firms needed to adopt green CSR for being more environmentally and socially responsible. Firms being responsible and green always acquire intangible assets that are vital for their innovation. With the increasing environmental awareness, organizations from around the world have acknowledged the prioritization of increasing environmental concerns.

### **Demarcating the Impact of innovation on Firm Performance**

Firm performance refers to the multidimensional concept. As suggested by Tuan et al., (2016) three indicators related to firm performance include finance, marketing, or production. Besides, outcomes such as profit and growth are also associated with this matter. Moreover, it can also be determined with subjective or objective indicators (Hernández-Linares et al., 2021). On the other hand, innovative performance is defined as the integration of every achievement of organizations due to improvement efforts and renewal of firm innovativeness; for example, products, marketing, processes, and organizational structure. Management and strategy research also validates the fact that MI can influence organizational outcome and conduct as technological and process innovations intend to (Wadhwa et al., 2017). Most studies based on innovation, particularly those which are conducted by technologists and economists have stressed tech-based process and product innovations (Haghghi Kaffash et al., 2015; Hall et al., 2016). Product innovations are referred to as the new services or products developed or produced to meet the need of external users or consumers. Process innovation defines new components produced into a company's service operation or production to provide a

service and build a product (Schilling & Shankar, 2019). Together they make way for technological innovation. The difference between MI and TI corresponds to the difference between social and technological structures. In this modern era, a company's responsibilities and duties need to be extended to other key stakeholders namely suppliers, communities, and employees. Innovation within an organization is not only meant for the improvements of one or more than one goods, but it affects a firm's wide range of services or products. The net economic performance is a prominent indicator of its sustainable development in comparison to the innovative performance of the company. Besides an effective economic performance, it is also required by the form to have a firm control in dealing with the environmental impact. On this note, the implementation of innovations lets the company find creative ways to ensure the welfare of the entire society and community.

### **Accentuating the correlation between CSR practices and Firm Performance**

CSR has achieved enormous momentum in the contemporary era. It is considered to be a vital factor for most firms due to the increasing awareness of the public about the implication of corporate actions on the society and environment (Amran et al., 2017). Firms are required to take their actions responsibly. Besides, it also has to look after the trending social concern while taking any decisions related to business operations and financially accountable (Welbeck et al., 2017). As per the study of Yang et al., (2019) CSR has evoked the attention of the general public in China due to increasing incidents related to environmental pollution and product safety. The absence of the criteria of social responsibility in Chinese companies has become a major trigger for the expansion of the CSR approach in China. Improving companies' performance is a significant factor to determine whether or not to undertake specific organizational practices and policies. On the other hand, Tapaninaho & Kujala (2020) commented that conflicting perception regarding the implementation of CSR approach exists based on the high implementation cost of CSR approach that may hinder the core objective of profit maximization. However, several studies have validated that CSR is advantageous for firms through attaining and retaining ethical consumers, building a prominent corporate image, and improving employee satisfaction (Latan et al., 2018; Sindhu Pundai et al., 2019). Although CSR is being valued in every industry, it is much more specific and prioritized in the matter of media operations. There lies a distinct opinion regarding the positive impact of the investment made on CSR practices on the performance of pharmaceutical-based companies of China. These firms are unwilling to make a huge investment in CSR practices due to resources allocated for required promotional activities and R&D in this kind of business operations (Crişan-Mitra et al., 2020). On the other hand, firm performance can also be linked with CSR-based management practices. Managing the department of HR, operational, marketing, and finance also determines the extent of performance of the company. In the hospitality sector, CSR has not only improved the brand image but also has positively influenced the financial performance of the firm. Since CSR is a multidimensional factor, there is still confusion about whether CSR poses a positive or negative impact on the performance of a company.

### **CONCLUSION AND RECOMMENDATIONS**

Innovation and CSR is regarded to be the two faces of one coin indicating the fact that both CSR and innovation are related to each other. The term 'innovation' is related to every stratum of business operations. Through implementing innovation, it is possible to stand out from the rest of the business entity. Since CSR is the compliance that helps business operations to be responsible for their actions and also helps to deal with the environmental concerns, with innovation, the approach can be made easier and more convenient. Nowadays, customers want more than quality services and products. While measuring a company's success, they look for the contribution of the company to society and the community. In this regard, innovation can help an entity to gain a competitive edge and improve firm performance. Since innovation is about finding new solutions and brainstorming a problem to get multi-dimensional solutions, it can be visibly linked with the compliance of CSR in promoting the success of an organization. Although several kinds of literature are present on CSR practices and innovative practices, there is a major gap pertaining to the integrated approach of CSR and innovation in improving business enterprise's performance. Several kinds of literature have been reviewed in this selected topic of discussion; however, the matter that the present study is aiming to discuss is yet to be detailed thoroughly. Thus, the current review paper has focused on discussing the combined approach in demonstrating its implication on the company's performance. This way, the current study has addressed the research gap that existed in the past papers. Moreover, the present study is also beneficial for future research since this will get in-depth analyses on the implications of innovation and CSR practices on the activities of business operators. However, the addressed research gap can be dealt with by finding connections between CSR, firm performance, and innovation from secondary sources and trying to find the relation between the three. It is recommended to conduct market research and observe the perception of business operators on the criteria of innovation and CSR practices.

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**STUDY OF INFLUENTIAL FACTORS AND CHALLENGES IN AGRO TOURISM IN  
MAHARASHTRA**

**MRS. DHANASHRI HAVALE AND DR. CHETAN CHAUDHARI****ABSTRACT**

As an industry, tourism in India is rising. With the growing socio-economic climate, the idea of tourism is slowly shifting from mainstream to niche. Agro-tourism is a subset of tourism that allows urban residents to experience a rural lifestyle, local people and cultural traditions. It has received increasing attention from researchers in both developed and developing countries due to its influence on shaping society. It has several influencing growth factors such as climate, socio-culture, demography, and economic background as a newly emerging phenomenon in the urban population. The study tries to find out some of the influential components that can affect the choice of destination as an important tourism development opportunity. However, Maharashtra's promotion of agro-tourism has its own challenges to face, and the study also attempts to identify and address them through a conceptual framework model. The study's main goal is to help rural people improve their economic condition through additional income and to establish an effective tool for rural job opportunities.

**Keywords-** Agro-Tourism, agro tourist, rural tourism, agro-tourism in Maharashtra, Tourism

**INTRODUCTION**

Globalization of Indian economy has created a scenario in which societies must change to conserve their social and economic viability. The change forces are demanding global operations that have brought a change in the way nature and rural resources are used. Recent developments have given rise to new concepts and approaches to recreation and leisure. Such theories and strategies paved the way for the growth of rural and agro tourism. Agro tourism is in addition to traditional farming practices. It is an opportunity for farmers to make creative and inventive use of available resources. It creates equal benefits for both tourists as well as farmers. Farmers get an opportunity to earn extra income by using available resources, and the tourist can relish village experience and nature in affordable prices. Not only that the development of agro tourism benefits the villages in various aspects. Some cases of Maharashtra districts agro-tourism at Raigad, Pune and Satara have shown that agro-tourism brings social and economic development not only to the farmers but to the village as a whole. (Upadhye, 2015).

Agriculture is perhaps the most significant development and invention made by mankind. The word 'agriculture' itself demonstrates how well it blends together with the origin of human culture. Agriculture is not just a profession; it is a lifestyle which is different. Furthermore, in times when the distinctive lifestyles have become tourist attractions, tourism as a sector has grown into one of the largest global and rapidly growing sectors, with several years of growth and diversification. Modern tourism has become more 'experience-oriented', requiring new forms of tourism with the potential to provide tourists with authentic and innovative tourism experiences (Borlikar, 2017).

Agriculture is regarded as the Indian economy's backbone. Around 85% of the population depends directly or indirectly on agriculture and related activities, and nearly 26% of India's GDP comes from agriculture. Ninety million farmers live in 0.625 million villages that produce more than twenty metric tons (MT) of food grain. Agriculture is deeply rooted in Indian culture, further than a profession or business. Farmers are now excited to try new ways away from the typical and orthodox patterns of directly building relationships with consumers and earning extra money. Therefore, adding some tourism activities to agricultural profits brings new hopes and better lives. In this direction, significant efforts are being made and Agro-Tourism is one such endeavor that fits the bill. But still, agro-tourism is not a novel concept; its reach is limited to just a few places. With its slow rise and the use of technology, agro-tourism will certainly bring changes in the lives of farmers and consumers will also benefit (Chatterjee & Durga Prasad, 2019).

Maharashtra is India's third biggest state, both in terms of area and population, with a 720 km long coastline. It is situated in the mountain ranges of the Western Ghats and Sahyadri with semi-evergreen and deciduous forests. Maharashtra is one of India's main tourist centers and there are considerable scope and opportunity for developing agro-tourism (Ghopal, Benke, & Gade, 2016).

Encouraging rural tourism is time-consuming, and the State of Maharashtra is also committed to improving the situation of farmers. The government of the Union and the government of the state took a poor pro position. Another major reason for encouraging and selling rural tourism is the resultant benefits of developing as farm land often develops infrastructure such as highways, bridges, communications, housing, hospital and healthcare services, sanitation and waste disposal, followed quickly by schools, colleges, business and economic activities. (htt).

### **LITERATURE REVIEW**

Theoretically, in the recent past, the idea of agro-tourism has grown, but Agro-tourism has been experienced in many countries for many decades. In both theoretical and practical terms, agro-tourism is prominent in developed countries such as the United Kingdom, the United States, France and other European countries, especially after the 1940s. The word agro tourism has emerged in the last 25 years (Sznajder , Przezbórska, & Scrimgeour, 2009).

As Shembekar stated up, "Agro tourism as a term has no specific literature from a comprehensive point of view that encompasses the entire scope of it. However, there are more regional studies in some specific places like some districts in Panjab or Rajasthan, which are either region-specific or focus on a certain part of it, such as agro-tourism destinations or agro-tourism. Before it relates to Indian contexts, most literature seems to focus on agro-tourism activities in Maharashtra's western belt and Agro Tourism Development Corporation (ATDC) practices (Shembekar P, 2016)."

Agro tourism is strictly defined by Manhas as "travel that combines farmland or rural settings with agricultural products, all in a tourism experience or a variety of farmers ' activities, facilities and services." He as well calls it "innovative activity generating income for entrepreneurial farmers" (Manhas P. S. , 2012).

Anne-Mette Hjalager (1996) states that tourism, by its very nature, affects the local people living in villages, which further leads them to economic benefits that can act as a survival factor for a rural community undergoing an economic transformation. These economic advantages include diversification of the base of the local industry, increased public employment, higher incomes, widening the tax base and growth of business income.' In this regard, agro-tourism is seen as a tool for sustainable economic development in rural areas. (Borlikar, 2017).

Global Studies in Sustainable Travel & Tourism' (2011) presents agro-tourism as a tourism solution that can set the stage for sustainable rural development. This provides a comprehensive overview of the agro-tourism idea, along with the advantages, constraints and success factors involved, using the illustration of India, a country where 85% of the population relies on agricultural income for their subsistence.

Azimi Hamzah et al. (2012) address the possible socio-economic benefits that agro-tourism activities can bring to the fishing communities in Malaysia in their article 'Socio-economic impact of agro-tourism activities on Desa Wawasan Nelayan community living in Peninsular Malaysia.' It strengthens the understanding of the potential that agro-tourism will bring about socio-economic changes.

### **IMPORTANT FACTORS AFFECTING THE AGRO-TOURISM IN MAHARASHTRA**

Most of the agro and rural tourism literature finds that farmers ' primary motivation to diversify from farming and opt for tourism is economical (Beus, 2008). The pressure of poor agro-product prices, the growing cost of production, intense competition, industrial development, suburban development encroachment on rural and agricultural areas and commodity market elasticity have led farm families to explore the sustainability of alternative economic methods in an attempt to preserve the family farm. The additional problems for Indian farmers are erratic monsoons and inadequate irrigation. (Barbieri , Mahoney, & Butler, 2008).

While entering the field of agro-tourism, these farmers must consider the following factors if they want to flourish this side business.

**Figure 1 - Factors Affecting Agro Tourism in Maharashtra**

#### **Location**

Location is perhaps the most important aspect of success in the agro-tourism. The location of the center must be easy to arrive and have a good natural background. Urban vacationers want to enjoy scenery and rural life. Farmers should therefore only grow their center in rural areas with a beautiful natural backdrop in order to attract urban visitors to your farm. The agro-tourism core site must be easy to access by rail and road. Tourists, along with agro-tourism, want to visit certain historical and natural tourist sites. Therefore, near these tourist sites, the center should be built. It is better for both tourists and farmers. Tourist destinations such as Panchgani, Mahbaleshwar, Nashik, Narshinghvadi, Jotiba, Akkalkot, Pandharpur, Konkan etc. These would be the best places for agro-tourism growth. Farmers can grow their centers in any affordable location besides these places.

#### **Infrastructure**

Infrastructure plays an important role in this field. Though the visitors come with an expectation to experience the rural ambience, they do expect a certain level of professional approach and compatible infrastructure. The farmers can provide them with accommodation facilities at the location or have collaboration with the nearest hotels. Farmhouse having a rural look and feel but offering urban comfort is one more option. Offering rich agricultural resources namely, plants, water at the place will be an added advantage. Providing rural cooking equipment to the interested tourists will enhance their rural experience. The main part of the infrastructure is it must have emergency medical care with a first aid box. The ambience should have a well or lake or swimming tank for fishing, swimming. Bullock cart, cattle shade, telephone facilities etc. Goat farm, emu (Ostrich bird) farm, sericulture farm, green house will add to the rural feel.

#### **Service Quality**

Service quality is the basic precondition for the stability of local agrotourism business owners. The current agrotourism products are attractive enough, and in the last few years, the equipment supporting these products has been improved. The problem is the lack of trained and qualified staff, competent presentation of goods, basic hygiene conditions, etc. Tourists want to enjoy the rustic flavor of rural life, but most urban tourists expect a professional approach through hosting and hygienic stay and food conditions. Quality service is a challenge because the services provided to tourists in agro-tourism are complex. The hosts usually try to provide private lodging facilities to reduce the cost of operation. On the other side, other amenities and other utilities such as entertainment services, rental services, swimming pools, etc. are missing in many villages. This leaves a negative impact on the level of visitor satisfaction. Majority agro-tourism entrepreneurs have no tourism and hospitality training. There is also a limited opportunity for entrepreneurial activities to gain professional knowledge.

***Agro-tourism boosters in Maharashtra***

Some following noteworthy factors are useful for Maharashtra agro-tourism. There are already tourist sites to support agro-tourism—good communication and transportation facilities—greenhouse cultivation of long stem cut flowers, vegetables, fruit etc. Maharashtra is already established as one of the top global tourist destinations. Maharashtra is India's biggest producer of fruit, spices, medicinal and fragrant plants. Here the number of visitors who choose non-urban tourist destinations is growing. Additionally, Maharashtra has varied agro-climatic conditions, deserts, people, and mountain ranges that provide room for all-season promotion, multi-location agro-tourism. The traditional Lavni dance, Povadas, Koli dance, Dhangari Gaja, and Tamasha are the common folk dances from rural Maharashtra. And some religious folk dances like Dindi, Kirtan. Maharashtra's culture with a great variety is very beautiful. It gives rural Maharashtra a unique identity.

Following factors are essential for enhancement of agro tourism in Maharashtra

- Diversity in terms of weather, crops, people, hills etc.
- Magnificent cultural heritage
- Existence of numerous tourist sites that supports agro tourism.
- Good connectivity through communication and transport facilities.
- High-Tech cultivation of fruits, flowers and vegetables in different areas.
- As a result of deliberate government efforts, Maharashtra has emerged as a horticultural province
- Development of tourist destinations outside the urban area.

***Problems of the agro-tourism in Maharashtra***

Due to the good environmental and climatic conditions, Maharashtra has a greater potential for the creation of agro-tourism centers. But there are some problems in the state's growth of agro-tourism. The following are major challenges and problems; Lack of information regarding the agro tourism

- Small farmers lack communication skills and an entrepreneurial approach.
- Lack of resources to build basic agro-tourism infrastructure.
- Farmers' ignorance of such activities.
- Unorganized sector presence in the agro-tourism sector.
- Many farmers have limited holdings, low-quality land and little or no credit access.
- The government's support for agro-tourism in India is missing.

***Key techniques for success in agro-tourism***

Agrotourism is one of the business activities, so for success, farmers need to have a business mind and some marketing techniques. For better success in agrotourism, the following tips should be pursued.

- Give new journals, television, etc. to a large tourism center campaign.

Use any form of advertisement.

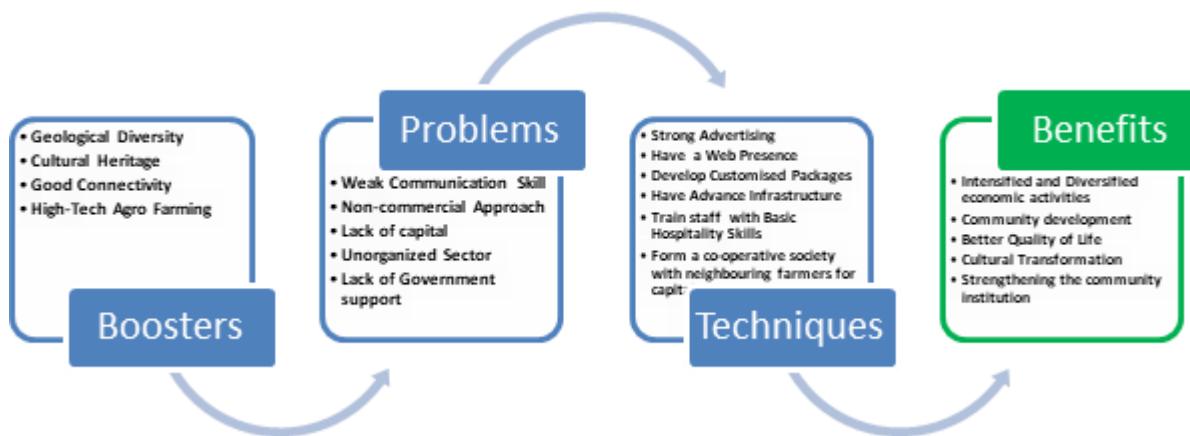
- Build connections with the schools, universities, charities, clubs, associations, organizations etc.
- Train personnel or family members for reception and hospitality.
- Understand the needs and desires of consumers and work accordingly.
- Optimum rent charges and fees for commercial-based facilities / services.
- Use local resources artificially to entertain / serve visitors.
- Improve your website and change your time to attract foreign tourists.
- Take feedback about the services to get suggestions for further growth and adjustment.
- Establish a good relationship with the visitors for future business and word of mouth publicity.
- Develop innovative agro-tourism packages for different types of tourists and their expectations.

- Be active and contributive with the guests.
- Small farmers can collectively form a cooperative society and develop their agro-tourism centers.
- Ensure hygiene and basic needs for urban visitors.

**Conceptual Framework**

According to the Global Development Research Center, in its purest sense, agrotourism is an industry that seeks to have a low impact on the environment and local culture while helping to generate income, employment, and local ecosystem conservation. Ecologically and culturally sensitive, it's responsible for tourism.

**Figure 2 - Conceptual Framework for Supporting the Agro-Tourism Industry in Maharashtra**

**CONCLUSION AND POLICY IMPLICATIONS**

Due to natural conditions and different types of agro-products as well as a variety of rural practices, festivals, Maharashtra has great potential for the growth of agro-tourism. More than 45% of the population live in urban areas and want to experience rural life and learn about rural life. Building an agro-tourism business in Maharashtra is a good opportunity. But in the farmers, there is a problem of low understanding of this sector and the financial problem and the correct view of the Maharashtra farmers. The paper, therefore, aims to suggest a conceptual framework for farmers to help them run their agro-tourism business in a more efficient manner and achieve maximum profits.

Therefore, the districts' agricultural departments, Agriculture Universities, should try to provide orientation and some innovative ideas on agro-tourism. The government should try to provide the best financial support through the grants and institutional financing to the agro-tourism activities in Maharashtra. Banks should provide optimum financial assistance for Maharashtra's agro-tourism activities. The need for these farmers is the Agro-tourism service providers' union, which supports the Indian agricultural tourism network, like Maharashtra.

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**IMPACT OF BRAND AWARENESS, USAGE, RECALL ON BRAND PROMOTION OF FILMS AND IT'S INFLUENCE ON CONSUMER BUYING INTENSIONS**

**MRS. DHANASHRI HAVALE, DR. CHETAN CHAUDHARI AND DR. AMIT PATIL****ABSTRACT**

The importance of product/brand placement has gradually increased with rising competition and globalization. With the intensified market competition in recent years, many innovative techniques for effective marketing communication have been established by organizations. In this context, many media channels like television serials, Hindi movies, computer games, and books are frequently employed for product promotion purposes. In this paper, the influential factors of product placement in Hindi movies used as a marketing communications practice will be discussed, and the correlation amongst product promotion, product awareness, product usage with product recall shall be established through regression analysis of the data collected using proper channels.

Today's marketers are vastly spending on product placements in films because they are perceived as advantageous when an advertisement is in the storyline which is hard to miss for viewers. This paper mainly evaluates the brand placement in Hindi films as compared to the commercials on television and its effect on buying attitude of the audiences, for exploring the brand awareness degree created by brand placement on the minds of the viewers and to examine the impact of the type of usage done while placing the brand in films.

Many studies have been conducted in this field to show why advertisers prefer product placements in movies to commercial ads. Nonetheless, the focus of this study is on the effects of product placement on consumer brand recognition and the promotion style adopted. To gather data for this study, a questionnaire was developed, which included questions about general opinion as well as product placement's impact on brand promotion, use, recall, and recognition through movies. The data was analyzed using the Exploratory Factor Analysis – EFA and the Regression Analysis.

**Key Words:** Product/ Brand placements, Hindi movies, Television, Consumer buying behaviour, Brand awareness, Brand Usage, Brand Promotion, Brand Recall, Brand Recognition.

**INTRODUCTION**

In the current internet era, brand placement is considered one of the strong marketing tools that widen existing marketing goals. Brand placement is the most cost-effective medium for getting global exposure with infinite viewer marketing. It is one of the proven ways to acquaint the consumer with the company's brand name and product lines and attach with them with the added advantage of association with known film personality, blockbuster movies, and/or hit television serial. The marketing industry across the globe is facing multiple challenges these days. With increasing media options, breaking through the clutter and setting up a good footprint in the market is becoming increasingly difficult. The common consumer is bombarded with various advertising tactics every day which turned his resistant to all kinds of communication attempts made by marketers. This buyer resistance has forced marketers and advertisers to think and implement innovative advertising strategies. This is where brand/product placement in movies comes into the picture. The systematic process of inserting a brand name, package, logo, product, or some trademark into any television show, movie, or other types of media to maximize brand knowledge and memory at the point of purchase is referred to as product placement.

Product/brand placement promotes the advertiser or the company to create unique content which helps them promote their product (Mustafa S., 2013) (Falkow, 2010). Because of their continual lifestyle and taste changes, for product placement, today's young adult masses all over the world are considered as the primary target audience. Surprisingly, young adults from all over the world are often found to think alike as a result of their exposure to current communication technologies and social media. Bollywood is the second-largest film industry in terms of audience size, after Hollywood, with a global audience (Srivastava, 2012). As a result, brands/products featured in Hindi films attract a lot of publicity. As studied by Gupta and Lord (Gupta, 1998), brands placed in films generated more consumer recall than those placed in television commercials. Therefore, product placement in Hindi movies is a proven tactic implemented for building the brand.

**HISTORY OF BRANDING PRODUCTS THROUGH FILMS**

The careful positioning of brands in films isn't a new trend these days. In 1945, Gordon's Dry Gin was poured on the sides of the boat in "The African Queen," and in the 1890s, the Lumiere brothers included Lever's "Sunlight Soap" in their film experiments (Newell, 2003). The haphazard and casual nature of the operation was what made these earlier days of product placements popular in the current period. Over time, this activity has become more complex, structured, and challenging. In 1982, in E.T. the placement of the Reese's Pieces brand led to a considerable rise in product revenue, triggering a shift in professional strategies (Wasko, 1993).

The Indian film industry, which is over a century old and produces nearly 1,000 films every year, counts for 1% of global film revenue (Dwyer R, 2005). As previously said, brand placement in Indian films is nothing new. A noticeable pattern has been observed recently and in the past, such as using in the plot of a film, showing brand in the background, or showing its use by actors in the film. Soft drinks, cars, clothes, gift goods, services, pharmaceuticals, and a variety of other products are among those chosen for film advertising. Though this industry seems to be an unorganized sector, the Government of India granted "industry status" to it in 2000 year (Rajadhyaksha, 2003). Subsequently, this industry then began its journey of establishing itself as an organized sector overall. In the film industry, there are currently 26 conglomerates. Few firms, such as Yash Raj Films, Adlabs Films, Pritish Nandy Communications, and UTV, have driven the vertical assimilation of filmmakers, exhibitors, distributors, broadcasters, and music companies.

**NEED FOR THIS STUDY AND THE PROBLEM STATEMENT**

In a developing country like India, nearly a thousand films are released each year (Kureshi, 2011), the question arises, how far and how much do brand placements influence or influence viewers' purchasing decisions? Consumers are becoming increasingly conscious of brand placement tactics, indicating resistance to being persuaded to buy. (Wei, 2008). India has seen a steep rise in the advertisement of diverse products in film and other media. Nowadays, if the advertisement does not hold attention, consumers tend to change the channel or media. Brand placement in movies seems to be an evergreen pathway to influence the attitude of the buyer. Since the method of positioning a brand correctly is not as easy as it is assumed, the impact of brand placement in films is something that needs to be investigated regularly. Measuring the effect of brand placement on brand recall, attitude, or the consumer's impression of placed products in movies is difficult because the brand placed is expected to produce income for the company. As a result, the study's objective is to see how brand placement affects Indian audiences. It was observed that few studies had been conducted in this field, particularly in the Indian film industry.

**OBJECTIVES OF RESEARCH****The research objectives are:**

- To study the influence of brand placement in Hindi movies and television commercials.
- To evaluate the effect of brand placement in Hindi movies on consumer's brand awareness and brand recognition.
- To examine the influence of brand presentation method in Hindi movies on consumer's brand recall

**Significance of Brand Placement**

Brand promotion majorly depends on the circumstances where the brand is emphasized (Karrh J, 1998). If one goes for an in-depth analysis, current product placement trends have moved close to the conventional marketing sphere as customers are well aware of the marketing tactics and even the approaching method has become very noticeable. Brand positioning is often used for the same reasons as advertisement is used either to enhance awareness, interest, or drive buyers ahead in the marketing funnel, and influence buying behavior keeping in mind various perspectives. Despite the numerous uses of placement of a product in various media, many studies have explored the influence of brand placement or product in films. Its effects are stated in several studies as traditionally set (Nelson M R & Deshpande, 2013), it also identifies financial effects of brand placement in movies (Karniouchina E V, 2011), and also the placement style and certainty (Wiles M, 2009). Earlier a lot of research has been carried out to determine the influence of product or brand placement in television series (Gillespie B, 2012) and video games (Hang H, 2014). Earlier many study attempts are made to evaluate the effects of product placements on consumer's buying behavior (Auty S, 2004) (Russell A, 2006) by emphasizing the expanding digital media audience and the television industry's viewer size. A study compared the effectiveness of placement of products in films to ads and television shows. To overcome the soar of electronic devices allowing skipping the commercial advertisement, product placement in movies seemed to be well accepted and recognized. (Lawrence, 1989) (Alwitt L) (Frank, 2002). Several researchers have noted the

usefulness of product placement in terms of brand recognized (Brennan I, 2004), awareness, and approach (Gupta P, 1997).

**H1** - Brand placement in Hindi movies is more influencing than brand placement in television commercials.

### **Significance of Brand Awareness and Brand Recall**

As a marketing tactic, product/brand positioning is primarily used to develop interest, draw attention and increase the likelihood of a prospective customer making a purchase.

Many attempts to place an automobile brand are seen thru different media for promotional purposes, creating awareness and influencing the purchase intentions of the customer. This regulates how the brand promotion and awareness are established through product placements which creates a strong image of the brand and how this image influences buyer's purchase decisions. A survey tool was used to collect data, and quantitative analyses were performed to evaluate the assumptions of the study (Guennemann, 2014).

Brand recall and brand recognition are two aspects of brand awareness. When a consumer's buying intent is evaluated as a two-dimensional quantity, brand recognition represents the depth, and brand recall represents the breadth of the buyer paradigm. The brand image has an automatic effect on how consumers relate to the brand, and it should preferably be solid (consistency as well as relevance), desirable (deliverability as well as desirability), and distinct (exceptional as well as sophisticated) (Keller, 2008). Repeated advertising, combined with strategic product placement, has been shown to increase customer recall, which leads to increased brand awareness (Belch, 2004). Also, the viewer's increased media exposure will increase the chances of subliminal impact from product placements (Johnstone, 2000).

**H2**- Brands placed in Hindi movies has a significant influence on consumers brand awareness and brand recognition.

### **Significance of Brand Usage and Brand Recall**

Many researchers have examined how efficient brand placements are in terms of how well they are recalled (Gupta, 1998). The efficacy is measured for parameters like brand recall, brand usage and its effect on brand memory or brand salience. The brand recall is greatly correlated to the prominent placement of the brand. This prominent brand placement has a higher impact on brand recall. The verbal or visual brand placements are normally recalled more. Likewise, the brand recall surges when placements are done through embedding it into the story (that is plot connection). According to the prototypical developed by Balasubramanian, Patwardhan, and Karrh, (Balasubramanian, 2006) four main components viz., individual-specific factors, execution factors, message outcomes, and the level of processing impact placement's success. Gupta and Lord, (Gupta, 1998) studied how brand recognition is affected by brand placement. This study looked at the impact of different brand placement categories (such as subtle vs. prominent) and brand placement modes (such as audio, audio-visual, and visual). They reported a significant brand placement advantage for both audio and visuals, a noticeable PPLs over subtle visual brand placements.

Looking at the above studies, the question arises, how to place the brand effectively? For example, the brand must be subtly placed without reference to the characters in the film or to be placed blatantly where the brand is completely integrated into the plot. The answer to such type of question will help promoters place their brand effectively and successfully. Hence, the study hypothesis is set as given below,

**H3** – The brand presentation method in Hindi movies has a significant influence on consumer's brand recall.

### **RESEARCH METHODOLOGY**

The majority of previous brand placement studies for Indian movies seem to be laboratory-based, whereas actual field research always provides proven results. In both lab and field environments, the effect of brand placement is difficult to measure. Brand positioning, brand recognition, brand use, and brand recall in movies can all be calculated and compared qualitatively using available research methods.

### **RESEARCH DESIGN & DATA COLLECTION**

Regarding the experimental study conducted, and within the context of true experimental designs, a group of recent movie watchers is considered eligible. In this design, subjects who have noticed at least one product placement in a Hindi movie in the last six months were selected for the study. In this scenario, the researcher volunteered to conduct this survey at various locations like colleges, multiplexes, and offices of Pune city. While they approached 1200 respondents, 230 responses were eliminated due to large missing values and incomplete questionnaires. In the context of this paper, the 970 valid responses were considered to analyze the

impact of brand placement on advertising media used, its brand awareness, and its brand usage, and also the correlation amongst these factors are established.

### **Research Analysis Method**

Factor analysis was used to extract components with enough variance. Since we thought that measures like the rank test, correlation coefficient, and regression could provide enough data interpretation and directions, this evaluation of participant responses was done using descriptive analysis through SPSS software for data implications. Also, it helps in the analysis of the study's primary objectives.

### **RESULT AND DISCUSSION**

Movies are a prominent medium for brand placement in India. According to the current study on outlooks, shows that the respondents' buying behavior might be both explicit as well as implicit. According to the results, the role of brand placement in Hindi movies is to raise brand awareness and boost brand recall. It is observed that 95% of respondents in India like the idea of brand placement in the movies and tend to follow their favorite actor brands. The next part of this study is to measure the correlation among the factors of brand placement in the film.

### **Significance of Awareness, Brand Promotion, Usage, as well as Recall**

Recognition of variables having large loadings on a similar factor facilitates interpretation. The variables that load high on that factor can then be interpreted. For this analysis, factor loading greater than 0.50 is highly important. Where loadings are more than 0.50, the variables are considered main variables under the relevant factor. In this study, any item that failed to load on a single factor at 0.5 or below was excluded. Dropping an item was factored until all items loaded at 0.5 or more on one and only one factor, according to a study.

The exploratory factor analysis (EFA) loadings are presented in below table 1.

**Table 1 Rotated Component Matrix for Brand Promotion, Awareness, Usage, and Recall**

Sr. No.	Categories		Components			
			1	2	3	4
1	<b>Brand Promotion</b>	Brand remembrance is more when it is placed in Hindi movies than in television commercials	0.063	0.035	0.808	0.092
2	<b>Brand Promotion</b>	Brand remembrance is more when it is placed in television commercials than in Hindi movies	0.647	0.259	-0.030	0.027
3	<b>Brand Awareness</b>	Brand messages through product placement highlight brand name or product name	0.229	0.243	0.034	0.762
4	<b>Brand Awareness</b>	Brands appeared in Hindi movies prompt buyer to purchase	.019	.811	.004	-.038
5	<b>Brand Usage</b>	Brand placement is effective when integrated with the storyline in hindi movies	0.668	0.199	0.009	-0.006
6	<b>Brand Usage</b>	Brand placement is effective when endorsed by my favorite star in movies	0.649	0.127	0.128	0.059
7	<b>Brand Usage</b>	When a brand appears in the background or foreground without being used, it is considered successful brand placement.	0.557	0.219	-0.042	0.121
8	<b>Brand Recall</b>	Brand is recalled if it appears multiple times in a movie	0.202	-0.028	0.040	0.700
9	<b>Brand Recall</b>	Brand recall is high if it appears for a longer duration movie	0.223	0.039	0.057	0.738

Table 1 shows that the maximum value of the Question 1 response was 0.808, while for Question 2, the maximum values were 0.647. This demonstrated that a brand placed in Hindi films received better promotion than a brand promoted in television commercials.

The maximum value for Question 3 was 0.762, while for Question 4, the value was 0.811. This showed that the brand placed in Hindi movies has a significant influence on consumer's brand awareness and brand recognition.

For Question 5, the maximum value of the response was 0.668, for Question 6, the maximum values were 0.649, and for Question 7 the value was 0.557. This showed that the brand usage method in Hindi movies has a significant influence on consumer's buying behavior.

Question 8 and 9 showed maximum values of 0.700 and 0.738 respectively. Thus when buying is considered the brand is remembered and recalled highly if it is appearing more number of times and stays for a longer duration on screen.

The scale's reliability demonstrates that the study is error-free. Cronbach's coefficient alpha was used to determine internal consistency in this research. Cronbach's alpha test is frequently used to evaluate the reliability and consistency of items on a Likert Type scale that are being considered for a study. After watching Hindi movies, Cronbach's alpha was found for the aggregated scale of consumer behavior.

There were nine items on the scale. For the integrated scale, Cronbach's alpha was found. The Reliability statistical test result is given below:

<b>Table 2 Reliability Statistics</b>		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.896	0.903	9

The Cronbach's alpha value is 0.903, as shown in Table 2, which is significantly higher than the 0.6 limits. Accordingly, if  $\alpha$  value is 0.7 or more, it is usually considered good. The Cronbach's alpha value being 0.903 denotes that the reliability of this data is 90.3%.

### Factors Wise Reliability Test

#### 1) Brand Usage

<b>Table 3 Reliability Statistics for Brand Usage</b>		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.874	.877	3

The integrated scale for Brand Usage 3 items had a Cronbach's alpha of 0.877, which was significant at 0.001 alpha.

<b>Table 4 ANOVA for Brand Usage</b>						
		Sum of Squares	df	Mean Square	F	Sig
Between People		2714.225	969	2.801		
Within People	Between Items	311.551	9	34.617	98.207	.000
	Residual	3074.049	8721	.352		
	Total	3385.600	8730	.388		
Total		6099.825	9699	.629		
Grand Mean = 4.16						
The result of ANOVA test for examining the brand usage is shown in Table 4, which states that the F value of 98.207 was significant (sig. F< 0.01), indicating that the model was fit.						

#### 2) Brand Recall

<b>Table 5 Reliability Statistics for Brand Recall</b>		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.742	0.742	2

The integrated scale for Brand recall for two items had a Cronbach's alpha of 0.742, which was significant at 0.001 alpha.

**Table 6 ANOVA for Brand Recall**

		Sum of Squares	df	Mean Square	F	Sig
Between People		2740.999	969	2.829		
Within People	Between Items	189.620	3	63.207	86.532	.000
	Residual	2123.380	2907	.730		
	Total	2313.000	2910	.795		
Total		5053.999	3879	1.303		
Grand Mean = 3.30						

The result of ANOVA test for examining the brand recall is shown in Table 6, which states that the F value 86.532 was significant at (sig. F< 0.01), thus confirming the fitness for the model.

### 3) Brand Promotion

**Table 7 Reliability Statistics for Brand Promotion**

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.895	0.900	2

The integrated scale for Brand promotions for two items has a Cronbach's alpha of 0.900, which was significant at 0.001 alpha.

**Table 8 ANOVA for Brand Promotion**

		Sum of Squares	df	Mean Square	F	Sig
Between People		3623.794	969	3.740		
Within People	Between Items	583.440	13	44.880	114.555	.000
	Residual	4935.202	12597	.392		
	Total	5518.643	12610	.438		
Total		9142.437	13579	.673		
Grand Mean = 4.03						

The result of ANOVA test for examining the brand promotion is shown in Table 8, which states that the F value 114.555 was significant at (sig. F< 0.01), thus confirming the fitness for the model.

### 4) Brand Awareness

**Table 9 Reliability Statistics for Brand Awareness**

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.775	0.775	2

The integrated scale for Brand awareness for two items had a Cronbach's alpha of 0.775, which was significant at 0.001 alpha.

**Table 10 ANOVA for Brand Awareness**

		Sum of Squares	df	Mean Square	F	Sig
Between People		998.136	969	1.030		
Within People	Between Items	54.665	3	18.222	78.697	.000
	Residual	673.085	2907	.232		
	Total	727.750	2910	.250		
Total		1725.886	3879	.445		
Grand Mean = 4.26						

The result of ANOVA test for examining the brand awareness is shown in Table 10, which states that the F value 78.697 was significant at (sig. F< 0.01), thus confirming the fitness for the model.

## 5) Buying Intentions

Table 11 Reliability Statistics for Buying Intentions		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.929	.929	7

The integrated scale for consumer Buying intention for seven items had a Cronbach's alpha of 0.929, which was significant at 0.001 alpha.

Table 12 ANOVA of Buying Intentions						
		Sum of Squares	df	Mean Square	F	Sig
Between People		2214.356	555	3.990		
Within People	Between Items	73.291	6	12.215	43.057	.000
	Residual	944.709	3330	.284		
	Total	1018.000	3336	.305		
Total		3232.356	3891	.831		
Grand Mean = 4.02						

The result of ANOVA test for examining the buying intentions is shown in Table 12, which states that the F value 43.057 was significant at (sig. F< 0.01), thus confirming the fitness for the model.

## HYPOTHESES TESTING

Multiple regression analysis is applied to test the hypothesis. The intention of consumers to purchase products after seeing Hindi films was kept as a dependent variable, while the other four elements were independent variables.

As per Wang and Benbasat, 2007 the average score of multiple items for a construct can be calculated to measure the construct. Because multiple items were used to measure a single construct in the questionnaire, the same score was used for further analysis including regression and correlation analysis.

Table 13 Descriptive Statistics				
	Mean	Std. Deviation	N	
Brand Recognition	4.1612	.52925	970	
Brand Recall	3.3018	.83976	970	
Brand Promotion	4.0263	.51173	970	
Brand Awareness	4.2564	.50388	970	
Consumer intention to buy	3.9931	.40068	970	

Table 14 Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.716 <sup>a</sup>	.512	.510	.28036
a. Predictors: (Constant), Brand Awareness, Brand Recall, Brand Usage, Brand Promotion				

1	Model (Constant)	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
		B	Std. Error	Beta			
	Brand Usage	.162	.019	.214	.8.375	.000	
	Brand Recall	.194	.011	.406	.17.508	.000	
	Brand Promotion	.191	.021	.244	.9.101	.002	
	Brand Awareness	.164	.020	.206	.8.188	.003	
a. Dependent Variable: Consumer intention to buy							

From Table 15, the result shows that Brand Usage ( $\beta = 0.214$ ;  $t = 8.375$ ,  $p = 0.000$ ), Brand Recall ( $\beta = .406$ ;  $t = 17.508$ ,  $p = 0.000$ ), Brand Promotion ( $\beta = 0.244$ ;  $t = 9.101$ ,  $p = 0.002$ ) and Brand Awareness ( $\beta = 0.206$   $t = 8.188$ ,  $p = 0.003$ ) have positive impact on consumer intention to buy products after watching products placement in Hindi movies.

**Table 16 ANOVA<sup>b</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4	19.930	253.556	.000 <sup>a</sup>
	Residual	965	.079		
	Total	969			
a. Predictors: (Constant), Brand Awareness, Brand Recall, Brand Usage, Brand Promotion					
b. Dependent Variable: Consumer intention to buy					

Multiple regression analysis revealed that the F value 253.556 in Table 16 was significant at (sig. F 0.01), confirming the model's fitness. The R-square revealed the model's predictive power and indicated that a dependent variable affects the independent variable significantly. After watching Hindi movies, the four factors accounted for 51.2 percent of the consumer intention towards products.

Table 17 Summary of regression result for product placement in Hindi movies

S. No	Products placements variables	Impact on consumer intention to buy products
1	Brand Usage	Yes
2	Brand Recall	Yes
3	Brand Promotion	Yes
4	Brand Awareness	Yes

Results indicate that Brand Recall one of the most contributing factors on consumer intention then after Brand Promotion, followed by Brand Usage, and Brand awareness. According to the findings, the null hypothesis is rejected and the alternative hypothesis is adopted. When it comes to Hindi films, product placement components have a significant impact on consumer buying behavior, as per the findings.

Consumer Intention to buy after watching products placement in Hindi movies (CI) =  $1.213 + .162 \times$  Brand Usage +  $.194 \times$  Brand Recall +  $0.191 \times$  Brand Promotion +  $0.164 \times$  Brand Awareness + 0.097.

**Table 18 Correlations**

		Brand Usage	Brand Recall	Brand Promotion	Brand Awareness	Consumer intention to buy
Brand Usage	Pearson Correlation	1	.114 **	.439 **	.350 **	.440 **
	Sig. (2-tailed)		.000	.000	.000	.000
	N	970	970	970	970	970
Brand Recall	Pearson Correlation			.245 **	.086 **	.508 **
	Sig. (2-tailed)			.000	.007	.000
	N			970	970	970
Brand Promotion	Pearson Correlation			1	.403 **	.520 **
	Sig. (2-tailed)				.000	.000
	N			970	970	970
Brand Awareness	Pearson Correlation				1	.414 **
	Sig. (2-tailed)					.000
	N				970	970
Consumer intention to buy	Pearson Correlation					1
	Sig. (2-tailed)					
	N					970

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

The correlation between Consumer intention to buy products after watching Hindi movies and four variables is shown in Table 18, where Brand Usage (0.440), Brand recall (0.508), Brand Promotion (0.520), Brand Awareness (0.414) had significant co-relations at .001 levels with consumer intention to buy products after watching Hindi movies.

## **FUTURE PROSPECTS**

The outcomes of the research have led to a better understanding of the impact of brand awareness, brand positioning, and brand usage on gathered responses according to the product/brand placement in Hindi movies, as well as the outcomes of earlier brand placement research (Nelson, 2013). According to the findings, when the brand promotion channel, its placement, and use are all consistent with the setting in which it is used, it is considered to have a strong brand impact.

Therefore, it's essential to understand the extent to which placement results do not apply across other mediums. Because television is an advertising-supported medium, viewers may be more accepting of brand placements/products in television serials. This shows that there is a difference in the film and television viewing patterns that exist (Russell, 2006) may also alter the parameters that influence the efficacy of brand placements. Readings examining the results with a variety of samples and in a variety of circumstances is an important area for future research.

Sponsors aiming to target the booming Indian market for their brands would benefit from this research, which measures how Indian audiences feel about brand placements and determine the impact of product/brand placement on buying behavior of consumers.

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**STUDY OF FACTORS INFLUENCING INVESTMENT DECISIONS IN INDIAN STOCK MARKET  
BY FIRST-TIME INVESTORS**

**VISHWESH RAVISHANKAR AND PROF. DR. ASHISH MOHTURE**

**ABSTRACT**

*Scam 1992, a web series based on Harshad Mehta's scam in Indian Share Market gave the topic to most people to think on the share market. In FY 2021, the total number of retail investors has increased by 14.2 million with 12.25 million new accounts being opened in CDSL & 1.9 million in NSDL. It results in domination of the Indian stock market by retail investor's up to some extent.*

*In NSE share of retail investors grew from 33% to 45% in FY 2021. This trend still carries the momentum with the registration of 1.5 million new investors in June-2021. So, we can see the interest of retail investors in the Indian stock market is increasing day by day.*

*In this research paper, we tried to find out various parameters of investment used by these retail investors in the Indian share market. Also, we tried to analyse & interpret the primary collected data.*

**Key Words:** - Stock Market, Retail Investors, First-time investors, NSE, BSE.

**INTRODUCTION**

Finance is a huge umbrella under which the study of the system of money, investments and other financial instruments are classified. The birth of finance came in with the death of the barter system while the roots of finance date back to the most ancient civilization where-in the storage of financial assets like grains, cattle and precious metals were stored in temples and palaces. Soon, during the middle age Bills of Exchange (BOE) were developed as means of transferring ownership of large volumes of precious metals over long distances without the need to physically transfer them. Later in the 17<sup>th</sup> century, the world's first exchange was found where-in shares were issued that anyone could trade on the Amsterdam Exchange.

Finance being the backbone of all the industries in an economy; it can be classified into 3 major parts:

- Public Finance
- Corporate Finance
- Personal Finance

Public Finance oversees the financial decisions of the government of any country by making sure that there is no failure in the process of allocation of resources, budgeting, distribution of income and creating tax slabs. Public finance is vital to the economic health of any country since a minor error in allocation of resources could jeopardize the economic stability and can cause a liquidity crunch which might lead to a country being budget deficit in the coming years.

Corporate Finance involves raising money for ventures, taking established companies public, mergers and acquisitions etc. Angel investors or venture capitalists provide capital in exchange for a percentage of ownership of the company. IPOs are a great way for companies to bring in that influx of cash which can help in expanding their operations.

Personal Finance involves planning or analyzing an individual's financial position, making plans, and taking some current financial or investment decisions to help achieve those plans without causing a liquidity crunch. Personal finance is important because an individual's financial position after a certain period is entirely dependent on how he/she plans their finances currently. To gain returns higher than inflation which is said to be around 6%, one must invest in the equity markets in the right way.

The stock market is a type of market where financial instruments like shares and derivatives are traded under the set of rules and regulations laid down by the governing body. The Indian Stock Market traces its history back to its roots in the late 18<sup>th</sup> century in Bombay currently Mumbai, Maharashtra. Following this many regional stock exchanges came up and it wasn't till 1957 that the Government of India recognized the Bombay Stock Exchange, under the Securities Contracts Regulations Act. Soon in 1986 SENSEX was launched

followed by the BSE National Index in 1989. Securities and Exchange Board of India (SEBI) was founded in 1988 and was given the status and power of being an autonomous body in 1992 after the Harshad Mehta Scam.

Following the scam soon an entire dematerialized exchange was formed called the National Stock Exchange (NSE) and it started its operations in 1994. In 2015, SEBI was merged with the Forward Markets Commission (FMC) to strengthen the governing of the commodities market. Currently, BSE is known as Asia's oldest stock exchange and is also measured as the world's 11<sup>th</sup> largest stock exchange with a market capitalization of over \$1.65 trillion with over 5000 companies being listed on it and the National Stock Exchange (NSE) surpasses the Bombay Stock Exchange (BSE) in terms of volume of shares traded and has over 1800 listed companies traded on it.

The Indian stock market is one of the most emerging and promising markets in terms of investment opportunities. In recent years, the Indian economy has been attracting a lot of Foreign Direct Investment (FDI) due to the robust business environment and favorable government policies. FDI equity flow in India was US\$ 17.56 billion between April 2021 and June 2021. Further, India is expected to attract FDI of US\$ 120-160 billion by the year 2025. What makes the Indian equity market one of the highest alpha-generating markets across the globe is that it has diverse small-cap and mid-cap segments which is less explored and stands at a higher probability of generating greater returns.

Primary Market consists of financial instruments being listed/issued for the first time to the public and IPO is one way for a company to announce that it has gone "Public" by offering its shares to the retail investors for the very first time. Once the listed securities are traded on the exchange it is known as the Secondary Market. The majority of the equity shares are traded in the Indian Stock Market on 2 exchanges: Bombay Stock Exchange (BSE) established in 1875 & National Stock Exchange (NSE) established in 1994. All the trades under the Primary and Secondary market are regulated by the governing body of the Indian Stock Market called the Securities and Exchange Board of India (SEBI).

The intermediaries that facilitate these transactions at an agreed-upon price are called stockbrokers. The role of the broker is to aggregate all the orders and send them to the exchange where a buy order is matched to a sell order and vice versa.

#### **Other intermediaries in the stock market are:**

- Depositories
- Banks
- National Security Clearing Corporation Ltd & Indian Clearing Corporation Ltd

#### **Stock Market Participant:**

- **Domestic Retail Participant:** All retail investors fall under this category.
- **NRIs:** Indians residing in foreign countries.
- **Domestic Institutions:** Huge corporate entities based out of India are involved in investing and trading in the Indian stock market.
- **Domestic Asset Management Companies (AMC):** Corporate entities or mutual funds or Asset Management companies who pool investors' money to invest in the Indian Stock Market. Example: HDFC AMC, SBI Mutual Fund etc.
- **Foreign Institutional Investors:** Corporate entities or mutual funds companies trading or investing in the Indian stock market who don't have an Indian origin. Eg: Hedge funds.

#### **OBJECTIVES**

- 1) To find various sources of information that are used by first-time investors.
- 2) To study various factors influencing investment decisions in the Indian Stock Market by first-time investors.
- 3) To study the demographic information of first-time investors in the Indian Stock Market.

**RESEARCH METHODOLOGY**

An exploratory type of research design is used in this research paper. Researcher used primary and secondary data which was collected from respondents who are investing in the Indian share market and from various websites, authorised agencies like BSE, NSE, CDSL, etc. Researchers critically observed and analysed the collected data and draw few conclusions from it to satisfy the objectives of this study.

Researchers approached 243 respondents, out of which 212 respondents have invested their money in the Indian share market for the first time. The study was carried out between April 2021 to October 2021 and data was considered for the last five financial years.

**STOCK MARKET INDICES**

A stock market index is a way to measure the kind of changes taking place in the market. An index is created by grouping similar stocks which are already listed on the exchange. There are various parameters for a stock to be grouped with other stocks to create an index like stock sector, the market capitalization of the chosen stocks, the size of the company etc. The total value of the index which is created by choosing specific stocks is gauged by the values of the stocks which are chosen to form that index. Once, the index is created with a chosen set of stocks, any delta in the prices of those underlying stocks will directly impact the overall value of that index.

For Eg: If the prices of the underlying stocks drastically shoot up, the value of that index will also rise simultaneously and vice-versa.

**Some of the important indices in the world are:**

- Dow Jones
- National Association of Securities Dealers Automated Quotation (NASDAQ)
- Standard & Poor (S&P 500)
- Morgan Stanley Capital International (MSCI)
- Hang Seng
- Financial Times Stock Exchange 100 (FTSE)
- European indices- Dax, CAC 40.

**Some of the important indices in India are:**

- SENSEX
- BSE MIDCAP
- BSE SMALLCAP
- BSE 100
- BSE 200
- BSE 500
- BSE Auto
- BSE BANKEX
- BSE Cons Durables
- BSE CAP GOODS
- BSE FMCG
- BSE HEALTHCARE
- BSE IT
- BSE Metal
- BSE Oil & Gas

- BSE PSU
- BSE TECK
- BSE REALTY
- BSE SME IPO
- S&P BSE CARBONEX
- S&P BSE GREENEX
- S&P BSE Shariah 50
- BSE IPO
- BSE POWER

An index typically represents the overall behaviour of the market and enables the investors to quickly gauge the performance of the market simply by looking at the overall returns a specific index has given over a given period. Indices are of vital importance because they have the potential to represent the investor sentiments of the entire market. In India, BSE SENSEX and NSE NIFTY are considered the benchmark indices. Indices also make it easier for investors to assess and compare the performance of different sectors at one glance.

Apart from this, Indices also enable investors who are risk-averse to invest in indexes rather than individual stocks due to their low volatility and stable returns through Exchange Traded Funds (ETFs). To mitigate the volatility of the indices, each stock that is grouped under an index is given a different weightage so even if a particular stock price crashes it won't have any major impact on the index value.

#### **Sectorial Indices in the Indian Stock Market are:**

- Nifty Auto Index
- Nifty Bank Index
- Nifty Consumer Durables Index
- Nifty Financial Services Index
- Nifty Financial Services 25/50 Index
- Nifty FMCG Index
- Nifty Healthcare Index
- Nifty IT Index
- Nifty Media Index
- Nifty Metal Index
- Nifty Oil & Gas Index
- Nifty Pharma Index
- Nifty Private Bank Index
- Nifty PSU Bank Index
- Nifty Realty Index

#### **CORPORATE ACTIONS**

These are actions taken by the companies that have an impact on their stocks. All the corporate actions are initiated by the board of directors and approved by the company's shareholders.

**Dividend:** Dividends are paid to the shareholders from the profit a company makes during the year. Dividends are paid voluntarily by the companies as it promotes goodwill in the market, and few companies choose not to share their profits through dividends if they feel that the profit generated can be used to expand the company's

operations thereby generating greater returns for its shareholders. The decision to pay dividends to its shareholders is taken in the Annual General Meeting (AGM). The dividends are given to the shareholders who hold shares before the Ex-Dividend date.

Dividends paid during the financial year are called interim dividend and the dividend paid at the end of the financial year is called the final dividend.

**Bonus Issue:** These are free shares given to the existing shareholders of the company from the company's reserves. Most of the times bonus shares are issued in a ratio format like 3:1 wherein any existing shareholder having 1 share will be allotted additional 3 shares for no extra cost. Since additional shares are issued by the company, the price of the share decreases and the overall value of the portfolio remains the same. Here, the face value of the share remains the same.

**Stock Split:** In this action, the price of the share, as well as its face value, is split in a particular ratio in a way that the number of shares increases but the price of the share decreases so that the total market capitalization of the company or the value of the portfolio remains same. The most recent example of a stock that went under a stock split is the Indian Railway Catering and Tourism Corporation (IRCTC).

**Rights Issue:** Rights Issue is another way for a company to raise money for paying debts or for expanding its operations. Rights Issue provides the listed company with an alternate way to raise funds rather than take the traditional route of issuing a Further Public Offering (FPO) wherein the existing shareholders are given the right to purchase the company's stock at a discounted rate as compared to the Current Market Price (CMP). The most recent example of a company that opted for a rights issue was Bharati Airtel.

**Buyback of Shares:** Buyback of shares occurs when a company offers to purchase its shares from the existing shareholders who had bought the shares through the exchange. Buyback reduces the number of shares available in the market thereby giving rise to a potential increase in the value of that stock. Buyback is offered to the existing shareholders with a premium as compared to the Current Market Price (CMP) to attract more buyback applications. Any company buying its shares back is indicative of management being very confident of the company's future.

#### **ANALYSIS & INTERPRETATION OF DATA**

This research was conducted during the period April to October 2021 in India. Primary data was collected through Google Forms and respondents were servicemen from different employment sectors and businessmen and the secondary data was collected from various websites and research papers. Data was collected from 212 respondents from Maharashtra State. The following are the findings from the data collected and analyzed.

1. 66% of the respondents were males and 34% of the respondents were females.
2. 55.2% of the respondents were unmarried, 42.5% were married and 2.4% declared their status as "others".
3. 61.79% of the respondents were graduates, 33.96% were postgraduates, 2.83% were below 12<sup>th</sup> and 1.42% had PhD.
4. 39.6% of the respondents were students, 38.7% were servicemen, 17% were business owners and 4.7% said "other".
5. 31.2% of respondents had income between 0-2 Lakhs, 27.3% between 2-5 Lakhs, 20.5% between 5-10 Lakhs and 27.3% had 10 Lakhs and above.
6. 42.9% of the respondents had Salary as their source of income for investment, 25.5% had pocket money, 20.3% had business profits and 11.3% had "other".
7. 84% of the respondents were aware of the market whereas 16% were not.
8. 69.3% of the respondents had a DEMAT Account whereas 30.7% did not.
9. 69.8% of the respondents invest in the Indian Stock Market whereas 30.2% did not.

Of all the respondents who invest in the Indian Stock Market, the following data has been collected from them.

1. 31.8% of the respondents have been investing for 4 years and above, 23.6% between 0- 1 year, 18.9% between 1-2 years, 15.5% between 2-3 years and 10.1% between 3-4 years.
2. 27.7% of the respondents invest in the Indian Stock Market for long term gains, 11.5% for short term gains,

- 26.4% for both, 6.1% for listing gains and 27.7% invested for all of the above.
3. 73% of the respondents invest in the Banking and Finance sector, 47.3% in FMCG, 68.2% in IT, 53.4% in Automobile, 56.1% in Pharma & Healthcare, 37.8% in Infrastructure, 27% in Chemical and 20.9% in "Others".
  4. 68.9% of the respondents selected both Fundamental and Technical Analysis as most important while selecting a stock to invest in, 17.6% chose Fundamental Analysis, 8.8% chose Technical Analysis and 4.7% chose "Others".
  5. 36.5% of the respondents have 1 Lakh and above as their invested amount in the portfolio, 23.6% had 20-50 thousand, 20.9% had 0-20 thousand and 18.9% had 50 thousand- 1 lakh rupees.
  6. 88.5% of the respondents have a profitable portfolio whereas 11.5% did not.
  7. Respondents who had a profitable portfolio said that 31.8% of them had 0-10 thousand as their profits, 24.2% had 1 lakh rupees and above, 16.7% had between 25-50 thousand, 14.4% had between 10-25 thousand and 12.9% had between 50 thousand -1 lakh rupee.
  8. Respondents who had their portfolio in loss, 48.5% of them had loss between 0-10 thousand rupees, 21.6% had between 10-25 thousand, 15.5% had between 25-50 thousand, 10.3% had between 1 lakh and above and 4.1% had between 50 thousand- 1 lakh rupees.
  9. 62.8% of the respondents Strongly Agree that they will continue to invest in the Indian Stock Market, 22.3% Agreed, 12.8% were Neutral. 1.4% Strongly Disagree and 0.7% Disagree.

## **CONCLUSIONS**

According to data analysis, official documents from NSE/BSE/Company, calls from brokerage houses/market experts, family, friends and relatives, Youtube or any other print or electronic media, technical analysis and other factors are the various sources of information collection by first-time investors.

As per data analysis and interpretation, fundamental analysis of companies and technical analysis of respective stocks, are the factors that are responsible for investment decisions by first-time investors in the Indian stock market.

According to data analysis 66 % are male & 34% females, 51.42% are below 25 years, 13.21% between 26-35 years, 27.83% between 36-50 years and 7.54% are 51 years old and above

55.2% are unmarried, 42.5% married and 2.4% are others, 61.97% are graduates, 33.96% postgraduates 2.83% are below 10<sup>th</sup> standard and 1.42% are PhD holders, 39.6% of the respondents were students, 38.7% were servicemen, 17% were business owners and 4.7% said other.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***IMPACT OF RETAIL STORE DESIGN & THE LAYOUT ON THE CUSTOMER MIND**

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SUSHIL KUMAR PARE**

**ABSTRACT**

*The retail business is changing as innovation keeps on forming the purchaser scene, the principal objectives of a sound retail technique haven't changed: Deliver Value in the store network and construct a clever client experience. The paper is trying to understand the role of store design and layout on the consumer mind in this process.*

**KeyWords:** *Retail, Store Design, Layout, Customer Experience*

**INTRODUCTION**

The retail market size in India was relied upon to add up to 1.7 trillion U.S. dollars by 2026, up from 883 billion dollars in 2020. While a general increment was noted up to 2019, 2020 denoted an abatement in light of the Covid pandemic. In any case, the market is assessed to recuperate in 2021. The Indian retail scene Despite the pandemic, India was among the couple of nations, showing development in retail deals in 2020. Portrayed by its sloppy retail essentially by means of Kirana stores, the nation went through a course of progress in retail shapes, which is yet to pace down.

Indian market has high complexities in terms of a large geographic spread and distinct consumer preferences varying by each region necessitating a need for localization even within the geographic zones. India has the highest number of outlets per person (7 per thousand) Indian retail space per capita at 2 sq. ft (0.19 m<sup>2</sup>)/ person is lowest in the world Indian retail density of 6 percent is highest in the world.[39] 1.8 million households in India have an annual income of over ₹4.5 million (US\$63,090.00).

The organized retail market incorporates a share of 8% as per 2012. While India presents an outsized market opportunity given the amount and increasing purchasing power of consumers, there are significant challenges yet only if over 90% of trade is conducted through independent local stores. Challenges include: Geographically dispersed population, small ticket sizes, complex distribution network, little use of IT systems, limitations of mass media and existence of counterfeit goods.

**THE DESIGN AND LAYOUT**

The skin store appearance affects consumer's choice of a store. Therefore, stores should listen to external appearance; if the external appearance isn't attractive, customers won't enter. Both service and merchandise quality exert a significant influence on store performance, measured by sales growth and customer growth, and their impact is mediated by customer satisfaction.

The store layout, consumer purchasing behaviour, and convenience stores are defined within the context of selling and retailing. The store layout is simple user movement through the shop to produce maximum exposure of products and attractive display. This includes doors, merchandise placement, shelf orientation, music, check-out counters, interior decorating, staff attitude, lighting, and site of the loading facilities. Consumer purchasing behaviour is that the process by which individuals rummage around for, select, purchase, use, and eliminate goods and services to satisfy their needs and needs. This process is influenced by the social and cultural environment. Hyper is comparatively large, low cost, low margin, high volume, self-service retail outlet having warehouse appearance.

**LITERATURE REVIEW**

Great store presentation and products merchandising is sort of a Good Book. It's got an alluring cover to entice, a stimulating first chapter to inform the reader they've made the proper choice, and a satisfying conclusion to urge the audience to require more. The tools want to achieve these attributes are supported creating the foremost satisfying experience for the consumer, turning browsers into buyers (UKESSAY, 2015).

Shopper conduct has changed drastically somewhat recently which is expanding the customers' need and decision on their everyday necessities. In the present dynamic and cutthroat business climate, retailers should completely comprehend and foresee how the shoppers act in buying different labor and products for their utilization. In this way, to make a cutthroat situation in the commercial center retailers are planning themselves to foster an unmistakable picture in the customers' psyche towards their store for firmly affecting their conduct.

The reason for this paper is to gauge the store plan and store climate impact towards client deals per visit of Widely Project Concept Store. This paper suggests that store plan and store environment significantly affect the shopping experience which can build the measure of product that client buy. Client deals per visit as reliant variable. Installation and show item plan, format, space, signage, window show and doorways, changing areas, lighting, air, music, and aroma demonstrated as autonomous variable.

This review looks at the intellectual impacts of atmospherics on client esteem, store picture, and support aims in a developing economic situation. Retail location visuals have the ability to rise above the limit between outside universes (Alan,2002) and what's going on inside us. The exploratory structure of the review makes it more obvious the arising retailing conditions as far as bigger stores, plan changes, building makeover and its worth discernment among clients. The review is effective in corresponding client esteem with retail climate. The review might be useful for supervisors to make and carry out client esteem methodologies in retail arrangement (Ishwar Kumar, 2010).

The idea of atmospherics is talked about and reclassified in view of administration and item retailers. An orderly methodology for researching planned climate conduct connections is then introduced as the aberrant impacts model. Using methods of plan examination, estimating enthusiastic states and administration appraisal, this model offers a structure for evoking and assessing the impacts of the retail location or branch climate upon its clients. Starter investigations of more than 2000 reactions, from clients of eighteen unique parts of five significant UK banks engaged with a review, propose that the cutting-edge styles well affect clients; a few clarifications for this result are advertised (Steven J. Greenland and Petr J. McGoldrick, 2006).

The determinants of a legitimate store design are scant on the grounds that they essentially rely upon conveying of administrations and furthermore the nature of administrations being given. Notwithstanding, there are six significant measurements that should be viewed as while deciding a good store appearance, to be specific: individual cooperation, strategy, actual appearance, premises, critical thinking, and furthermore the comfort of a store. The discoveries uncover that the effect of actual appearance and accommodation are the principal essential promoting device for retailers to make upper hands and to support clients shopping experience. The actual appearance of a store beastly affects the overall assistance quality, higher client maintenance, and better future utilization, individually (Noel Y.M. Siu, 2001)

(Doreen Chze Lin Thang, 2003) further declare that credits of store picture and appearance influence customers inclination for the stores. The boosts that relate to store credits incorporate marketing, store climate, in-store administration, availability, notoriety, advancement, offices and post-exchange administration. Customer's inclination depends on their post-visit positioning of the stores. Somewhat, purchasers visit to retail locations regularly take the state of a sporting movement whose value is supported by the degree of administration arrangement inside the shop. Thus, the norm of in-store administrations is probably going to claim a powerful effect on customers buying conduct and, if not enjoyed or contrary with the qualities or the convictions looked for by the objective buyers, may hinder fascination. Beneath might be a graph with parts of a legit store appearance.

(Vrechopoulos, 2004) discovered that store design is an urgent factor influencing shopper conduct and a basic determinant towards the production of store picture. All around planned designs are critical on the grounds that they emphatically impact in-store traffic designs, shopping climate, shopping conduct, and functional effectiveness.

(Dion, 2004) states that swarming isn't just an issue of thickness in a really given space. Swarming seems to emerge through the juxtaposition of thickness with certain social and individual conditions which sharpen the person to the possible imperatives of restricted space. The view of such imperatives winds up in a perceived dissimilarity between the quantity of spaces requested, or viewed as sufficient, by the individual, and furthermore the measure of room accessible to them. To supply prime quality administrations under states of swarming, know the connections among swarming and private control. Separating among swarming and private control may permit one to higher comprehend the job of non-public control inside the swarming system.

### **STORE FLOOR SPACE**

Floor space shows how store plan and in-store interchanges can make shopping trips simpler and more diversion for the two guardians and young people. The centre necessities are sufficient room to move around the store, straightforward access from outside the shop, and clear route and shows. Stores may likewise work on the correspondence of their qualities by important window shows, solid offices utilizing better retail location (POS),

individual contacts to energize client faithfulness, illustrations, featuring costs and age ranges in occupied regions (Cowles, 2002).

(Richard Michon, 2008) further validate that the natural brain research hypothesis proposes that floor space should impact customers' state of mind and conduct expectations. The hypothesis lays on ideas that a straightforward floor space might be a craving to stay longer, investigate the premises, and offshoot with different customers or potentially deals partners. Shopping esteem includes a connection between a shopper and an item or administration that relates not exclusively to what itself yet in addition to the utilization experience. It includes the characteristic and extraneous upsides of the article. Shopping goes far past useful utility and undertaking direction and gives other experiential advantages and satisfactions. Basic floor space was found to have a positive effect on apparent shopping esteem, which, thusly, decidedly impacts a buyer's predictable recurrent buy conduct.

Customers' considerable craving for shopping joy communicates their quest for social and experiential worth given by retail conditions and store workers. Specifically, the persuasive example concerning shopping joy focuses round the ideal amusing to purchase, feeling great inside stores, and human contact. Buyers expect that space inside a store bring about experience of shopping delight, as shown in **Figure 2.7 (Wagner, 2007)**.

### **STORE VENTILATION SYSTEM**

Ventilation of buildings depends significantly on the used criteria for the indoor environment, which also affects the health, productivity, and luxury of retail consumers. First of all, store ventilation measures shouldn't sacrifice peoples' comfort and health while shopping. There is, therefore, a requirement for ventilation for the indoor environment for retail design, and to boost shopping conditions (Olesen, 2006).

According to (Hayter, 2000), the retail sector has been slow to adopt sustainable building practices for a spread of reasons. These reasons include a desire to construct 37 retail spaces quickly (allowing little time to style the building) and also the uncertainty of how non-traditional building envelopes and systems will affect sales. Retailers have significant experience in controlling lighting levels and other store-related elements to ensure that stores remain profitable. because of the chance of reduced profits, most retailers are reluctant to include ventilation systems in their stores. Improving the ventilation systems provided the best opportunities to cut back energy costs and results in improved shopping morale.

(Kotzab, 2005.) have observed that today's retailers must perform on an extra-ordinary level by combining different decisions regarding location, assortment, selection of target markets, negotiations with suppliers, motivation of staff and other typical retail decisions, like store ventilation and merchandising, are all tired a very competitive and global environment. Since the 1990s, there has been the increasing importance of store ventilation, which was recognized to get competitive advantages by increasing in-store traffic and delight of shopping. The ultimate goal of store ventilation is efficiency, which implies offering the simplest shopping atmosphere.

### **STORE ENTRANCES**

Retail sector organizations frequently disregard the positive commitment that store Entrance and Exit focuses could make to their prosperity. At a time when more decisions than ever are made in-store, any media must provide a pathway to the acquisition that's subconsciously triggered. Therefore, it'd be a wise move to spend more on below-the-line and through-the-line strategies. A key challenge is to form an environment where the consumer perceives a one-to-one relationship with the store; to optimize the shopper's time; to create it appear as if the ranging and categorization of products have been personalized only for them; and by giving attention to the current, retailers will deliver an experience the patron will want to repeat (Soars, 2003).

(Noad, 2008) further support the argument that a variety of studies have explored the impact of store entrances on consumer behaviour. The findings 38 indicate that store entrances are relevant to retailing, although there are differences in the levels of importance attached to varied retailing elements. Store entrances can improve a retail outlet's performance by causing the patron to undertake unplanned or impulse purchase buying intention before entering the shop. Efficient and well-planned store entrances can generate positive consumer behaviour towards the shop and this behaviour will be linked to increased levels of browsing and increased levels of consumer spending future.

According to (Lesley-Ann Wilson, 2004), this wave of shop refurbishment and expansion of store entrances illustrate the increasing managerial emphasis that's being placed on efficiency and effectiveness and operating the shops within the commercial approach. Retail attractions are increasingly struggling to supply the best value for money by generating revenue further by offering a service. Therefore, emphasis is put on store entrances as

they're becoming more important in retail operations. Viewing store entrances holistically becomes clear that they form a concerted effort to optimize the shop's performance despite the assorted drawbacks that will be encountered.

### **STORE ACCESSIBILITY**

The most important aspect with relevance to the situation of a store is that it should be highly accessible to the target market. The target market must be ready to visit the shop without making any special effort. The store's atmosphere determines, to a large extent, how consumers feel and behave in a very shop, and that they expect the identical atmosphere to try and do justice to the products or services which they intend to buying (**Terblanche, 1998**).

(Julie Baker, 2002) are of the opinion that for several shoppers one in all the key goals for shopping is convenience, which incorporates entering into and out of the shop quickly and finding the merchandise they seek easily. Layout, product assortment, and lighting are examples of designs that will influence customers' expectations of their efficient movement through a store. As clients' impression of store configuration become better, clients will see time/exertion expenses to be lower.

(Anne Findlay, 2008) maintain that to achieve success in retailers, one has to attract and retain consumer spend profitably. Consumers nearly always have the opportunity to alter their shopping behaviour. They survey and reconsider the shopping openings accessible to them. Accordingly, they will change their conduct by exchanging between stores or retailers. Consumer store-switching behaviour (defined as the change of the most buy a main shopping trip, e.g., food) is thus of fundamental importance to retailers. the flexibility to get change in behaviour and then to retain the "switched" customer may be a critical long-term success factor for retailers. Similarly, the power to scale back switching to rival retailers by valuable consumers will lead to a competitive advantage.

(Moye, 2002) report that consumer shopping orientations will be used to predict why consumers support certain stores. so as to successfully service consumers, retailers must identify their shopping needs and preferences. Evidence suggests that customers make patronage decisions supported store accessibility. Consumers evaluate stores while shopping and assess whether or not a selected retail store is predicated on their shopping orientation or experience with the shopping process. Consumers are likely to avoid places of business that don't present the specified retail store environment and seek a more congenial store to patronize. Store attributes like accessibility, location, and services influence consumer decisions to patronize or shop at particular retail stores.

### **RESEARCH METHODOLOGY**

The overall aim of the study is to investigate the impact of store layout on consumer mind at convenience stores in Kolhapur & few more areas in Maharashtra.

#### **Sample Size**

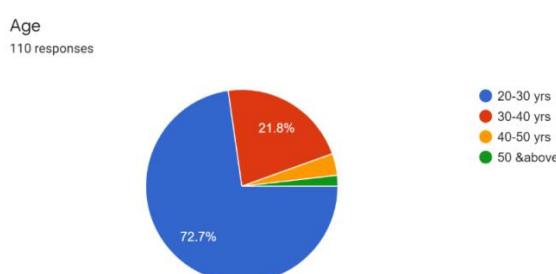
Sample size is defined as the number of elements to be included in a study. In this case the sample size was 110 respondents as they were considered to provide sufficient input to ascertain findings.

#### **Data**

The method of data collection was the survey method. Hawkins et al. (2007: 750) suggest that surveys are systematic ways of gathering information from a large number of people through the use of questionnaires. Therefore, personal interviews were done as well as collected some responses through the online sources whereby questionnaires were administered to the selected sample in order to extract detailed information on the topic and clarify complex questions (Hawkins et al., 2007). The structure of the questionnaire was kept simple and easy for the respondents to complete with closed-ended questions and Likert scale questions.

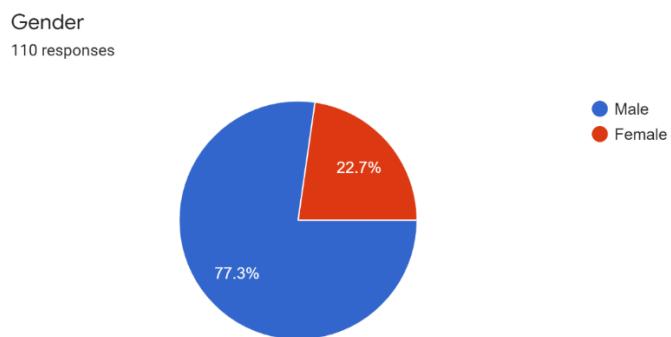
#### **The Analysis**

##### **Age of respondents**



According to Figure 4.1, 72.7% of the respondents were between the ages of 20 and 30, 21.8% of the respondents were between the ages of 30 and 40, 3.6% of the respondents were aged 40 and 50. 1.8% of the respondents were 50 years and above. Therefore, the majority (94.5%) of the shoppers are between 20-40 years (young and middle aged). Senior citizens constitute a small portion of shoppers at convenience stores. The present data analysis suggests that the age 20-40 group has an impact on convenience stores.

### **Gender of respondents**



From the selected sample, 77.3% were male and 22.7% were female respondents who participated in the study. The results reveal that men are the predominant shoppers.

### **Educational Level**

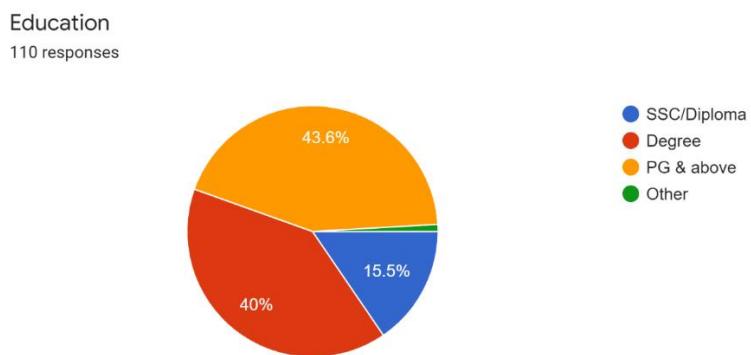


Figure 4.3 reveals that 15.5% of the respondents have SSC/Diploma, while 40% of respondents hold a degree and 43.6% of the respondents have PG & above, and .9% are Other. Therefore, the majority (83.6%) of the shoppers have Post Matriculation certificate and constitute a bigger portion of shoppers at convenience stores. This finding implies that educational levels have a major impact on shoppers of convenience stores' lifestyle patterns.

### **Frequency of shopping**



Figure 4.4 reflects that 53.6% of respondents indicated that they did their shopping once in a month, 25.5% of them did their shopping twice in a month and 20.9% did shopping thrice and more in a week. The results illustrate that a significant portion (46.4%) of respondents did shopping twice and more in a week. The results show consumers shop often.

Vrechopoulos et al. (2004) further contend that shopping is habitual to customers. Good floor layouts are extremely important because they strongly increase store visits, in-store traffic patterns, shopping atmosphere, shopping behaviour and operational efficiency. A well-designed store layout encourages shoppers to visit stores regularly and creates a shopping atmosphere that contributes towards shopping efficiency (Lewison, 1997). Therefore, the results tend to agree with the literature.

#### **Encountering problems with merchandise display in stores**

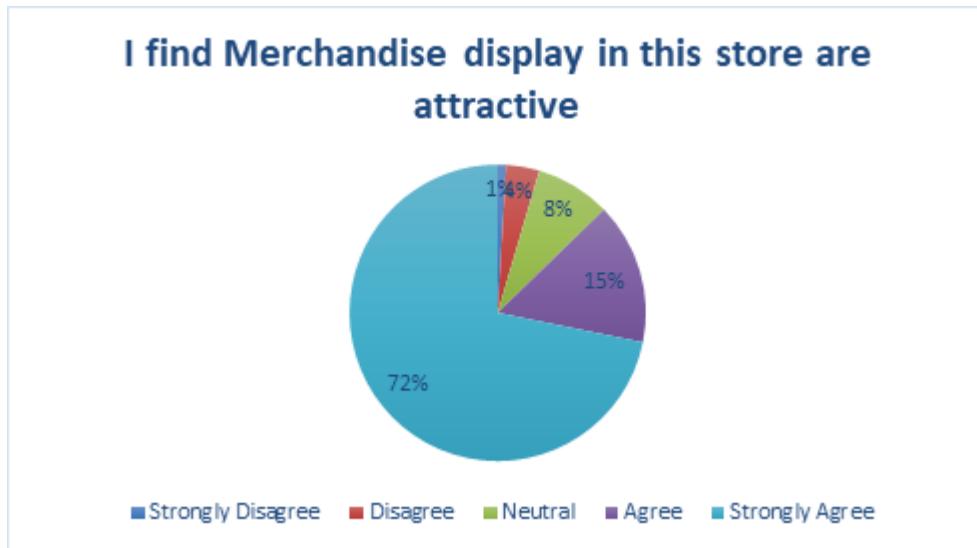


Figure 4.6 reflects that 1% of respondents from the convenience stores strongly disagreed that they encountered problems with merchandise display in stores, 4% disagreed, 8% were uncertain, 15% agreed and 72% strongly agreed. Therefore, the majority (87%) of the respondents Finds merchandise display Attractive in convenience stores. Therefore, it can be assumed that, since customers finds merchandise display attractive, patronage of convenience stores would be positively impacted. The results tie in with trends 71 observed by Paulins and Geistfeld (2003) that most convenience stores are perceived with respect to in-store displays and external appearance. Hence, the result concurs with the literature review and suggests that merchandise display in stores is an important factor in influencing shopping at convenience stores.

#### **Adequacy of the aisle width**

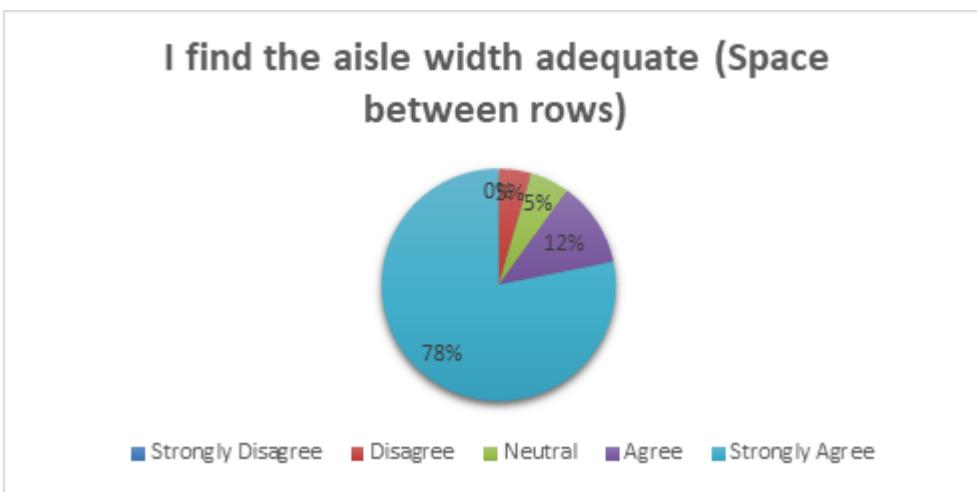
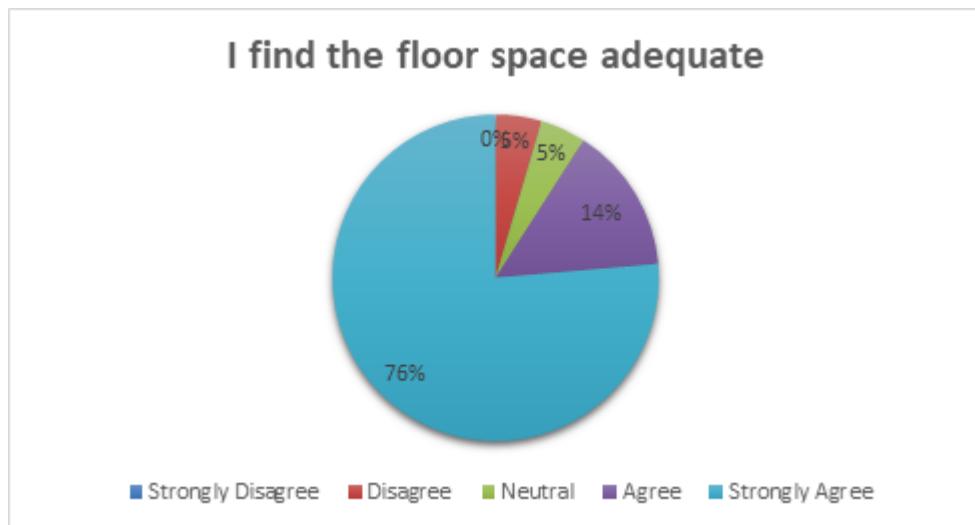


Figure 4.6 shows that 0% of respondents from the convenience store strongly disagreed that they found the aisle width in stores adequate, 5% disagreed, 5% were uncertain, 12% agreed, and 78 % strongly agreed. The results, therefore, indicate that 90% of the respondents find the aisle width at convenience store adequate. Therefore, the results may have an impact on store layout, design, traffic and merchandise display. Byron (2007) supports the

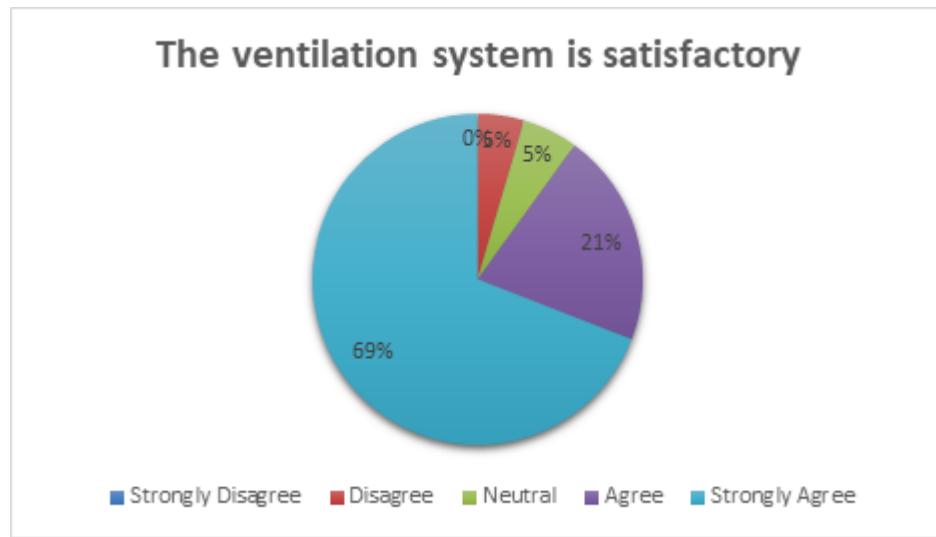
results by emphasizing that well-designed aisles help better understand consumer behaviour and make the testing of new products faster, more convenient and more precise. This finding is an indication that aisle width plays an important part in the customer shopping process.

#### Adequacy of the floor space



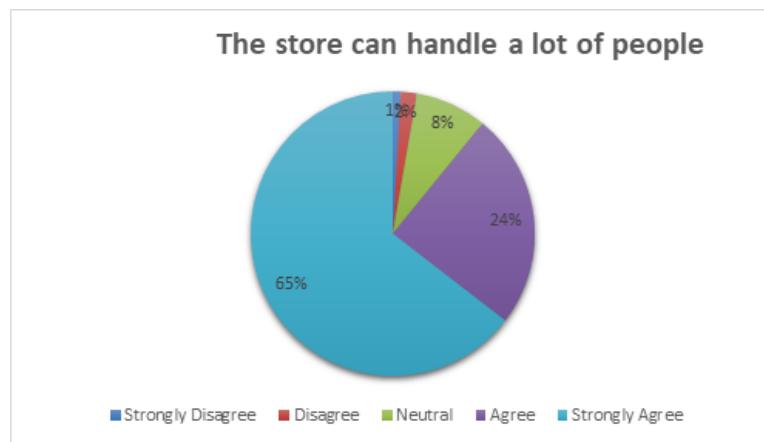
Illustrated by Figure 4.6, 0% of respondents from the convenience stores strongly disagreed that they found floor space adequate in convenience stores, 5% disagreed, 5 % were uncertain, 14% agreed, and 76% strongly agreed. The results, therefore, indicate that a significant portion (90%) of the respondents found the floor space of convenience stores adequate. As noted in the literature study, Floor Ideas (2008) substantiates that the look and feel of a store can actually influence the amount of time a customer spends browsing and even the urge to purchase. Floor space has been proven to directly affect moods, especially when it comes to shopping space, which will have a big impact due to the sheer surface area it covers. Therefore, it is suggested that floor space of convenience stores has an impact on store layout and design.

#### Level of satisfaction about store ventilation systems



Illustrated by Figure 4.9, 0% of respondents from convenience stores strongly disagreed that they were satisfied with the ventilation systems of convenience stores, 5% disagreed, 5% were uncertain, 21% agreed and 69% strongly agreed. From the results, it appears that most consumers (90%) were satisfied with the ventilation systems of convenience stores. Moreover, literature by Miranda *et al.* (2005) suggests that a number of store image studies concluded that store ventilation systems and service provided by the store contributed much to the customer's intention to return to the store. Pan *et al.* (2008) further contend that well-functioning air-conditioning and comfortable lighting may simply act as hygiene factors that are essential and motivate customer satisfaction. The overall results state that most of the respondents are satisfied with the store ventilation systems. Therefore, convenience stores satisfying the customer with efficient ventilation systems.

### Store crowd density



A total of 1% of the respondents strongly disagreed that convenience stores can handle a lot of people, while 2% of the respondents disagreed, 8% were uncertain, 24% agreed and 65% strongly agreed. The results, therefore suggest that 89 % of the respondents agreed that convenience stores could handle a crowd of shoppers. In acknowledgement of the results, Bennett (1998) claims that researchers in the retailing field have justified that customers consistently report great aversion of having to be crowded at supermarkets. Crucially, it has been claimed that longish waits and crowding impacts Positively on customer evaluations of an outlet's quality. Long queues and congestions affect negatively the customer's perceptions of punctuality, efficiency and reliability.

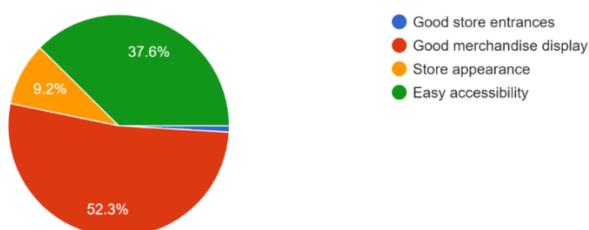
### Store is badly designed



Figure 4.17 reveals that 78% of the respondents strongly disagreed that convenience stores were badly designed, 12% of the respondents disagreed, 5% of the respondents were uncertain, 4% of the respondents agreed and 1% strongly agreed. The overall findings reflect that a significant portion (90%) of the respondents felt that convenience stores weren't badly designed. Therefore, store design has an impact on store patronage and layout.

### Best components of a good store layout

What do you consider as the best component of a good store layout?  
109 responses



With regard to the best components of a good store layout, 0.9% of the respondents regarded good store entrances as one of the best components, 52.3% perceived good merchandise display to be the best component, while store appearance accounted for 9.2% and easy accessibility accounted for 37.6%. Good merchandise display was the preferred component of a good store layout.

## **CONCLUSION**

Shoppers find Product assortment as well as aisle width (space between rows) adequate. Most of shoppers find merchandise display attractive in stores; Adequate floor space; and Convenience stores do provide appropriate lighting.

The objective of the examination was to research the effect of store design on purchaser buying conduct at odds and ends shops. As indicated by the fundamental issue and sub-issues that emerged, the examination plan and section layout was set up.

The review was quantitative in nature as 110 polls were utilized to remove data from the respondents. From the outcomes, it is noticed that there are significant parts of store design that corner shops should set up to give further developed client support and fulfilment.

## **RECOMMENDATIONS**

### **Floor space**

It is suggested that odds and ends shops at Kolhapur keep up with their floor space, as Findings show that general stores at Kolhapur have sufficient floor space. (Griffith, 2005) additionally proves that floor space is a basic factor driving customer elaboration and reaction in retailing. The floor space of a retail location has been found to essentially affect a retailer's general presentation through its effect on data preparing, buy aims, disposition toward the retail foundation. Retailer's floor space brings about more noteworthy buyer elaboration and more certain shopper results

### **Store traffic flow and crowd density**

Further developing traffic stream is likewise fundamental at corner shops in Kolhapur as a large portion of the respondents didn't say anything negative with regards to swarm thickness and insufficient store traffic stream. Consequently, measures and typologies to try not to swarm must be created (Dion, 2004).

### **Store ventilation system**

From the outcomes, apparently a portion of the purchasers are not happy with the ventilation frameworks of odds and ends shops in Kolhapur. There is, in this manner, a requirement for ventilation for the indoor climate for retail plan, and to further develop shopping conditions (Olesen, 2006).

### **Store entrances**

Findings reflects that a large portion of the respondents favoured one grand appearance filling in as both passageway and leave focuses, or one separate passage and one separate leave point. It is, thusly, suggested by (Moerloose, 2005) that retailing can be executed effectively with up to three simple to-utilize passages to the store taking into account worked on in-store traffic stream. In the retail area, usability with straightforward store doorways and welcoming appearance are positive factors that advance commitment from purchasers.

### **Aisle and décor**

In the current layout, as clients are prepared to pay for their things and leave the store, they are at present holding up in lines and go through squeezed look at paths. Another improvement is to in make space in and around these looks at paths. This will assist with diminishing one more blocked space of the store. There is additionally a requirement for a general improvement in stylistic theme as corner shops need more added appeal to urge purchasers to return (Aghazadeh, 2005)

This study has highlighted the impact of store layout and purchasing behaviours of consumers at convenience stores in Kolhapur. Issues relating to store layout and purchasing behaviour were discussed. It is believed that the importance of store layout is at an all-time high in major convenience stores. In today's volatile economy, providing 118 excellent store layouts can be the critical difference in any company's success. With ever-changing store layouts in the retail industry, retailers face the ongoing challenge of gaining competitive advantage from creating added customer value. In order to accomplish this value, retailers have to constantly review their store layout strategies. The empirical data used during this study were based on questionnaires that were administered amongst customers

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**MOTIVATIONAL FACTORS IN BANCASSURANCE – A STUDY OF CANARA BANK IN CHIKKAMAGALURU DISTRICT**

**NIKKI KUMARI AND DR. GIRIDHAR K.V.**

### **ABSTRACT**

*The expansion of banking activities to insurance sector has created new window along with the existing ones mainly concentrated with deposit mobilisation and lending process. With the existing customer's database, Bancassurance not only turned out to be economy but also provided an opportunity to explore the untapped and uninsured population. Further, with the trust of the bank customer on the bank as reliable financial provider initiated banks to go with bancassurance as the result of which bank were equipped with parallel income along with traditional banking services. On the other hand, professionalism of the staff, customer acquaintance, infrastructure and network/ geographical were the major motivational factors initiating banks to go with bancassurance. In this context, the present paper focuses in studying bank employees' perception in adoption and implementation of bancassurance.*

### **INTRODUCTION**

Gone are the days where banks concentrated on deposit mobilization, savings and lending activities. Today, banks have expanded their activities to insurance sector also. This is mainly due to integration of banking services with other financial activities, innovative technologies in banking operations and swift of banks from traditional banking functions to non-banking activities. On the other hand, the necessity of insurance companies to create wide spread awareness among the consumers and enable consumers to access insurance products at competitive price demanded insurance companies to open up with new products. It was at this situation, banking sector with wide reach was thought to be more effective distributional channel for insurance companies wherein the union of banking sector and insurance sector gave birth to Bancassurance.

#### **Bancassurance – Global Scenario**

Bancassurance which benefits bank to earn additional income by selling insurance products on one hand and insurance companies increasing their market share resulting in expansion of their customer base is gaining momentum all over the world. As such, on geographical base, Europe commands foremost position in bancassurance market due to its favourable tax structure where countries like Luxembourg, Russia and Slovenia provides potential markets for bancassurance. The estimated bancassurance global growth rate in between 2013 and 2017 stood at 5.29 percent per annum which is expected to record still higher growth rate in future. However, in 2018, total amount of global bancassurance market touched US\$ 1166 billion and further estimated to reach US\$ 1665 billion by 2024. It is expected to record compound annual growth rate of 6.1 percent per annum for the period between 2019 and 2024.

#### **Bancassurance – Indian Scenario**

Bancassurance though is a new concept in India but is recording faster growth rate. Under bancassurance, life products are being more prominent when compared to non-life products. However, banks in India with client base near to 100 million have turned out to be an ideal channel to take bancassurance forward very successfully. Bancassurance in India was initiated in the year 2000 and got greater recognition after passing of Corporate Agencies by Insurance Regulatory and Development Authority in 2002. In India SBI Life Insurance Co being the biggest player is associated with ICICI-Prudential Life and ICICI Lombard General Insurance, HDFC Standard Life and HDFC Ergo General Insurance and many more.

#### **REVIEW OF LITERATURE**

The study conducted by Mahesh Kumar and Ramakrishna (2014) reveals the strategy and challenges of Indian bancassurance. The study showed that banks can have sustainable income through bancassurance as banks have vast geographical network and customer database with it. On the other hand with insurance penetration at lower level, banks can easily tap the untapped and uninsured customers within it. Puneeth Bhushan and Mohd Abbas Murtaza (2014) identified that through bancassurance banks can diversify their products and get additional income, insurance companies can increase their market penetration by entering banking sector and reap the benefit of the trust the bank has gained by its customers and customers can access quality product at reduced price with expertise guidance. Tripti M. Gujral (2015) while studying the impact of bancassurance on Indian banking sector stated that bancassurance is an insurance product distributed through banking channel after convergence with insurance company. The author studied the impact of bancassurance in terms of additional fee

income and sustainable income to banks, higher market penetration to insurance company and availability of wide range of products to customers under single roof.

The work of Bhavan Sharma and Ruchika Bhateja (2016) examined the scope of bancassurance in Indian banking sector and insurance sector and showed that insurance companies are to use banking network to penetrate market through bancassurance. The study suggested for the development of customer centric approach to align both banker as well as insurers. Further, the study suggested managers of insurance companies to establish synergic relationship with banking companies as banking sector in India has deep root in urban as well as in rural areas where insurance companies can use the infrastructure of banking sector to reach the untapped and uninsured population in the customer database. Muthumari A. and Pushpavani K. (2017) in their study of customer service loyalty towards bancassurance noted that bancassurance is a tool to deepen market penetration as well as premium turnover. The study showed that customers feel that banks were supposed to resolve the problem and also to update the services in providing bancassurance. The study suggested for the development in bancassurance services through adoption of new technologies, banks to be accurate, reliable and also helpful in gaining customer's confidence leading to better connectivity of customers with the banks enabling banks to take up faster and more convenient customer services. The research article by Elda Marzai (2018) revealed that the adoption of bancassurance as a new product has not only strengthened the competitive environment but also has satisfied the consumer's requirements. The study noted that the trust of the customers on bank as a financial institution is more responsible for sustainability of bancassurance. Further, the study showed that bancassurance was the new way to get connected with the customers, build relationship with them and promote a range of new products with no geographic agents. Deepalakshmi M. and Kavya K. (2019) highlighting the rapid growth of banking sector and insurance industries in the current economic scenario noted that the application of new technologies and banks entering into non-banking activities like insurance sector opened new channels in the area of distribution. In their study the authors making an attempt to study the awareness level with regard to bancassurance revealed the motivating factors to adopt bancassurance.

Hence, though there are studies been done on bancassurance with different objectives, but none of the earlier studies been done on the title, objectives and scope of the present study, therefore, it's an effort to fill the existing gap in the study.

## **OBJECTIVES**

- 1) To study bank employees perception in adoption and implementation of bancassurance,
- 2) To study motivational factors for inclusion of bancassurance by banks

## **HYPOTHESES**

$H_1 \text{ } 0$ : Age insignificantly influences bank employee's perception in adoption and implementation of bancassurance

$H_1 \text{ } a$ : Age significantly influences bank employee's perception in adoption and implementation of bancassurance

$H_2 \text{ } 0$ : There is insignificant difference in perception among the employees regarding motivational factors for inclusion of bancassurance by banks

$H_2 \text{ } a$ : There is significant difference in perception among the employees regarding motivational factors for inclusion of bancassurance by banks

## **METHODOLOGY**

The present study considers primary data to study the framed objectives. As such, 50 respondents were randomly selected from Canara Bank operating in Chikmagaluru district. Further, through structured questionnaire was used to collect the necessary primary data. The collected data were classified and tabulated. In order to identify most influential and least influential factors in implementation and adoption of bancassurance, Garrett's ranking technique was employed in

## **RESULTS AND DISCUSSION**

Bancassurance being a new concept both to the banking sector as well as bank customers is subjected to various factors in the course of its adoption and implementation. However, it is observed that there exist high and least influential factors in adoption and implementation of bancassurance.

**Table - 1: Garrett's ranking regarding Bank employee's perception regarding adoption and implementation of bancassurance**

<b>Particulars</b>	<b>Actual Observation</b>					<b>Garrett's Ranking</b>		
	<b>SD</b>	<b>D</b>	<b>UD</b>	<b>A</b>	<b>SA</b>	<b>Total Score</b>	<b>Mean Score</b>	<b>Rank</b>
Existence of customer data base reduces competition	3	5	4	11	27	3180	63.10	1
Bancassurance provides opportunity to explore untapped and uninsured population	2	4	7	19	18	3050	61.00	3
Awareness associated with demand for insurance among bank customers	1	3	5	25	16	3095	61.90	2
Possibility of providing better range of financial services through bancassurance	6	4	8	20	12	2810	56.20	4
Bancassurance reduces the risk of margin decline on traditional banking products	9	12	6	16	7	2490	49.80	5

Source: Survey Data

Note: SD- Strongly Disagree, D-Disagree, UD-Uncertain, A-Agree, SA-Strongly Agree

The existing customer's data base with the banks creates better opportunity to explore the untapped customers with the increasing demand for insurance. At the outset, majority of the respondents either strongly agree or agree with major factors presented in Table 1, but the Garrett's ranking exhibits that the existing customer data base helped the bank to overcome the completion and the awareness about insurance among bank customers along with the demand for insurance were the most benefiting factors in the course of adoption and implementation of bancassurance as these two factors acquired highest mean score with top two ranks. Further, majority of the respondents kept neutral with the factor that the existing customer data base will provide an opportunity to touch the untapped and uninsured bank customers. On the other hand, majority of them opinion that using bancassurance as hedging tool against decline on traditional banking products and bank can provide better range of financial services through bancassurance were the least influential factors to adopt and implement bancassurance.

With the mixed opinion of the respondents regarding customer database as motivational factor to adopt and implement bancassurance, the Garrett's ranking shows that trust on the bank as reliable financial provider highly motivated banks to adopt and implement bancassurance which is followed by financial position and financial requirement of customers helping in designing customised products.

**Table - 2: Garrett's ranking regarding Customers Database as motivational factors for Bancassurance**

<b>Motivational Factor</b>	<b>Actual Observation</b>					<b>Garrett's Ranking</b>		
	<b>SD</b>	<b>D</b>	<b>UD</b>	<b>A</b>	<b>SA</b>	<b>Total Score</b>	<b>Mean Score</b>	<b>Rank</b>
Trust on the bank as reliable financial provider	4	7	2	9	28	3120	62.40	1
Large data base make insurance inclusion easier	2	10	13	8	17	2855	57.10	3
Bank's service motive create trust in the customers mind	3	5	12	19	11	2840	56.80	4
Financial position and financial requirement of customers helps to design customized products	4	6	7	18	15	2895	57.90	2

Source: Survey Data

Further, bank employees don't believe that the existence of large data base will be the motivational factor which makes insurance inclusion easier. However, bank's service motive creating trust in the customers mind turned out to be least motivating factor in adoption and implementation of bancassurance.

**Table - 3: Garrett's ranking regarding Professionalism of the Staff as a motivational factor for Bancassurance**

<b>Motivational Factor</b>	<b>Actual Observation</b>					<b>Garrett's Ranking</b>		
	<b>SD</b>	<b>D</b>	<b>UD</b>	<b>A</b>	<b>SA</b>	<b>Total Score</b>	<b>Mean Score</b>	<b>Rank</b>
Bank staff as an effective financial advisor	6	12	8	11	13	2665	53.30	1
Knowledge of financial requirements of the customers by the staff	11	7	9	7	16	2625	52.50	3
Adequate well trained	4	14	13	10	9	2568	51.71	4
Familiarity with financial terms by the staff leads to smooth implementation	7	11	6	15	11	2640	52.80	2

Survey Data

Professionalism of the staff could be motivational factor if the image of the staff is turned out to be as effective financial advisor. In other words, when bank staffs have adequate awareness and information with regard to bancassurance products on one hand and on the other hand effective communicative skill to convenience bank customers, then that would be the motivational factor in adoption and implementation of bancassurance. Further, bank staffs very familiar with financial terms will be another motivational factor in implementing bancassurance. However, it is felt by the respondents that separate training facility could not motivational factor in implementing bancassurance as bank staff are well trained in handling and proving financial services. Likewise, awareness about financial requirement of customers by bank staff has very less role to play as motivational factor in implementing bancassurance when compared to other factors.

**Table 4: Garrett's ranking regarding Customers Acquaintance Factors as motivational factors for Bancassurance inclusion in Bank**

<b>Motivational Factor</b>	<b>Actual Observation</b>					<b>Garrett's Ranking</b>		
	<b>SD</b>	<b>D</b>	<b>UD</b>	<b>A</b>	<b>SA</b>	<b>Total Score</b>	<b>Mean Score</b>	<b>Rank</b>
Face to face contact with customers	2	8	3	14	23	3093	61.73	1
Strong understanding with customers	6	14	6	14	10	2600	52.00	4
Personalized services to customers	7	9	4	13	17	2790	55.80	2
Extensive follow-up with customers	10	8	7	12	13	2589	52.14	3

Survey Data

In the process of implementation of bancassurance, customer's acquaintance is also equally important as they are the end users. In this regard, bank employees feel that face to face contact would be the most influential motivational factor in implementing bancassurance followed by personalized to the customers. However, extensive follow-up with the customers and strong understanding with customers are felt as least motivational factor in implementation.

With regard to infrastructural facility as motivational factor in adoption and implementation of bancassurance, the study showed that minimum additional capital requirement is needed to adopt and implement bancassurance as banks are well established with sufficient infrastructural facilities.

**Table 5: Garrett's ranking regarding Infrastructural Factor as a motivational factor for Bancassurance inclusion in Bank**

<b>Motivational Factor</b>	<b>Actual Observation</b>					<b>Garrett's Ranking</b>		
	<b>SD</b>	<b>D</b>	<b>UD</b>	<b>A</b>	<b>SA</b>	<b>Total Score</b>	<b>Mean Score</b>	<b>Rank</b>
Minimum additional capital requirement	5	8	4	11	22	2955	59.10	1
Insurance fee income as parallel income	11	15	7	8	9	2380	47.60	4
One stop shopping for banking and insurance	9	12	9	15	5	2430	48.60	3
Existing processing capabilities makes bancassurance implementation less complicate	7	9	6	17	11	2680	53.60	2

Survey Data

Further, the existing processing capabilities make bancassurance implementation less complicated. As such, these two factors are considered as most influential infrastructural factors in implementing bancassurance. On the other hand, bank employees opinion that implementation of bancassurance would not insurance fee income could not be felt as effective parallel income. They also don't feel that one stop shopping for banking and insurance might motivate them to adopt and implement bancassurance. Hence, these two infrastructural factors are found to be least motivation in adoption and implementation of bancassurance.

**Table 6: Garrett's ranking regarding Network /Geographical Factor as a motivational factor for Bancassurance**

<b>Motivational Factor</b>	<b>Actual Observation</b>					<b>Garrett's Ranking</b>		
	<b>SD</b>	<b>D</b>	<b>UD</b>	<b>A</b>	<b>SA</b>	<b>Total Score</b>	<b>Mean Score</b>	<b>Rank</b>
Banks equipped with multiple communication channel	5	9	7	13	16	2823	56.28	1
Banks utilizing multiple promotional tool	7	15	8	9	11	2540	50.80	3
Vast geographical area coverage enables bank to tap middle and lower income groups	2	20	13	8	7	2505	50.10	4
Computerization of bank makes insurance promotion easier	7	12	9	10	12	2571	51.89	2

Survey Data

When Geographical network is taken into consideration as motivational factor to adopt and implement bancassurance, it is evident that banks equipped with multiple communication channel and computerization of bank making insurance promotion easier are the most influential geographical factors in motivating the adoption and implementation of bancassurance, while banks utilizing multiple promotional tools and vast geographical area coverage enabling bank to tap middle and lower income groups are least geographical factors in motivating the adoption and implementation of bancassurance.

#### Testing of Hypotheses

$H_1$  : Age insignificantly influences bank employee's perception in adoption and implementation of bancassurance

$H_{1a}$  : Age significantly influences bank employee's perception in adoption and implementation of bancassurance

#### ANOVA Table regarding Age influencing bank employee's perception in adoption and implementation of bancassurance

<b>Particulars</b>	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>	<b>Sig.</b>
<b>Existence of customer data base reduces competition</b>					
Between Groups	18.313	20	.916	.429	.973
Within Groups	61.867	29	2.133		
Total	80.180	49			
<b>Bancassurance provides opportunity to explore untapped and uninsured population</b>					
Between Groups	18.503	20	.925	.581	.895
Within Groups	46.217	29	1.594		
Total	64.720	49			
<b>Awareness associated with demand for insurance among bank customers</b>					
Between Groups	24.703	20	1.235	.634	.854
Within Groups	56.517	29	1.949		
Total	81.220	49			
<b>Possibility of providing better range of financial services through bancassurance</b>					
Between Groups	32.303	20	1.615	1.560	.134
Within Groups	30.017	29	1.035		
Total	62.320	49			
<b>Bancassurance reduces the risk of margin decline on traditional banking products</b>					
Between Groups	36.067	20	1.803	.838	.655

Within Groups	62.433	29	2.153		
Total	98.500	49			

**Interpretation:**

At 5 percent level of significance for variation  $V_1 = 20$  and  $V_2 = 29$ , the table value of  $F = 1.90$ , while for the factors regarding Existence of customer data base reduces competition, Bancassurance provides opportunity to explore untapped and uninsured population, Awareness associated with demand for insurance among bank customers , Possibility of providing better range of financial services through bancassurance and Bancassurance reduces the risk of margin decline on traditional banking products the calculated value of  $F$  is 0.429, 0.581, 0.634, 1.560 and 0.838 respectively. As the calculated value of  $f$  for all the factors is less than the table value of  $f$  null hypothesis is accepted and concluded that age insignificantly influence bank employee's perception in adoption and implementation of bancassurance.

$H_2 0$ : There is insignificant difference in perception among the employees regarding motivational factors for inclusion of bancassurance by banks

$H_2 a$ : There is significant difference in perception among the employees regarding motivational factors for inclusion of bancassurance by banks

**Chi-Square Value for perception among the employees regarding motivational factors for inclusion of bancassurance by banks**

Motivational Factor	$\chi^2$ Value
<b>Customer Database</b>	
Trust on the bank as reliable financial provider	43.4
Large data base make insurance inclusion easier	12.6
Bank's service motive create trust in the customers mind	16
Financial position and financial requirement of customers helps to design customized products	15
<b>Professionalism of the Staff</b>	
Bank staff as an effective financial advisor	3.4
Knowledge of financial requirements of the customers by the staff	5.6
Adequate well trained	6.2
Familiarity with financial terms by the staff leads to smooth implementation	5.2
<b>Customers Acquaintance</b>	
Face to face contact with customers	30.2
Strong understanding with customers	6.4
Personalized services to customers	10.4
Extensive follow-up with customers	2.6
<b>Infrastructural Factor</b>	
Minimum additional capital requirement	21
Insurance fee income as parallel income	4
One stop shopping for banking and insurance	5.6
Existing processing capabilities makes bancassurance implementation less complicate	7.6
<b>Network /Geographical Factor</b>	
Banks equipped with multiple communication channel	8

Banks utilizing multiple promotional tool	4
Vast geographical area coverage enables bank to tap middle and lower income groups	18.6
Computerization of bank makes insurance promotion easier	1.8

**Interpretation**

At 5 percent level of significance for degree of freedom 4 the table value of  $X^2 = 9.488$ . The calculated value of  $X^2$  for all factors under Customer Database, Face to face with customer and Personalized service to customer under Customer Acquaintance, Minimum additional capital requirement under Infrastructure and Vast geographical area coverage enables bank to tap middle and lower income groups under Network/ geographical factor is found to be greater than the table value. Hence, for these factors it can be concluded that there exist significant difference in perception among the employees regarding motivational factors for inclusion of bancassurance by banks, while in other factors it is insignificant.

**CONCLUSION**

Bancassurance which is a new concept in financial services sector uses bank's distributional channels to market insurance products. Bancassurance which enabled the selling of insurance products through banking network exploited synergies of both banks as well as insurance companies. The effective implementation of Bancassurance can change the situation of both banks and insurance along with the customers also wherein banks can generate additional and long term risk free income, while insurance companies can expand their market and sell their products at low cost and the customers can avail both banking facilities and insurance requirement at one stop. In India, banks equipped with huge network and culturally more acceptable than insurance companies across the country can definitely play significant role in the insurance market under the banner bancassurance.

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**CAUSE AND EFFECT MODELING OF PROFITABILITY WITH SPECIAL REFERENCE TO  
STEEL AUTHORITY OF INDIA LIMITED & TATA STEEL LIMITED****MONIKA VARSHNEY AND DR S K AGARWAL****ABSTRACT**

A company is required to have good profitability, market share and sustainable competitive advantage for its growth and survival. In this paper, an endeavor has been made to establish cause and effect relationship among variables of profitability with special reference to Steel Authority of India Limited and Tata Steel Limited has been made in this paper covering a period of 14 years from 2005-06 to 2018-19. The study is based on secondary data compiled from annual reports of SAIL and TATA Steel analyzed with the help of statistical techniques; viz. Multiple Correlation, Multiple Regression, 'F' ratio & 'T' test so as to make accurate predictor of profitability.

*Keywords:* Profitability, Rate of Return, Return on Assets

**INTRODUCTION**

Profitability is *sine-qua-non* for the survival and growth of the Company. Yet profits should be taken keeping social welfare in mind. Indeed, sufficient profits should be earned to sustain the operations, expansion and growth and to contribute towards the social overheads for the welfare of the society.

The profitability ratios are calculated to measure the overall efficiency of the company. All the stakeholders including management of the company, creditors and owners are interested in the profitability. As out of this, creditors get interest and repayment on the principal amount timely, Owners get a required rate of return on their investments. All these are met only when the company earns sufficient profits.

Steel Authority of India Limited (SAIL) is the largest public sector, producer of steel in India and it owns five Integrated Steel Plants at Bhilai, Durgapur, Bokaro, Rourkela and Burnpur & three Special Steel Plants at Salem, Durgapur and Bhadravati and produced Hot Metal of 17.5 MT, Crude Steel of 16.3 MT, Saleable Steel of 15.1 MT, 28.35 million tons of iron ore and continuous Cast (CC) Steel production of 13.8 MT using 72,339 manpower as on 31.03. 2019. Tata Steel Limited (Tata Steel) is the largest private sector with 37 Steel Processing Centres, few of them located at Jamshedpur, Kalinganagar, Chennai, Kolkata, Faridabad, Manesar, Pune, Mumbai, Indore, Delhi and Nagpur and has manufacturing produced 14.24 MT of Hot metal and 13.23 MT of Crude Steel with 32,984 employees enrolled in India as on 31.03.2019.

Besides the above introductory note, this paper has three other parts. Part two defines the conceptual framework regarding variables of the profitability. Part three presents results for profitability. Part four summarizes main empirical conclusion. The main purpose of this paper is to make econometric models for better accuracy in prediction. The hypothesis to be tested is that overall profitability in the form of Rate of Return depends upon Pre Tax Profit and Capital Employed.

**II CONCEPTUAL FRAMEWORK**

Profitability has been measured in terms of Gross Profit Ratio, Net Profit Ratio, Pre Tax Rate of Return, Post Tax Rate of Return and Return on Assets. As a matter of fact, overall efficiency is measured with the help of Rate of Return wherein Pre Tax Rate of Return as dependent variable and Pre Tax Profit and Capital Employed as independent variables are taken into account. As regards, Pre Tax Profit, it consists of trading profit plus dividends, interest received and other profits less depreciation. An alternative definition of profitability which has also been employed in the interest of owners of the company is Post Tax Rate of Return on Capital Employed.

As regards, Capital Employed, it implies value of equity shares plus reserves attributable to them plus interest of minority holders in subsidiary companies plus long term liabilities. Alternatively, it can be derived by taking total assets and deducting current liabilities and provisions. In a nutshell, Net Fixed Assets plus Net Current Assets make Capital Employed or Net Assets.

**III RESULTS**

As Regression Analysis is the most scientific method and provides best, linear and unbiased estimates hence this technique has been widely used as follows:

**(i) Gross Profit Ratio**

Gross Profit ratio reflects the efficiency with which the management produces each unit of product. This ratio requires Gross Profit as numerator and sales as denominator. Cause and effect modeling has been made with the help of Multiple 'R', 'R<sup>2</sup>', Multiple Regression, 'F' ratio & 'T' test taking 'Y' as an dependent variable and 'X<sub>1</sub>' and 'X<sub>2</sub>' as an independent variables and shown in Table 1.1 & 1.2 respectively in case of SAIL and Tata Steel.

**Table No 1.1 GROSS PROFIT (X<sub>1</sub>), SALES (X<sub>2</sub>) AND GROSS PROFIT RATIO (Y) OF SAIL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In times)
2005-06	9,826.5	32,554.7	0.30
2006-07	12,681.1	39,236.8	0.32
2007-08	14,544.9	45,662.0	0.32
2008-09	12,812.0	48,824.4	0.26
2009-10	13,247.1	44,001.7	0.30
2010-11	16,428.3	47,842.9	0.34
2011-12	16,218.0	51,431.6	0.32
2012-13	16,267.8	50,429.9	0.32
2013-14	16,361.5	52,718.7	0.31
2014-15	18,273.6	51,473.2	0.36
2015-16	11,646.4	43,932.7	0.27
2016-17	14,259.2	49,829.0	0.29
2017-18	20,817.4	58,966.2	0.35
2018-19	28,437.7	66,973.6	0.42

**(Source:** Computed with the help of Statistics compiled from various issues of annual report of SAIL)

**Results (SAIL)**

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.3218373+0.00000173X<sub>1</sub>-0.0000056X<sub>2</sub>

Where Y= Gross Profit Ratio, X1=Gross Profit, X2=Sales

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.32	15844.39	48848.37
Multiple R	0.98898	Adjusted R sqr	0.97410

**ANALYSIS OF VARIANCE**

	DF	Sum of Squares	Mean Square
Regression	2	0.02162	0.01081
Residual	11	0.00048	0.00004
F =	245.4571	Signif F =	0.000000001

**VARIABLES IN THE EQUATION**

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	1.952E-05	1.236E-06	1.680E-05	2.224E-05	15.7942	6.6E-09
X2	-1.142E-05	5.538E-07	-1.264E-05	-1.020E-05	-20.6247	3.8E-10
(Constant)	0.59033	0.01829	0.55009	0.63058	32.2849	3.0E-12

**Table No 1.2 GROSS PROFIT ( $X_1$ ), SALES ( $X_2$ ) AND GROSS PROFIT RATIO (Y) OF TATA STEEL**

YEAR	$X_1$ (Rs. In Crore)	$X_2$ (Rs. In Crore)	Y (In times)
2005-06	9,448.5	22,272.1	0.42
2006-07	14,156.0	27,437.3	0.52
2007-08	54,405.4	134,086.8	0.41
2008-09	56,416.6	149,984.9	0.38
2009-10	41,802.9	104,229.8	0.40
2010-11	49,629.9	121,345.8	0.41
2011-12	49,926.0	135,975.6	0.37
2012-13	55,263.3	138,821.1	0.40
2013-14	65,573.6	153,212.8	0.43
2014-15	62,428.7	144,298.4	0.43
2015-16	48,130.8	106,339.9	0.45
2016-17	60,862.8	117,419.9	0.52
2017-18	60,903.5	124,109.7	0.49
2018-19	78,129.8	157,669.0	0.50

(Source: Computed with the help of Statistics compiled from various issues of annual report of Tata Steel)

### Results (Tata Steel)

Regression Equation of Y on  $X_1$  &  $X_2$

The Required equation  $Y = 0.4641124 + 0.0000076X_1 - 0.0000035X_2$

Where Y= Gross Profit Ratio,  $X_1$ =Gross Profit,  $X_2$ =Sales

	Y	$X_1$	$X_2$
Mean	0.44	50505.55	116943.08
Multiple R	0.94929	Adjusted R sqr	0.88317

### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.02957	0.01478
Residual	11	0.00324	0.00029
F =	50.1383	Signif F =	0.000002968

### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	7.61186E-06	7.98724E-07	5.85388E-06	9.36984E-06	9.530030117	1.2E-06
X2	-3.521E-06	3.516E-07	-4.295E-06	-2.747E-06	-10.0129	7.3E-07
(Constant)	4.641E-01	1.401E-02	4.333E-01	4.949E-01	33.1277	2.3E-12

### Conclusions

Table 1.1 & 1.2 respectively infer that Gross Profit ratio on an average being 32 percent in case of SAIL is less than that of 44 percent in case of Tata Steel. Respective multiple R being 0.98898 and 0.94929 shows high degree of positive correlation among the variables for SAIL and Tata Steel.

The regression coefficient for independent variable Gross profit indicates positive relationship with the dependent variable, i.e., Gross Profit Ratio. It implies that with the rise of Re. 1 in Gross Profit when Sales are kept constant, will lead to an increase of 0.0000173 times in Gross Profit Ratio of SAIL; whereas it will result in an increase of 0.0000076 times in case of Tata Steel. The regression coefficient for independent variable

Sales indicates negative relationship with its dependent variable, i.e., Gross Profit Ratio. It implies that with the rise of Re. 1 in Sales when Gross Profit is kept constant, will lead to a decrease of 0.0000056 times in Gross Profit Ratio of SAIL; whereas it will result in a decrease of 0.0000035 times in case of Tata Steel.

Adjusted R<sup>2</sup> indicates that 97.410 percent of change in Gross Profit Ratio of SAIL is observed due to the independent factors; while this is 88.317 percent in case of Tata Steel. Standard Error of Regression Coefficients being very low testifies that there exists really a line of estimates among the variables.

Computed ‘t’ value in case of all variables with respect to SAIL and Tata Steel are greater than the tabulated values at a significance level as displayed against the values of ‘t’, which are statistically significant and testify that the linear relationship definitely exists.

At 2 & 11 degree of freedom respectively, ‘F’ ratio is greater than the table value of ‘F’ at a given level of significance as shown in the respective tables. Thus, the null hypothesis ‘the Regression is not significant’ cannot be accepted.

#### **(ii) Net Profit Ratio**

Net Profit Ratio measures the efficiency of the management in manufacturing, selling, administrative and other activities in an organization. This ratio requires Net Profit as numerator and sales as denominator. Cause and effect modeling has been made with the help of Multiple ‘R’, ‘R<sup>2</sup>’, Multiple Regression, ‘F’ ratio & ‘T’ test taking ‘Y’ as an dependent variable and ‘X<sub>1</sub>’ and ‘X<sub>2</sub>’ as an independent variables and shown in Table 1.3 & 1.4 respectively in case of SAIL and Tata Steel.

**Table No 1.3: NET PROFIT (X<sub>1</sub>), SALES (X<sub>2</sub>) AND NET PROFIT RATIO (Y) OF SAIL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	3,590.5	32,554.7	0.11
2006-07	5,703.3	39,236.8	0.15
2007-08	7,121.5	45,662.0	0.16
2008-09	5,757.2	48,824.4	0.12
2009-10	6,224.3	44,001.7	0.14
2010-11	3,876.7	47,842.9	0.08
2011-12	3,746.6	51,431.6	0.07
2012-13	1,850.9	50,429.9	0.04
2013-14	941.5	52,718.7	0.02
2014-15	1,297.1	51,473.2	0.03
2015-16	-4,705.5	43,932.7	-0.11
2016-17	-2,988.9	49,829.0	-0.06
2017-18	-723.0	58,966.2	-0.01
2018-19	2,410.9	66,973.6	0.04

**(Source:** Computed with the help of Statistics compiled from various issues of annual report of SAIL)

#### **Results (SAIL)**

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.0596838+0.0000217X<sub>1</sub>-0.0000012X<sub>2</sub>

Where Y= Net Profit Ratio, X1=Net Profit, X2=Sales

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.05	2435.93	48848.37
Multiple R	0.99522	Adjusted R sqr	0.98874

#### **ANALYSIS OF VARIANCE**

	DF	Sum of Squares	Mean Square
Regression	2	0.08006	0.04003
Residual	11	0.00077	0.00007
F =	571.6684	Signif F =	0.00000000001

**VARIABLES IN  
THE EQUATION**

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	2.1676E-05	6.89272E-07	2.0159E-05	2.31931E-05	31.44773835	3.99184E-12
X2	-1.190E-06	2.916E-07	-1.831E-06	-5.478E-07	-4.0795	1.8E-03
(Constant)	5.968E-02	1.493E-02	2.683E-02	9.254E-02	3.9986	2.1E-03

**Table No 1.4: NET PROFIT (X<sub>1</sub>), SALES (X<sub>2</sub>) AND NET PROFIT RATIO (Y) OF TATA STEEL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	1,681.6	22,272.1	0.08
2006-07	2,011.4	27,437.3	0.07
2007-08	5,628.5	134,086.8	0.04
2008-09	8,752.7	149,984.9	0.06
2009-10	-1,623.0	104,229.8	-0.02
2010-11	5,312.5	121,345.8	0.04
2011-12	679.9	135,975.6	0.01
2012-13	-248.4	138,821.1	0.00
2013-14	3,409.9	153,212.8	0.02
2014-15	-823.0	144,298.4	-0.01
2015-16	-2,359.8	106,339.9	-0.02
2016-17	4,084.8	117,419.9	0.03
2017-18	7,226.2	124,109.7	0.06
2018-19	8,487.7	157,669.0	0.05

**(Source:** Computed with the help of Statistics compiled from various issues of annual report of Tata Steel)

### Results (Tata Steel)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y= 0.0668151+0.0000084X<sub>1</sub> -0.0000005X<sub>2</sub>

Where Y= Net Profit Ratio, X1=Net Profit, X2=Sales

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.03	3505.43	116943.08
Multiple R	0.97308	Adjusted R sqr	0.93723

**ANALYSIS OF VARIANCE**

	DF	Sum of Squares	Mean Square
Regression	2	0.01354	0.00677
Residual	11	0.00071	0.00006
F =	105.5248	Signif F =	0.00000006640

**VARIABLES IN THE EQUATION**

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	8.39473E-06	6.30541E-07	7.00692E-06	9.78254E-06	13.31352353	3.97216E-08
X2	-5.302E-07	5.516E-08	-6.516E-07	-4.088E-07	-9.6132	1.1E-06
(Constant)	6.682E-02	6.503E-03	5.250E-02	8.113E-02	10.2751	5.6E-07

**Conclusions**

Table 1.3 & 1.4 respectively infer that Net Profit ratio on an average being 5.0 percent in case of SAIL is more than that of 3.0 percent in case of Tata Steel. Respective multiple R being 0.99522 and 0.97492 shows high degree of positive correlation among the variables for SAIL and Tata Steel.

The regression coefficient for independent variable Net profit indicates positive relationship with the dependent variable, i.e., Net Profit Ratio. It implies that with the rise of Re. 1 in Net Profit when Sales are kept constant, will lead to an increase of 0.0000217 times in Net Profit Ratio of SAIL; whereas it will result in an increase of 0.0000084 times in case of Tata Steel. The regression coefficient for independent variable Sales indicates negative relationship with its dependent variable, i.e., Net Profit Ratio. It implies that with the rise of Re. 1 in Sales when Net Profit is kept constant, will lead to a decrease of 0.0000012 times in Net Profit Ratio of SAIL; whereas it will result in a decrease of 0.0000005 times in case of Tata Steel.

Adjusted  $R^2$  indicates that 98.874 percent of change in Net Profit Ratio of SAIL is observed due to the independent factors; while this is 94.145 percent in case of Tata Steel. Standard Error of Regression Coefficients being very low testifies that there exists really a line of estimates among the variables.

Computed 't' value in case of all variables with respect to SAIL and Tata Steel are greater than the tabulated values at a significance level as displayed against the values of 't', which are statistically significant and testify that the linear relationship definitely exists.

At 2 & 11 degree of freedom respectively, 'F' ratio is greater than the table value of 'F' at a given level of significance as shown in the respective tables. Thus, the null hypothesis 'the Regression is not significant' cannot be accepted.

**(iii) Pre Tax Rate of Return**

Pre Tax Rate of Return measures the efficiency with which Capital employed of the Company has been employed. This ratio requires Pre Tax Profit as numerator and Capital Employed as denominator. Cause and effect modeling has been made with the help of Multiple 'R', ' $R^2$ ', Multiple Regression, 'F' ratio & 'T' test taking 'Y' as an dependent variable and 'X<sub>1</sub>' and 'X<sub>2</sub>' as an independent variables and shown in Table 1.5 & 1.6 respectively in case of SAIL and Tata Steel.

**Table No 1.5 PRE TAX PROFIT (X<sub>1</sub>), CAPITAL EMPLOYED (X<sub>2</sub>) AND PRE TAX RATE OF RETURN (Y) OF SAIL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	5,106.5	18,580.9	0.27
2006-07	8,683.2	23,378.7	0.37
2007-08	10,867.2	28,648.9	0.38
2008-09	8,783.7	38,424.3	0.23
2009-10	9,368.7	52,767.3	0.18
2010-11	5,664.6	51,645.3	0.11
2011-12	3,944.6	56,452.9	0.07
2012-13	2,597.6	59,786.2	0.04
2013-14	1,314.1	60,805.7	0.02
2014-15	1,569.6	61,263.5	0.03
2015-16	-7,607.4	56,448.7	-0.13
2016-17	-5,142.4	52,886.6	-0.10

2017-18	-1,253.1	63,318.3	-0.02
2018-19	3,221.3	68,151.4	0.05

(Source: Computed with the help of Statistics compiled from various issues of annual report of SAIL)

### Results (SAIL)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.2784444 + 0.0000219 X<sub>1</sub> - 0.0000048 X<sub>2</sub>

Where Y= Pre Tax Rate of Return, X<sub>1</sub>=Pre Tax Profit, X<sub>2</sub>=Capital Employed

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.11	3365.58	49468.48
Multiple R	0.98742	Adjusted R sqr	0.97046

### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.32287	0.16143
Residual	11	0.00828	0.00075
F =	214.5450	Signif F =	0.000000002

### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B	T	Significance T
X <sub>1</sub>	1.91233E-05	1.67663E-06	1.54331E-05	2.28136E-05	11.40583746
X <sub>2</sub>	-4.768E-06	5.757E-07	-6.035E-06	-3.501E-06	-8.2820
(Constant)	2.784E-01	3.274E-02	2.064E-01	3.505E-01	8.5056

**Table No 1.6PRE TAX PROFIT (X<sub>1</sub>), CAPITAL EMPLOYED (X<sub>2</sub>) AND PRE TAX RATE OF RETURN (Y) OF TATA STEEL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	5,322.4	12,328.7	0.43
2006-07	6,028.0	25,140.9	0.24
2007-08	9,560.1	70,610.3	0.14
2008-09	10,572.1	68,925.8	0.15
2009-10	528.9	59,680.9	0.01
2010-11	8,376.1	65,959.9	0.13
2011-12	3,650.0	71,453.8	0.05
2012-13	2,777.8	71,152.6	0.04
2013-14	6,233.0	79,846.9	0.08
2014-15	1,744.4	91,139.6	0.02
2015-16	-1,669.9	101,940.2	-0.02
2016-17	5,916.8	104,188.3	0.06
2017-18	10,475.9	120,733.2	0.09
2018-19	14,606.1	134,327.2	0.11

(Source: Computed with the help of Statistics compiled from various issues of annual report of Tata Steel)

### Results (Tata Steel)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.2391681 + 0.0000146 X<sub>1</sub> - 0.0000028 X<sub>2</sub>

Where Y= Pre Tax Rate of Return, X1=Pre Tax Profit, X2=Capital Employed

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.11	6008.69	76959.16
Multiple R	0.86065	Adjusted R sqr	0.69358

### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.12628	0.06314
Residual	11	0.04420	0.00402
F =	15.7129	Signif F =	0.0005966

### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	1.45999E-05	4.11173E-06	5.55006E-06	2.36498E-05	3.55079744	0.004545695
X2	-2.837E-06	5.521E-07	-4.053E-06	-1.622E-06	-5.1394	3.2E-04
(Constant)	2.392E-01	4.618E-02	1.375E-01	3.408E-01	5.1792	3.0E-04

### Conclusions

Table 1.5 & 1.6 respectively infer that Pre Tax Rate of Return on an average being 11.0 percent in case of SAIL is same as of 11.0 percent in case of Tata Steel. Respective multiple R being 0.98742 and 0.86065 shows high degree of positive correlation among the variables for SAIL and Tata Steel.

The regression coefficient for independent variable Pre Tax Profit indicates positive relationship with the dependent variable, i.e., Pre Tax Rate of Return. It implies that with the rise of Re. 1 in Pre Tax Profit when Capital Employed is kept constant, will lead to an increase of 0.0000191 times in Pre Tax Rate of Return of SAIL; whereas it will result in an increase of 0.0000146 times in case of Tata Steel. The regression coefficient for independent variable Capital Employed indicates negative relationship with its dependent variable, i.e., Pre Tax Rate of Return. It implies that with the rise of Re. 1 in Capital Employed when Net Profit is kept constant, will lead to a decrease of 0.0000048 times in Pre Tax Rate of Return of SAIL; whereas it will result in a decrease of 0.0000028 times in case of Tata Steel.

Adjusted R<sup>2</sup> indicates that 97.046 percent of change in Pre Tax Rate of Return of SAIL is observed due to the independent factors; while this is 69.358 percent in case of Tata Steel. Standard Error of Regression Coefficients being very low testifies that there exists really a line of estimates among the variables.

Computed ‘t’ value in case of all variables with respect to SAIL and Tata Steel are greater than the tabulated values at a significance level as displayed against the values of ‘t’, which are statistically significant and testify that the linear relationship definitely exists.

At 2 & 11 degree of freedom respectively, ‘F’ ratio is greater than the table value of ‘F’ at a given level of significance as shown in the respective tables. Thus, the null hypothesis ‘the Regression is not significant’ cannot be accepted.

### (iv) POST TAX RATE OF RETURN

Post Tax Rate of Return measures the efficiency with which Capital employed of the Company has been employed. This ratio requires Post Tax Profit as numerator and Capital Employed as denominator. Cause and effect modeling has been made with the help of Multiple ‘R’, ‘R<sup>2</sup>’, Multiple Regression, ‘F’ ratio & ‘T’ test taking ‘Y’ as an dependent variable and ‘X<sub>1</sub>’ and ‘X<sub>2</sub>’ as an independent variables and shown in Table 1.7 & 1.8 respectively in case of SAIL and Tata Steel.

**Table No 1.7POST TAX PROFIT (X<sub>1</sub>), CAPITAL EMPLOYED (X<sub>2</sub>) AND POST TAX RATE OF RETURN (Y) OF SAIL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)

2005-06	3,590.5	18,580.9	0.19
2006-07	5,703.3	23,378.7	0.24
2007-08	7,121.5	28,648.9	0.25
2008-09	5,757.2	38,424.3	0.15
2009-10	6,224.3	52,767.3	0.12
2010-11	3,876.7	51,645.3	0.08
2011-12	3,746.6	56,452.9	0.07
2012-13	1,850.9	59,786.2	0.03
2013-14	941.5	60,805.7	0.02
2014-15	1,297.1	61,263.5	0.02
2015-16	-4,705.5	56,448.7	-0.08
2016-17	-2,988.9	52,886.6	-0.06
2017-18	-723.0	63,318.3	-0.01
2018-19	2,410.9	68,151.4	0.04

(Source: Computed with the help of Statistics compiled from various issues of annual report of SAIL)

### Results (SAIL)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.1905485 + 0.0000188 X<sub>1</sub> -0.0000033 X<sub>2</sub>

Where Y= Post Tax Rate of Return, X<sub>1</sub>=Post Tax Profit, X<sub>2</sub>=Capital Employed

	Y	X1	X2
Mean	0.07	2435.93	49468.48
Multiple R	0.98774	Adjusted R sqr	0.97119

### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.13655	0.06828
Residual	11	0.00341	0.00031
F =	220.1033	Signif F =	0.000000001

### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	1.87864E-05	1.65787E-06	1.51374E-05	2.24353E-05	11.33162164	2.09185E-07
X2	-3.266E-06	3.660E-07	-4.071E-06	-2.460E-06	-8.9225	2.3E-06
(Constant)	1.905E-01	2.107E-02	1.442E-01	2.369E-01	9.0422	2.0E-06

**Table No 1.8POST TAX PROFIT (X<sub>1</sub>), CAPITAL EMPLOYED (X<sub>2</sub>) AND POST TAX RATE OF RETURN (Y) OF TATA STEEL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	1,681.6	12,328.7	0.14
2006-07	2,011.4	25,140.9	0.08
2007-08	5,628.5	70,610.3	0.08
2008-09	8,752.7	68,925.8	0.13
2009-10	-1,623.0	59,680.9	-0.03
2010-11	5,312.5	65,959.9	0.08
2011-12	679.9	71,453.8	0.01
2012-13	-248.4	71,152.6	0.00

2013-14	3,409.9	79,846.9	0.04
2014-15	-823.0	91,139.6	-0.01
2015-16	-2,359.8	101,940.2	-0.02
2016-17	4,084.8	104,188.3	0.04
2017-18	7,226.2	120,733.2	0.06
2018-19	8,487.7	134,327.2	0.06

(Source: Computed with the help of Statistics compiled from various issues of annual report of Tata Steel)

### Results (Tata Steel)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.0872691 + 0.0000130 X<sub>1</sub>-0.0000010 X<sub>2</sub>

Where Y= Post Tax Rate of Return, X<sub>1</sub>=Post Tax Profit, X<sub>2</sub>=Capital Employed

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.05	3015.79	76959.16
Multiple R	0.94249	Adjusted R sqr	0.86798

### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.03171	0.01586
Residual	11	0.00399	0.00036
F =	43.7339	Signif F =	0.0000058

### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	1.29726E-05	1.50379E-06	9.66274E-06	1.62824E-05	8.626558098	3.16701E-06
X2	-1.034E-06	1.682E-07	-1.404E-06	-6.640E-07	-6.1489	7.2E-05
(Constant)	8.727E-02	1.330E-02	5.799E-02	1.165E-01	6.5600	4.1E-05

### Conclusions

Table 1.7 & 1.8 respectively infer that Post Tax Rate of Return on an average being 7.0 percent in case of SAIL is more than that of 5.0 percent in case of Tata Steel. Respective multiple R being 0.98774 and 0.94249 shows high degree of positive correlation among the variables for SAIL and Tata Steel.

The regression coefficient for independent variable Post Tax Profit indicates positive relationship with the dependent variable, i.e., Post Tax Rate of Return. It implies that with the rise of Re. 1 in Post Tax Profit when Capital Employed is kept constant, will lead to an increase of 0.0000188 times in Post Tax Rate of Return of SAIL; whereas it will result in an increase of 0.0000130 times in case of Tata Steel. The regression coefficient for independent variable Capital Employed indicates negative relationship with its dependent variable, i.e., Post Tax Rate of Return. It implies that with the rise of Re. 1 in Capital Employed when Net Profit is kept constant, will lead to a decrease of 0.0000033 times in Post Tax Rate of Return of SAIL; whereas it will result in a decrease of 0.0000010 times in case of Tata Steel.

Adjusted R<sup>2</sup> indicates that 97.119 percent of change in Post Tax Rate of Return of SAIL is observed due to the independent factors; while this is 86.798 percent in case of Tata Steel. Standard Error of Regression Coefficients being very low testifies that there exists really a line of estimates among the variables.

Computed ‘t’ value in case of all variables with respect to SAIL and Tata Steel are greater than the tabulated values at a significance level as displayed against the values of ‘t’, which are statistically significant and testify that the linear relationship definitely exists.

At 2 & 11 degree of freedom respectively, 'F' ratio is greater than the table value of 'F' at a given level of significance as shown in the respective tables. Thus, the null hypothesis 'the Regression is not significant' cannot be accepted.

#### (v) RETURN ON ASSETS

Rate on Assets measures the overall efficiency of an organization on total assets. This ratio requires Pre Tax Profit as numerator and Total Assets as denominator. Cause and effect modeling has been made with the help of Multiple 'R', 'R<sup>2</sup>', Multiple Regression, 'F' ratio & 'T' test taking 'Y' as an dependent variable and 'X<sub>1</sub>' and 'X<sub>2</sub>' as an independent variables and shown in Table 1.9 & 1.10 respectively in case of SAIL and Tata Steel.

**Table No 1.9: PRE TAX PROFIT (X<sub>1</sub>), TOTAL ASSETS (X<sub>2</sub>) AND RETURN ON ASSETS (Y) OF SAIL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	5,106.5	18,817.8	0.27
2006-07	8,683.2	23,545.4	0.37
2007-08	10,867.2	28,744.3	0.38
2008-09	8,783.7	38,461.4	0.23
2009-10	9,368.7	52,812.4	0.18
2010-11	5,664.6	78,097.2	0.07
2011-12	3,944.6	78,493.9	0.05
2012-13	2,597.6	86,504.3	0.03
2013-14	1,314.1	93,868.5	0.01
2014-15	1,569.6	101,318.9	0.02
2015-16	-7,607.4	101,302.3	-0.08
2016-17	-5,142.4	107,615.2	-0.05
2017-18	-1,253.1	115,441.0	-0.01
2018-19	3,221.3	117,952.3	0.03

(Source: Computed with the help of Statistics compiled from various issues of annual report of SAIL)

#### Results (SAIL)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.2972188 + 0.0000089 X<sub>1</sub>-0.0000030X<sub>2</sub>

Where Y= Return on Assets, X<sub>1</sub>=Pre Tax Profit, X<sub>2</sub>=Total Assets

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.11	3365.58	74498.21
Multiple R	0.95954	Adjusted R sqr	0.90631

#### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.27016	0.13508
Residual	11	0.02326	0.00211
F =	63.8773	Signif F =	0.000001

#### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	8.85907E-06	3.64305E-06	8.40757E-07	1.68774E-05	2.431768717	0.033305135
X2	-2.952E-06	5.584E-07	-4.181E-06	-1.723E-06	-5.2860	2.6E-04
(Constant)	2.972E-01	5.301E-02	1.805E-01	4.139E-01	5.6070	1.6E-04

**Table No 1.10PRE TAX PROFIT (X<sub>1</sub>), TOTAL ASSETS (X<sub>2</sub>) AND RETURN ON ASSETS (Y) OF TATA STEEL**

YEAR	X <sub>1</sub> (Rs. In Crore)	X <sub>2</sub> (Rs. In Crore)	Y (In %)
2005-06	5,322.4	16,177.6	0.33
2006-07	6,028.0	42,074.8	0.14
2007-08	9,560.1	92,193.6	0.10
2008-09	10,572.1	91,355.1	0.12
2009-10	528.9	79,789.3	0.01
2010-11	8,376.1	135,488.2	0.06
2011-12	3,650.0	146,852.1	0.02
2012-13	2,777.8	146,912.8	0.02
2013-14	6,233.0	171,644.5	0.04
2014-15	1,744.4	159,132.1	0.01
2015-16	-1,669.9	177,511.4	-0.01
2016-17	5,916.8	173,333.2	0.03
2017-18	10,475.9	209,757.9	0.05
2018-19	14,606.1	233,582.4	0.06

(Source: Computed with the help of Statistics compiled from various issues of annual report of Tata Steel)

### Results (Tata Steel)

Regression Equation of Y on X<sub>1</sub> & X<sub>2</sub>

The Required equation Y = 0.1635946 + 0.0000087 X<sub>1</sub>-0.0000011X<sub>2</sub>

Where Y= Return on Assets, X<sub>1</sub>=Pre Tax Profit, X<sub>2</sub>=Total Assets

	Y	X <sub>1</sub>	X <sub>2</sub>
Mean	0.07	6008.69	133986.07
Multiple R	0.81910	Adjusted R sqr	0.61110

### ANALYSIS OF VARIANCE

	DF	Sum of Squares	Mean Square
Regression	2	0.06513	0.03256
Residual	11	0.03194	0.00290
F =	11.2136	Signif F =	0.002214

### VARIABLES IN THE EQUATION

Variable	B	SE B	95% Confidence Interval B		T	Significance T
X1	8.72615E-06	3.43416E-06	1.16762E-06	1.62847E-05	2.540985663	0.027431805
X2	-1.085E-06	2.452E-07	-1.625E-06	-5.456E-07	-4.4257	1.0E-03
(Constant)	1.636E-01	3.795E-02	8.007E-02	2.471E-01	4.3107	1.2E-03

### Conclusions

Table 1.9 & 1.10 respectively infer that Return on Assets on an average being 11.0 percent in case of SAIL is more than that of 7.0 percent in case of Tata Steel. Respective multiple R being 0.95954 and 0.81910 shows high degree of positive correlation among the variables for SAIL and Tata Steel.

The regression coefficient for independent variable Pre Tax Profit indicates positive relationship with the dependent variable, i.e., Return on Assets. It implies that with the rise of Re. 1 in Pre Tax Profit when Total Assets is kept constant, will lead to an increase of 0.0000089 times in Return on Assets of SAIL; whereas it will result in an increase of 0.0000087 times in case of Tata Steel. The regression coefficient for independent variable Total Assets indicates negative relationship with its dependent variable, i.e., Return on Assets. It

implies that with the rise of Re. 1 in Total Assets when Pre Tax Profit is kept constant, will lead to a decrease of 0.0000030 times in Return on Assets of SAIL; whereas it will result in a decrease of 0.0000011 times in case of Tata Steel.

Adjusted R<sup>2</sup> indicates that 90.631 percent of change in Return on Assets of SAIL is observed due to the independent factors; while this is 61.110 percent in case of Tata Steel. Standard Error of Regression Coefficients being very low testifies that there exists really a line of estimates among the variables.

Computed ‘t’ value in case of all variables with respect to SAIL and Tata Steel are greater than the tabulated values at a significance level as displayed against the values of ‘t’, which are statistically significant and testify that the linear relationship definitely exists.

At 2 & 11 degree of freedom respectively, ‘F’ ratio is greater than the table value of ‘F’ at a given level of significance as shown in the respective tables. Thus, the null hypothesis ‘the Regression is not significant’ cannot be accepted.

### **Empirical Models**

The main empirical models derived in the whole of paper can be summarized as follows:

<b>Parameter</b>	<b>Predictor</b>
(i) Gross Profit Ratio	
SAIL	$Y = 0.3218373 + 0.0000173X_1 - 0.0000056X_2$
TATA Steel	$Y = 0.4641124 + 0.0000076X_1 - 0.0000035X_2$
(ii) Net Profit Ratio	
SAIL	$Y = 0.0596838 + 0.0000217X_1 - 0.0000012X_2$
TATA Steel	$Y = 0.0668151 + 0.0000084X_1 - 0.0000005X_2$
(iii) Pre Tax Rate of Return	
SAIL	$Y = 0.2784444 + 0.0000191 X_1 - 0.0000048 X_2$
TATA Steel	$Y = 0.2391681 + 0.0000146 X_1 - 0.0000028 X_2$
(iv) Post Tax Rate of Return	
SAIL	$Y = 0.1905485 + 0.0000188 X_1 - 0.0000033 X_2$
TATA Steel	$Y = 0.0872691 + 0.0000130 X_1 - 0.0000010 X_2$
(v) Return on Assets	
SAIL	$Y = 0.2972188 + 0.0000089 X_1 - 0.0000030 X_2$
TATA Steel	$Y = 0.1635946 + 0.0000087 X_1 - 0.0000011 X_2$

On the whole, it can be very safely concluded that a strong causal relationship between Profits and Capital Employed does exist. This cause and effect relationship should be kept in view while making in-depth financial predictions so that excellence in inferences drawn might be achieved in the supreme interest of the company.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***FINGERPRINT RECOGNITION OF NEWBORNS BABY: A REVIEW****MOHAMMED SHABIL\* AND DR. H.S. FADEWAR****ABSTRACT**

*In hospitals, birthing centers, health centers, and other locations where multiple births occur concurrently, infant kidnapping, switching, missing, illegal adoption and abduction are growing problems.*

*A biometric system using the fingerprint of the newborn is proposed to overcome such issues. In multiple organizations, authentication and recognition of babies and Newborns are a big problem.*

*In authenticating and recognizing adults, the fingerprint recognition scheme performs well. However, it faces problems such as the poor quality of fingerprint photographs and incorrect enrollment in the case of babies and toddlers, thereby decreasing the precision of identification.*

*The aim of this paper is to highlight the significance of the Fingerprint Recognition of Newborns Baby in the area of secure individual and to know where the researches concerned with this topic has reached and the challenges facing researchers and the methodology used to detect the fingerprint of the newborn and the metrics that use in accounts biometrics.*

**Keywords:** Biometrics, Fingerprint recognition, Identification, Infants, Newborn, toddlers

**INTRODUCTION**

The most important biometric feature for civil identity is that fingerprints are used, and fingerprints are the subject of the vast majority of national identification identity programs. And from the very beginning of the twentieth century, they have been known as such. This information is used by many nations to identify their citizens, and some of them also have databases of fingerprint that are more than 100 years old. In addition, fingerprints can be divided into groups, making the scanning task very straightforward. [1].

It is estimated that more than 600 million children are expected to live between the ages of 0-5 worldwide. [2], (2020 est.) 18.1 births/1,000 people, resulting in 4.3 births per second and about 259 births every minute worldwide [3].

The largest of these births take place in the world's poorest areas. Effective delivery and fraud protection of healthcare, immunization, and dietary supplies are also extremely difficult, and it is possible that neither children nor their parents will have access to any formal identity papers. This is extremely difficult for children (0-1 year of age) when the infant is at the most vulnerable level of development.

In recent years, in many applications, such as controlling child vaccination and detection of missing children, infant recognition has gained growing attention.

Owing to the lack of modern means of identification for infants and newborns, do still most countries rely on old methods of recognition of infants that rely on parent identification or identity certificates. Biometric identification systems (e.g. recognition of faces and fingerprints) have been commonly used in many adult and adolescent recognition applications. For several decades, biometric recognition has been extensively studied to address the issue of personal identity. Many of the methods have been widely applied in a wide variety of civil and forensic implementations, but nearly all of the techniques are developed for adults, not for newborns.

The DNA test is known to be effective in distinguishing individuals individually, but it comes at a high cost and involves specialized laboratory techniques, so it cannot be used in real-time applications. so create a system for fingerprint recognition is important for newborn personal authentication, the present research attempts to explain new intelligent approaches using principles of artificial intelligence to authenticate easily and reliably, identifying newborns and children based on their fingerprints, and we seek for getting Integrated system (Stable over time), uniqueness (Distinct for each person), ergonomic, low cost (Accessible to all), lifelong usability, Portability and acceptability of easy applicability, wide acceptance.

Several experiments have been undertaken in recent years to determine the suitability of using fingerprints in infants, as we will explain later.



**Figure1** Models of Newborns Faces and their Fingerprint images [21]

## LITERATURE REVIEW

The year **1879** marked the beginning of interest in the identification of children and newborns, as Mr. Francis Galton was considered one of the first persons to explore the use of fingerprints to identify children, took images of newborn inked fingerprints and constant to do so to the age of 4.5. He originally collected the ten fingerprints of an infant over a span of a some days, compared them manually after a some months, and hypothesized that fingerprints could be used to identify children over the age of 2.5 years. It must be remembered that Galton based the latter inference on a single child's fingerprint [4].

In **1883**, Kollman studied the development on our hands and feet of dermatoglyphic ridge patterns and in the fourth month of gestation, the ridge patterns become evident to a degree and are fully established by the sixth month of gestation [5].

Penrose, Ohama [7], and Cummins, Midlo[6], validated from **1969 - 1973** that completely shaped fingerprints are present at birth. Since then, in child fingerprinting, a few feasibility experiments have been carried out that are summarized as follows:

The Netherlands Association for Applied Science Research published a study in **2004** and tested the viability of using biometric characteristics for travel documents in the Netherlands and found that due to the minuteness of the ridge pattern, fingerprints could not be obtained from children under 4 years of age [8].

The BIODEV II visa pilot project was launched in **2007** by eight European Member States with the aim of developing a biometric registration solution. In Damascus (Syria) and Ulan Bator (Mongolia), where fingerprints were obtained from 300 children under the age of 12, it was concluded that it is impossible to capture fingerprints from children under the age of 12 [9].

The research was carried out by Ultra-Scan from **2006 - 2009** with the goal of quantifying dermatoglyphics in children through puberty by collecting 300 children's fingerprints. They proposed a statistical model to foresee the change in the development of commonality. And concluded that the progress is too early to assess [10].

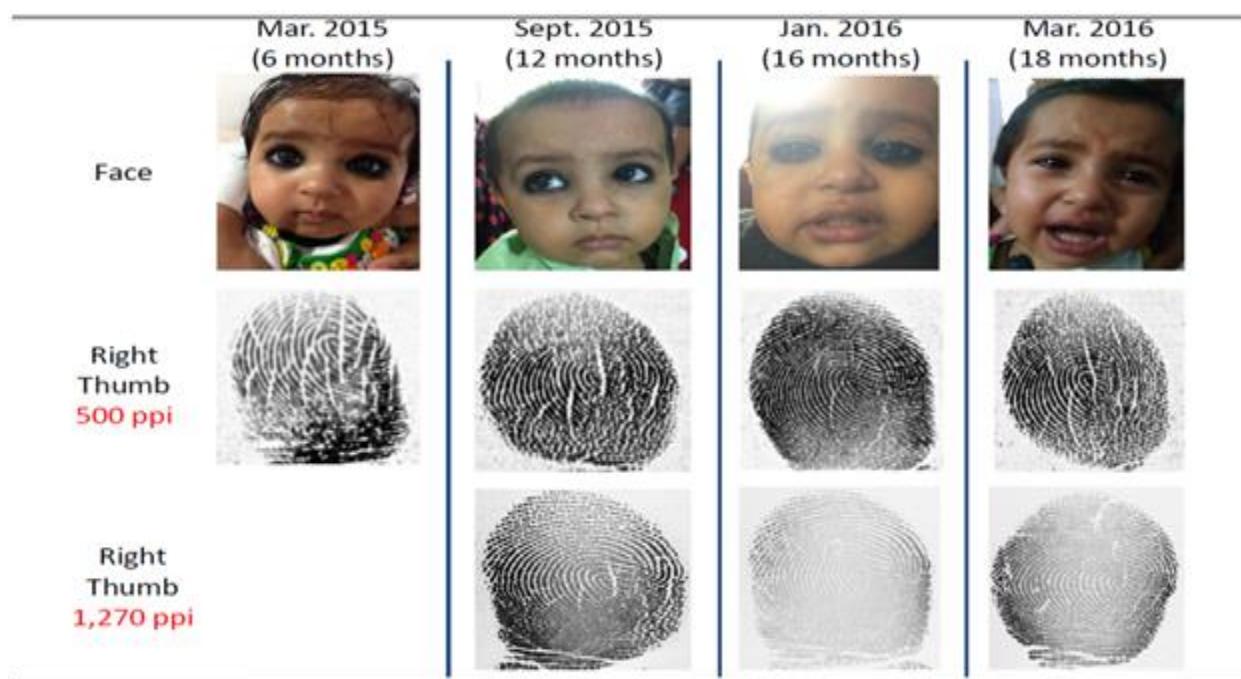
An agreement was reached in **2013** between the European Commission's Joint Research Center and the Immigration Embassy of Portugal, where the latter moved fingerprint pairs of 3,264 babies to the prior. They might claim that development has a small effect on fingerprint identification, and image accuracy ultimate obstacle to children's fingerprints .They infer that it was impossible to reliably print fingerprints of children aged 6-12 years and to collect fingerprints of babies below this age range [11].

Table1 shows the results of various works the last from **2014 to this year** that has been implemented and deployed by researchers and the Investigators.

**TABLE 1: Literature review on fingerprint recognition of Newborns and children**

Authors	Year	Fingerprint accuracy	Subjects	Age at Enrolment	Time interval	Results
Anil k.jain, Kai coo, Sunpreet S.Arora (12)	2014	500 ppi	90	0 - 4 year		A state SDK achieves identification accuracy of 98.97% (99.39%) and 67.14% (71.43%)
Kai Cao, Anil K. Jain, Sunpreet S. Arora, Lacey Best-Rowden (13)	2015	500 ppi	206	0 - 4 years	3 months	Based on preliminary results appears promising, They intend to gather statistical data from the same subjects three times over a span of one year.
Bhatnagar, Anil k.Jain, Sunpreet S.Arora, Kai cao, Anjoo (14)	2016	1,270 ppi	309	0 - 5 years	1 year	Recognition children over 6 months
Vanina Camacho, Francesco Franzoni, Luis Di Martno, Javier Preciozzi..etc (15)	2017	500 ppi	45000 Finger prints	0 - 10 years		Recognition of children over 1 year
Francesco Franzoni, Javier Preciozzi, Guillermo Garella, Vanina Camacho, Luis Di Martn..etc(16)	2019	500 ppi	16865	0 - 20 years		Good accuracy from ages beginning at 1 year of age, the standard obtained after pre-processing for five years of age is higher than that obtained for adult fingerprints
Amol D.Rahulkar, Ashwini R.Patil, Chirag N.Modi (17)	2019	Real Scan G10	119 + 154	0 – before school		they used the Euclidean distance method for matching of the fingerprint datasets were very encouraging
Tom Kalisky, Steven Saggese, Yunting Zhao, Courtney Avery, Deborah..etc (18)	2019	3,400 ppi	142	month	2 years	For newborns, we find for infants = 96.2%, at FAR = 0.1%, and Find per finger TAR = 85.0%; for neonates = 95.4%.
Prem S. Sudhish, Joshua J.Englesma, Debayan Deb, Kai Cao, Anjoo Bhatnagar, Anil K. Jain (19)	2020	1900 ppi	315	0 - 3 months	1 year	TAR = 92.8% @ FAR = 0.1% for infants enrolled at age of 2-3 months

We conclude that there is serious work, although it is not sufficient to determine the identity of newborns and children with high accuracy. There is scope to improve the evaluation framework for biometrics quality assessment metrics by experimenting with more accurate algorithms, as consideration must also be given to reducing the computational cost in developing a quality assessment approach.



**Figure 2** Face and fingerprint photographs of a subject obtained during four data collection sessions using 500 and 1270 PPI to demonstrate precision for the same subject in four data collection sessions [4]

## OBSERVATIONS AND CHALLENGES IN DATA COLLECTION

The major difficulties and some findings during the capture and data processing of newborn fingerprints are summarized below [13]:

### Dry fingers

In certain nations, owing to the comparatively warm and dry climate, the finger skin of many newborns and infants, notably, is very dry. Dry fingerprints often do not cause the fingerprint reader to record prints automatically. In this case, before collecting fingerprints, we will use wet wipes to moisten the digit.

### Wet fingers

At the time of data capture, some newborns and infants suck their thumb. Because wet fingers result in low fingerprint image quality, before collecting their prints, we should dry their thumbs.

### Dirty fingers

The hands of some newborns and children were dirty. In this case, we wiped them with wet wipes on their fingertips.

### Small finger size

Although fingerprint reader accuracy and easy, we found that putting the finger correctly on the reader platen was difficult for younger newborns (less than 6 months) very very small their fingers. As a consequence, it was only possible to obtain a partial fingerprint. The reader was also often not activated by tiny fingertips to record a fingerprint automatically. It was sufficient to make repeated attempts in these situations to successfully collect the prints.

### Manual vs. auto-capture

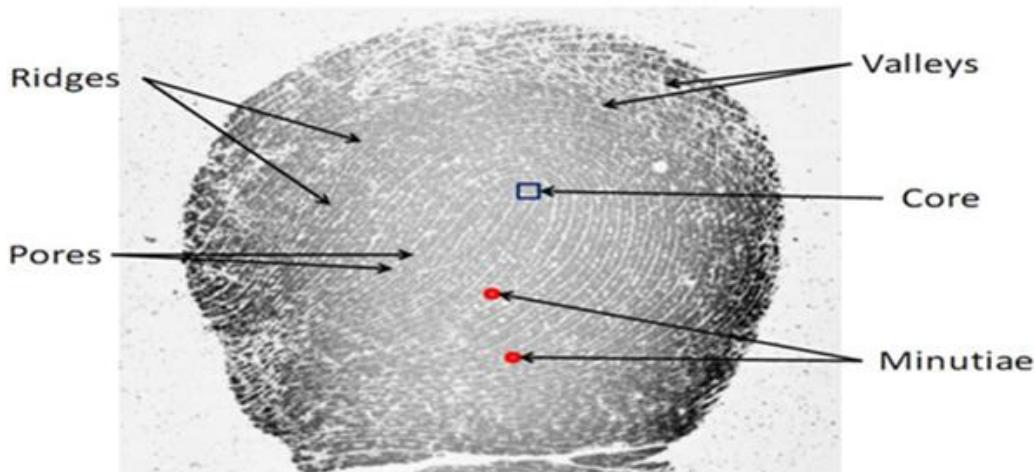
It is hard to collect fingerprints in manual mode as you try to grab children's fingerprints in manual capture mode, since it is difficult to keep the babies hand stable on the reader plate and trigger the capture manually at the same time. In manually taken fingerprint images, we found minor motion blur as well. In this trouble, automatically capture is more comfortable and useful for the capture of young babies of fingerprints.

### The “fear” of vaccination

Usually we capturing fingerprints in a clinic of a doctor, some newborns, and children uncomfortable (start crying) because they think being administered vaccination.

### Small inter-ridge spacing of newborns and children

Small inter-ridge spacing of newborns and children (4-5 pixels) vs. (9-10 pixels) for adults.

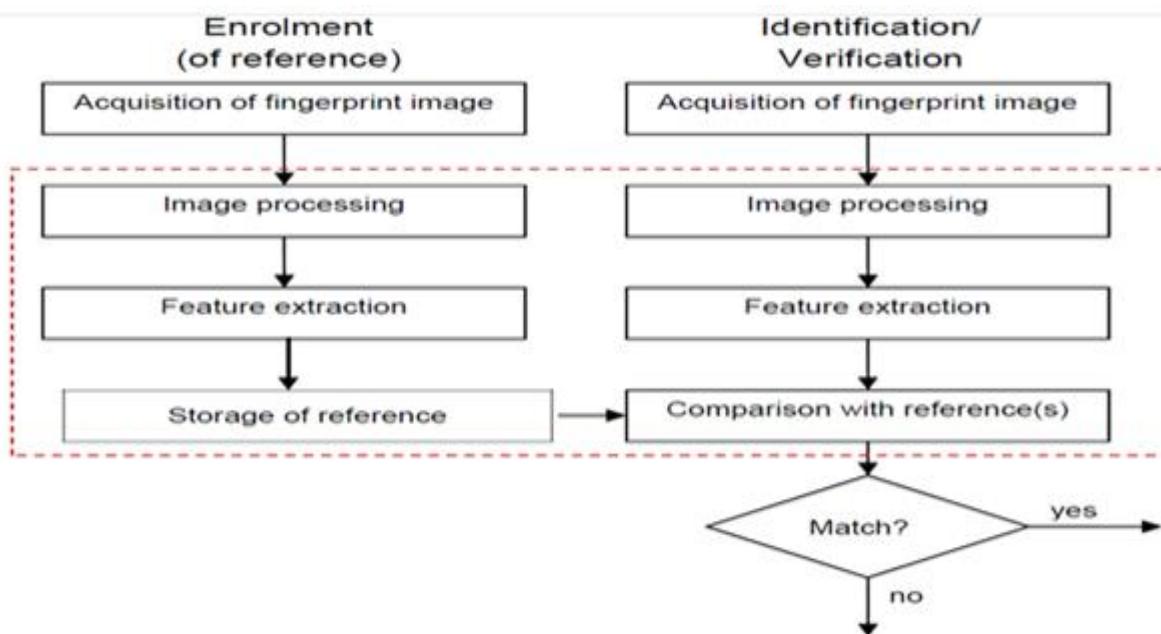


**Figure 3** The capture of a 6-hour-old newborn after passing the challenges using the custom 1,270 PPI fingerprint reader, captured with seen features (core, pores, valleys, minutiae, and ridges)[4]

## METHODOLOGY

Samples (subjects) undergo 4 main stages namely (1) Image Acquisition (2) Image processing and include (enhancement, Binarization, skeletonized) (3) Feature Extraction (4) In the context of a prototype, the extracted features are stored in a database known as the enrollment stage.

After that, we do identification/Verification being 4 main stages namely (1) Image Acquisition (2) Image processing and include (enhancement, Binarization, skeletonized) (3) Feature Extraction (4) comparison with references as identification/Verification. All these stages showed in figure 4, I will explain all that with details in the following:



**Figure 4** stages Fingerprint recognition of Newborns [22]

### Acquisition

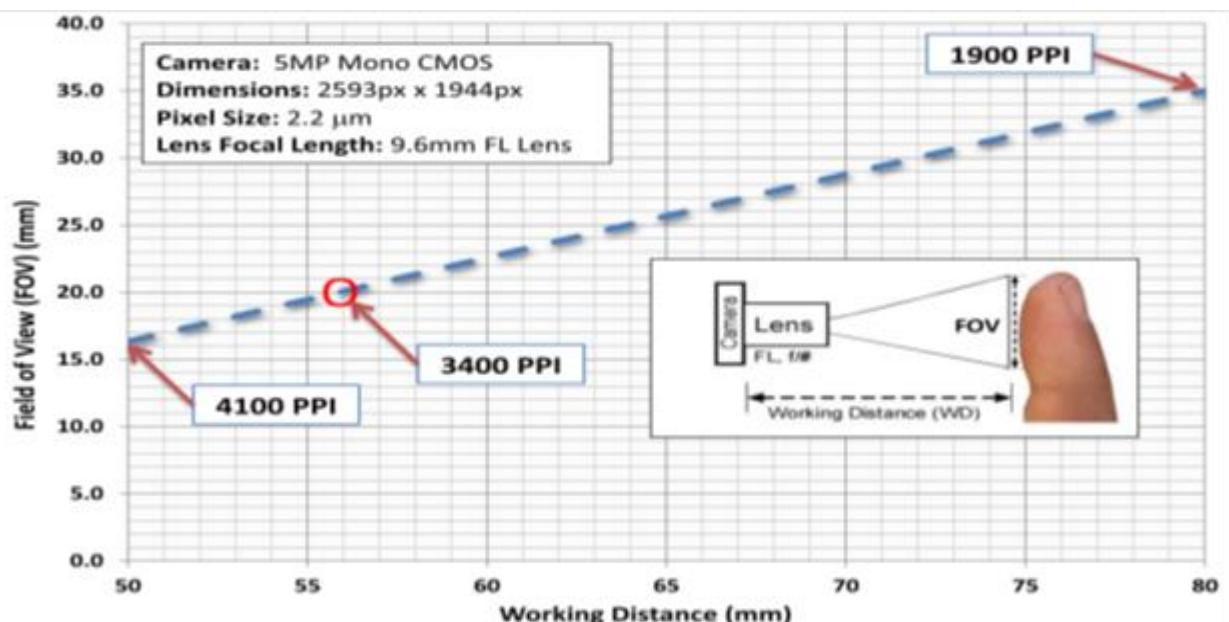
Acquiring the fingerprint image by putting the fingertip on the specially built scanner and creating an image of the fingerprint. This technique usually only makes smooth fingerprints, so the fingertip has to be held relatively still.

A significant factor affecting the capacity to create a perfect fingerprint picture of an infant is the actions and interaction between the baby and the practitioner. Children are "uncooperative" and the device architecture and retrieval process should be compliant with how infants, and often parents, manage, not how technology functions better. As seen in Figure 5, children scream and twist their fingers and the palmar grip reflex fuss and will not be asked to participate.



**Figure 5** Infant reflexes and behaviors [11]

Keeping their hands exposed to capture finger or palm prints needs several people in normal circumstances (for example, while an adult is fingerprinting), in a predictable and deliberate manner, and the inconsistency of magnification, illumination, and field of view of the images taken by an expert pointing a camera at the hand of the child may be too wide. Also with machine learning and automatic image processing.



**Figure 6** shows that, depending on judgment needs, we can accomplish through 1900 PPI to 4100 PPI over appropriate working distances that fit a portable device with this hybrid camera/lens [11]

### Image processing

In order to better differentiate between ridgelines and space in between, the first step is to remove low contrast results (i.e., valleys). For this purpose, image processing techniques are used as in Figure 7 shows pipelines of Image processing.

A distinct advantage of ink on paper or FTIR-based touch fingerprints is the high contrast images that are produced by image processing. Before the identification of minutiae, very a few image processing is required in addition to resizing.

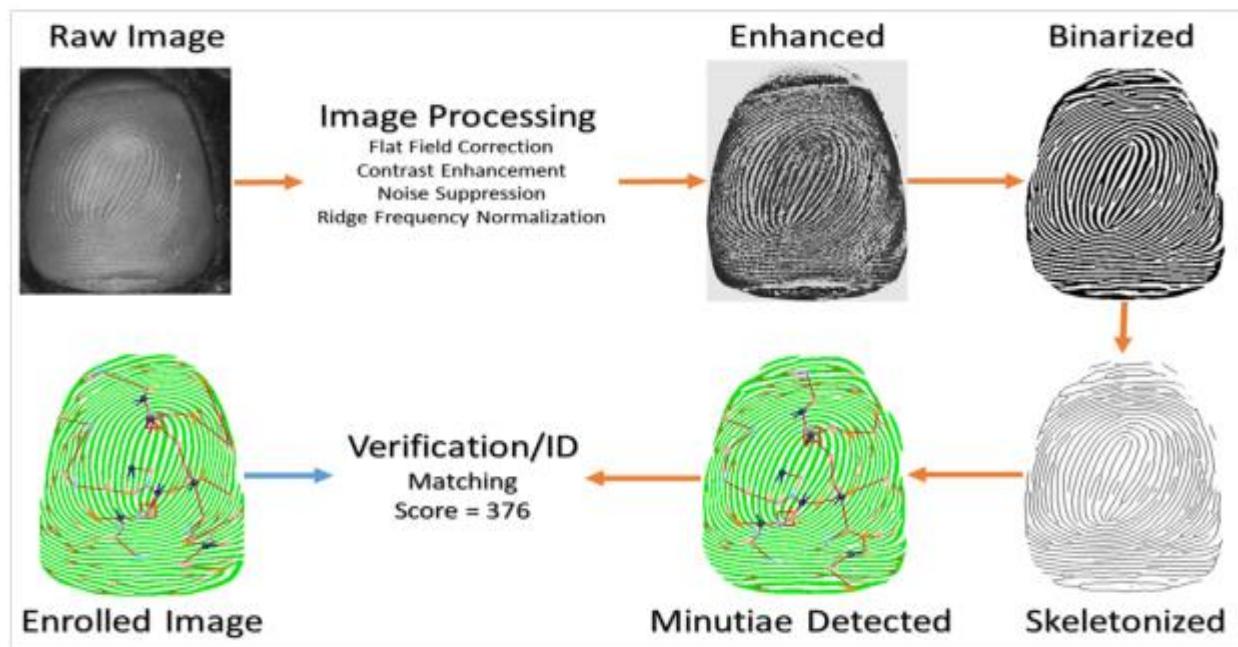


Figure 7 pipelines of Image processing [11]

The plots display the light intensity at the red line around the ridges of the print and it is shown that the pixel intensity is 8 pixels from ridge to ridge in both adult and newborn printing. This intensity of pixels is what the algorithms for image processing used to construct binary and skeletonized images. Figure 8 displays fingerprint photographs taken within 12 hours of birth for a newborn, a one-year-old, and an adult. In the raw pixel/ridge imagery, the ridge-to-ridge frequency will shift from 20 pixels /ridge in the infant to 60 pixels /ridge in the adult. We can efficiently eliminate any problems related to size and age by resampling to 8 pixels /ridge. The binary images produced can all be readily analyzed by the algorithms of minutiae detection without a limiting factor being size/age, as the lower row of Figure indicates.

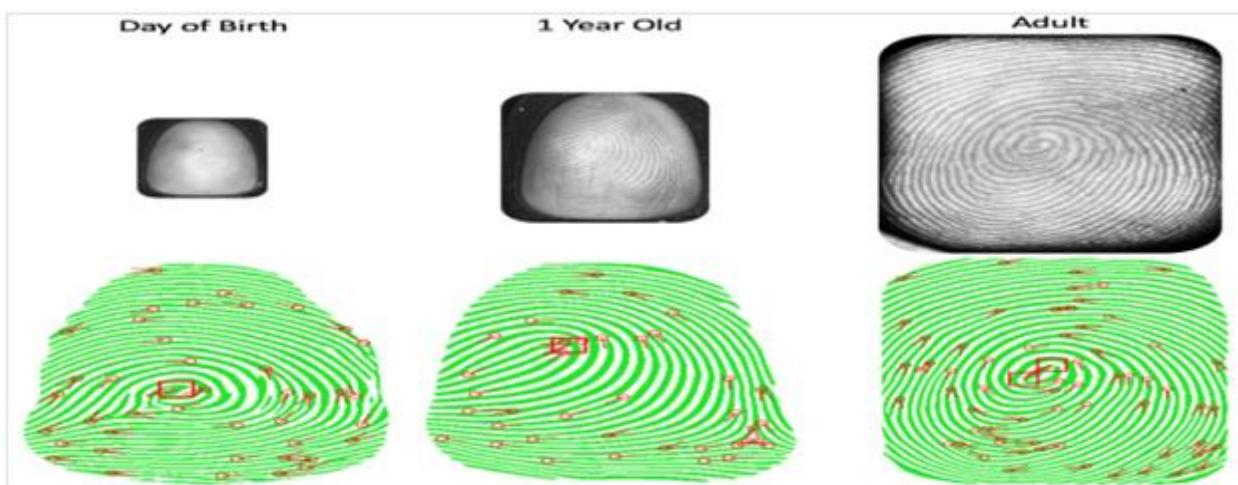


Figure 8 Newborn (age) 1 Day, year, and adult (Upper) with processed templates and minutiae (Low) [11]

#### Feature extraction

After processing, once the image is in its best state, common structures or patterns (called features) need to be identified between the two comparative fingerprints. Feature extraction usually starts with identifying ridgelines to follow them (pixel by pixel) until ends or bifurcations are found. This move, to some degree, is similar to a blind person "feeling" his way forward. Like a blind person, objects can mislead the algorithm.

The result of the extraction of features is a so-called "template" consisting primarily of a list of features, each defined by its coordinates (relative to the image), its relative angle, its form (usually a ridge line's "bifurcation" or "ending") and a certain confidence score.

What was already discussed about distortion and positioning of fingers during acquisition should be recalled here. This translates to the fact that, even when translated into the same coordinate system, the distinctive

characteristics of the fingerprints of the same finger hardly ever have the same coordinates or angle. Distortion leads to different coordinates of the positioning of the two sets of features that need to be compared.

In the worst case, to allow proper identification, the intersection of both sets of features is too small or the deviation of coordinates is too large. This form of "non-similarity" must therefore be taken into account and resolved by computer-based comparison.

### **Storing of reference fingerprint**

After acquisition the image, processing it, and extracting the features from it, it comes to be converted as a template and stored in the database, This is how the data is collected after that we doing a comparison and matching fingerprints.

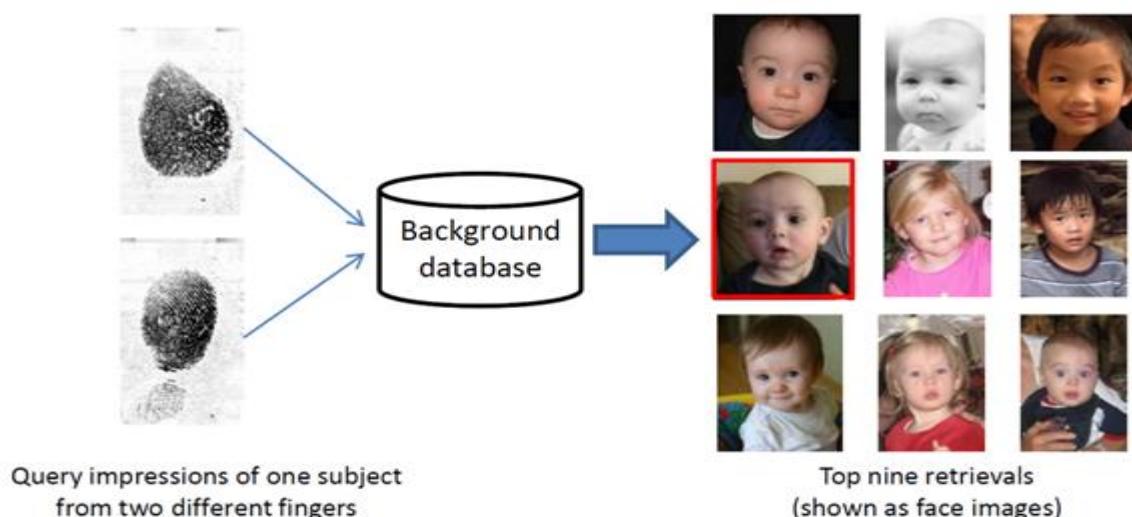
### **Comparison and matching fingerprints**

Following feature extraction, the comparison of two models is the most vendor-dependent part of the method and is based on a so-called matching algorithm. Each algorithm's common property is the fact that it calculates a comparability score for the two fingerprints to be compared. Given the inevitable "non-similarities" between even the same fingerprint samples, as just described, the score is a statistical measure to what degree, considering those troubling elements; two samples come from the same individual.

If the score has at least the threshold value for a given score threshold, two "match" fingerprints do not match if the score is lower. Illustration of fingerprint-based recognition (left thumb and left index finger) in Figure 9 below, displaying the face images of the top-9 collected subjects; the true mate is the face picture with red borders.

In the worst case, to allow proper identification, the intersection of both sets of features is too small or the deviation of coordinates is too large. This form of "non-similarity" must therefore be taken into account and resolved by computer-based comparison.

The method for measuring the resemblance between the input fingerprint image and the reference fingerprint image contained in the database is the matching process [20].



**Figure 9** Illustration of fingerprint children based identification [1]

After a feature extraction process is performed by either improving and before feature improvements, this matching process compares each feature that belongs to every image. Index scores such as MCC, singular point, and ridge period are combined in this comparison process. The indexing score for two MCC templates is provided by:

$$S_M(T_1, T_2) \cong \frac{\sum_{v \in V_1} \left( \max_{v_j \in V_2} \{C_F(v, v_j)\}^{\frac{p}{h}} \right)}{|V_1| \times (H_M)^{\frac{p}{h}}} \quad (1)$$

Where  $T_1$  and  $T_2$  are two details from two images.  $V_1$  is the number of the cylinder in the seek print and  $C_F$  is number of collisions times  $V$  and  $v_j$ . Then, using Eq.3. The matching score of singular points can be computed from two images.

$$S_{SP} = \frac{1}{N_{SP}} \sum_{m=1}^{N_{SP}} \max_n S_{m,n} \quad (2)$$

Inside the Eq. 3,  $S_{i,j}$  is the resemblance between  $m$ th singular pair in the database fingerprint image and  $n$ th the reference image in the image. It can be computed by:

$$S_{m,n} = \frac{1}{3} \left( f_{20,60}(\Delta d_{m,n}) + f_{\frac{\pi\pi}{6'3}}(\Delta \alpha_{m,n}) + f_{\frac{\pi}{6'3}}(\Delta \beta_{m,n}) \right) \quad (3)$$

$$\text{And a piece wise linear function is } f_{i,j}(x) = \begin{cases} 1 & x < i \\ 0 & x > j \\ \frac{j-x}{j-i} & \text{otherwise} \end{cases} \quad (4)$$

$\alpha_{m,n}$  in Eq. 3 is the distance that differs.  $\Delta \alpha_{m,n}$  and  $\Delta \beta_{m,n}$  are the difference between the singular points. The similarity of the ridge period is, in addition, computed as follows:

$$S_R = \exp \left( -\frac{|R_m - R_n|}{\sigma_R} \right) \quad (5)$$

Where  $\sigma_R$  is a normalization notion.  $R_m$  and  $R_n$  are respectively note the average ridge cycles in latent and the reference prints.

## THE METRICS THAT USE IN ACCOUNTS BIOMETRICS

For a pair of fingerprint images  $q_i, q_j$ , let  $d$  be the distance function and let  $\text{id}$  be the function that returns the correct identity for a given sample  $q_i$ . We define the following metrics, Given the threshold  $\delta$ :

### True acceptance rate (TAR)

This is the percentage of that a valid assertion of identity is correctly checked by the identity.

$$\text{TAR}(\delta) = 1 - \text{FRR}(\delta) \quad (6)$$

### False Rejection Rate (FRR)

Percentage of cases of registration in which approved individuals are mistakenly denied.

$$\text{FRR}(\delta) = \frac{\#d(q_i, q_j) < \delta \text{ t.q } \text{id}(q_i) = \text{id}(q_j)}{N} \quad (7)$$

### False Acceptance Rate (FAR)

This is the likelihood of the system wrongly matching the input pattern in the database to a non-matching prototype.

$$\text{FAR}(\delta) = \frac{\#d(q_i, q_j) > \delta \text{ t.q } \text{id}(q_i) \neq \text{id}(q_j)}{N(N - 1)} \quad (8)$$

### Receiver Operating Characteristics (ROC)

To illustrate the success of the verification, the curve is plotted as TAR vs. FAR at various thresholds (from 0 to 1).

## CONCLUSIONS

We believe that serious work continues, but the identity of newborns and children with high precision is not adequate to be determined. There is potential for improving the evaluation process for quality assessment indicators for biometrics by experimenting with more precise algorithms, as consideration must also be given to reducing computational costs when designing an approach to quality assessment.

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School of Computational Sciences, S.R.T.M. University, Nanded-431606, Maharashtra, India

*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***NBA: QUALITY ASSESSMENT PARADIGM FOR MANAGEMENT EDUCATION****DR. VAISHALI AJOTIKAR AND DR. PALLAVI INGALE****ABSTRACT**

*Accreditation is a quality assessment tool that ensures excellence for management education. External governing body evaluates the course/program in context to various criteria. National Board of Accreditation (NBA) is a governing body under AICTE. It is playing a very significant role at present and has shifted paradigm for management education. The paper attempts to examine various criteria enclosed in NBA accreditation. Each criterion is a reflection of the quality enhancement in management education by setting standard benchmark to be achieved by institutes. The motivation, opportunities, challenges, of NBA accreditation is examined.*

**Keywords:** NBA, Accreditation, Criteria, motivations, challenges.

**INTRODUCTION**

Accreditation is a formal verification and assessment process undertaken by an institution to meet the required quality standards by any recognized competent authoritative body. Accreditation is a quality assessment tool that ensures excellence for management education. In today's competitive era, Management institutes ensure a seal of quality assurance to its stakeholders. The higher grades or a rank of an institution is a reflection of its credibility. National Board of Accreditation (NBA) is one of the accreditation bodies set up under AICTE, for assessment of management institutes. The paper attempts to examine various criteria or parameters enclosed in NBA accreditation. Each parameter is a reflection of the quality enhancement in management education by setting standard benchmark to be achieved by institutes. How NBA motivates the institutes and offers opportunities is elaborated and the challenges faced by the institutes are examined.

**REVIEW OF LITERATURE:**

The popular rise of college rankings can be attributed to four drivers of social change i.e. Transition to a knowledge-intensive economy; Global pursuit of talent; Importance of higher education to the economy; and Consumerist student attitudes toward higher education (Meredith Davis, 2016). With the dawn of new millennium, while there was phenomenal growth in the number of B-Schools, the benchmarks were also on the rise. Quality in higher educational institutes has become a necessity for the Indian educational system. The education system of India is considered as the reason for the economic rise of India (Gupta & Gupta, 2012). Under the AICTE, a separate Board of Management Studies (BMS) was set up to 'advise' the executive committee of the Council on issues like 'norms, standards, model curricula, model facilities and structure of courses' for management institutes (AICTE Act, 1987). It plays a significant role in shaping management education in India but has been criticized for its engineering centricity Since, it cannot deal with complexity and divers. Hence, to be able to monitor quality of management institutes, National Board of Accreditation (NBA), was set up to achieve 'assurance of quality' under section 10(u) of the AICTE Act in 1987 and from January 7, 2010, was given an autonomous status (NBA, 2013). Also, many management institutes have mushroomed across the country without any quality standards in teaching and research as a result academic standards are compromised (T V Raju, 2016). Hence, emphasizing critical role played by NBA. Accreditation provides measure of quality assurance for the educational institutes. (Vasudevan N a, SudalaiMuthu Tb, 2019). Due to the intangible factors such as knowledge of faculty, faculty qualification and teaching pedagogy of the education services, it is quite difficult to identify the actual quantitative data. Thus, identification and assessment of quality parameters is not a simple task (Parri, 2006). NBA focuses on the Program accreditations rather than accrediting institutes (Gholap, Kushare 2019).

**RESEARCH GAP:**

The above pertinent literature study elucidates on the importance of the evaluation process in higher education institutions, the role of accreditation bodies, etc. However, no study so far has detailed the parameters of NBA in the context of its opportunities and challenges. This study is an effort to examine the details of various parameters enclosed in NBA accreditation, the motivations for the institutes and probable challenges. The paper emphasis on the opportunities to be tapped by the institutes by overcoming challenges for quality assurance.

**OBJECTIVES OF THE STUDY:**

1. To examine the various criteria enclosed for NBA Accreditation.

2. To find out the motivational attributes for the management institutes to seek NBA accreditation.
3. To understand the challenges faced by institutes seeking NBA accreditation.

#### **SCOPE OF THE STUDY:**

The research paper attempts to understand the various criteria enclosed in NBA accreditation. The points for criteria assessment are detailed. The topical scope of paper is confined to Quality assessment governing body i.e. NBA and for management institutes only. The geographical scope undertakes the management institutes in the Indian context. The functional scope is to critically examine various parameters of NBA accreditation, the motivations for organizations to seek quality assurance and the challenges faced by them.

#### **RESEARCH METHODOLOGY:**

The outline of the paper revolves around the quality assurance benchmark parameters set by National Board of Accreditation (NBA). The source of data collection is on the bases of secondary data. The key words related to ‘quality assurance’, ‘National Board of Accreditation’, ‘Management institute and Accreditation’, ‘Institute Rankings’ were searched on the websites. The relevant articles/papers were considered and reviewed for the present paper.

#### **NBA**

The key body for accreditation of management programmes is the National Board of Accreditation (NBA), set up under section 10(u) of the AICTE Act in 1987. With effect from January 7, 2010, it was given an autonomous status to achieve ‘assurance of quality’ and ‘relevance of education’ (NBA, 2013). Apart from the NBA, the National Assessment and Accreditation Council (NAAC), also accredits institutions of management education in India (NAAC, 2013).

#### **NBA Regulatory Model**

NBA consists of ten criteria. Each criterion is a reflection of quality parameter. Each Parameter is sub-divided into sets of items to be judged and evaluated. These quality parameters are converted in a quantitative metrics, by means of attainment of score or allocation of marks. Compliance with the set benchmark of standards will ensure adherence to quality assurance.

#### **CRITERIA AND STANDARDS:**

##### **Criterion 1:**

Criterion deals with the vision, mission and program educational objectives and has 50 grades. These grades are spread across the parameters which include vision and mission statements, program educational objectives (PEOs), framing its process, How effectively the institutes disseminates this information among its stakeholders, A matrix of mapping of Program educational objectives(PEOs) to elements of mission statement by marking level of relevance is expected. This point has provoked many institutes to rethink about the vision and mission statements (elements), as it is expected to be shaped by program educational objectives and relevance has to be mapped. The institutes should seize this opportunity to redesign these drivers that defines the path ahead. These statements are the reflection of mark of quality assurance to be communicated to the society. The challenge lies in transforming the broad vision and mission statement into items of program educational objectives and in quantifying them.

##### **Criterion 2:**

The second criterion encloses the parameters of Governance, leadership and financial resources and the scores assigned are 100. The governing structure of the organization, administration bodies, their memberships, details of minutes of meetings, the transparency maintained with employees with reference to service rules and policies updated to faculties and students. Formulation and implementation of the strategy is crucial task. The organization should frame policies to motivate faculty members for their continuous development. The distribution of financial and administrative responsibility and authority has to be specified. Various committees, like Grievance redressal committee, anti-ragging committee, etc are formulated and transparency is ensured by uploading the relevant information on the website. The staff selection process has to be in conformity with the norms and rules of the organization/university. The stability of the employees has to be ensured. Summary of the financial resources available and its utilization by proper allocation of budget has to be prepared. The audited reports should be uploaded on the institute’s website.

The platform of accreditation plans for upliftment of faculty development and motivates the institutes to frame a policy for the faculty excellence. Permitting paid leave for attending FDPs, their travel and allowance, financial aid in attending workshops, winter schools, publications, etc to name a few. This aspect definitely helps in quality enhancement of faculties. The faculties are stuck up in day-to-day routine of teaching, assessment,

completion of administrative work. The documentation, report generation and its maintenance serves as a proof, Hence, becomes mandatory.

**Criterion 3:**

The program outcomes are mapped with course outcomes and the level of relevance is mapped. Each course faculty evaluates the students by assessing them through various assessment tools, like mid-semester exam, case study, MCQs, quiz, presentation, report writing, projects, etc. A tedious task of recording PO attainment and CO attainment is accomplished. This task is time consuming for a faculty to achieve, who teacher more than 3-4 courses. Many a times, a visiting faculty (expert) ensures completion of syllabus for that particular course and is not more involved in this task. In such scenario the responsibility for this criterion rests on in-house faculty and here lies the challenge. An ERP software proves to be helpful in this regard. Institute have to allocated fund for ERP implementation and maintenance.

**Criterion 4:**

The fourth parameter is dealing with Curriculum & Learning Process followed in the institute. This criterion evaluates the programme curriculum development as per industry to bridge the curium gap as well as achievement of the outcome of programme. The number of sessions conducted for practice or tutorial help to achieve course outcomes gets measured. This parameter measure how the institute have implemented the system to assess each course for quality improvement. This Criterion check implementation of program core, electives subject and summer projects, dissertation, seminars if any. If the course is affiliated with any university, then the institute has to present how institute ensures the compliance as per university programme outcome, the action plan adopted to bridge the gap etc. Here institute is guided to prepare an academic calendar to plan activities. These activities will lead to the planning of guest sessions and workshops, seminars, etc. Institute also guided here to implement a comprehensive mechanism for summer projects and dissertations to enhance quality in the project report and learnings of students.

**Criterion 5:**

This fifth parameter has given more emphasis on student quality and performance in programme. The admitted students having excellent entrance scores signifies their progress. As well as admitted students' geographical diversification indicates the reach of the institute in a state or in the nation. The gender ratio of admitted students signifies the preference of students to get enroll in the institute course. The final grade obtained by students presents an increasing trend, then it is more favorable to the institute. The fifth criterion is the link with the ninth criterion to measure the student's inclination towards higher studies as well as towards competitive exams. This parameter ensures how many students got a placement through the institute. This parameter also gives emphasis on how students got involved in different organized events of institute and research of students.

Institutes face a challenge to get geographically diversified students in university-affiliated courses. The autonomous institutes are facing challenges to admit more girls.

**Criterion 6:**

The sixth parameter is dealing with faculty attributes and contributions. This parameter gives more focus on the quality of teaching faculties working in institutes. This parameter gives importance to the qualification of faculty, the experience of faculty, research of faculty. To enhance more quality features, the emphasis has given on permanent/ contract faculty members, adjunct faculty and retention of faculty. This criterion guided faculty members to adopt innovative ways to conduct sessions with help of information and technology. The institutes were guided to motivate faculty members to do more research and consultancy services. It is presumed that institutes have a provision of funds for the participation of faculty in faculty development programmes, workshops, and conferences to sharpen their skill set to develop cases.

**Criterion 7:**

The seventh parameter is dealing with industry & international Connect. This parameter is more focused on industry participation in curriculum development and supervisor/assessor which will result in enhancement of students as per industry. To provide quality education apart with the foreign universities NBA guide to have international connect for students or faculty for research and development. This criterion guided Institutes to have different MOU with industry.

Sponsored project from the industry is the biggest challenge for faculties because still, Indian, corporate don't consider educating community to solve any issues or development of procedures or conduct surveys etc. Industry people on board or in assessment in this regard institute must put up effort. A strong association with alumni will be beneficial the institute for industry connect.

**Criterion 8:**

The eighth parameter deals with the infrastructure of the institute. The main objective of the criterion is to check the availability of best infrastructural facilities to the student like a library, canteen, hostel, medical facility, ITC unable classrooms, indoor and outdoor sports facility, etc. This criterion confirms whether the institute has all the required infrastructure with updated books and software. Institute is directed to develop or implement a learning management system. This LMS will lead to automation of documents and handling of e-content.

To provide outdoor and indoor sports facility the institute need space as well as a staff or faculty who will take care of this sports activity. Educational campus able to offer medical facility but one-course offering institute not able to offer this facility. Institute needs to update all hardware and software to offer quality ITC services.

**Criterion 9:**

Criterion deals with the Alumni Performance and Connect. This parameter gave importance to the registration of the alumni association and the role of alumni. The alumni of the institute must get involved in alumni association meetings, mentoring, project guidance, special session, or assist students to become entrepreneurship. Some institutes have started entrepreneurship cell which deals with creating a support system to motivate students to become an entrepreneur in coming future.

Alumni association registration and actively working of this association need the involvement of alumni. To appoint an active person to this Alumni association is challenging as well as conducting meetings.

**Criterion 10:**

Criterion deals with the Continuous Improvement done by the institute in relation to programme outcome, curriculum, adopt new pedagogy for programme course. Institutes are guided to conduct academic review meetings to ensure quality improvement in the curriculum as per industry needs. The employability and acceptance of students are measured through the placement of students. This criterion is giving importance to how many students choose for higher studies like Ph.d or preparing for competitive studies. The growth of placement indicated the quality of the curriculum and students. The upward trend of students' good academic records got admitted into the institute, this indicates the exitance of mechanisms of continuous improvement.

This institute has to organize a special programme or expert talk to guide students for higher education as well as for competitive exams. The challenge for the institute is the majority of the students are fascinated to get placement, very few students are inclined to higher studies.

**Motivations:**

Accreditations / Grades are a seal of quality mark that serves as a jewel on the crown of the educational institute. It uplifts the ranking of the institute in terms of today's competitive era. A vision and mission of an institution for academic excellence, good governance, and financial resource utilization for upgradation of the institute from all the perspectives will help in improving the status in terms of quality service. Doctorate faculties with a large pool of knowledge by means of attending FDPs, Certifications, Participations in various events, workshops, paper publications, conference proceedings, case studies, development of MOOCs courses, best research paper awards, excellence academic awards, consultancy projects, government/ non-government funded projects, academia-industry tie-ups, excellent placements records, etc proves to be an intangible asset for any educational institutes. This intangible asset ultimately sets an important factor in consideration of admissions, from parents and students' perspective.

**Challenges:**

Institute guide faculty members to documents all activities conducted by them as well as same faculty is playing role guardian for students. Some institutes have made research and consultancy services as one of big parameter for performance appraisal linked with increments. More weightages are given to development of teaching cases. In this regards proper FDPs as well as workshop need to be conducted where faculty will get comprehensive learning to write cases. Institute must invest in Sports activities as well as think of upgrading information technology aspect. Motivating students for higher education and to take competitive examinations. Establishment of active alumni association to get more industry involvement. Getting funded research projects from industry is again one of the challenging tasks. By overcoming challenges, the institutes can step ahead towards achieving excellence in quality enhancement for management course.

**CONCLUSIONS**

The National Assessment and Accreditation Council (NAAC) became obligatory in 2015 by the University Grants Commission (UGC) which linked it to the funding for the government-managed institutions. Then private institutes were guided to go for NAAC. Now many institutes are looking forward to getting National

board accreditation (NBA). The NAAC gave more emphasis on all documentation to ensure quality education. NBA gives more weightage to the outcome-based learning process with quality teaching and learning process to create quality employable man force.

The biggest motivational factor for the management institutes to get NBA accreditation is achieving the standard benchmarks which will create a brand name or get recognition in the educational sector. This will help the institute to get quality students admitted, following the quality mechanism to provide placement or motivate for entrepreneurship etc. The NBA needs many quality improvements in the institute, it needs investment, if the institute treats this investment as a long-term investment, then the institute will get returns on it. Faculty are more focused on research and development and adoption of new pedagogy, this will lead to improvement in the teaching-learning process. Successfully overcoming challenges of the NBA will lead to the creation of the strength of the institute.

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**OPTIMIZATION OF POLAR-LDPC CODES FOR 5G MODELING**

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**ABSTRACT**

The Communication industry is rapidly advancing towards 5G. The Prime Objectives of 5G are higher throughput, reliability, higher Bandwidth, high Spectral efficiency, high energy efficiency. Major challenges for implementation of 5G systems are related to introduction of noise or error during propagation of signal in wireless channels. To get maximum advantage of various features of 5G Communication advanced error correction techniques are required. Low density Parity Check codes (LDPC) and POLAR codes are proved to support high throughput and highly reliable error correction techniques for modeling of 5G. Both the codes can efficiently transmit data over a noisy channel with high data rate and lower BER. This paper focus on optimizing a POLAR-LDPC codes for modeling of 5G Communication System beside their advantages and limitations which can help in future improvement of the next Generation. In this paper, we investigate BER (Bit Error Rate) with various code rates and information block length to analyze the performance of LDPC and Polar codes.

**Index Terms:** 5G NR, Channel Coding, LDPC code, Polar Code, BER, and Computer Simulation Technology

**I. INTRODUCTION**

Communication is very essential in all over the world since long. There are various nature and types of communication like verbal, written and transmitted by other resources. Wireless communication especially mobile communication technology have upgraded from basic 2G to advanced 5G and served human kind with diverse revolutionary features. With each generation of mobile network released, In first generation mobile system was basic in technology and main focus was on voice signal communication. Unfortunately that it was not sufficient for accommodation of large number of users because it was using FDMA/ FDD multiple access technique and analog FM modulation. While in second generation mobile communication system digital modulation technique was used and TDMA/FDD multiple access technique was used. 2G was focused on improvement of the voice service along with providing text message service (SMS) to large number of users by using cellular concept and frequency reuse concept in GSM. 3G mobile system was revolutionary candidate for internet access on mobile with speed in order of MBPS. VoIP (Voice Over Internet Protocol) was also introduced in 3G [1]. 4G mobile system was expected to provide 100 MBPS data rate in mobile phone with high mobility environment. Technologies like WiMAX and LTE was supported by 4G. 4G system does not employ traditional circuit switched technique, instead of that it uses IP based communication. 4G technology fulfilled demand of live video streaming, high speed online gaming, multimedia offices and educational campuses, video conferencing etc. Recently, 5G is aiming to provide high speed broadband internet connectivity in society. IoT is the key technology based on 5G. Massive MIMO, mm Wave transmission, adaptive beam forming, NOMA (Non Orthogonal Multiple Access) are the key players of 5G technology. 5G network is expected to provide uninterrupted speed of around 1 Gbps. Goal of the 5G ‘new radio’ is to carry on the tendency of giving ever increasing great user experience and various advanced applications for cellular communications [2]. In any cellular system, the received data always is different than transmitted data because of transmission errors or noise introduced by wireless channel or fading. It is inevitable to detect the error and correct it to provide reliable communication. Channel coding technique is used to correct this error in wireless communication system. Channel coding performs the operation of adding extra bits in controlled manner to increase the reliability and decrease BER of the system and is proved to be very convincing building block of wireless communication technology [3]. Main purpose of channel coding are Error free transmission, High throughputs, Low latency, Improving SNR & BER, Better transmission quality, High bandwidth efficiency, High spectrum efficiency, High data rate etc. LDPC Codes and Polar Codes are extensively utilized for 5G systems due to their inbuilt benefits of exceptional bit error rate (BER) performance, high speed encoding and decoding processes, Lower bit error rate, lower delay are some of the important parameters.[4]

The major concern in providing good performance of wireless channel is to use proper error correcting code to enhance the BER performance at the receiver. Advanced channel coding methods are essential to attain error free wireless transmission for modern systems in 5G network. 3G and 4G communication systems employed turbo coding for error correction transmission. Previously Turbo Codes were used extensively but in advanced

generation they are reinstated by LDPC (low density parity check) Codes because the previous was suffered from poor performance. [5]

## II. OVERVIEW OF 5G (NR)

The 5G New Radio (NR) is being developed by the 3GPP as a new technology for radio access in the fifth generation of mobile networks. The original time frame for developing the standard was set in March 2017 at RAN#75. The first set of specifications, Release-15, was finished in June 2018, while the second release was completed on July 3rd, 2020, slightly delayed by the pandemic [6-8] This network as a base uses the LTE network to offer even higher throughputs and significantly higher wireless internet efficiency. Since LTE has served as a foundation for 5G NR, there are similarities between LTE and 5G NR. New radio networks are structured so that they are compatible with LTE, but with the aim of enabling higher spectral efficiency, shorter response time for the user plane, and greater traffic capacity.

The actual specific minimum requirements for the 5G network are indicated in Table 1 [9].

**Table I. Specific minimum requirements for the 5G network**

Parameter	Requirement
data rate	DL: 20GB/s UL: 10GB/s
spectral efficiency	DL: 30b/s/Hz (assuming 8 streams) UL: 15b/s/Hz (assuming 4 streams)
data rate	DL: 100MB/s UL: 50MB/s
User plane latency	eMBB: 4ms URLLC: 1ms
Control plane latency	20ms (encouraged to consider 10ms)
Connection density	1 million devices per km <sup>2</sup>
Reliability	99.9999% success prob.
Bandwidth	> 100 MHz; up to 1 GHz in > 6 GHz

5G network applications can be divided into three fundamental categories :-

- 1) Enhanced Mobile Broadband:-eMBB corresponds to achieving an enhanced user experience, by reaching higher data rates it should be greater than 10 GB/s,
- 2) Massive Machine Type Communication:- mMTC corresponds to the technology supporting massive amounts of devices with low costs and energy consumption. more than 1 million/km<sup>2</sup> connections are needed.
- 3) Ultra Reliable and Low Latency Communication (URLLC):- URLLC corresponds to the technology achieving high reliability and very low latencies. It must be under 1ms.[10]

## III. ERROR CORRECTING CODES FOR 5G

In this paper, two types of coding schemes used in the 5G network are presented: LDPC and Polar codes. LDPC codes are mainly used for user data whereas Polar codes are used for downlink and uplink transmission of control information. [11]

### A. LDPC Code

LDPC ( Low Density Parity Check) code comprise of strong FEC (Forward Error Correction) Coding system by that it can achieve exceptional error correction for very small value of SNR. Parity check matrix (H) with less number of non zero element in LDPC coding is used. Due to its efficient error correction capability, it is extensively used nowadays. In 5G system, it is known as NR- LDPC codes. The basic theory related to LDPC codes are as follow [12-15].

*Tanner Graph:* Bipartite graph is used to show Tanner's graph of H matrix. Sequence of nodes are generated and terminated at same nodes. A (3, 7) parity-check matrix for code word length of 7-bit is shown below.

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 \end{bmatrix}$$

(3,7) Parity Check Matrix (H)

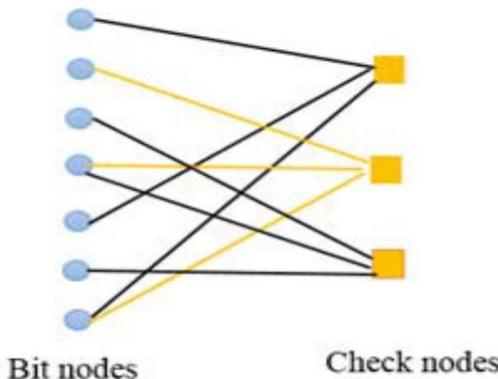


Fig. 1 Tanner Graph Depiction of given Matrix

### 1. Encoding process of LDPC

LDPC codes perform efficiently and compete turbo codes in terms of performance. Encoding process of LDPC uses parity check matrix with Double-diagonal structures. The encoding is done systematically. Some systematic bits are punctured at the output of the encoder. These punctured bits will never come into circular buffer [16]. Below is the parity check matrix (H)

$$H = [C^T \mid I] = \begin{array}{c|ccccc|cccccc} d_1 & d_2 & d_3 & d_4 & d_5 & d_6 & p_1 & p_2 & p_3 & p_4 & p_5 \\ \hline 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{array}$$

Generator matrix G is derived from Parity Check Matrix H.

$$G = [I \mid C] = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Channel code word vector (b) is derived from generator matrix G and data vector 'a'.

$$b = a \otimes G$$

### 2. Decoding of LDPC codes

Decoding of LDPC code is carried out by using various steps.

Step-1: Iterative Decoding Algorithms (Message Passing Algorithms)

Step-2: Based upon Firm (hard) decision

Step-2(a): Bit Flicking Algorithm

Step-3: Based upon Flexible (soft) decision

Step-3 (a): Using Maximum Posteriori Algorithm (addition-multiplication Algorithm)

Step-3(b): Using Min sum Algorithm

(i) Weighted bit flicking

(ii) Modified Weighted bit flicking

(iii) Gradient descent algorithms

(iv) Set partition algorithms

Hard decision and soft decision decoding employed in algorithms according to its application. The most widely used algorithms are discussed below.

**a) Hard Decision Decoding:**

In hard decision decoding, check nodes are used to find error bits. Various nodes transmits message to check nodes where parity of the bit is checked. If the required parity is satisfied, data bits are sent back to the message nodes. If the parity is not satisfied, check nodes will adjust bits to satisfy parity and then send to nodes.

$$H = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & 1 & 0 & 1 \end{bmatrix}$$

Parity Check Matrix for Hard Decision Decoding

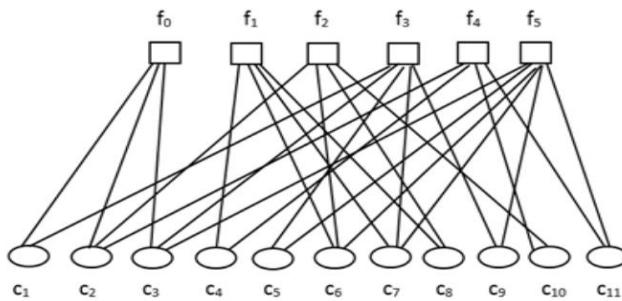


Fig. 2 Tanner graph representation

If check nodes finds an error and different bits control also finds error in its checks, then bits in the boxes are error bits.

- Bit flipping algorithm**

The bit flipping algorithm works as hard decision initially for each received bit. In this, bits are passed from the nodes of Tanner graph. Bit node transmits a bit to every check nodes whether it is a 1 or 0. Then each check node will transfer bit to the entire connected bit nodes, by stating value the bit either 1 or 0 according to information of check node.

The check nodes will decide whether its parity check condition is fulfilled or not. If we perform modulo-2 sum of the incoming bits, and its output results in zero then the condition is fulfilled. If most of the bits received by a bit node are dissimilar than received value, after that the bit node will change its existing equation will satisfy. If one or two bits of data is missed from the input data, Bit flipping algorithm is useful. [17]

**b) Soft Decision Decoding**

For belief propagation, soft decision decoding gives higher performance in LDPC codes. In this decoding, received bit stream is conditional probability that in received vector received is 1 or 0. Priori probability for the incoming bits are known in advance before running of decoder, while posterior probability is the bit probability returned after decoding process. Min sum algorithm, Sum product algorithm and message passing algorithm are some important algorithms of soft decision decoding method.

- Sum Product Algorithm**

Sum product algorithm is fundamental decoding algorithm nowadays for capacity approaching codes like LDPC and turbo codes. Variable node is given Log Likelihood Ratio (LLR) as input. It allocates to the variable as shown in equation (2).

$$vi = LLRn \sum_{j \neq 1} Cj \quad (2)$$

Where,

n is variable node, having values 1,2 ...n

i, j are variable node amount.

Equally, Check node process can be described as below

$$Ck = 2\tanh^{-1} \prod \tanh\left(\frac{Vi}{2}\right) \quad (3)$$

Where Ck is check node and 1 and 2 is degree of check nodes. It is essential to use multiple nonlinear behaviors in an algorithm.

- **Min sum Algorithm**

By slightly changing the sum product algorithm, it can be applied to execute a deviation of maximum likelihood (ML) sequence decoding instead of APP decoding. The resulting min sum algorithm turn into a modified version of the Viterbi algorithm by Trellis method. In fact, likelihoods are generally transformed to log likelihoods, that transform products into sums and gives the max sum algorithm. On the other hand if log likelihoods are transformed to negative log likelihoods, which transforms max to min and generates the min sum algorithm. Initially, variable nodes are dispersed LLR amounts and then it will arrive at check nodes. By using check node restore process, by converting the check node, the smallest of factual amount is produced and the same are delivered to the variable node.

All received information bits are composed at the edge of iteration. This bulk is called variable node bulk. At the frame of the procedure, the problem is confirmed. This method repeats till the received bits are corrected or it will be direct towards the ending norm [17].

- **Message passing algorithm**

Message passing algorithm which is iteration based algorithm. It uses factor graph to factorize the inclusive function of many variables into product of simpler local functions. Decoding of LDPC code is carried out by message passing algorithm by factor graph method. Factor graphs are generated by simply connecting check nodes with variables. Nodes swap the information bits along the edges of the factor graph to execute decoding process.

As shown below, in the first iteration process, the bits that are received from the channel are transferred to the variable nodes and from there bits are propagated from the edges to the nearby check nodes since there are no incoming bits from the check nodes. This process repeats till codeword is found.

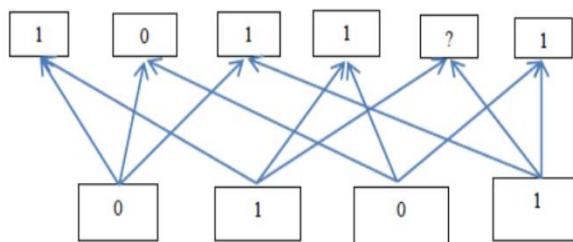


Fig. 3 First iteration process

#### B. POLAR Code

Polar codes is a type of linear block error correcting code which provide nice structure for efficient encoding and decoding in advanced wireless communication systems. Shannon channel capacity is achieved by this coding method. It is simple and provides lower value of BER. It is used nowadays in 5G technology because of its higher error correction capability. The code structure consists of multiple recursive sequence of a convert the physical channel into virtual channels. This virtual channel will be polarized when more number of recursions occurs. It appropriately works as control channels in 5G-NR systems.[19]

##### 1. Encoding of polar codes

Butterfly structure and tree structure are used to design encoder of Polar codes. Consider a base matrix is G, generator matrix is GN, where N is block length of a code. Generator matrix is produced by doing the Kronecker product of G  $\otimes$  n, where n = ( $\log_2 N$ ).

$$G = [1 \ 0 \ 1 \ 1] \quad (3)$$

Consider above is the base matrix. Kronecker product and traditional matrix multiplication are different process. Process is as below. M1 and M2 are two matrices, and then the Kronecker product of both is shown below.

$$M1 = [a \ b \ c \ d] \quad M2 = [a * \ b * \ c * \ d]$$

$$A \otimes B = \begin{bmatrix} a & \begin{bmatrix} a^* & b^* \\ c^* & d^* \end{bmatrix} \\ c & \begin{bmatrix} a^* & b^* \\ c^* & d^* \end{bmatrix} \end{bmatrix} \begin{bmatrix} a & \begin{bmatrix} a^* & b^* \\ c^* & d^* \end{bmatrix} \\ c & \begin{bmatrix} a^* & b^* \\ c^* & d^* \end{bmatrix} \end{bmatrix} = \begin{bmatrix} aa^* & ab^* & ba^* & bb^* \\ ac^* & ad^* & bc^* & bd^* \\ ca^* & cb^* & da^* & db^* \\ cc^* & cd^* & dc^* & dd^* \end{bmatrix}$$

In this process, bit to bit multiplication of each element of matrix M1 with the entire M2 matrix is done. As a result, we can derive the generator matrix at the  $n^{\text{th}}$  product of G as shown in equation (4).

$$G = G \otimes n \quad (4)$$

Initially, as per appropriate sequence, unremitting channels are positioned with frozen bits, and more reliable channels obtain message bits. Subsequently above code words are transferred to polar encoder together with sequence of Cyclic Redundancy Code bits. Multiplication of generator matrix G and code words  $u_1, u_2, \dots$  are processed as in Eq. (5).

$$y = u * G \quad (5)$$

After finishing above operation mentioned in equation (5) the encoded code words are transmitted to AWGN channel. At the receiver end, the received bits go through demodulation process to get beliefs (r). As shown in Eq. (6).

$$r = \text{real}(r_{\text{x}} \text{bits} * (1 - 1i)) \quad (6)$$

beliefs depends on the value of r. for higher value of r belief will be more strong. "If the belief is positive, it is mapped to 0, and if it is negative, it is mapped to 1".

## 2. Decoding of polar codes

### a) SC decoder

Successive cancellation (SC) decoding is explicitly configured for Polar Codes. In the case of polarized channel communication, summation of the probability of error of all the information achieves block error rate improvement using SC decoding. QPSK modulation is done to encoded bits and then given to AWGN noise. Then information is transferred to polar decoder. Correlation between the source bits are implemented by butterfly unit of polar encoder. This guarantees each encoded message bit with a particular index to depend on all its earlier bits with lesser indices. This kind of connection directs to a good decoding performance since back tracing method is implemented for detecting decoded bits and in this way it comprises the main focused plan of a fundamental decoding algorithm. [20-22]

### b) SCL Decoder

Successive cancellation list (SCL) decoder provides competent output than SC decoder.  $O(LN \log N)$  is the complexity of SCL. It has a very critical parameter called the list size L. All the time the powers of 2 of L mean minor error rates at the cost of higher running times and more memory usage. The SC decoder is simple in configuration, easy to understand, and rapid in execution. Though, some limitations are present like to take a decision at each node. It is time consuming process.

When message bits reach to the node, a decision either 0 or 1 has to be taken at  $\hat{u}$ . So, as shown in figure one direction to be decided at that node. SC decoder can correct error in spite of the fact that the pick made at the leaf node is false.

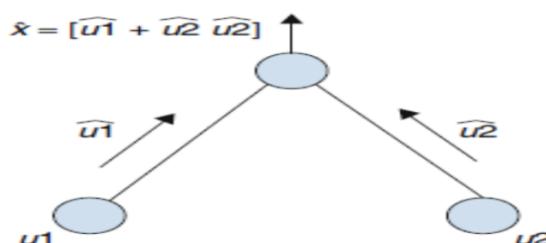


Fig. 4 Tree of SC decoder

Nevertheless, the last code word will contain error, as single mistake is done at that node. Therefore, when an error occurs in decision, it can't be corrected. To beat this challenge, "List" was introduced. In this algorithm, two path decision to be taken in both the paths  $\hat{u} = 0$  and  $\hat{u} = 1$  [23-24].

**c) CRC aided SCL Decoder**

CRC (Cyclic Redundancy Code) aided SCL decoder can be applied for downlink and uplink of any system. Enhanced mobile broadband (eMBB) and the broadcast channel (BCH) uses this decoder.. For the downlink process, the input bits are supplied before polar encoding. The CRC bits are attached at the last of the message bits. This process of interleaving is not specified for the uplink [25].

- **Frame Processing Loop**

Here Block Error rate simulation processes with application of the various coding components are analyzed.

Below described steps are executed for each frame:

- K-crcLen random bits are generated,
- Calculation of CRC is and affix bits at last.
- The CRC affixed bits are polar encoded to the original code block length
- Rate-matching is executed to send E bits
- QPSK modulation is done with above E bits
- Addition of AWGN noise
- Signal with noise is demodulated by soft QPSK to output LLR values
- Execution of rate recovery considering either puncturing, shortening or repetition
- Polar decoding of recovered LLR values by CA SCL algorithm.
- From decoded K bits, the first K-crcLen bits are correlated with transmitted bits to update the BLER matrix and BER.

#### IV. SIMULATION & RESULTS

LDPC and Polar coding schemes for different message lengths and code rates was performed using MATLAB. For simulation purposes, the Additive White Gaussian Noise (AWGN) channel model serves as a noise channel. It has been chosen as it is able to imitate the naturally occurring noise that exists all around us. The simulations are carried on considering different message lengths and variable code rates.

**Table 2. Simulation parameter for Polar codes**

PARAMETER	POLAR CODE
Channel	AWGN
Modulation	QPSK
CRC	24C
Message Length	54,94,128,164
Code Rate	1/2,1/3,1/4,3/4
Decoder	CRC Aided SCL(L=2,4,8,16)

1) K=54, DL, L=2, Code Rate=1/2, 1/3, 1/4, 3/4

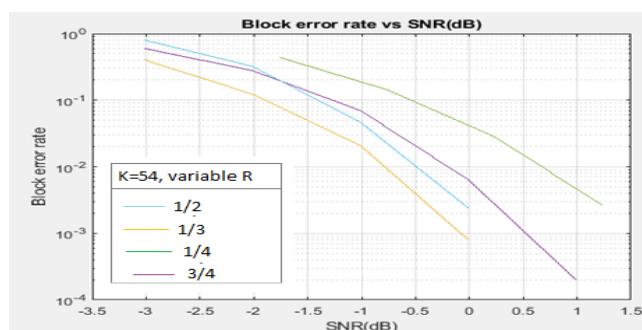


Fig. 5 Polar coding Downlink –BER Performance for 54bits long message for variable code rates

2) K=54, DL, Code Rate=1/2, L=2, 4, 8, 16

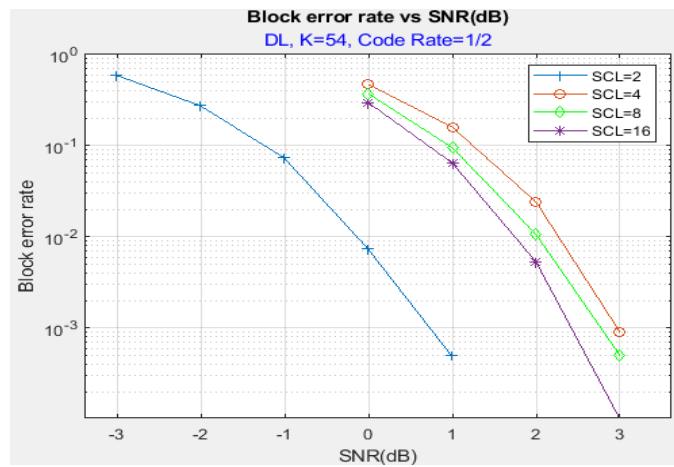


Fig. 6 BER Performance for 54bits message for 1/2 code rates and variable list size L

3) L=8, Code Rate=1/2, K=54, 94, 128

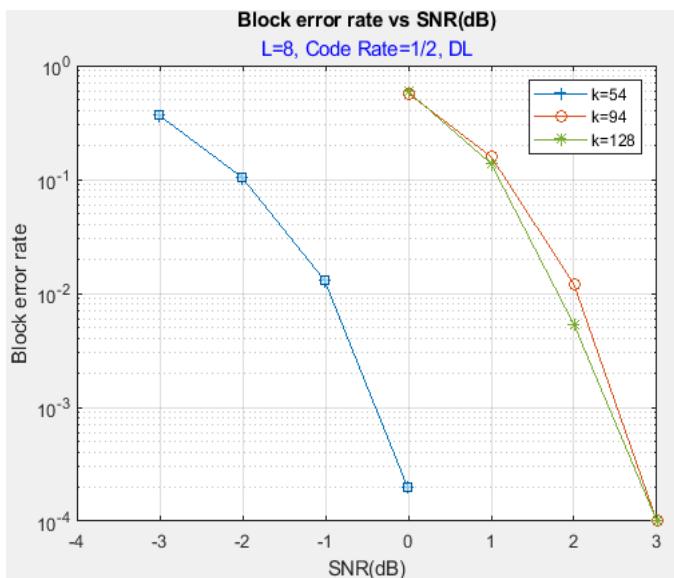


Fig. 7 Polar coding Downlink BER Performance for different message length

This coding scheme is suitable only for uplink, because in downlink transmission of long messages in Polar coding because they exceed the maximum input length for PDCCH that must be less than or equal to 164 (140 information bits + 24-bit CRC). Therefore, BER performance simulation can be done only for a Small information message. Simulations have been performed using the CRC-SCL algorithm with the decoder list size L=8. Fig 5 shows the simulation results for variable code rate (1/2, 1/3, 1/4, 3/4) in the case of small list size. Fig. 6 shows the simulation results for variable list sizes {2, 4, 8, 16} in the case of 1/2 code rate.

Evidently, a larger list size of the CRC-SCL decoder means enhanced Polar coding performance but with a retreating effect (larger L value means lower error rate, but longer simulation time). BER follows a typical curve - decreases with the higher values of SNR.

- **LDPC CODE**

**Table 3. Simulation parameter for LDPC codes**

PARAMETER	POLAR CODE
Channel	AWGN
Modulation	QPSK
Message Length	648,1296
Code Rate	1/2,2/3,3/4,5/6
Decoder	Min-sum

- LDPC coding –BER Performance for 648 bits long message for variable code rates

1) K= 648, Code Rate=1/2

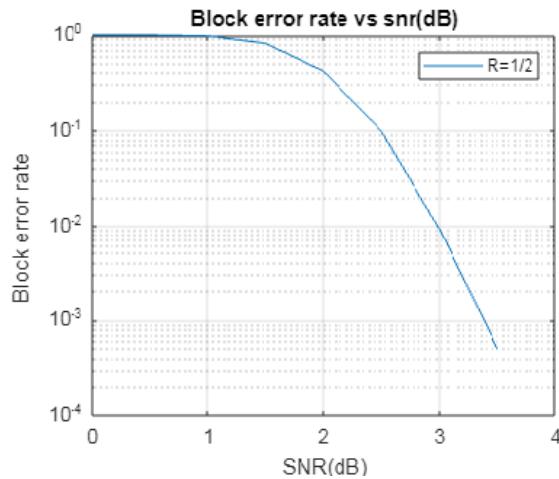


Fig. 8 LDPC code – BER performance for K= 648, Code Rate=1/2

2) K= 648, Code Rate=2/3

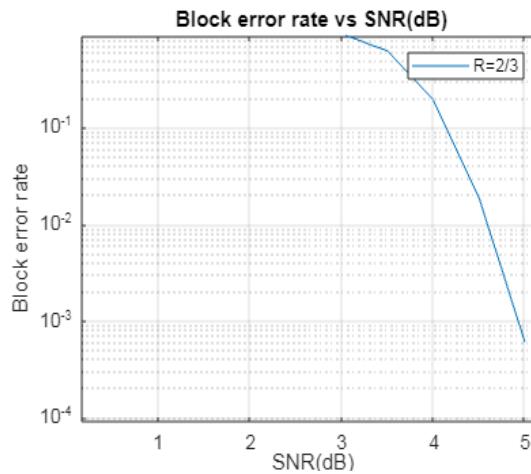


Fig. 9 LDPC code – BER performance for K= 648, Code Rate=2/3

3) K=648, Code Rate= 3/4

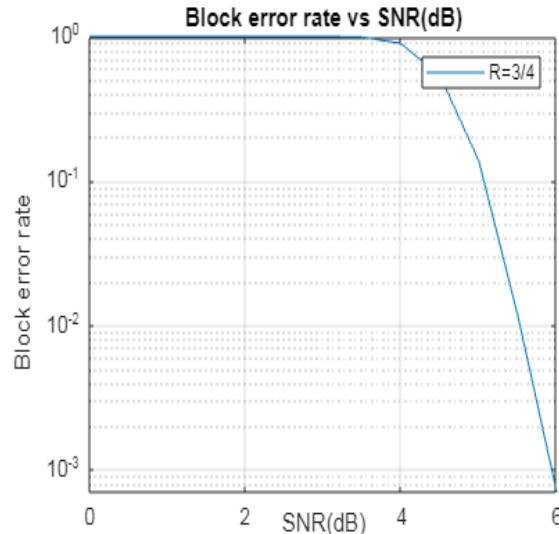


Fig. 10 LDPC code – BER performance for K= 648, Code Rate = 3/4

- LDPC coding –BER Performance for (648, 1296) bits long message for variable code rates 2/3.

1) K=648, R=2/3

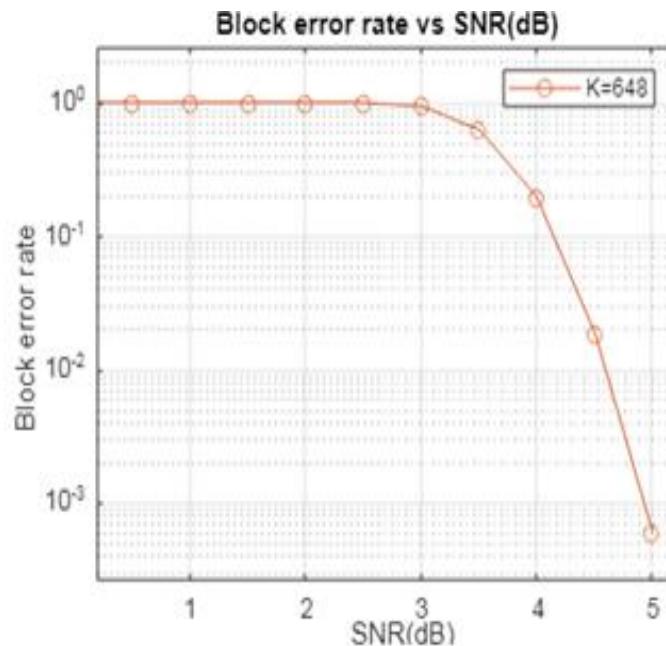


Fig. 11 LDPC code – BER performance for K= 648, Code Rate=2/3

2) K=1296, R=2/3

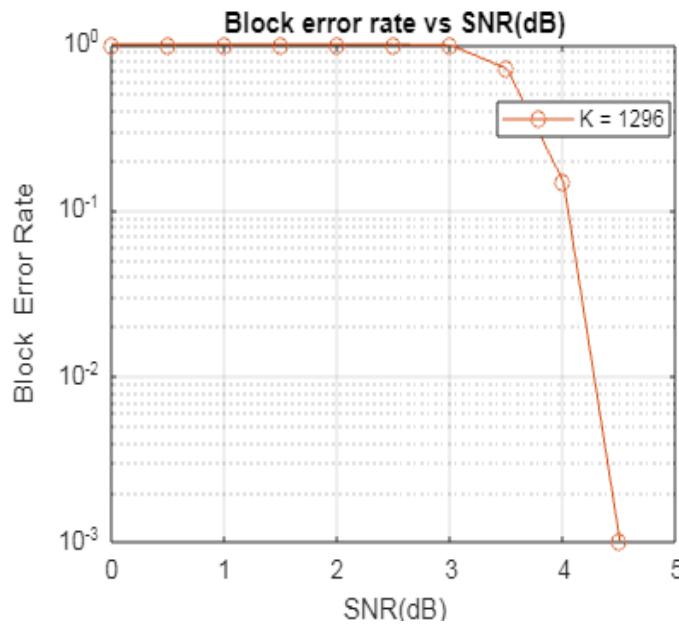


Fig. 12 LDPC code – BER performance for K= 1296, Code Rate=2/3

## CONCLUSION

LDPC and Polar error correcting codes are analyzed with respect to various performance measuring parameters like SNR and BER with different values of message length and code rate by using MATLAB simulation. We simulate the performance of 5G codes with various code rates and code lengths for AWGN channel. We used Min-sum and CRC Aided SCL decoding algorithm. We obtained the specific relationship between code rate and code length, by analyzing SNR vs BER Graph. We optimize the best output for polar code by using Small length of bits(i.e 54, 64,128) and higher code rate (i.e 1/2, 1/3, 1/4, 2/3) with small list size (i.e 2, 4, 8, 32). LDPC Code with min-sum decode, we achieved better BER Performance at large block length..We optimize the best output for LDPC code by using Large length of bits (648, 1296) and higher code rate (1/2, 2/3, 3/4).For large block lengths LDPC Codes performs superior and for short block lengths Polar codes performs superior.

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**AN ANALYTIC AND COMPARATIVE STUDY OF  $\beta_1$  AND  $\beta_2$  NEAR-RINGS****HRISHIKESH PALIWAL, RAKESHWAR PUROHIT, BHUMIKA SHRIMALI AND KHEMRAJ MEENA****ABSTRACT**

This paper aims to establish the comparative theorems, examples and propositions between  $\beta_1$  and  $\beta_2$  Near-Rings symmetrically. Moreover, some theorems and examples have shown the necessity of the comparative research of Near-Rings.

**Keywords and phrases:**  $\beta_1$  Near-Ring,  $\beta_2$  Near-Ring, Idempotent, Near-Field.

**1 INTRODUCTION**

This paper is inspired by the work of S.Uma and G.Sugantha about the study of  $\beta_1$  Near-Ring and  $\beta_2$  Near-Ring respectively. Here  $N_r$  stands for Right Near-Ring i.e.  $(N_r, +, \cdot)$  and If  $N_r$  is additive group (need not to be commutative), and is multiplicative semi group also it satisfies right distributivity, is known as right Near-Ring.[2] A **Regular Near-Ring** is the Ring that satisfies the following property:  
For every  $x \in N_r \exists y \in N_r$  s.t.  $x = xyx$  [2].

A mapping  $\phi$  defined from  $N_r$  to  $N_r$  is called a **Mate Function** for  $N_r$  if for every  $x \in N_r, x \phi(x) = x$  [5].

Analogous to the comparative study of  $\beta_1$  and  $\beta_2$  Near-Rings, we are presenting some examples and also obtaining their complete characterization [3]. For the basic concepts, notations and terms used we refer to [1], [2].

**2 NOTATIONS**

Throughout the paper these are some Notations that will be used:

1.  $N$  denotes the set of all Nilpotents of  $N_r$ .
2.  $Z(N_r) = \{a \in N_r ; ax = xa \forall x \in N_r\}$  denotes Centre of  $N_r$ .
3. All distributive elements  $N_r$  is represented by  $N_d = \{a \in N_r ; a(x+y) = ax + ay \forall x, y \in N_r\}$ .
4. Set of all idempotents of  $N_r$  is represented by  $E$ .
5. Zero-symmetric part of  $N_r$  is denoted by  $N_0 = \{a \in N_r ; a0 = 0\}$ .

**3 PRELIMINARIES**

Here are some important definitions and lemmas which were reviewed and useful in advance study of related topics.

**Lemma 3.1.** (Lemma 2.5, of [7]) For any ideal  $I$  of  $N_r$ ,  $N_r I \subseteq I$  and hence  $N_r I N_r \subseteq I$  if  $N_r$  is a zero symmetric Near-Ring.

*Proof.* If any  $r \in I$  and  $a, b \in N_r$  then  $a(b+r) - ab \in I$ . We have  $N_r$  is a zero-symmetric Near-Ring so put  $b = 0 \Rightarrow a(b+0) - a0 = ar \in I$ . Hence  $N_r I \subseteq I$ . Also  $I N_r \subseteq I$ . Hence  $N_r I N_r \subseteq I N_r \subseteq I \Rightarrow N_r I N_r \subseteq I$ .

**Lemma 3. 2.** (Problem 14, of [1]) For all  $a \in N_r$ ,  $a^2 = 0 \Rightarrow a = 0$  iff there is no non-zero nilpotent elements in  $N_r$ .

**Definition 3.1.** (Definition 1.31 of [2]) A sub Near-Ring  $R$  of  $N_r$  is called invariant Near-Ring If  $R N_r \subseteq R$  &  $N_r R \subseteq R$ .

**Lemma 3. 3.** (Lemma 2.6, of [7]) Idempotents are central if  $E \neq 0$  and  $N_r$  is a sub commutative Near-Ring.

**Lemma 3. 4.** (Theorem 8.3, of [2]) If  $N_d \neq \{0\}$  and  $N_r x = N_r \forall x \in N_r - \{0\}$  then a zero-symmetric Near-Ring  $N_r$  is a Near-Field.

**Lemma 3. 5.** (Lemma 3.2, of [5]) If  $\phi$  is a mate function for  $N_r$  then every  $x \in N_r, x \phi(x), \phi(x)x \in E$  and  $N_r x = N_r \phi(x)x$  and  $x N_r = x \phi(x) N_r$ .

**Definition 3. 2.** (Definition 9.4, of [2]) If  $abc = acb$   $a, b, c \in N_r$  then the Near-Ring  $N_r$  is called weak commutative.

**Lemma 3.6.** (Proposition 2.9, of [6]) Let  $N_r$  be any Pseudo commutative Near-Ring and  $e$  is its right identity then  $N_r$  is weak commutative.

**Theorem 3.1.** (Theorem 1.62, of [2]) Let  $N_r$  be a Near-Ring and  $G$  be a sub direct product of sub directly irreducible Near-Rings  $N_{r_i}$ 's then  $N_r \simeq G$ .

**Theorem 3.2.** (Theorem 5.9, of [4]) Every zero-symmetric  $\beta_1$  Near-Ring with a mate function ' $f'$  has (\*, IFP).

**Theorem 3.3.** ([2])

1. Every sub-directly irreducible zero symmetric Near-Ring  $N_r$  without non-zero nilpotent is integral.

2. Let  $a$  be any idempotent of  $N_r$  and  $a \neq 0$  then  $a = e$  where  $e$  is the right identity.

#### 4 DEFINITION OF $\beta_1$ AND $\beta_2$ NEAR-RINGS WITH EXAMPLES

These are detailed definitions of  $\beta_1$  and  $\beta_2$  Near-Rings with some of useful Examples.

**Definition 4.1.** A Right Near-Ring  $N_r$  is said to be  $\beta_1$  Near-Ring if  $xN_r y = N_r xy \forall x, y \in N_r$ .

**Definition 4.2.** A Right Near-Ring  $N_r$  is said to be  $\beta_2$  Near-Ring if  $xN_r y = xyN_r \forall x, y \in N_r$ .

**Example 4.1.** Let  $(N_r = \{1, 5, 7, 11\}, \times_{12}, \cdot)$  be a Near-Ring where  $(N_r, \times_{12}, \cdot)$  be a particular Klein's four group then

**Example 4.2.** Let  $(N_r = \{1, 2, 3, 4, 5, 6\}, \times_7, \cdot)$  be a Near-Ring where  $(N_r, \times_7)$  be the group of integers modulo 6 then

(a) $(N_r, \times_{12}, \cdot)$ is the $\beta_1$ Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 4, p.408 of [2])	(b) $(N_r, \times_{12}, \cdot)$ is the $\beta_2$ Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 12, p.408 of [2])																																																		
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(c) $(N_r, \times_{12}, \cdot)$ is not a $\beta_1$ Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 8, p.408 of [2])	(d) $(N_r, \times_{12}, \cdot)$ is not a $\beta_2$ Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 13, p.408 of [2])																																																		
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(a)  $(N_r, \times_7, \cdot)$  is zero-symmetric  $\beta_1$  Near-Ring with no identity where second operation ( $\cdot$ ) is defined according to Pilz (scheme 36, p. 409 of [2])

(b)  $(N_r \times_7, \cdot)$  is zero-symmetric  $\beta_2$  Near-Ring with no identity where second operation ( $\cdot$ ) is defined according to Pilz (scheme 36, p. 409 of [2])

#### 5 SIMILAR PROPERTIES of $\beta_1$ AND $\beta_2$ NEAR-RINGS

In this section we have studied some similar properties of  $\beta_1$  and  $\beta_2$  Near-Rings ([4],[7]). Throughout this section  $N_r$  denotes the Right Near-Ring and  $N_r^* = N_r - \{0\}$

**Proposition 5.1.** Every homomorphic image of  $\beta_1$  Near-Ring is also  $\beta_1$  Near-Ring.

*Proof.* The proof is straight forward.

**Proposition 5.2.** Every homomorphic image of  $\beta_2$  Near-Ring is also  $\beta_2$  Near-Ring.

*Proof.* The proof is straight forward.

**Theorem 5.1.** Every  $\beta_1$  Near-Ring with a mate function is sub directly irreducible Near-Ring iff it is a Near-Field.

*Proof.* Let  $N_r$  be a  $\beta_1$  Near-Ring with a mate function  $f$  and  $A$  be the intersection of arbitrary family of non-zero ideals of  $N_r$ . Since  $N_r$  is subdirectly irreducible Near-Ring  $\Rightarrow A \neq \{0\}$ . Now if any  $x \in A$

$$\text{s.t. } x =/ 0 \Rightarrow xe = 0 \quad \forall e \in E \dots (1) \text{ By}$$

Theorem 3.2,  $ex = 0$

$$\Rightarrow ef(x)x = f(x)x \in E.$$

Thus  $xf(x)x = 0$  [by(1)]  $\Rightarrow x = 0$  which is not possible. So, no non-zero idem-potent of  $N_r$  is a zero-divisor ... (2) Let  $G$  be any non-zero  $N_r$  subgroup of  $N_r$  and let any non-zero  $x \in G$ . Now  $\forall a, a_1 \in N_r$ ,

$$(a - a_1x)f(x)x = 0. \text{ by}(2), a - a_1x = 0$$

$$\Rightarrow a = a_1x \in N_rG \subset G.$$

Thus  $N_r \subset G$ . Consequently,  $N_r$  has no non trivial  $N_r$ -subgroups. ... (3) Let  $a \in N_r - \{0\}$ . Then by (3),  $N_r a = N_r$ . Now, we have if  $E \subset Z(N_r)$  and  $Z(N_r) \subset N_d$ . Therefore,  $N_d \neq \{0\}$ . Thus  $N_r$  is a Near-Field. The converse of this theorem is straight forward.

**Proposition 5.3.**  $\beta_1$  Near-Ring need not to be Regular Near-Ring.

*Proof.* Let  $(N_r = \{1, 5, 7, 11\}, \times_{12}, \cdot)$  be a Near-Ring where  $\{N_r, \times_{12}\}$  be a particular Klein's four group then  $(N_r, \times_{12}, \cdot)$  is the  $\beta_1$  Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz.(scheme 4, p.408 of [2])

But it is not regular Near-Ring.

**Proposition 5.5.** Let  $N_r$  be a  $\beta_1$  Near-Ring and  $G$  be a sub direct product of sub directly, irreducible Near-Rings  $N_{r_i}$ 's then  $N_r \approx G$ .

*Proof.* Let  $N_r$  be a  $\beta_1$  Near-Ring then we have,  $N_r$  is isomorphic to a sub direct product of sub directly irreducible Near-Rings  $N_{r_i}$ 's [by Theorem 3.1] and under the projection mapping  $\pi_i$  every  $N_{r_i}$ 's is a homomorphic image of  $N_r$ .[by Proposition 5.1] We have every homomorphic image of  $\beta_1$  Near-Ring is again  $\beta_1$  Near-Ring. Hence every  $\beta_1$  Near-Ring is isomorphic to a sub direct product of sub directly irreducible Near-Rings.

**Proposition 5.7.** Every  $\beta_1$  Near-Ring which has identity 1, is zero-symmetric.

*Proof.* Let  $N_r$  be a  $\beta_1$  Near-Ring which has

**Theorem 5.2.** Every  $\beta_2$  Near-Ring with a mate function is sub directly irreducible Near-Ring iff it is a Near-Field.

*Proof.* Let  $N_r$  be a  $\beta_2$  Near-Ring with a mate function  $f$  and  $A$  be the intersection of arbitrary family of non-zero ideals of  $N_r$ . Since  $N_r$  is subdirectly irreducible Near-Ring  $\Rightarrow A \neq \{0\}$ . Now if any  $x \in A$

$$\text{s.t. } x =/ 0 \Rightarrow xe = 0 \quad \forall e \in E \dots (1) \text{ By}$$

Theorem 3.2,  $ex = 0$

$$\Rightarrow ef(x)x = f(x)x \in E.$$

Thus  $xf(x)x = 0$  [by(1)]  $\Rightarrow x = 0$  which is not possible. So, no non-zero idem-potent of  $N_r$  is a zero-divisor ... (2) Let  $G$  be any non-zero  $N_r$  subgroup of  $N_r$  and let any non-zero  $x \in G$ . Now  $\forall a, a_1 \in N_r$ ,

$$(a - a_1x)f(x)x = 0. \text{ by}(2), a - a_1x = 0$$

$$\Rightarrow a = a_1x \in N_rG \subset G.$$

Thus  $N_r \subset G$ . Consequently,  $N_r$  has no non trivial  $N_r$ -subgroups. ... (3) Let  $a \in N_r - \{0\}$ . Then by (3),  $N_r a = N_r$ . Now, we have if  $E \subset Z(N_r)$  and  $Z(N_r) \subset N_d$ . Therefore,  $N_d \neq \{0\}$ . Thus  $N_r$  is a Near-Field. The converse of this theorem is straight forward.

**Proposition 5.4.**  $\beta_2$  Near-Ring need not to be Regular Near-Ring.

*Proof.* Let  $(N_r = \{1, 5, 7, 11\}, \times_{12}, \cdot)$  be a Near-Ring where  $\{N_r, \times_{12}\}$  be a particular Klein's four group then  $(N_r, \times_{12}, \cdot)$  is the  $\beta_2$  Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz.(scheme 12, p.408 of [2])

But it is not regular Near-Ring.

**Proposition 5.6.** Let  $N_r$  be a  $\beta_2$  Near-Ring and  $G$  be a sub direct product of sub directly, irreducible Near-Rings  $N_{r_i}$ 's then  $N_r \approx G$ .

*Proof.* Let  $N_r$  be a  $\beta_2$  Near-Ring then we have,  $N_r$  is isomorphic to a sub direct product of sub directly irreducible Near-Rings  $N_{r_i}$ 's [by Theorem 3.1] and under the projection mapping  $\pi_i$  every  $N_{r_i}$ 's is a homomorphic image of  $N_r$ .[by Proposition 5.1] We have every homomorphic image of  $\beta_2$  Near-Ring is again  $\beta_2$  Near-Ring. Hence every  $\beta_2$  Near-Ring is isomorphic to a sub direct product of sub directly irreducible Near-Rings.

**Proposition 5.8.** Every  $\beta_2$  Near-Ring which has identity 1, is zero-symmetric.

*Proof.* Let  $N_r$  be a  $\beta_2$  Near-Ring which has

<p>identity one. Then for all <math>x, y</math> in <math>N_r</math>, <math>xN_r y = N_r xy</math>. Put <math>y = 1</math> then <math>xN_r 1 = N_r x 1 \forall x \in N_r</math>. When <math>x = 0</math>, <math>0N_r = N_r 0 = \{0\}</math>.  <math>\Rightarrow ox = 0 \forall x \in N_r</math> It follow that <math>N_r</math> is zero-symmetric.</p>	<p>identity one. Then for all <math>x, y</math> in <math>N_r</math>, <math>xN_r y = N_r xy</math>. Put <math>y = 1</math> then <math>xN_r 1 = N_r x 1 \forall x \in N_r</math>. When <math>x = 0</math>, <math>0N_r = N_r 0 = \{0\}</math>.  <math>\Rightarrow ox = 0 \forall x \in N_r</math> It follow that <math>N_r</math> is zero-symmetric.</p>																									
<p><b>Proposition 5.9.</b> Every Regular Near- Ring need not be <math>\beta_1</math> a Near-Ring.  <i>Proof.</i> Let <math>(N_r = \{1,5,7,11\}, \times_{12}, \cdot)</math> be a Near-Ring where <math>\{N_r, \times_{12}\}</math> be a particular Klein's four group then <math>(N_r, \times_{12}, \cdot)</math> is the Regular Near-Ring where second operation <math>(\cdot)</math> is defined according to Pilz (scheme 4, p.408 of [2])  But it is not <math>\beta_1</math> Near-Ring.</p>	<p><b>Proposition 5.10.</b> Every Regular Near- Ring need not be <math>\beta_2</math> a Near-Ring.  <i>Proof.</i> Let <math>(N_r = \{1,5,7,11\}, \times_{12}, \cdot)</math> be a Near-Ring where <math>\{N_r, \times_{12}\}</math> be a particular Klein's four group then <math>(N_r, \times_{12}, \cdot)</math> is the Regular Near-Ring where second operation <math>(\cdot)</math> is defined according to Pilz (scheme 12, p.408 of [2])</p> <table border="1"> <tr> <td>.</td><td>1</td><td>5</td><td>7</td><td>11</td></tr> <tr> <td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr> <td>5</td><td>1</td><td>5</td><td>1</td><td>5</td></tr> <tr> <td>7</td><td>1</td><td>1</td><td>1</td><td>1</td></tr> <tr> <td>11</td><td>1</td><td>5</td><td>1</td><td>5</td></tr> </table> <p>But it is not <math>\beta_2</math> Near-Ring.</p>	.	1	5	7	11	1	1	1	1	1	5	1	5	1	5	7	1	1	1	1	11	1	5	1	5
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<p><b>Theorem 5.3.</b> Every <math>\beta_1</math> Near-Ring with a mate function is isomorphic to a subdirect product of Near-Fields.  <i>Proof.</i> Let <math>N_r</math> be a <math>\beta_1</math> Near-Ring By <b>Proposition 5.5.</b>, <math>N_r</math> is isomorphic to a subdirect product of sub directly irreducible <math>\beta_1</math> Near- Rings <math>N_{r_i}</math>'s. Since <math>N_r</math> has a mate function it follows that each <math>N_{r_i}</math> also has a mate function. Again by <b>Theorem 5.1.</b>, we have every <math>\beta_1</math> Near-Ring with a mate function is sub directly irreducible Near-Ring if it is a Near-Field. Hence <math>N_r</math> is isomorphic to a subdirect product of Near-Fields.</p>	<p><b>Theorem 5.4.</b> Every <math>\beta_2</math> Near-Ring with a mate function is isomorphic to a subdirect product of Near-Fields.  <i>Proof.</i> Let <math>N_r</math> be a <math>\beta_2</math> Near-Ring By <b>Proposition 5.5.</b>, <math>N_r</math> is isomorphic to a subdirect product of sub directly irreducible <math>\beta_2</math> Near- Rings <math>N_{r_i}</math>'s. Since <math>N_r</math> has a mate function it follows that each <math>N_{r_i}</math> also has a mate function. Again by <b>Theorem 5.1.</b>, we have every <math>\beta_2</math> Near-Ring with a mate function is sub directly irreducible Near-Ring if it is a Near-Field. Hence <math>N_r</math> is isomorphic to a subdirect product of Near-Fields.</p>																									

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**A BRIEF STUDY OF NEAR-RINGS WITH SOME RELATED ALGEBRAIC STRUCTURE**

**KHEMRAJ MEENA<sup>\*</sup>, RAKESHWAR PUROHIT , HRISHIKESH PALIWAL AND BHUMIKA SHRIMALI**

**ABSTRACT**

The aim of this study is to establish comparative theorems, examples and propositions between  $\alpha_2$  and  $\beta_2$  Near-Rings which find out the relation established between these Near-Rings. Some results have shown the inevitability of this research.

**Keywords.** Near-Field,  $\alpha_2$  Near-Ring,  $\beta_2$  Near-Ring, Idempotent.

**1. INTRODUCTION**

This paper is inspired by R. Balakrishnan's work on the study of  $\alpha_2$  and  $\beta_2$  Near-Rings respectively. Throughout this paper  $N_r$  stands for Right Near-Ring. According to Pilz[2], An additive group which is multiplicative semi-group and also satisfies the property  $(a + b).c = a.c + b.c$  [Right Distributivity] is known as Right Near-Ring. Similarly if it satisfies left distributivity then it is known as left Near-Ring. Again by Pilz[2], a Ring which satisfies that  $\forall a \in N_r$  there exist  $b \in N_r$  s.t.  $a = aba$  is known as Regular Near-Ring. And according to S.Suryanarayanan and N.Ganesan[5], a mate function for Near-Ring  $N_r$  is a function  $f: N_r \rightarrow N_r$  s.t.  $x f(x)x = x \forall x \in N_r$ . In line with the cognitive study of  $\alpha_2$  and  $\beta_2$  Near-Rings we are introducing some theorems, propositions and examples and providing their complete evaluation. We refer to [1] & [2] for the notations, basic concepts and terms used. In this paper ubiquitously denotes  $N$ ,  $E$  and  $Z(N_r)$  for set of all Nilpotents, set of all idempotents and centre of Near-Ring  $N_r$ .

Respectively  $N_d = \{x \in N_r : x(a + b) = xa + xb \forall a, b \in N_r\}$  and  $N_0 = \{x \in N_r : x0 = 0\}$  represents all distributive elements and zero-symmetric part of Near-Ring  $Nr^*$ .  $Nr^*$  means non-zero elements of Near-Ring  $N_r$  i.e.  $Nr^* = N_r - \{0\}$ .

**2. PRELIMINARIES**

In this section, some important definitions, theorems and lemmas are given which are useful in further study.

**Lemma .1.** For an arbitrary ideal  $I$  of a Right Near-Ring  $N_r$ ,  $N_r I \subseteq I$  and if  $N_r$  is a zero-symmetric Near-Ring then  $N_r I N_r \subseteq I$  (S.Uma[7]).

**Lemma .2.** Let  $N_r$  be a Right Near-Ring then  $N = \{0\}$  iff  $x^2 = 0 \Rightarrow x = 0 \forall x \in N_r$ .

**Definition 1.** Let  $R$  be any sub Near-Ring of a right Near-Ring  $N_r$  and if  $RN_r$  and  $N_rR$  contained in  $N_r$  then  $R$  is known as invariant Near-Ring(Pilz[2]).

**Lemma .3.** If a right Near-Ring  $N_r$  is sub-commutative and  $E \neq 0$  then idempotent are central(S.Uma[7]).

**Lemma .4.** A Near-Ring  $N_r$  which is zero-symmetric and  $N_d$  is non-trivial then  $N_r$  is a Near-Field if  $N_a = N_r \forall a \in Nr^*$ (Pilz[2]).

**Lemma .5.** If  $f$  is a mate function defined on a Near-Ring  $N_r$  then

- (i)  $af(a), f(a)a \in E \forall a \in N_r$
- (ii)  $N_r - ra = N_r f(a)a \forall a \in N_r$
- (iii)  $aN_r = af(a)N_r$  (Suryanarayanan[5]).

**Definition 2.** A Near-Ring  $N_r$  is said to be a weak commutative Near-Ring if  $xyz = xzy \forall x, y, z \in N_r^*$ (Pilz[2]).

**Theorem .6.** Let  $N_r$  be a Near-Ring,  $A_i$ 's are sub directly irreducible Near-Rings and  $A$  is sub direct product of  $A_i$ 's then Near-Ring  $N_r$  is isomorphic to  $A$ (Pilz[2]).

**Theorem .7.** Every zero-symmetric  $\beta_1$  Near-Ring with a mate function ' $f$ ' has (\*, IFP) (G.Sugantha[4]).

**Theorem .8.** Let  $N_r$  be a Right Near-Ring then

- (i) If  $N_r$  is sub-directly irreducible zero-symmetric Near-Ring and  $N = \{0\}$  then  $N_r$  is integral.
- (ii) Let  $a$  be any idempotent of  $N_r$  s.t.  $a \neq 0$  and 'e' is the right identity of  $N_r$  then  $a = e$ (Pilz[2]).

### 3. DEFINITIONS AND EXAMPLES OF $\alpha_2$ AND $\beta_2$ NEAR-RINGS

The detailed definitions of  $\alpha_2$  Near-Ring and  $\beta_2$  Near-Ring were introduced by S.Uma, G.Sugantha, R.Balakrishnan and others in[4],[7].

**Definition 3.** A Right Near-Ring  $N_r$  in which  $\forall b \in N_r^* \exists a \in N_r^* \text{ s.t. } a = aba \text{ then it is known as } \alpha_2 \text{ Near-Ring.}$

**Definition 4.** A Right Near-Ring  $N_r$  in which  $\forall a, b \in N_r, aN_r b = abN_r \text{ then it is known as } \beta_2 \text{ Near-Ring.}$

**Example 1.** Let  $(N_r = \{1, 5, 7, 11\}, \times_{12}, \cdot)$  be a Near-Ring where  $(N_r, \times_8)$  is a particular Klein's four group then

(a)  $(N_r, \times_{12}, \cdot)$  is the  $\beta_1$  Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 4, p.408 of[2]).

.	1	5	7	11
1	1	1	1	1
5	1	1	5	5
7	1	5	11	7
11	1	5	7	11

(b)  $(N_r, \times_{12}, \cdot)$  is a  $\beta_2$  Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 12 and p.408 of[2]).

.	1	5	7	11
1	1	1	1	1
5	1	5	1	5
7	1	1	1	1
11	1	5	1	5

(c)  $(N_r, \times_{12}, \cdot)$  is neither regular nor  $\alpha_2$  Near-Ring where second operation ( $\cdot$ ) is defined according to Pilz (scheme 2,p. 408 of[2])

.	1	5	7	11
1	1	1	1	1
5	1	1	5	5
7	1	5	7	7
11	1	5	11	11

(d)  $(N_r, \times_{12}, \cdot)$  is not a  $\beta_2$  Near-Ring where 2<sup>nd</sup> operation ( $\cdot$ ) is defined according to Pilz (scheme 13, p. 408 of [2])

.	1	5	7	11
1	1	1	1	1
5	1	5	7	11
7	1	1	1	1
11	1	5	7	11

**Example 2.** Let  $(N_r = \{1, 2, 3, 4, 5, 6\}, \times_7, \cdot)$  be a Near-Ring where  $(N_r, \times_7)$  is a particular group of order 6 then

(a)  $(N_r, \times_7, \cdot)$  is a Near-Ring which is not regular, also it is not  $\alpha_2$  Near-Ring where 2<sup>nd</sup> operation ( $\cdot$ ) is defined according to Pilz (scheme 34, p.409 of[2])

.	1	2	3	4	5	6
1	1	1	1	1	1	1
2	1	6	2	1	6	2
3	1	5	3	1	5	3
4	1	4	4	1	4	4
5	1	3	5	1	3	5
6	1	2	6	1	2	6

(b)  $(N_r, \times_7, \cdot)$  is a  $\beta_2$  Near-Ring which is zero-symmetric and has no identity where the 2<sup>nd</sup> operation ( $\cdot$ ) is defined as per Pilz (scheme 34, p.409 of [2])

.	1	2	3	4	5	6
1	1	1	1	1	1	1
2	5	3	1	1	5	3
3	1	3	5	1	3	5
4	1	1	1	1	1	1
5	1	5	3	1	5	3
6	1	3	5	1	3	5

#### 4. RESULTS ON $\alpha_2$ AND $\beta_2$ NEAR-RINGS

##### Similar Results on $\alpha_2$ and $\beta_2$ Near-Rings

**Proposition 1.** Every Isomorphic image of  $\alpha_2$  Near-Ring is also an  $\alpha_2$  Near-Ring.

*Proof.* Let  $N_r$  be an  $\alpha_2$  Near-Ring and  $f: N_r \rightarrow N'_r$  be Near-Ring Isomorphism. Let any  $a', b' \in N'_r - \{0\}$  then  $\exists a, b \in N_r - \{0\}$  s.t.  $f(a) = a'$  &  $f(b) = b'$ . Since  $N_r$  is an  $\alpha_2$  Near-Ring so

$$a = aba \quad (1)$$

$$\text{Now, } a'b'a' = f(a)f(b)f(a)$$

$$= f(aba) \quad [\because f \text{ is isomorphism}]$$

$$= f(a) \quad [\text{By(1)}]$$

$$= a'$$

$$\Rightarrow a' = a'b'a'$$

Hence  $N'_r$  is also an  $\alpha_2$  Near-Ring. □

**Proposition 2.** Every isomorphic image of a  $\beta_2$  Near-Ring is also a  $\beta_2$  Near-Ring.

*Proof.* Let  $N_r$  be a  $\beta_2$  Near-Ring and  $f: N_r \rightarrow N'_r$  be a Near-Ring isomorphism.

Let any  $n', a', b' \in N'_r$  then  $\exists n, a, b \in N_r$  s.t.  $f(n) = n'$ ,  $f(a) = a'$  &  $f(b) = b'$ . Since  $N_r$  is a  $\beta_2$  Near-Ring.

$$\Rightarrow aN_r b = abN_r \quad (2)$$

$$\text{Now } a'n'b' = f(a)f(n)f(b) = f(anb) \quad [\because f \text{ is an isomorphism}] \quad (3)$$

and by (2)  $anb = abm$  for some  $m \in N_r$

$$\therefore \text{By(2), } a'n'b' = f(anb) = f(abm)$$

$$= f(a)f(b)f(m)$$

$$= a'b'm' \in a'b'N'_r$$

$$\Rightarrow a'n'b' \in a'b'N'_r \& a'N'_rb' \in a'b'N'_r \quad (4)$$

$$\text{Similarly we can say that } a'b'N'_r \subseteq a'N'_rb' \quad (5)$$

Hence by (3) & (4), we get  $a'Nr'b' = a'b'Nr'$

Therefore  $N'_r$  is also a  $\beta_2$  Near-Ring. □

**Theorem 9.** Let  $N_r$  be an  $\alpha_2$  Near-Ring with sub commutativity then  $N_r$  is sub directly irreducible Near-Ring iff  $N_r$  is a Near-Field.

*Proof.* Let  $N_r$  be an  $\alpha_2$  Near-Ring with subcommutativity and  $E$  be the set of all idempotent then we have  $E$  is non-trivial. Let any  $a \in N_r$ ,  $a \neq 0$  and  $a$  is idempotent element of  $N_r$  then 'a' is equal to identity element 'e'. Since  $E$  is non-trivial and  $N_r$  is subcommutative then  $ae = e = ea \Rightarrow a = e$ .

Therefore  $N_r$  has a unique idempotent 'e'  $\Rightarrow e \neq 0$  which represents identity element of  $N_r$ .

Again since  $N_r$  is  $\alpha_2$  Near-Ring for all  $a \in N_r - \{0\}$  then there exist  $x \in N_r - \{0\}$  s.t.  $x = xax \Rightarrow ax$  and  $xa \in E$  and hence  $ax = xa = e$ . Thus  $N_r$  is a Near-Field.

Conversely if  $N_r$  is a Near-Field then it will be a Near-Ring which is integral and an  $\alpha_2$  Near-Ring with subcommutativity is zero-symmetric reduced sub-directly irreducible Near-Ring.

Therefore  $N_r$  is sub-directly irreducible Near-Ring.  $\square$

**Theorem .10.** Let  $N_r$  be a  $\beta_2$  Near-Ring with a mate function  $f$  then  $N_r$  is sub-directly irreducible Near-Ring iff  $N_r$  is a Near-Field.

*Proof.* Let  $N_r$  be any  $\beta_2$  Near-Ring with mate function  $f$  and  $A$  be the intersection of arbitrary family of non-zero ideals of Near-Ring  $N_r$ . Hence  $A$  is non-trivial because  $N_r$  is sub-directly irreducible Near-Ring.

Now if any  $x(\neq 0) \in A$  then  $xe = 0$  for all idempotent  $e \in E$  (6)

and by theorem(7), if  $ex = 0 \Rightarrow e f(x)x = f(x)x \in E$ . Therefore  $xf(x) = 0$  [By(6)]

$\Rightarrow x = 0$  which is contradiction. Hence our supposition is wrong.

Thus, every non-zero idempotent of  $\beta_2$  Near-Ring  $N_r$  is zero-divisor. (7)

Let  $G$  be any non-zero  $N_r$  subgroup of Near-Ring  $N_r$  and any  $x(\neq 0) \in G, \forall a, b \in N_r$

$$(a - bx)f(x)x = 0 \Rightarrow a - bx = 0 \quad [\text{By (7)}] \Rightarrow a = bx \in N_r G \subseteq G \Rightarrow N_r \subseteq G.$$

Hence Near-Ring  $N_r$  has non-trivial  $N_r$ -subgroup (8)

Let  $a \in N_r^* \Rightarrow N_r a = N_r$  [By (8)].

If  $E \subseteq Z(N_r)$  and  $Z(N_r) \subseteq N_d$ . Then  $N_d \neq \{0\}$ .

Therefore  $N_r$  is a Near-Field. And its converse is obvious.  $\square$

**Proposition 3.** Every  $\alpha_2$  Near-Ring need not to be a Regular Near-Ring.

*Proof.* Let  $(N_r = \{1, 5, 7, 11\} \times_{12}, \cdot)$  be a Near-Ring where  $(N_r, \times_{12})$  is a particular Klein's four group then  $(N_r, \times_{12}, \cdot)$  is the  $\alpha_2$  Near-Ring where 2<sup>nd</sup> operation ( $\cdot$ ) is defined according to Pliz [2] (scheme 4, p.408).

.	1	5	7	11
1	1	1	1	1
5	5	5	5	5
7	1	1	7	7
11	5	5	11	11

But this  $\alpha_2$  Near-Ring is not a regular Near-Ring.  $\square$

**Proposition 4.** Every  $\beta_2$  Near-Ring is not necessarily a Regular Near-Ring.

*Proof.* Let  $(N_r = \{1, 5, 7, 11\} \times_{12}, \cdot)$  be a Near-Ring where  $(N_r, \times_{12})$  is a particular Klein's four group then  $(N_r, \times_{12}, \cdot)$  is the  $\beta_2$  Near-Ring where 2<sup>nd</sup> operation ( $\cdot$ ) is defined as per Pliz [2] (scheme 4, p.408).

.	1	5	7	11
1	1	1	1	1
5	1	5	1	5
7	1	1	1	1
11	1	5	1	5

But this  $\beta_2$  Near-Ring is not a Regular Near-Ring.  $\square$

**Non-Similar Results on  $\alpha_2$  and  $\beta_2$  Near-Rings.**

**Proposition 5.** Every Regular Near-Ring is always an  $\alpha_2$  Near-Ring.

*Proof.* Let  $N_r$  be any Regular Near-Ring. Then for every  $a \in N_r$  there exist  $b \in N_r$  s.t.  $a = aba$

$$\text{Let } x = bab \text{ s.t. } x \in N_r - \{0\} \text{ Then } xax = (bab)a(bab)$$

$$= b(aba)(bab)$$

$$= b(a)(bab)$$

$$= b(aba)b$$

= bab

= x

$\Rightarrow xax = x$

i.e. if  $\forall a \in N_r - \{0\} \exists x \in N_r - \{0\}$  s.t.  $xax = x$

Hence  $N_r$  is an  $\alpha_2$  Near-Ring.

**Proposition 6.** Every Regular Near-Ring need not to be a  $\beta_2$  Near-Ring and vice versa.

*Proof.* Let  $(N_r = \{1, 5, 7, 11\}, \times_{12}, \cdot)$  be a Near-Ring where  $(N_r, \times_{12})$  is a particular Klein's four group then  $(N_r, \times_{12}, \cdot)$  is a Regular Near-Ring but this is not a  $\beta_2$  Near-Ring where 2<sup>nd</sup> operation ( $\cdot$ ) is defined as per Pliz [2] (scheme-4, p.408).

.	1	5	7	11
1	1	1	1	1
5	5	5	5	5
7	1	1	7	7
11	5	5	11	11

And Conversely, a Near-Ring cited in Proposition 4 is  $\beta_2$  Near-Ring but that is not a Regular Near-Ring.

**Proposition 7.** Every homomorphic Image of  $\alpha_2$  Near-Ring need not to be an  $\alpha_2$  Near-Ring. But Every homomorphic image of  $\beta_2$  Near-Ring is always a  $\beta_2$  Near-Ring.

*Proof:* Let us consider two Near-Rings  $(N_r = \{1,3,5,7\}, \times_8, \cdot)$  where 2<sup>nd</sup> operation ( $\cdot$ ) is defined as per Pliz [2] (Schem-23 and p-408) and  $(N'_r = \{1,5,7,11\}, \times_{12}, \oplus)$  where 2<sup>nd</sup> operation  $\oplus$  is defined as per Pliz[2] (Scheme -22, p - 408)

$\oplus$	1	5	7	11
1	1	1	1	1
5	5	5	5	5
7	1	1	1	1
11	5	5	5	5
.	1	3	5	7
1	1	1	1	1
3	3	3	3	3
5	5	5	5	5
7	7	7	7	7

Then

where  $(N_r = \{1,3,5,7\}, \times_8)$  and  $(N'_r = \{1,5,7,11\}, \times_{12})$  are two particular Klein's four groups

Now define a mapping  $\phi: N_r \rightarrow N'_r$  s.t.  $\phi(1) = 1, \phi(3) = 5, \phi(5) = 1, \phi(7) = 5$  which is a homomorphism.

Then  $(N_r, \times_8, \cdot)$  is an  $\alpha_2$  Near-Ring but  $(N'_r, \times_{12}, \cdot)$  is not an  $\alpha_2$ -Near-Ring.

This shows that every Homomorphic image of  $\alpha_2$  Near-Ring is not necessarily an  $\alpha_2$  Near-Ring

But if  $N_r$  be a  $\beta_2$  Near-Ring &  $f: N_r \rightarrow N'_r$  be a Near-Ring onto homomorphism

$$\text{Then } a'n'b' = f(a)f(n)f(b) = f(anb) \quad [\because f \text{ is homomorphism}] \quad (9)$$

And we have  $anb = abm$  for some  $m \in N_r \quad [\because N_r \text{ is a } \beta_2 \text{ Near-Ring}]$

$$\therefore \text{By (9)} \quad a'n'b' = f(anb) = f(abm) = f(a)f(b)f(m) = a'b'm' \in a'b'N'_r$$

$$\Rightarrow a'n'b' \in a'b'N'_r \Rightarrow a'N'_rb' \subseteq a'b'N'_r \quad (10)$$

$$\text{And similarly} \quad a'b'N'_r \subseteq a'N'_rb' \quad (11)$$

Hence By (10) & (11), we get  $a'N'_rb' = a'b'N'_r$

Therefore  $N'_r$  is also a  $\beta_2$  Near-Ring.

**Theorem .11.** Every  $\alpha_2$  Near-Ring is not necessarily isomorphic to a sub direct product of Near-Fields.

*Proof.* By **Theorem 9**, we have if  $N_r$  be an  $\alpha_2$  Near-Ring with sub commutativity then  $N_r$  is sub directly irreducible Near-Ring if and only if  $N_r$  is a Near-Field. And if an  $\alpha_2$  Near-Ring  $N_r$ , which is a Near-Field then  $N_r$  is isomorphic to zero symmetric reduced sub directly irreducible Near-Ring. Hence  $N_r$  is isomorphic to sub-direct product of Near- Fields. But if  $N_r$  is not an Integral Near-Ring then it is not necessary that  $N_r$  is isomorphic to a sub-direct product of Near-Fields.

**Theorem .12.** Every  $\beta_2$  Near-Ring  $N_r$ , with a mate function is isomorphic to a sub-direct product of Near-Fields.

*Proof.* Let  $N_r$  be a  $\beta_2$ . Near-Ring which admits a mate function then according to **Theorem 6**, if  $A_i$ 's are sub-directly irreducible Near-Rings and  $A$  is the sub-direct product of  $A_i$ 's then  $N_r$  is isomorphic to  $A$  and under the projection mapping every  $A_i$  is a homomorphic image of  $N_r$  and by **Proposition 6**. Every homomorphic image of  $\beta_2$  Near-Ring is again a  $\beta_2$  Near- Ring. And  $N_r$  is also a  $\beta_2$  Near-Ring. Hence every  $\beta_2$  Near-Ring is isomorphic to sub- direct product of sub-directly Irreducible Near-Rings. And By **Theorem 10**,  $\beta_2$  Near-Ring  $N_r$  with a mate function  $f$  is sub directly irreducible Near-Ring if and only if  $N_r$  is a Near-Field. Hence  $\beta_2$  Near-Ring  $N_r$  is isomorphic to a sub-direct product of Near-Fields.

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**A RELATIVE STUDY OF COMMUTATIVITY IN PRIME RINGS AND NEAR-RINGS WITH DERIVATIONS**

**B. SHRIMALI\*, R. PUROHI, K. MEENA AND H.K. PALIWAL****ABSTRACT**

*In this paper, we have studied Prime Rings and Near-Rings simultaneously to give more prominence to their commutative properties using derivations. A comparative study has shown for understanding some similar and non-similar propositions and theorems between these Rings.*

**Keywords and phrases:** Prime Rings, Near-Rings, Commutativity, Derivations, Generalized Derivations.

**1. INTRODUCTION**

In this Paper,  $I$  denotes ideal of  $R$  (Providing  $I \neq 0$ ),  $Z = \{a \in R : ax = xa \text{ for all } x \in R\}$  represents centre of  $R$ ,  $N_r$  represents Near-Ring,  $R$  represents Prime Ring and  $N'$  denotes 3-Prime Near-Ring. A Prime Ring is a Ring  $R$  which satisfies;  $\forall a, b \in R$ , if  $aRb = 0 \Rightarrow a = 0$  or  $b = 0$  [1]. If  $N_r$  is an additive group (not necessarily abelian), is multiplicative semi-group and satisfies right distributivity then it is known as Right Near-Ring [9]. A Near-Ring  $N_r$  is 3-prime Near-Ring iff  $\forall s, t \in N_r$  if  $sN_r t = 0$ , then  $s = 0$  or  $t = 0$ . An additive mapping  $d$  is called a derivation on  $R$  if it holds the property  $d(pq) = d(p)q + pd(q) \forall p, q \in R$ . A derivation  $f$  is associated with  $d$ , is called generalized derivation if it holds,  $f(pq) = f(p)q + pd(q), \forall p, q \in R$ , where  $d$  is derivation on  $R$  and  $f$  is an additive map on  $R$  [1],[8],[7]. For any  $a$  and  $b$  in Ring the symbol  $[a, b]$  will denote the commutator  $ab - ba$ , and the symbol  $a \circ b$  will denote the skew commutator  $ab + ba$ .

A Derivation  $d$  is called commuting if  $[d(x), x] = 0, \forall x \in R$ . A Derivation  $d$  is called skew commuting if  $d(x) \circ x = 0, \forall x \in R$  [4]. A Derivation  $d$  will denote an  $I^{-*}$  derivation if it holds,  $d(a)d(b) + d(ba) = d(b)d(a) + d(ab) \forall a, b \in I$  [1].

**2. PRELIMINARIES**

**Lemma 2.1.** Every derivation  $d$  on  $N_r$  satisfies:  $x(d(yz)) = x(d(y)z + yd(z)) = xd(y)z + xyd(z), \forall x, y, z \in N_r$ . [Lemma 2.4 of [4]]

**Lemma 2.2.** Let  $a \in A$ ,  $a$  is commuting or skew commuting element and is not a right zero-divisor where  $A$  is additive non-zero  $N_r$ -subgroup of  $N_r$  and  $d$  be a derivation on  $N_r$ , then for any  $b$  in  $N_r$ ,  $(a, b)$  is constant. [Lemma 2.5 of [4]]

**Lemma 2.3.** For a 3-Prime Near-Ring  $N'$ , if we take  $z \in Z(N')^*$ , Then  $z$  is not a zero-divisor. Also, if  $z + z \in Z(N')$  then  $(N', +)$  is abelian. [Lemma 3(i) and (ii) of [3]]

**Lemma 2.4.** Let  $I$  be a non zero semigroup Ideal of  $N'$ . If  $a, b \in N'$  and  $ab = 0$ , then either one of  $a$  or  $b$  will be zero. Also if  $d$  is a derivation on 3-prime Near-Ring  $N'$  ( $d \neq 0$ ) and  $a \in N'$  s.t.  $d(I)a = (ad(I)) = \{0\}, \Rightarrow a = 0$ . [Lemma 1.4 of [2]]

**Lemma 2.5.** Let  $I$  be a semigroup right(left) ideal of  $N'$  (providing  $I \neq 0$ ). If  $x \in N'$  is such that it centralizes  $I \Rightarrow x \in Z(N')$  [Lemma 1.3(iii) of [2]]

**Lemma 2.6.** Let  $I$  be a semigroup right(left) ideal of  $N'$  (providing  $I \neq 0$ ). If  $x \in N'$  and  $Ix = 0$  ( $xI = 0$ ),  $\Rightarrow x = 0$ . [Lemma 3(iii) of [3]].

**Lemma 2.7.** Let  $I$  be a semigroup ideal of 3-prime Near-Ring  $N'$  (providing  $I \neq 0$ ). Also  $N'$  has a generalized derivation  $f$  associated with Zero derivation(providing  $f \neq 0$ ). If  $f(I)a = 0$  for some  $a \in N'$ , then  $a = 0$ . Moreover, if  $af(I) = 0 \Rightarrow af(N') = 0$  [Lemma 4.6(ii) of [7]]

**Theorem 2.8.** A Near-Ring  $N_r$  admits a derivation if it is zero symmetric. [Theorem 2.7 of [8]]

**Proposition 2.9.** Taking  $R$  being a semiprime Ring and  $I$  be an ideal of  $R$  (providing  $I \neq 0$ ). If  $[I, I] = [a, b]$  s.t.  $a, b \in I$  then if  $z$  centralizes  $[I, I] \Rightarrow z$  centralizes  $I$  where  $z \in R$ . [Lemma 1 of [5]]

**Proposition 2.10.** For any Prime Ring  $R$ , the centralizer of any one-sided ideal =  $Z(R)$ . [[1]]

**Lemma 2.11.** For any Prime Ring  $R$  and  $I$  be a two sided Ideal (providing  $I \neq 0$ ), If  $I$  admit  $I^{-*}$  derivation  $d$  (derivation being non-zero)  $\Rightarrow R$  is commutative. [Corollary 2 of [1]]

**Lemma 2.12.** For any Near-Ring  $N_r$  and  $d$  being derivation on  $N_r$  which holds the condition  $d(N_r) \subseteq Z(N_r)$ , If  $\exists a \in N_r$  s.t.  $d(a)$  is non left zero divisor in  $N_r \Rightarrow N_r$  is a commutative Ring. [Corollary 3.6 of [8]]

**Lemma 2.13.** For a 3 prime Near-Ring  $N'$  with generalized derivation  $f$  associated with zero derivation (providing  $f \neq 0$ ), If  $f(ab) = f(ba) \forall a \in A, b \in B$ , where  $A$  is a semigroup ideal and  $B$  is a semi group left ideal of  $N'$  (providing  $A, B \neq 0$ )  $\Rightarrow N'$  is a commutative Ring. [Corollary 3.4 of [7]]

**Lemma 2.14.** Let  $N'$  be a 3-Prime Near-Ring which has derivation such that If  $f(ab) = f(ba) \forall a \in A, b \in B$ , where  $A$  is a semigroup right (left) ideal and  $B$  is a semi group ideal of  $N'$  (providing  $A, B \neq 0$ )  $\Rightarrow N'$  is a commutative Ring. [Corollary 3.2 of [6]]

**Lemma 2.15.** Let  $N'$  be a 3-Prime Near-Ring with a semigroup right(left) ideal  $I$  (providing  $I \neq 0$ ). If  $a \in I$  which centralizes  $I$ , then  $a \in Z(N')$ . Also if  $I \subseteq Z(N') \Rightarrow N'$  is commutative. [Lemma 1.5 of [2]]

**Lemma 2.16.** Let  $N'$  be a 3-Prime Near-Ring with a semigroup right ideal  $I$  (providing  $I \neq 0$ ) and  $X$  is a subset of  $N'$ , then if  $\forall a \in I, x \in X, ax = (-x)(-a) \Rightarrow -X \subseteq Z(N')$ . [Lemma 4.1 of [6]]

**Lemma 2.17.** Let  $N_r$  be a Near-Ring with derivation  $d$  (providing  $d \neq 0$ ). Now If any one of these holds (i)  $N_r$  is a 3-Prime Near-Ring (ii) for any  $a \in N_r$ ,  $d(a)$  is non left zero divisor in  $N_r$ , then for every integer  $n \geq 2$ ,  $nN_r = 0$  iff  $nd(N_r) = \{0\}$ . [Lemma 2.8 of [8]].

### 3. MAIN RESULTS ON PRIME RINGS AND NEAR-RINGS

**Theorem 3.1.** For a Prime Ring  $R$  and a Near-Ring  $N_r$  (without zero divisors), Let  $d$  be a derivation on both the Rings. If  $R$  and  $N_r$  are non-trivial commuting then Rings will be commutative. (Provided that for Prime Ring  $d \neq 0$ ).

**Proof.** Case (I) - For Prime Ring  $R$ :

Let  $a \in R$  if  $ad(x) = 0 \quad \forall x \in R \Rightarrow$  either  $a$  will be zero or  $d$  will be zero. Also if  $ad(x) - d(x)a \in Z \quad \forall a \in R$  and  $d \neq 0 \Rightarrow R$  is commutative.

$\forall a \in R$ , if  $d \neq 0 \Rightarrow a$  is central in  $R$  and  $d(a) \neq 0$  for some  $a \in R$ . Clearly  $d(a)bx = xd(a)b$ ;  $d(a)$  is central. Hence  $ad(x) - d(x)a$  is central in  $R$ . Thus if  $d \neq 0$  and  $ad(x) - d(x)a \in Z \quad \forall a \in R$  then  $R$  is commutative.

**Case (II) - For Near-Ring  $N_r$ :**

Let  $a$  be commutator in  $N_r$  which is additive. Then Lemma 2.1 and 2.2 says that

**$a$  is constant. Moreover, for any  $x$  in  $N_r$ ,  $ax$  will also be an additive commutator**

$\Rightarrow ax$  is also constant. Thus  $0 = (ax) = d(ax) + ad(x)$  and  $ad(x) = 0$ . As  $d$  is non-trivial,  $\exists y$  in  $N_r$  s.t.  $y \neq 0$ . Also from above  $a(y) = 0$ . Since  $N_r$  has no non-zero divisors of zero  $\Rightarrow a = 0$ . Hence  $N_r$  is commutative.

**Theorem 3.2.** For a Prime Ring  $R$  and a 3-Prime Near-Ring  $N'$ , Let  $d$  be derivation (Provided  $d \neq 0$ ) on both the Rings then

- (1) For Prime Rings  $R$ , if  $x \in R$  s.t.  $d(I)x = 0$  or  $xd(I) = 0 \Rightarrow x = 0$ , where  $I$  is two-sided ideal of  $R$ . (Provided  $I \neq 0$ )
- (2) For 3-Prime Near-Ring  $N'$ , if  $x \in N'$ , s.t.  $d(N')x = 0$  or  $xd(N') = 0 \Rightarrow x = 0$ .

**Proof.** The Proof is obvious.

**Theorem 3.3.** For a Prime Ring ( $Char \neq 2$ ) and a 3-Prime Near-Ring  $N'$ , Let

and  $f$  are derivation on both the Rings s.t. their products (or composition) is also a derivation then

(1) For Prime Ring  $R$ , one of the derivation must be zero.

(2) For 3-Prime Near-Ring  $N'$ , either one of the derivation is zero or  $2N' = \{0\}$ .

**Proof.** (1) As we are taking  $df$  is a derivation, so  $df(ab) = df(ab) + adf(b)$ . also,  $d$  and  $f$  are each derivations so  $df(ab) = d(f(ab)) = d(f(a)b + af(b)) = df(a)b + f(a)d(b) + d(a)f(b) + adf(b) = 0 \quad \forall a, b \in R$ . But

$$df(ab) = df(a)b + adf(b), \text{ so } f(a)d(b) + d(a)f(b) = 0. \quad -(1)$$

put  $a = ad(c)$  in (1)  $\Rightarrow f(ad(c))d(b) + d(ad(c))f(b) = 0 \quad \forall a, b, c \in R$

R.  $f(a)d(c)d(b) + afd(c)d(b) + d(a)d(c)f(b) + ad(c)f(b) = 0$ . Now  $a(f(d(c))d(b) + d(d(c))f(b)) = 0$ , since  $f(d(c))d(b) + d(d(c))f(b) = 0$ , that is same as equation(1) with  $a$  being replaced by  $d(c)$ . Then  $f(a)d(c)d(b) + d(a)d(c)f(b) = 0 \quad \forall a, b, c \in R$ . -(2)

But  $d(c)f(b) = -f(c)d(b)$  by (1) with  $c$  replacing  $a$ . Then (2) becomes  $f(a)d(c)d(b) - d(a)f(c)d(b) = 0 \Rightarrow (f(a)d(c) - d(a)f(c))d(b)$ . We know for any  $a \in R$ , If  $ad(x) = 0 \quad \forall x \in R$ , then either  $a$  or  $d$  will be zero which

$\Rightarrow f(a)d(c) - d(a)f(c) = 0 \quad \forall a, c \in R$ , unless  $d$  is zero. But (1) with  $c$  replacing  $b$  gives us that instead  $f(a)d(c) + d(a)f(c) = 0 \quad \forall a, c \in R$ . Adding these equations, we will get  $2f(a)d(c) = 0 \Rightarrow f(a)d(c) = 0$  (As characteristic of  $R$  is not 2)  $\forall a, c \in R$  or  $d$  is zero. Again proceeding the same way with  $f(a)$  replacing  $a$  we will get that either  $d$  is zero or  $f(a) = 0 \quad \forall a \in R$ , i.e.  $d$  or  $f$  will be zero.

(2) For all  $a, b \in N'$ , we have  $df(ab) = d(f(ab)) = d(af(b) + f(a)b) =$

$adf(b) + d(a)f(b) + f(a)d(b) + df(a)b$ . -(1)

But  $df(ab) = adf(b) + df(a)b$  (as  $df$  is derivation). By both the equations, we can write  $d(a)f(b) + f(a)d(b) = 0 \quad \forall a, b \in N'$ . -(2)

**Now put  $a = ac$  where  $c \in N'$  and using lemma 2.1, we have  $0 =$**

$$d(ac)f(b) + f(ac)d(b) = d(a)cf(b) + ad(c)f(b) + af(c)d(b) + f(a)cd(b) =$$

$$d(a)cf(b) + a[d(c)f(b) + f(c)d(b)] + f(a)cd(b) = d(a)cf(b) + f(a)cd(b). \text{ So}$$

$$d(a)cf(b) + f(a)cd(b) = 0 \quad \forall a, b, c \in N' \text{ -(3)}$$

Now put  $c = f(c)$  in (3) and applying (2), so  $0 = d(a)f(c)f(b) + f(a)f(c)d(b)$

$$= d(a)f(c)f(b) + f(a)[d(c)f(b)]. \text{ Thus, } d(a)f(c)f(b) - f(a)d(c)f(b) = 0$$

$$\forall a, b, c \in N' \text{ -(4)}$$

Now put  $b = cb$ , by (2) & (3),  $0 = d(a)f(cb) + f(a)d(cb) = d(a)f(c)b +$

$$d(a)cf(b) + f(a)cd(b) + f(a)d(c)b = d(a)f(c)b + f(a)d(c)b. \text{ Put } b = f(b)$$

$$\text{in it } \Rightarrow d(a)f(c)f(b) + f(a)d(c)f(b) = 0 \quad \forall a, b, c \in N' \text{ -(5)}$$

Comparing (4) and (5)  $\forall a, b, c \in N', 0 = d(a)f(c)f(b) + d(a)f(c)f(b) =$

$$d(a)[f(c)f(b) + f(c)f(b)] = d(a)f(c)[2f(b)]. \text{ Hence, } d(N')[f(c)[2f(b)]] = 0$$

**$\forall b, c \in N'$ . If  $d$  is not zero, then  $f(N')[2f(b)] = \{0\} \quad \forall b \in N'$  Using Lemma 2.17 it can be proven that  $2N' = \{0\}$ .**

**Theorem 3.4.** For Prime Ring  $R$  and a 3-Prime Near-Ring  $N'$ , let  $A$  be non-void subset and  $B$  be semi group ideal for both the Rings.(Provided  $B \neq 0$ ) Then

(1) For Prime Rings  $R$ , If  $f(ab) = f(ba) \quad \forall a \in A, b \in B$  then Either  $d(A)$  will be zero or  $A \subseteq Z(R)$  where  $f$  is generalized derivation ( $f \neq 0$ ) associated with derivations  $d$ .

(2) For  $N'$ , If  $f(ab) = f(ba), \quad \forall a \in A, b \in B$  then either  $f(a)$  will be zero or  $A \subseteq Z(N')$  where  $f$  is a generalized derivation associated with derivation which is zero.

*Proof.* (1) Replacing  $b = ba$  in  $f(ab) = f(ba) \Rightarrow 0 = f((ab - ba)a) = (ab - ba)d(a) \quad \forall a \in A, b \in B$ . Replacing  $b = bc$ , where  $c \in B$ , we have  $abcd(a) = b(cad(a)) = b(acd(a))$  and  $(ab - ba)cd(a) = 0$ . Also from Lemma

**2.4  $\Rightarrow$  for each  $a \in A$  either  $d(a) = 0$  or  $a$  centralizes  $B$ . If  $d(A) \neq \{0\}$ ,**

then  $\exists x \in A$  s. t.  $d(x) \neq 0, x \in Z(R)$  (from Lemma 2.5). Replacing

$b = bx$  in  $f(ab) = f(ba)$ , we will get  $0 = f((ab - ba)x) = (ab - ba)d(x) \quad \forall$

**$a \in A, b \in B$ . But  $d(x) a \in Z(R)^*$ , is not a zero divisor including Theorem**

3.6 and Lemma 2.3. Thus,  $ab = ba \quad \forall a \in A, b \in B$  and  $A$  centralizes  $B$ . Therefore,  $A \subseteq Z(R)$  from Lemma 2.5

(2) Replace  $b = ab$  in  $f(ba) = f(ab)$  to get  $f(aba) = f(aab) \forall b \in B, a \in A$ . It follows that  $f(a)ba = f(a)ab$ . Replacing  $b = bc$  where  $c \in B$ , we will get  $f(a)abc = f(a)abc = f(a)bac \Rightarrow f(a)b(ca - ac) = 0 \forall b, c \in B, a \in A$ . Lemma 2.4 says that,  $\forall a \in A$  either  $f(a) = 0$  or  $a$  centralizes

B. If  $f(A) \neq \{0\}$ , then  $\exists x \in A$  s.t.  $f(x) \neq 0$ . Thus,  $x$  centralizes  $B$  and then  $x \in Z(N')$  from Lemma 2.5. Now,  $\forall b \in B, a \in A$  we will get  $f((xb)a) = f(a(xb)) = f(xab)$  which means  $f(x)b(ac - ca) = 0 \forall b, c \in B, a \in A$ . Including Lemma 2.4 and  $f(x) \neq 0$ , we've got  $ac = ca \forall a \in A, c \in B$ . So Lemma 2.5 says that,  $A \subseteq Z(N')$ .

**Theorem 3.5.** For a Prime Ring  $R$  and a 3-Prime Near-Ring  $N'$ . If we take  $n \in \mathbb{Z}^+$  then for every  $n \geq 2$ , these statement will be equivalent:

**(a) For Prime Ring  $R$ ,**

- (i)  $f(nR) = 0$
- (ii)  $nR = \{0\}$
- (iii)  $nI = \{0\}$
- (iv)  $f(nI) = \{0\}$

Where  $f$  be a non-zero generalized derivation and  $I$  be a non-zero semi group ideal of  $R$ .

**(b) For 3-prime Near-Ring  $N'$ ,**

- (i)  $d(nN') = 0$
- (ii)  $nN' = \{0\}$
- (iii)  $nI = \{0\}$
- (iv)  $d(nI) = \{0\}$

Where  $d$  is a derivation and  $I$  be a semi group ideal on  $N'$ . (Provided  $d, I \neq 0$ )

*Proof.* (a) (i)  $\Rightarrow$  (ii). Let any  $a, b \in R$  we can say  $0 = f(nab) = f((na)b) = f(na)b + (na)d(b) = (na)d(b)$ . Lemma 2.4 says that,  $nR = 0$  or  $d$  will be zero. Let  $d = 0$ . Then  $\forall a, b \in R$  we get  $0 = f(nab) = f(a(nb)) = f(a)(nb)$ . Lemma 2.7 says that,  $nR = 0$ . It is clear, (ii)  $\Rightarrow$  (iii) and (iii)  $\Rightarrow$  (iv) and (iv)  $\Rightarrow$  (i). Now if  $\forall r \in I, a, b \in R$  we have  $0 = f(narb) = f(nar)b + (nar)d(b) = (nar)rd(a)$ . Using Lemma 2.4,  $nR = 0$  or  $d$  will be zero. Let  $d = 0$  then  $\forall r \in I, a \in R$  we will get  $0 = f(nar) = f(na)r$ . Again Lemma 2.6 says that,  $f(nR) = 0$

(b) (i)  $\Rightarrow$  (ii). Let  $x, y \in N'$  We can say  $d(nxy) = d((nx)y) = d(nx)y + (nx)d(y) = (nx)d(y)$ . Then either  $nN' = 0$  or  $d$  will be zero. Let  $d = 0$ , Then  $\forall a, b \in N'$  we get  $0 = d(nab) = d(a(nb)) = d(a)(nb) \Rightarrow nN' = 0$

#### 0. Clearly (ii) $\Rightarrow$ (iii), (iii) $\Rightarrow$ (iv) and (iv) $\Rightarrow$ (i) Now if

$\forall r \in I, a, b \in N'$  we have  $0 = d(narb) = d(nar)b + (nar)d(b) = (nar)rd(a)$ . Clearly, either  $nN' = 0$  or  $d$  will be zero. Let  $d = 0$  then  $\forall r \in I, a \in N'$  we will get  $0 = d(nar) = d(na)r$ . Hence we've come to the conclusion that  $d(nN') = \{0\}$ . Q

**Theorem 3.6.** For a Prime Ring  $R$  and Near-Ring  $N_r$ , Let  $d$  be derivation and

$Z$  be centre for both the Rings.then

- (1) For Prime Ring  $R$ , Let  $a \in Z$  s.t.  $a \neq 0 \Rightarrow d(a) \in Z$ .
- (2) For Near-Ring  $N_r$ , Let  $a \in Z(N_r)$  s.t.  $a \neq 0 \Rightarrow d(a) \in Z(N_r)$

*Proof.* (1) Here  $d$  is a derivation on  $R$  and  $Z$  be the centre. Now,  $0 \neq a \in Z$  and  $[a, b] = 0 \forall b \in R$  and Hence  $d[a, b] = 0 \Rightarrow d[ab - ba] = 0$  i.e.  $d(a)b + ad(b) - d(b)a - bd(a) = 0$ . That is  $[d(a), b] + [a, d(b)] = 0$ . As  $a \in Z$  so we get  $[d(a), b] = 0 \forall b \in R$  implies  $d(a) \in Z$ .

(2) As  $d : N_r \rightarrow N_r$  is a derivation on  $N_r$  and  $Z$  be the centre. Now if any  $0 \neq a \in Z(N_r)$ , that is  $[a, b] = 0 \forall b \in N_r$  and hence  $d[a, b] = 0 \Rightarrow d[ab - ba] = 0$  i.e.  $d(a)b + ad(b) - d(b)a - bd(a) = 0$ . That is  $[d(a), b] + [a, d(b)] = 0$ . Since  $a \in Z(N_r)$  so we get  $[d(a), b] = 0 \forall b \in N_r$  which yields that  $d(a) \in Z(N_r)$ .

**Theorem 3.7.** For a Prime Ring  $R$  and Near-Ring  $N_r$ , Let  $f$  be generalised derivation (provided  $f \neq 0$ ) for both the Rings. Then these Rings will be commutative if-

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- (1) For Prime Ring  $R$ ,  $f(ab) = f(ba)$ ,  $\forall a \in A$  and  $b \in B$  where  $A$  is a semi group ideal on  $R$  and  $B$  is a semi group left ideal on  $R$ . (provided  $A, B \neq 0$ )
- (2) For Near-Ring  $N_r$ ,  $f(ab) = f(ba)$ ,  $\forall a, b \in A$  where  $A$  is two sided  $N_r$ -subgroup of  $N_r$  (provided  $A \neq 0$ ).

**Proof.** (1) Lemma 2.13 says that,  $d = 0 \Rightarrow N$  is commutative. Also theorem 3.4 says that,  $A \subseteq Z$ . According to Bell, Now  $d(I)$  can't be zero. Then Lemma 2.15 says that,  $R$  will be commutative.

(2) Lemma 2.13 says that, if  $d$  is equals to zero  $\Rightarrow N_r$  will be commutative. If  $d \neq 0$  then, Given that  $f(ab) = f(ba) \forall a, b \in A$ . Putting

$$b = ab \Rightarrow (aab) = f(aba) \forall a, b \in A \Rightarrow f(a(ab-ba)) = f(a)(ab)$$

$ba + ad(ab - ba) = 0$ . Put  $a = [a, c]$ , where  $c \in A \Rightarrow f([a, c])([a, c]b - b[a, c]) + [a, c]d([a, c]b - b[a, c]) = [a, c]d([a, c]b - b[a, c]) = 0$ ;  $\forall a, b, c \in A$  as  $f([a, c]) = 0$ . Let us take  $x \in X$ ,  $b \in A$  where  $X = \{[a, c] : a, c \in A\}$  Now clearly  $x = 0$  or  $d(xb-bx)$  will be zero as  $N_r$  is without zero divisors But  $x = 0 \Rightarrow d(xb-bx) = 0$  so in either case  $d(xb - bx) = 0 \forall x \in X, b \in A$ . Replacing  $b = xb$  in above equation we will get  $\Rightarrow d(xxb-xbx) = 0 \Rightarrow d(x(xb - bx)) = xd(xb - bx) + d(x)(xb - bx) = 0$ . We know that  $\forall x \in X \Rightarrow$  either  $d(x)$  will be zero or  $xb = bx \forall b \in A$ . If  $d(x) = 0 \forall x \in X$  then from Lemma 2.14  $N_r$  is again commutative. Taking  $x_0 \in X$  s.t.  $d(x_0) \neq 0$  then  $x_0b = bx_0 \forall b \in A$ . Lemma 2.15 says that,  $x_0 \in Z(N_r)$  Hence  $f((ax_0)b) = f(b(ax_0)) \forall a, b \in A \Rightarrow f((ab-ba)x_0) = f(ab-ba)x_0 + (ab-ba)(x_0) = (ab-ba)d(x_0) = 0$ . Hence  $\forall a, b \in A$ ,  $ab = ba \Rightarrow A \subseteq Z(N_r)$ . Now from Lemma 2.15,  $N_r$  is commutative.

**Theorem 3.8.** For a Prime Ring  $R$  and a 3-Prime Near-Ring  $N'$ ,

- (1)  $\forall i \in I$  and  $k \in K$ ,  $f(ki) = -f(-ik)$  then either  $d(K)$  will be  $\{0\}$  or  $K \subseteq Z(R)$ , where  $K$  be subset,  $I$  be semi group ideal and  $f$  be generalized derivation associated with  $d$  on  $R$ . (provided  $f, I \neq 0$ )
- (2)  $\forall i \in I$  and  $k \in K$ ,  $f(ik) = -f(ki)$  then either  $f(K) = 0$  or  $-K \subseteq Z(N')$ , where  $K$  be subset,  $I$  be semi group ideal and  $f$  be generalized derivation associated with zero derivation on  $N'$ . (provided  $f, I \neq 0$ )

**Proof.** (1) We know that  $f(ik) = -f(ki)$  -(1)

Replacing  $i = ik$  then  $f(iik) = -f(kik)$ ,  $\forall i \in I, k \in K \Rightarrow f((ki + ik)k) = f(ki + ik)k + (ki + ik)d(k) = 0 \Rightarrow (ki + ik)d(k) = 0 \Rightarrow kid(k) = -ikd(k) \forall i \in I, k \in K$  -(2)

Again Replacing  $i = iw$  where  $w \in I \Rightarrow kiwd(k) = -iwd(k) =$

$-i(-kwd(k)) = ikwd(k)$ . Hence  $(ki - ik)wd(k) = 0$  Now By Lemma 2.4

$d(k) = 0$  or  $ki = ik \forall k \in K, i \in I$  If  $d(I)$  is not equals to zero then  $\exists x \in I$

s.t.  $d(x)$  is not equals to zero. Hence  $xi = ix \forall i \in I \Rightarrow x \in Z(R)$  from Lemma 2.16. So  $f(k(ix)) = -f((ix)k) = -f(ikx) \Rightarrow f((ki + ik)x) = (ki + ik)d(x) = 0$  Replacing  $i = iw$  where  $w \in I \Rightarrow kiwd(x) = ikwd(x) \Rightarrow (ki - ik)wd(x) = 0$ . Lemma 2.3 and theorem 3.6 says that,  $d(x) \in Z(R)^*$  is non zero divisor. Thus  $ki = ik \forall k \in K, i \in I \Rightarrow$  Lemma 2.16 says that,  $K \subseteq Z(R)$ .

(2) We have  $f(ik) = f(ki) \forall k \in K$  and  $i \in I$  Replacing  $i = ki$  then  $f(kik) = -f(kki) \Rightarrow f(k)ik = -f(k)ki$  Again Replacing  $i = iw$ , where  $w \in I \Rightarrow f(k)iwk = -f(k)kiw = -(-f(k)ik)w = -f(kik)(-w) = f(k)i(-k)(-w) \Rightarrow f(k)i(wk - (-k)(-w)) = 0 \forall i, w \in I$  and  $k \in K$ . From Lemma 2.4,  $f(k) = 0$  or  $wk = (-k)(-w) \forall i, w \in I$  and  $k \in K$ . If  $f(k) \neq 0 \Rightarrow \exists x \in k$  s.t.  $f(x) \neq 0$ . Hence  $wx = (-x)(-w) \forall w \in I \Rightarrow -x \in Z(N_r)$  by Lemma 2.16  $\Rightarrow f(((x)i)k) = -f(k((-x)i)) =$

$-f((k(-x))i)f(-x)ik = -f(-x)ki$ . Replacing  $i = iw$  and also using the same approach  $f(-x)i(wk - (-k)(-w)) = 0 \forall i, w \in I, k \in K$ . Lemma 2.4 says that, if  $f(x)$  is not equal to zero,  $\Rightarrow wk = (-k)(-w) \forall k \in K, i \in I$ . Hence from Lemma 2.16  $-K \subseteq Z(N')$ .

**Theorem 3.9.** For a Prime Ring  $R$  and Near-Ring  $N_r$ ,  $d$  be a derivation on both the Rings ( provided  $d \neq 0$ ) then

- (1) For Prime Ring  $R$ , if  $d(xy) = d(yx)$ ,  $\forall x \in R \Rightarrow R$  is commutative where  $I$  be its two sided ideal. (provided  $I \neq 0$ )
- (2) For Near-Ring  $N_r$ , if  $d(xy) = d(yx)$ ,  $\forall x, y \in N_r$  and  $\exists b \in N_r$  s.t.  $d(b)$  can not be left zero divisor for multiplicative commutator in  $N_r \Rightarrow N_r$  is commutative.

*Proof.* (1) Let  $c \in I$  be a constant s.t.  $d(c) = 0$ ; and let  $z \in I \Rightarrow d(cz) = d(zc)$  yields  $cd(z) = d(z)c$ . Again  $\forall x, y \in I$ ,  $[x, y] = p$ ;  $p$  is constant; hence  $d(z)[x, y] = [x, y]d(z) \quad \forall x, y, z \in I$ . Proposition 2.9 and 2.10 says that,  $d(z)$  is central  $\forall z \in I$ ; hence  $d$  is a  $I-$ derivation and  $R$  is therefore commutative by proposition 2.11.

(2) Replacing  $x = yx$  in  $d(xy) = d(yx)$ , we get  $d(yxy) = d(yyx)$  and hence  $0 = d(yxy) - d(yyx) = d(y(xy - yx)) = yd(xy - yx) + d(y)(xy - yx)$ . As  $d(xy) = d(yx)$ , we find that  $d(y)(xy - yx) = 0 \quad \forall x, y \in N_r$ . As  $d(a)$  is non left zero divisor  $\forall [x, y]$ , it follows from  $d(a)(xa - ax) = 0$  that  $xa - ax = 0$

$\forall x \in N_r$  Therefore,  $a \in Z(N_r)$ . From  $d(xy) = d(yx) \quad \forall x, y \in N_r$ , thus  $d(a(xy)) = d((ax)y) = d(y(ax)) = d((ya)x) = d((ay)x) = d(a(yx))$ . So  $0 = d(a(xy)) - d(a(yx)) = d(a(xy - yx))$ . Thus,  $0 = ad(xy - yx) + d(a)(xy - yx) = d(a)(xy - yx)$ . Therefore,  $xy - yx = 0 \quad \forall x, y \in N_r$  and  $N_r$  is commutative.

**Theorem 3.10.** *For a Prime Ring  $R$  and a Near-Ring  $N_r$ , Let  $d$  be derivation on both the Rings (provided  $d \neq 0$ ) and  $d(x)d(y) = d(y)d(x) \quad \forall x$  and  $y$  can be elements of Rings respectively*

(1) *For Prime Ring,  $R$  will be commutative if  $\text{char } R = 2$*

(2) *For Near-Ring, if for some  $b \in N_r$ ,  $d^2(b)$  is non left zero divisor in  $N_r \Rightarrow N_r$  is commutative.*

*Proof.* (1) Let  $X$  is subring of  $R$  which is generated by all  $d(x)$ ,  $\forall x \in R$ . It can be clearly said that  $X$  is a commutative subring of  $R$ . Let  $a \in X$  and  $x \in R$  then  $d(a)x + ad(x) = d(ax) \in X$ , Thus centralizes  $X$ . So, Let  $b \in X$ ,  $0 = bd(ax) - d(ax)b = d(a)(bx - xb)$ . If  $X \not\subseteq Z \Rightarrow d(a) = 0$ , for the annihilator of all  $bx = xb$  and  $\forall x \in R$ , will clearly

be an ideal of  $R$ . Let  $X \not\subseteq Z$ . Then from above,  $d(X) = 0$ , hence  $d^2(R) \subseteq d(A) = 0 \Rightarrow d^2(x) = 0 \quad \forall x \in R$ . Now Using Leibniz' rule  $2d(x)d(y) = 0$ , Now, if  $\text{char. } R$  is not equals to two,  $\Rightarrow d(x)d(y) = 0$ . If we use  $y = zx \Rightarrow d(x)Rd(x) = 0 \Rightarrow d(x) = 0 \quad \forall x \in R$  which is contradiction. Thus, if  $X \not\subseteq Z$ ,  $\text{char } R$  must be 2.

(2) For all  $x, y, z \in N_r$ ,  $d(d(x)y)d(z) = d(z)d(d(x)y)$ . From Lemma 2.1 and

$d(x)d(y) = d(y)d(x)$ , we will find  $d(z)d(x)d(y) + d^2(x)yd(z) = d(z)d(x)d(y) + d^2(x)d(z)y$  and so  $d^2(x)yd(z) - d^2(x)d(z)y = 0$ . Hence  $d^2(x)yd(z) +$

$d^2(x)(-d(z)y) = d^2(x)[yd(z) - d(z)y] = 0 \quad \forall x, y, z \in N_r$ . Since  $d^2(b)$  is non left zero divisor  $\Rightarrow yd(z) = d(z)y \quad \forall y, z \in N_r$  and then  $d(N_r) \subseteq Z(N_r)$  therefore Lemma 2.12 says that,  $N_r$  is a commutative Ring.

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**REJUVENATE HEAVY TRAFFIC ZONES - ENHANCE HUMAN BREATH! (A PROPOSAL TO DEAL WITH THE AIR POLLUTION ISSUE THROUGH THE DESIGN OF 'BREATHING TOWER')**

**AR. S.D. UPASANI\* AND DR. PARAG GOVARDHAN NARKHEDE****ABSTRACT**

*Environmental conservation, which was the way of living once, now, has become one of the most essential needs of society. Air, water, soil, and our surroundings are becoming waste bins because of the insensitive, neglected urban living activities and tremendous population explosion in urban areas. The research proceeds towards a proposal based on the understanding of an importance of 'Green pockets' in urban settlements like hills, nearby reserved forest areas which are the lungs of the city e.g. Taljai hill, ARAI hill (VetalTekadi) etc. of Pune City. As these 'lungs' purify and supply fresh air to the area around, the proposal is to try and create a similar device with a practical and simple approach. Architectural contribution to environmental conservation can be through erecting functional green pockets in urban environments. This should be done in smaller scales, understanding the space scarcity of urban fabric to deal with one of the major pollution elements i.e. air pollution. The applied research study is based on secondary data of pollution levels of Pune City, air purification needs and solutions by Botany researchers from a plantation point of view, chemistry-based reactions-materials and Taljai Hill green zone. This led the authors towards designing a simple proposal of 'Breathing Tower' in heavy traffic zones. The research needs more in-depth statistical data collection in terms of pollution factors and solutions-oriented information. But as a designer, the proposal is more theory & concept based; a path opener to invite environmentalists and subject experts to come together for a more realistic solution. The research-based design of a breathing tower will help with air filtration by inhaling polluted air and exhaling cool fresh air around. The simple & practical contributions towards implementations are needed in the fight for better breathing space.*

**Keywords:** Pollution, plantation, road,

**I. INTRODUCTION**

In the contemporary environment around, unaware-ignored-neglected human activities have invited tremendous pressure on liveable conditions. All the basic natural resources like water, soil, and air are the victims of pollution due to these activities. Vernacular and sustainable lifestyles are changing day by day. Not only the changes but also the needs of working areas, commuting places, less public transportation facilities, industrial zones, and many more are the reasons behind increasing urban air pollution levels. 'Pollution', from the Latin origin - 'Pollutus', means 'unclear/foul'. Air pollution can be defined as "Atmospheric conditions in which substances are present at concentrations higher than their normal ambient levels to produce significant effects on humans, animals, vegetation or materials". (Seinfeld 1986)

It is the author's personal experience that breathing becomes difficult in the heavy traffic zones of the Pune city, while waiting for a red signal to go green. Statistics and graphs of comparative analysis in the last few years for air pollution levels in metropolitan cities are sufficient to highlight the issue and need to deal with the same. The PM2.5 concentration of Pune city recorded on Wednesday, 12/01/2021, is 85 ( $\mu\text{g}/\text{m}^3$ ). Recommended threshold concentration of PM2.5, by the World Health Organization (WHO), is 25  $\mu\text{g}/\text{m}^3$  which means the concentration as compared to the recommended limit is 3.40 times. [9] This is definitely not a healthy condition. People need to go to nearby green pockets for fresh air to breathe. These pockets are either manmade gardens or reserved hilly areas that act as the respiratory system of the city.

The outer layer of the trees, plantations filters, dust particles, and pollution particles enter the inner parts and also participate in increasing the oxygen level by accepting Carbon dioxide. The inner part of the green zone purifies the air by enhancing its breathing qualities and releases fresh cool air. It is a simple cycle to understand the role of green pockets in purifying air quality. But for allowing this process to happen naturally, the countable size of green areas is needed as outer and inner layers when the air pollution level is on the higher side due to heavy traffic. Plantation on dividers and traffic islands will not be sufficient to deal with the problem. Hence understanding the whole situation, the research tries to formulate the solution for this air pollution with a practical approach and limitations of space, cost, etc.

**II. LITERATURE STUDY**

- First part of the research process was to understand the pollution factors and elements so as to find the most suitable solution. For this study, NAMP was studied by the authors and the summary is as follows.

The National Air Monitoring Program (NAMP) is in operation by the state pollution control board with the help of the Central pollution control board. 240 cities from India are under more than 342 monitoring stations. Based upon the Air Quality Index (AQI) tool, people are conveyed the air quality information effectively. Six categories are created and eight main pollutants are named to check the measures as mentioned in Table No. 1 along with the sub-index calculated from ambient concentrations. The sub-index reflects the overall AQI of the city and their records are easily available to the viewers on the internet through official websites and other applications. The table 1 gives the elements, which need to be dealt with, to improve the air quality, as per the recorded values.

Particulate matters can be separated from the polluted air by using different filters. To filter the gaseous pollution contents only the filtration processes are not sufficient. The chemical reactions and conversions of the harmful gases into other lesser harmful or useful forms can be the most effective way for making air pollution-free and fresh for breathing.

As compared to industrial smoke, the air pollution created by vehicular traffic does not contain a high percentage of CO<sub>2</sub>, NO<sub>x</sub> etc. The various gases in the atmosphere are around 78% Nitrogen, 21% Oxygen, 0.9% Argon, 0.04% Carbon Dioxide and other gases. These natural compositions are the causes of life on the Earth. Minor changes in these compositions due to human activities become a threat to healthy conditions for breathing. Hence the compositions of the gases like CO<sub>2</sub> and NO<sub>x</sub> should be controlled to natural composition.

**Table 1:** AQI Category, Pollutants and Health Breakpoints

AQI Category (Range)	Good (00-50)	Satisfactory (51-100)	Moderate Pollution (101-200)	Poor (201-300)	Very Poor (301-400)	Severe (401-500)
PM <sub>10</sub> (24hr)	0-50	51-100	101-250	251-350	351-430	430+
PM <sub>2.5</sub> (24hr)	0-30	31-60	61-90	91-120	121-250	250+
NO <sub>2</sub> (24hr)	0-40	41-80	81-180	181-280	281-400	400+
O <sub>3</sub> (8hr)	0-50	51-100	101-168	169-208	209-748	748+
CO (8hr)	0-1.0	1.1-2.0	2.1-10	10-17	17-34	34+
SO <sub>2</sub> (24hr)	0-40	41-80	81-380	381-800	801-1600	1600+
NH <sub>3</sub> (24hr)	0-200	201-400	401-800	801-1200	1200-1800	1800+
Pb (24hr)	0-0.5	0.5-1.0	1.1-2.0	2.1-3.0	3.1-3.5	3.5+

(Source: <https://aqicn.org/city/pune/>, <https://airpollutionapi.com/aqi/india/maharashtra/swargate>)

**Table 2:** AQI range & Associated Health Impacts

AQI	Associated Health Impacts
Good (0-50)	Minimal impact
Satisfactory (51-100)	May cause minor breathing discomfort to sensitive people.
Moderately polluted (101–200)	May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults.
Poor (201-300)	May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease.
Very poor (301-400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases.
Severe (401-500)	May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity.

(Source: <https://aqicn.org/city/pune/>, <https://airpollutionapi.com/aqi/india/maharashtra/swargate>)

- Second part of literature study includes searching for plantations which will survive by themselves in high pollution areas and play a role in the filtration process. For this, few research papers by botanists were referred to which talk about the role of plantation in pollution control. The summary is as follows -

A few plants act as an accumulator, which allow settling some specific air polluting substances readily without harming themselves. They are actively involved in selective capturing of pollutants that can be quantitatively analysed by a physicochemical method in the plant material. There is direct proportion of foliar dust fall and traffic density. It is a well-accepted method to collect the foliar dust and represent it in gm/m<sup>2</sup>. The foliar dust holding is measured in DRI (Dust Retention Index) of the plant. The method was tested by Chapekar and Mancharkar in 2007 [2] in closed chamber with and without blowing fans. The plants that hold more dust without running fan can be considered as good dust receivers. Another parameter in choosing plant species in traffic zones is Air Pollution Tolerance Index (APTI). Many researchers have worked in this area and proved that vegetation played important role in adsorption and trapping of particulates.

This is highly dependent on the size, shape, and texture of particles, plant parts, and conditions around. "For particulate removal, species with high leaf circumference-to-area and surface-to-volume ratios, along with leaf surface roughness may be recommended. It may be concluded that within their limits of tolerance, plants absorb pollutants and to that extent remove air pollutants." [2] Hence while choosing the plant species, parameters like APTI, DRI, and their trimming capacity are influential. The recommended plant species by Botanists Dr. Nitesh Joshi and Ambika Joshi are *Ficusbenjamina*, *Pedilanthustihymaloides*, *NeriumOdorum* and *Bougainvillaea* species for example. Also Tulsi Plant, due to its high oxygen emission property, can be used in the design, not for the air absorption or filtration but for the air quality improvement.

**Table 3:** Common information about the above mentioned Plants

<p>All four plant species are</p> <ul style="list-style-type: none"> <li>Easy to maintain – grow, Sun-light lovers plant.</li> <li>Moderate, temperate, Subtropical climatic conditions, unsuited in frosting climate</li> <li>Available in various flowers, leaves and forms.</li> </ul>			
<b><i>Ficusbenjamina</i></b>	<b><i>Pedilanthestihymaloides</i></b>	<b><i>NeriumOdorum</i></b>	<b><i>Bougainvillea Glabra</i></b>
<p>Common Name: Weeping Fig Full Grown Height: 10-30 mt. Can be grown in Pot. Easy Maintenance</p> 	<p>Common name: Euphorbia tithymaloides Full Grown Height: Around 1.5-2 metre Easy Maintenance</p> 	<p>Common Name: Nerium or Oleander. Pink-Red flowers throughout the year, summer peak season.</p> 	<p>Common Name: Paper-flower, Bougainvillea. Evergreen climbing shrub. Around 3-3.5 m tall. Heat and Drought tolerant.</p> 

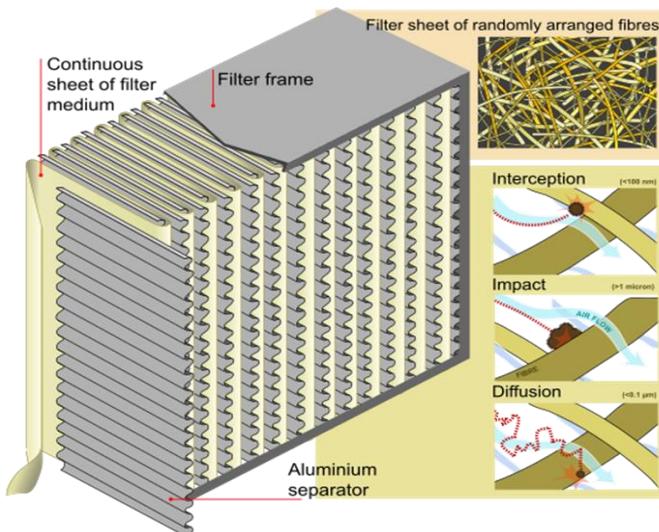
**(Source of information and Pictures:** [https://en.wikipedia.org/wiki/Ficus\\_benjamina](https://en.wikipedia.org/wiki/Ficus_benjamina),  
*Pedilanthes\_tihymaloides*, *Nerium*, *Bougainvillea\_glabra*)

- Third part of the literature study was finding the different types of filters and Catalyst converters for the actual air purification process in the proposed 'Breathing Tower' model.

**Filters:** The study of different types of filters used for various purposes like indoor air purification, industrial smoke and particles' purification, healthcare environmental requirements from the secondary sources like research papers, air-conditioning system providers' data etc. was carried out by the authors. There are many

types of air purification filters available in the market as per the pollution particles, air purification level required, and the area that needs to be purified etc. Few of the common filters listed below are suggested in the proposed air purification model of the ‘Breathing Tower’.

- **Coarse filter (Pre-Filter)** This layer restricts larger particles such as dust, lint and can be reused after washing, dusting, and vacuuming.
- **HEPA filter (High Efficiency Particulate Air filter)** Particles with the size of 0.3 micrometers such as pollen, dust, airborne particles, and bacteria can be restricted up to 99.97% by these filters. [6]



**Figure 1:** HEPA Filter Internal Structure and Aluminium internal support along with the functional principle description

(Source: Public Domain, <https://commons.wikimedia.org/w/index.php?curid=4552953> )

Air pollutants can be subdivided into categories but the most harmful of them all are particulate matter of sizes less than 2.5 microns and NO<sub>x</sub> emissions. Human body is equipped suitably to trap the particulate matter entering while we exhale but the problem occurs in dealing with PM 2.5 as their size becomes so minute that it is not technically possible for our body to trap them. In an effort to find a solution to this problem, HEPA filters were designed which are a multi-layered structure of glass fibres in order to trap the PM 2.5 particles. They do promise a very high efficiency of 99.97% but all of this comes at a cost owing to the expensive and intensive process of production. [5] Different thicknesses are available in HEPA filters as per the brand, filtration need, and air flow rate.

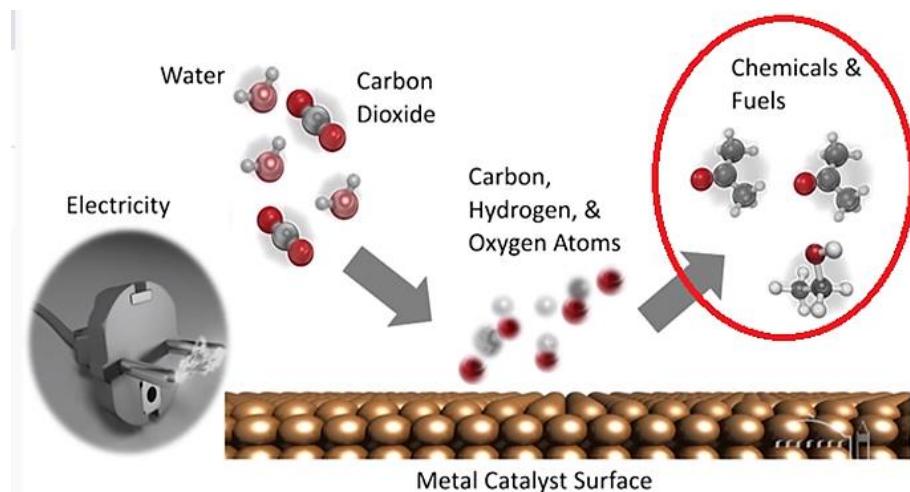
#### Activated Carbon filter

It can be used to absorb particles and trap odours. Carbon air filters use activated carbon to trap chemicals and gases, and can also filter cigarette smoke. The special properties of activated carbon, which helps in removing volatile organic compounds (VOCs), some gaseous pollutants, and odours from air, play a role in the filtration process. Here lies the difference with HEPA filters that remove only particle pollution. Hundreds of square metres of internal surface area can be possible in a single gram of activated carbon. When polluted air flows through the internal surface of activated carbon, it blocks the pollutants. Because of this functioning strategy, sufficient thickness of carbon and ‘dwelling time’ of polluted air is needed and periodical carbon layer replacement is compulsory due to saturation of the surface areas.

#### The catalyst convert (Credits: Berkeley Lab, Jessie Eastland)

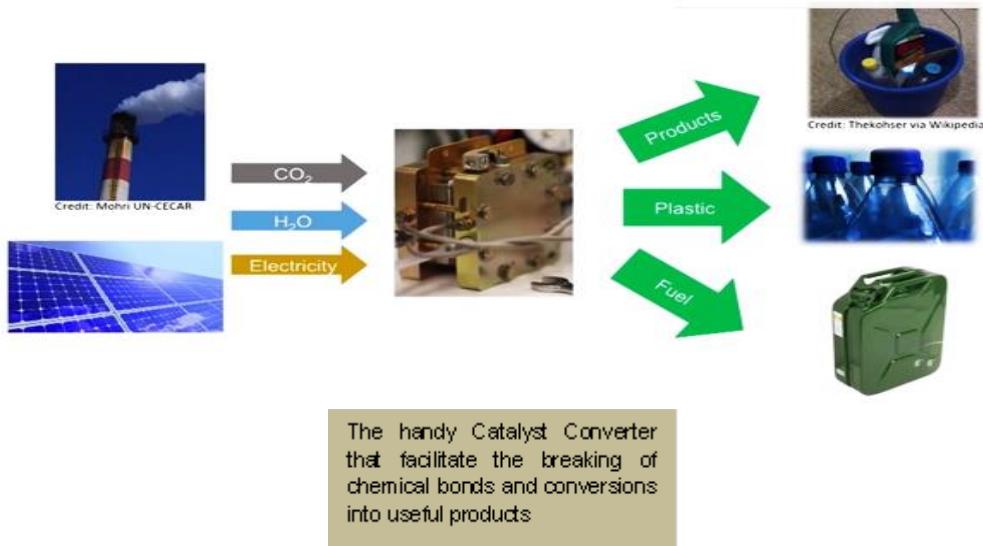
Catalyst is a material that facilitates changes of CO<sub>2</sub> into usable by-products like ethanol, Ethane, Ethylene, and Polyethylene, natural fuels – Methane, Ethanol, diesel fuel etc. and saves fossil fuel consumption. In this process specific metal surfaces in the presence of some reactors and electricity (that can be achieved by renewable energy sources) convert the harmful CO<sub>2</sub> into the useful chemical, plastic and some form of fuel. [8] The electrical energy required for this process can be obtained from the Solar Panels or other form of renewable sources. The 'Cyclotronroad' program made by the Berkeley Lab is an example of this kind of catalyst converter. “Kendra Kuhl co-founded Opus 12 to find out if an electrochemical process, operating inside a desk-sized reactor, can do on an industrial scale what is often hailed as the Holy Grail of carbon-recycling research—convert CO<sub>2</sub> and NO<sub>x</sub> captured from smokestacks into ethanol and other valuable products.” (University Of

California Television UCTV) With the lower capital cost, all scale chemical production is possible in greener way by using this process. Household products like Acetone, Ethylene-Glycol, etc. can be easily obtained from this electrochemical reaction.



**Figure 2:** Schematic working of Catalyst Converters  
 (Source: <https://www.youtube.com/watch?v=LIXbt-ops-E&t=300s>)

16 different compounds can be obtained from these chemical reactions, based on the type of recycling CO<sub>2</sub> catalyst used that can be utilised in many possible ways in the chemical industry. These compounds are Propanol, Acetaldehyde, Acetone, Ethanol, Methanol, Ethylene glycol, Acetate, Methane, Carbon monoxide, Glycolaldehyde, Allyl Alcohol, Ethylene, Hydroxyacetone, Propionaldehyde, Formate, Glyoxal.



**Figure 3:** The handy module of Catalyst Converter and the by-products possible after the reactions  
 (Source: <https://www.youtube.com/watch?v=LIXbt-ops-E&t=300s>)

- Hills/Hillocks and reserved forest areas in/near-by the Urban Spaces: Symbolic Lungs and green pockets of Urban area

More than 5 hills are maintained by the Pune City Local Government. They are Taljai Hill, Chaturshrunji Hill, Baner Hill, Ram Hill, Hadapsar, Vetal Hill. Understanding the importance of these hills in the ecological balance of Urbanscape, these lush green spaces are conserved. [11] The people use these hilly areas for walking, jogging, and other similar activities so as to get the fresh-clean air for breathing. Also these green spaces act like natural stress relievers. As per human psychology, the fresh green plantation plays a role in relaxing the human body and mind to some extent. These two are the important phenomena of hilly green spaces which should be considered while designing the solutions to air pollution issues.

### III. DATA AND METHODOLOGY CONSIDERED

The applied research approach was the need of the study that will find out some solution to the present traffic pollution problem. Based on the understanding of different aspects of the study as mentioned in the literature

study (secondary data), the design of the Breathing Tower model (the proposal) is formulated. This tower will absorb and inhale the particulate matter at different levels from the traffic air pollution and will provide fresh air to the people moving around. As per the locations, small sitting areas, news-paper/ periodicals' reading areas at the traffic islands can be designed below this tower so as to get the fresh air as it is available on the hillocks of Taljai, Parvati, ARAI – Pune, Maharashtra.

#### **IV. ANALYSIS / PROPOSAL**

The issues related to air pollution are much more severe than they seem to be at the first glance. The long run and difficult to rectifiable issues like health deteriorations, ecosystem disturbance, ozone layer deterioration etc. are accompanied by the immediate issues like breathing problems, temperature increase, visibility issues.

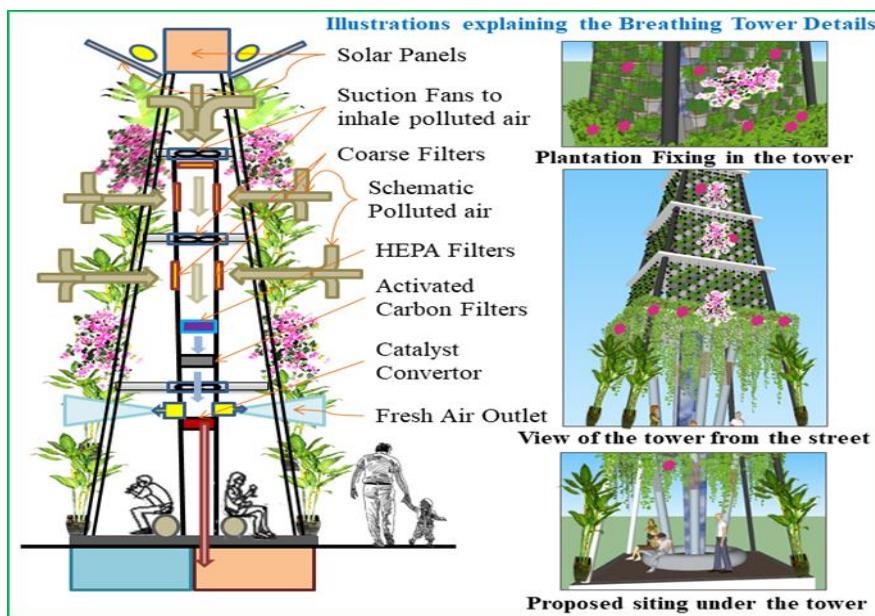
##### **Proposal to deal with air pollution issue in heavy traffic zones**

One of the famous pioneer architects, designers, theorists - Buckminster Fuller from America stated that "Pollution is nothing but the resources we are not harvesting. We allow them to disperse because we have been ignorant of their value." On the similar line, the authors tried to formulate the proposal. Among all the air pollution types, authors tried to work on the air pollution issue in the heavy traffic zones. Fresh air for every living kind is the universal right. "The rapid population growth together with high rate of urbanisation, industrialization and increase in motorised transport have resulted in an increased concentration of various air pollutants namely; Sulphur Dioxide (SO<sub>2</sub>), Nitrogen Oxides (NO<sub>x</sub>), Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM/PM10), Carbon Monoxide (CO), Lead (Pb), Ozone (O<sub>3</sub>), Benzene, Hydrocarbons (HCs) etc." [12].

This causes immediate health issues like heavy breath, sneezing, irritations in the nasal and throat pipe, cough etc. Long term diseases' list is much longer and like a slow poisoning. Hence the basic idea was to suck this polluted air, filter it by some mechanism and throw fresh air back into the environment for breathing. The mechanism should be simpler for implementation, maintenance, and installations and should be suitable to the surroundings.

#### **V. DESIGN ATTRIBUTES OF BREATHING TOWER:**

- Key Aspects of the Design:(Figure No. 04)
- A tower is shaped in such a way to inhale polluted air with the help of suction fans from the upper part and exhale the fresh air from the lower part at the human level.
- Solar panels fitted at the top of the tower will supply the electricity to suction fans and catalytic converters.
- First step of adsorption by the plants mentioned in the Table No.3
- The conical shaped pipe will pass the polluted air allowing it to pass through different filtration layers to make the air purer at every step.
- Coarse/ Primary filters to remove dust, lint, larger pollution particles
- HEPA Filter – Activated Carbon Filter will clean the air as per their capacity.
- Catalyst Converter will convert CO<sub>2</sub>; NO<sub>x</sub> fresh air will be exhaled from the outlets.
- Water tanks (for the plants) + Storage for By-products of catalytic reactions will be positioned below the tower.
- Fresh air will escape through the opening provided as an outlet of the breathing pipe. The outlet level will be in accordance with human anthropometry.
- Sittings can be provided which will serve as the refreshments for smaller communal gatherings.
- In the plantation layer or near the sitting area, *Tulsi* (Holy Basil) can be added to enhance the air quality. Purifying plants will be used as per the study, considering maintenance, plant life, visual effect and aesthetic values.



**Schematic Design Sketch of Breathing Tower**

(Source: Drawn by the authors based on the study)

**Figure 4:** Schematic Proportionate Design Sketch of the Breathing Tower  
 (Source: Drawn by the authors based on the research)

## VI. IMPLICATIONS OF THE PROPOSAL

SWOT Analysis of the 'Breathing Tower' Design:

- **Strength:**

- Simple mechanism to implement
- Filtration layers can be used as per the density of pollution
- Tower can be placed at any desirable location, at the junctions or at the corners. The traffic islands will keep the space fresh along with aesthetic enhancement and regulating vehicular movement.
- As per the availability of space, dimensions can be worked out.
- Adding 'Green' in heavy traffic zones will be a visual relief to traffic and driving stress

- **Weakness**

- Actual pollutant contents can vary from place to place and filtration layers need to be worked on in detail.

- **Opportunities**

- Wide range of materials can be used to minimise the construction cost
- Any other form can be adopted as per the context and scale of the tower can be varied as per the availability of space.
- Renewable energy can be utilised as per the area to minimise mechanical means. Ex. Solar energy/Wind energy can be used for the functioning of the tower as suction fans, lights at night time, pumping water, and catalytic converter working.
- By-products from the catalyst convertor may be smaller in quantity as compared to industrial pollution. But the pollutants are reused in some usable form.

- **Threats**

- The biggest threat will be 'lack of maintenance'. This can be overcome by creating awareness, respect and need for environmental conservation.

## VII. CONCLUSION

The breathing tower proposal is a better solution to reduce the air pollution caused due to heavy traffic. Many researchers and experiments have not made significant change in the actual situation. Architecture and built

environment can be enhanced to resolve the environmental issues. Literature study sets a background to this research study and supports the importance of breathing towers. In the future, it is recommended to encourage more number of breathing towers at certain intervals to control the air pollution levels. In the analysis it is revealed that the strength and opportunities have wide scope. The tower is systematically designed for the congested environment and sets a basic framework for breathing tower designed according to different areas and situations. This research study is an attempt to highlight the pollution threats and provide adequate solutions for the same.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***THE PRISONER'S DILEMMA FOR INDIA AND PAKISTAN: KASHMIR DISPUTE****SWATI MENE\* AND M. M SINGH****ABSTRACT**

The Prisoners' Dilemma is one of the essential problems of international politics. Every nation's most-valuable result is supposed to be the place they pick high arms and their enemies low. Prisoner's dilemma is the most important non-cooperative game in game theory. The present paper deals with the prisoner's dilemma between two countries India and Pakistan. The strategies adopted by India and Pakistan regarding Kashmir dispute has also been analysed. Moreover, the role of China and Turkey in the dispute between India and Pakistan has also been taken into consideration and the impact on the strategies of India and Pakistan if China and Turkey favour Pakistan or not?

**Keywords:** Prisoner's dilemma, Game, Game theory, Strategy, Non-cooperative game.

**Mathematics Subject Classification:** 91A80, 91A35.

**INTRODUCTION**

The notable Prisoner's Dilemma (PD) game[6] is as regularly as conceivable applied to arms races between two countries India and Pakistan. Every country has a choice between a high and a low level of arms[3]. Every country's most-supported outcome is believed to be the spot they pick high arms and their foes low, expanding an unquestionable military favoured position. Their most un-supported outcome is inverse [4]. Else, the second-best outcome for each is the spot both pick low; if no better position is acquired, then it is believed to be more affordable and more secure to avoid the weapons challenge. The Prisoners' Dilemma and the Problem of Cooperation is one of the focal issues of all governments around the world. Arms races give a genuine case of the issue of collaboration. From one perspective, if all governments spend a lot on military budget; no administration increases any extra security or is better ready to impact others [2].

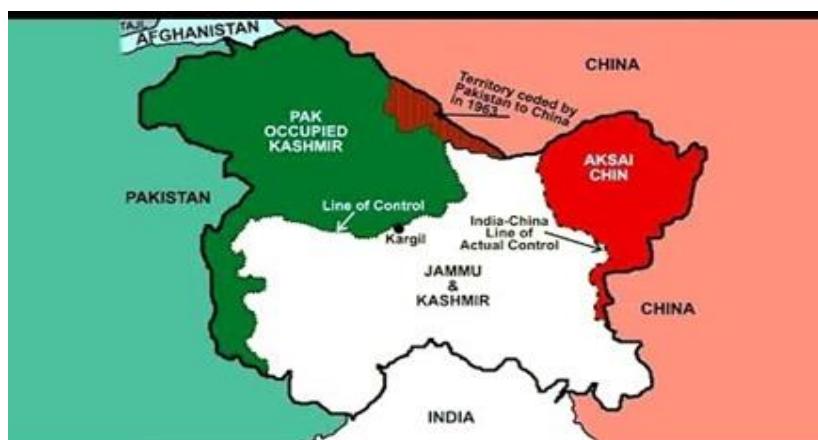
**WHAT IS THE MATTER BETWEEN INDIA AND PAKISTAN ABOUT KASHMIR?**

The Kashmir dispute between India and Pakistan remains the most sought conflict after the partition. The situation of India and Pakistan can be understood as the prisoners in the prisoner's dilemma game[5]. Both nations have always in dilemma regarding Kashmir. Both military strength and nuclear capabilities are the same. Therefore both could not get possession of Kashmir by defeating each other. Therefore the best strategy for both is co-operation.

This paper is divided into two parts. The first part describes the strategic game between India and Pakistan. It also explains what the role of China and Turkey is in this entire game. This means that whether China and Turkey favour Pakistan or not, they play a crucial role in the entire game.

In the second part, it has been discussed that the best strategy for all the four nations involved in this strategic game about the Kashmir dispute.

Map 1: Aksai Chin Plateau and the Shaksgam Valley



**Source:** India Today

**ROLE OF CHINA AND TURKEY**

China and Turkey may support Pakistan against India or play a diplomatic role by not supporting China. These two cases affect our matrix.

**RELATION BETWEEN PAKISTAN AND CHINA**

The diplomatic relationship between China and Pakistan was started in May 1951. Later on, the political and military relations between China and Pakistan are getting stronger with time. The China-Pakistan economic relations started to strengthen after the end of the Free Trade Agreement in 2007. China-Pakistan Free Trade agreement seems to be a stepping stone in growing the economic relations between China and Pakistan [4].

The two countries support the war on terrorism and thus find themselves on the same side in this latest global conflict, China will come under considerable pressure from the USA to distance itself from Pakistan by halting the supply of nuclear material and technology which could be used by Islamabad to refine its nuclear weapons and ballistic missile capabilities[2].

**RELATION BETWEEN PAKISTAN AND TURKEY**

Diplomatic relations between Turkey and Pakistan were started in 1947, soon after Pakistan came into being as the then biggest Muslim country on the world map. Turkey was among a few countries that rapidly recognized Pakistan after its formation and supporter to become a member of the United Nations.

In 1988, the Turkish-Pakistani Military Advisory Group was formed to give-and-take experiences in military training and the defence industry [7]. From time to time, Turkey and Pakistan have clasp combined military exercises. Turkey has become the second-largest provider of weapons for the Pakistan Army after China. Both the countries act friendly and generally being termed as Kardesler (“brothers” in Turkish).

**WHY CHINA AND TURKEY SHOULD SUPPORT PAKISTAN?**

Turkey has openly supported Pakistan's stance on the Kashmir conflict. The Pakistani people helped a lot in the independence of Turkey, which turkey can never forget. Therefore, Turkey always supports Pakistan on the Kashmir issue.

A slight sliver of Kashmir is also held by China [7]. For many years, Kashmir has become an issue due to self-interest for many countries; China is one of them [1]. Therefore, China also supports Pakistan on the Kashmir issue.

**ANALYSIS OF ACTIONS BY BOTH THE COUNTRIES****Step 1: The Mission**

Chief of the army staff (COAS) ordered the Indian army that the Pakistani army should not occupy Kashmir.

**Step 2: Situation and courses of action**

The Army of India and Pakistan are always standing on the border in front of each other. The armies of both countries are ready with their weapons for a long time. Both countries stand on the border with the same objective that neither of the two countries could take possession of Kashmir.

**Step 3: Analysis of opposing forces of action**

India and Pakistan are stationed in front of each other with thousands of soldiers, tanks, and the latest weapons. Both do not underestimate their power performance.

**Step 4: Comparison of available courses of action**

Both India and Pakistan have two choices. They should cooperate and share Kashmir among themselves or face the war and capture Kashmir.

**Step 5: Decision**

The best decision for both countries is to maintain peace along the border. Both of them can maintain peace in Kashmir through partnership rather than a monopoly.

**DISCUSSION**

Since independence, the Kashmir dispute remains live between India and Pakistan .Kashmir is an integral part of Integralpart of India and Pakistan wants to capture it through terrorism and other foul practices. The same issue can be understood from the Prisoner's Dilemma Game Here we have taken two cases.

**Table -I:** Case-1 If China and Turkey Support Pakistan

India's Strategy		Pakistan's Strategy	
		Co-operate	Defect
	Co-operate	<p>If India and Pakistan compromise each other where China and Turkey are also in support of Pakistan, i.e. China and Turkey want to co-operation between India and Pakistan, then peace will maintain in all the four countries. There is no loss to any country.</p> <p><b>(Peace-Pareto Optimal Solution)</b>  <math>(8 \ 8 \ 8 \ 8)</math>  <b>I P CT</b></p>	<p>If only India compromises but Pakistan defect where China and Turkey give full support to Pakistan in every action. Its result will be that Pakistan will take over Kashmir and India may have to face defeat.</p> <p><b>(Kashmir Goes To Pakistan)</b>  <math>(2 \ 7 \ 7 \ 7)</math>  <b>I P CT</b></p>
	Defect	<p>If only Pakistan compromises where China and Turkey are with Pakistan, i.e. China and Turkey also want to co-operation between India and Pakistan but India will defect then India will try its best to capture Kashmir. But with Pakistan getting full support from China and Turkey, it will be very difficult for India to take over Kashmir.</p> <p><b>(Kashmir Can Go To India)</b>  <math>(6 \ 4 \ 4 \ 4)</math>  <b>I P C T</b></p>	<p>If India and Pakistan defect where China and Turkey give full support to Pakistan for defection, which will result in a war among four countries and eventually prove fatal for all of them.</p> <p><b>(Nash Equilibrium)</b>  <math>(1 \ 1 \ 1 \ 1)</math>  <b>I P CT</b></p>

Here I=India, P= Pakistan, C= China, T=Turkey

**Table -II:** Case-2 If China and Turkey play neutral role

India's Strategy		Pakistan's Strategy	
		Co-operate	Defect
	Co-operate	<p>If India and Pakistan compromise where China and Turkey play a neutral role then peace will maintain in all Four countries. There is no loss to any country.</p> <p><b>(Peace-Pareto Optimal Solution)</b>  <math>(8 \ 8 \ 8 \ 8)</math>  <b>I P CT</b></p>	<p>If only India compromises and Pakistan will defect where China and Turkey are neutral then Pakistan will try to take possession in Kashmir.</p> <p><b>(Kashmir Can Go To Pakistan)</b>  <math>(2 \ 6 \ 8 \ 8)</math>  <b>I P CT</b></p>

	Defect	<p>If only Pakistan compromises where China and Turkey are neutral then India will try to take possession in Kashmir.</p> <p><b>(Kashmir Can Go To India)</b>  <math>(\begin{matrix} 6 &amp; 2 &amp; 88 \end{matrix})</math>  <b>I P CT</b></p>	<p>If India and Pakistan defect where China and Turkey are neutral, then there will be situation of war between India and Pakistan. This war will affect India and Pakistan directly.</p> <p><b>(Nash Equilibrium)</b>  <math>(\begin{matrix} 1 &amp; 1 &amp; 8 &amp; 8 \end{matrix})</math>  <b>I P CT</b></p>
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Here I=India, P= Pakistan, C= China, T=Turkey

Whether China and Turkey support Pakistan or not, India and Pakistan have 2 choices:

(i)Co-operate (ii) Defect. India and Pakistan adopt strategies without knowing each other's decisions. When India and Pakistan go to war, it is a negative strategy (Nash Equilibrium).When India and Pakistan co-operate each other then it is a positive strategy (Pareto-optimal solution).

The above matrix shows all the options of dispute between the two countries. This matrix also shows the result of each option.

## **CONCLUSION**

The prisoner's dilemma is a classic example of game theory. The four countries India, Pakistan, China and Turkey are involved in this war game. The players of this game are their people and leadership. The Matrix is important to understand the game and its outcome very well. In this game we got both positive and negative strategies. The correct decision for both India and Pakistan is peace (pareto-optimal solution).Whether China and Turkey support Pakistan or play a neutral role, peace will be the best solution for all the four countries.

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**ROLE OF NEP-2020 IN ENHANCING QUALITY AND SUSTAINABILITY OF HIGHER  
EDUCATION IN INDIA**

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**ABSTRACT**

*Formed in 1986, the last NEP (National Education Policy) underwent an extensive revision in 1992. Following that, numerous changes were made in order to revise the policy. Several initiatives for primary and secondary education have been launched in recent years. Quality education is the backbone of any society's growth, and education policy is the means to achieve it. The current government in India has introduced the NEP-2020 after three decades. The 66-page document discusses the government's vision for ECCE, School Education, Higher Education, and Professional Education. Higher education has a huge impact on the economic prosperity of a country and sustainable livelihoods. The NEP 2020 is also compliant with Goal 4 of the UNs SDG 2030, which states strongly that equal access to education is the cornerstone of long-term development. To achieve this, a number of initiatives for quality higher education must be undertaken to connect the three main elements of sustainable development-society, economy, and ecology. This paper examines the current situation of higher education in India, as well as the improvements that must be made in order to build a great higher education system that will lead to achieve sustainable development.*

**Keywords:** New Education Policy (NEP), higher education, Sustainable Development Goals (SDG 2030), Sustainable development

**1. INTRODUCTION**

Education and federalism have a long history together, dating back to the colonial period, when the Sadler Commission recognised education as a state matter in 1917 while giving the federal government extensive coordination powers. Following India's independence, the framers of the constitution left education in the hands of state governments while providing the Union government with key responsibility for ensuring educational parity and standards. Furthermore, constitutional provisions such as the Directive Principles of State Policy (Art. 45), which provided for children under the age of 14 to receive free and obligatory education, as well as the facilitation of the education needs of society's poorer sectors. Despite these exceptions allowing the Union to intervene selectively, India's school and higher education sectors were dominated by states in the early decades of independence. The constitution's 42nd amendment in 1976, it was ratified, tipped the scales considerably in favour of the Union government. This action has the consequence of turning education into "shared responsibility" in which both the Union and the states were "equal partners." Aside from this, the Union government has been able to secure a crucial position in the field of education through a variety of state funded initiatives. For example, Child Development Services, the main programme (ICDS), which includes key Early Childhood Education and Care (ECCE), has ensured that the Union plays an important role in early school education.

Higher education is essential for fostering human and societal well-being and for transforming India into a democratic, socially conscious, cultured, and humane society that supports the Constitution's principles of liberty, equality, fraternity, and justice for all. A growing number of young Indians are anticipated to pursue higher education as India strives to become a knowledge economy and society. Its main goal is to develop a "knowledge society" that will benefit Indian students by providing them with "global standards" education. It also proposes the creation of a NRF with the purpose of fostering a favourable research environment through means of money and guidance. According to the NEP 2020 was developed by considering over millions of suggestions with a GER of 50%. The NEP aims to put India on track to accomplish SDG 4 of the 2030 Agenda for SD by delivering comprehensive and a fair education and providing opportunities for all people to study throughout their lives. NEP recognises that reaching SDG 4 will necessitate a complete reorganisation of the educational sector in order to meet all important targets and SDGs.

Given the preceding facts, the primary purpose of this study is to present India's existing ways to investigating SDG 4 on education in Indian contexts by including them in the development of a NEP and its positive influence on education value.

**LITERATURE REVIEW**

Helen Kopnina (2011) analyses the ramifications of the move from environmental education (EE) to education for sustainable development in the perspective of environmental ethics (ESD). The purpose of this article is to show the value of environmental morality in environmental studies in general and education for long-term development, as well as to make the case for a return to institutional theory based on twin presuming that the environment issues are serious and those environmental studies can help solve them.

At the University of Otago in New Zealand, Kerry Shephard, John Harraway, Brent Lovelock, Miranda Mirosa, Sheila Skeaff, Liz Slooten, Mick Strack, Mary Furnari, Tim Jowett, and Lynley Deaker enhanced research-based improvements in 2015. While sustainability qualities can be expressed with information, abilities, and competences, they are grounded by emotional qualities such as beliefs, views, and inclinations are examples, meaning "education for sustainable development" is largely a search for emotive transformation. They argue if higher education is to analyse or evaluate their performance, the goals of "education for sustainable development" must be clearly stated. Kerry Shephard's narrative on student engagement, written in 2015, provides the backdrop understanding much of what is currently happening around the world in the sector and provides different perspectives for reviewing higher education. It focuses on research, contrasting the goals of student empowerment, participation, and change agency with research themes and methodologies that focus on students as knowledge receivers, attitudinal survey respondents, or as test subjects for behaviour change theories.

Tripathi, H. (2016) investigated the current state of higher education in India and the significance of three pillars of sustainable development in ensuring the country's quality higher education. The study's data was gathered from secondary sources. According to the paper, some changes in the teaching-learning process and improvements in the learning environment are required. The study also recommended changes to ensure a strong higher education system in order to achieve long-term development.

Allam, M. (2017) examined link amongst quality learning with SDG's, and the the significance of a good education in achieving these goals. The paper came to the conclusion that there is a clear correlation between high-quality education and attaining long-term development objectives.

Mary Panmei, A.K. (2018) examined the current state of SDG 4 target implementation in India. The study gathered information from secondary sources such as the National Sample Survey,(MHRD), and other reliable sources. According to the study, the education sector in India has improved over the years as a result of a number of initiatives, but they have been insufficient.

Ellen Boeren (2019) investigated the current emphasis on education strategies around the world, as well as the implementation of SDG 4. The study concluded that SDG 4 targets can only be met if administrative government, individuals, and education and training institutions share responsibility.

**2. Objectives Of The Study**

- To investigate the significance of education, higher education, and sustainability.
- To investigate the conceptual framework of Sustainable Development Goals 4 (SDG4).
- To investigate the reasons for linking education to Sustainable development.
- To make recommendations to improve the country's education system.

**3. RESEARCH METHODOLOGY**

This is a descriptive study. Secondary information was gathered from a number of different sources, websites, including those of the Government of India, magazines, journals, and other publications, among others.

The study attempted to investigate the status of Sustainable Development Goal 4 in India. The research is based on a thorough examination of secondary data gathered from domestic and international journals, books, and websites focusing on various aspects of Sustainable Development Goals 4 (SDG 4).

**4. Overview: Definition and Meaning Of Education**

The term "education" has a wide range of meanings, making it difficult to provide a precise definition. When attempting to define education, different people meant different things at different times. Some of the definitions are as follows:

Swami Vivekananda defined education as the "Manifestation of perfection already in man."

"Nothing on earth is more purifying than knowledge," says Bhagavadgita.

According to the Rig Veda, "education is something that makes man self-reliant and self-less."

According to the Indian Education Commission (1964–1966), education should be related to people's lives, needs, and aspirations in order to be a powerful tool for social, economic, and cultural transformation.

### **Education - Meaning**

"Education" word is derived from the Latin word called "Educatum," which means "to lead out" or "to bring ideas out of the mind" Thus, education is a process or activity that leads ideas or emotions out of the mind. It is a life-long process of changing one's behaviour as a result of one's life experiences. In this sense, education is imparted by anyone to anyone, at any time, at any place, and in any way, with the goal of total development of the individual. In a narrow sense, education refers to the training provided within the four walls of an educational institution over a specific period of time in order to achieve predetermined goals and objectives.

### **Higher Education Meaning**

Higher education mainly and generally means university level education. Higher education encompasses all post-secondary education, training, and research guidance at educational institutions such as universities that have been designated as institutions of higher education by state authorities. Higher education institutions, most notably universities, serve three functions in total: education, research, and societal contribution. The functions of research and education are two sides of the same coin; research enables higher levels of education, and education, in turn, develops the human resources to conduct research.

### **Sustainability Meaning**

In simple words, Sustainability entails meeting our own needs without jeopardising future generations' ability to meet their own. The term "sustainability" refers to programmes, initiatives, and actions aimed at preserving a specific resource. However, it actually refers to four distinct areas: human, social, economic, and environmental, which are referred to as the four pillars of sustainability. While the concept of sustainability is a novel one, the movement as a whole has origins in social justice, conservationism, internationalism, and other historical movements. Many of these ideas had converged into the call for "sustainable development" by the end of the twentieth century.

### **Nep 2020 Vision and Guidelines for Achieving Sdgs (Sdg 4)**

Let us examine the vision and guidelines outlined in the NEP for sustainable development, with a focus on Education for Sustainable Development and Target 4.7.

Goal 4 of the Sustainable Development Goals includes ten targets that cover a wide range of educational topics. There are seven targets that represent expected outcomes and three targets that represent means of achieving these targets.

- All should have access to primary and secondary education: By 2030, all should have access to free and equitable high school and elementary education, resulting in meaningful and effective learning outcomes.
- Universal early child development and nursery education: Assist all girls and boys in receiving high-quality early childhood development, care, and pre-primary education by 2030 in order to be ready to start elementary school.
- Equitable access to education and training as well as higher education: Assure that everyone have equitable access of cheap and high-value education, training, post-secondary and higher education, by 2030.
- Required skills for proper work: Raise the number of young and adults with required skills, including education and training abilities, will be required for work, respectable opportunities, and own business by 2030.
- Participation and fairness on Gender: Minimize misogyny by 2030 in education and give disadvantaged students, including disabled people, native peoples, and children in dangerous situations, with fair approach to education and occupational learning across levels.
- Universal literacy of youth: Assure that all young and a substantial number of adults, including males and females, are literate, numerate by 2030.
- Worldwide nationality and learning for long-term development: Ascertain that all students have the information and skills required to promote long-term growth by 2030, such as long-term development and healthy lifestyles through education.

**There are Three Different Ways to Put It into Action**

- Classrooms that work: Build and improve academic settings that are sensitive to child's needs, impairments, and sexuality, as well as provide a secure, secure environment nonviolent, including, and effective educational environment for everyone.
- Increase the number of scholarships and avail them to emerging nations, particularly by 2020, the undeveloped, small island developing nations, and african countries will be eligible for enrolment in higher education in developed and developing countries, including vocational training and information and communications technology, technical, engineering, and scientific programmes.
- Educators with teachers- greatly expand the flow of trained instructor, especially through international collaboration for teacher education in emerging nations.

**Indian Framework: Current Scenario**

The goals for Sustainable Development were established in 2015. Although notable efforts have been made to promote primary education, there is still much work to be done. Education is the most crucial aspect of achieving long-term development goals. SDG 4 (education), which calls for universal, equitable and critical for socioeconomic growth in all countries. India is committed to fulfilling SDG 4 by 2030 as a signatory to the SDGs.

**The Following are Some of the Reasons Why Education is Important for Long-Term Development**

The foundation for secondary and higher education is laid in the primary level of school. The evidence from the past and present scenario demonstrates that states that place a greater emphasis on primary education while ignoring higher education cannot progress economically, socially, or politically. Teaching ways for the protection of next generation's economic and environmental future. Quality assurance, accountability, employability, and moral obligations are just a few of the reasons why education should be integrated to sustainable development.

**Challenges****➤ Accessibility Challenges-**

- According to GER of 25.8, three-quarters of the eligible people still exist be excluded from the higher education system.
- Access to education, especially higher education, varies greatly from one state to another within countries.

**➤ Equity Challenges-**

- Unequal growth in gender size, inclusion of the disadvantaged in society
- people, minorities, and people with disabilities

**➤ Quality challenges-**

- Senior teacher and technical vacancies have an impact on the quality of education provided.
- In school education, negative learning outcomes are found.
- Low pass rates / low drop rates in higher education
- Inadequate approaches aimed at improving the quality of teachers, such as professionalism development and management of administrative / teaching work

- Challenges associated with student employment after the completion of
- higher / higher education

**➤ Efficiency Challenges-**

- Resistance to change, limited use of future technologies
- Insufficient monitoring and data collection methods, leading to depletion the spread of evidence-based decision-making
- Institutions have shown insufficient focus on results, which has led to lack of accountability.
- Financial issues such as inadequate funding and inadequate allocation of funds aimed at improving quality

**The Role of Higher Education in Achieving the SDGs**

- Increase public involvement in the SDGs' implementation.
- Establish and facilitate cross-sectorial discussions and steps in the implementation of the SDGs.
- Leading policy formulation and promoting long-term development.
- Emphasize the role of the higher education sector in achieving the SDGs.
- Enhance higher education's dedication towards Sustainable Development Goals.
- Encourage and promote the Sustainable Development Goals' ideals.
- Allow learners to gain information and competencies necessary for sustainable development support.
- Conduct study to identify solutions to the problems of long-term sustainability.
- Assist in fulfilling SDGs by guaranteeing the long-term viability and social inclusion of our major programmes and campuses.

**Obstacles to Higher Education Institutions**

Major roadblocks include a lack of management support, appropriate technology, attention and consciousness, an absence of a council dedicated to the ecology, an absence of viable infrastructure, obstacles posed by the administration, a scarcity of r&d., as well as laws and rules, a lack of understanding and awareness on the subject, a lack of experience and cooperation. Students, instructors, administrators can work together to create a plan for long-term education. In order to improve higher education in a sustainable manner, collaborative efforts should be undertaken to revamp out-of-date curriculum, policies, and standards.

**Suggested Solutions and Plans to Overcome Obstacles**

- Sustainable Campus Programs: Reflecting on campus plans to improve human and social well-being and resilience.
- Compass as a City Live Laboratory: The premises and surrounding regions are utilised to explore new ideas, research, and education.
- Capacity building and leadership: Involving and empowering academics, students, and staff in the development, implementation, and ongoing improvement of sustainable practises.
- Make a setting in which students can participate in the transformation of sustainability, as students tend to ask for basic ideas, are naturally curious about change, and are less likely to represent someone other than themselves.
- Collaborative: The use of integrated networks and communities to solve common problems.
- To begin implementing the SDGs in higher education institutions, important steps must be made, including increasing discussion between higher education learners and equipping individuals with the resources they require talents, tools, and skills.
- Accessibility must be improved for information and dissemination, as well as to encourage the exchange of experience in various institutions, as well as foster the exchange of experience among various institutions.

**CONCLUSION**

Without the support of higher education and research, none of the 17 SDGs (Sustainable Development Goals) can be met. Universities play a unique role in developing new knowledge and innovation to address global concerns, as well as giving proof of well-informed public policy, through their research. Universities educate the next generation of leaders and professionals who will drive social and economic progress. Through community engagement, universities collaborate with a number of stakeholders, including governments, the commercial sector, and the general public, to achieve local, national, and international influence.

With its concentration on academic research, higher education frequently produces graduates with few or no practical skills. Without the university's help, the Sustainable Development Goals for the 2030 Agenda will not be realised. Higher education is an important part of a successful and long-term educational system. Because they are centres of creativity and critical thought, higher education institutions are the major influencers of the SDGs globally. This situation is the same as in other places of the world. It's long overdue for Indian HEIs seen

as centres of long-term expression, with the next generation accepting responsibility for attaining India's goals by 2030.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***CONSUMER INNOVATIVENESS AND ENGAGEMENT IMPACT ON MOBILE BANKING  
ACCEPTANCE OF SENIOR CITIZENSAN INVESTIGATION STUDY****VATSALA BOSE AND DR. GAGANDEEP NAGRA****ABSTRACT**

The study aims to investigate the consumer innovativeness and engagement impact in accepting mobile banking services . Research tries to analyse the effect of engagement and security concerns on senior citizens. Focus group discussions were conducted as well as experimental analysis was also used with a group of respondents. Study used high and low metrics of consumer innovativeness and consumer engagement and Perceived Trust with 100 senior citizens using banking services. The results apparently showed striking features of Innovativeness and Engagement as a moderating variable which enhances the capacity to undertake the innovation . Senior citizens has been a growing area of concern for banking sector and require new innovative way to attract them . This research can help both banks and academics to understand new methods and ways to enrich the customers and provide a robust mechanism to strengthen the acceptability and usage of mobile banking.

*Keywords:* Consumer Innovativeness, Consumer Engagements, Perceived Security Trust, Senior Citizens .

**1. INTRODUCTION**

Technology has paved the path for multifunctional devices and for better functionality of business and society at large. Devices today have become more powerful, smarter and has changed lives. It has made fun, health and wealth easily accessible. These devices are used today for various activities like e commerce, m commerce, banking activities and financial services. One of the widely used device today are mobile phones and primarily Smart phones.

This device helps in improving our day to day activities and also provide freedom to conduct activities at our free will. Activities undertaken by smart phones are shopping ,socialising, gaming ,payments, studying and financial transactions( Aydin and Burnaz 2016). The smartphone has even revolutionised the retail landscape( Shankar et al, 2010). According to survey done by economic times 2020, Indians spend about one third of their time after waking up on smart phones and that to browsing various websites. The smart phone market in India is growing exponentially because of a larger youth population( Wani and Ali,2015). This potential of smartphone combined with Internet facility has changed the business scenario( Mallat2007;Shew 2018), to an ever emerging market of mobile commerce (Islam et al, 2017). So today is the age of apps and all businesses ideas ,concepts and utilities require app for their delivery purpose.

In 2020, 53% of the Indian population accessed Internet on phones and will reach 96% by 2040. India has the world's second largest Internet penetration. The traffic at this stage is mostly dominated by mobile internet users. By 2022 M banking population would cross around 32 % of the Indian population ie around 1.8 billion (TRAI ,2022). This provides with massive opportunity to the financial sector primarily banks.

Banking sector realized and understood the importance of technological advancements and utilized it in their delivery mode. There are numerous delivery mode available to the customer starting from ATM to Debit card to Online banking, Mobile banking, Wallet payments(Laukkanen, 2016; Shankar and Kumari, 2016).These options are 24x7x365 basis (with half hourly settlements) .Mobile banking is considered as the most cost effective , flexible and efficient mode of service delivery for the banks(Mullan et al., 2017; Shankar et al., 2020). Through M banking mode customers can pay bill, view transactions, download statement (Shankar et al., 2019), pay for Zomato and Swiggy or any app for e commerce and even pay credit card bills.

Consumers use m banking services for better efficiency and providing services on the go, anywhere anytime. But customers have been finding difficulty in utilizing the m banking app visa vise other mobile wallets or banking website. Hence it was understood that the system (m -banking app) should be more engaging and secure so that the customers can find it more innovative for their future and continues usage.

This study is significant for both academic point of view and practical purpose. Firstly, it suggests how consumer engagement affects mobile banking adoption. This study extends the thought by adding consumer innovativeness as a moderator to the entire process. Although different socio- economic factors have been extensively studied on consumer engagements in mobile banking adoption (Carvalho and Fernandes 2018).

Secondly the study uses S-O-R theory which is today utilized and accepted in the e-commerce space. There are no studies that suggest use of S-O-R theory in Mobile banking adoption process. The findings of this study will help banks to strategies for prospective Senior Citizens as users of mobile banking in future.

## **2. THEORETICAL CONSTRUCT AND HYPOTHESIS DEVELOPMENT**

### **2.1 Theoretical Framework**

Engagement has its roots in organisational behaviour, and it drew attention of marketing as a construct (Kahn 1990). It is considered as a connection between a customer and a brand. According to the Gallup research a fully engage customer provides 23% more revenue than average customer. If banks do not have engagement strategy then they really are missing on opportunities for further usage .Engagements are positive customer experiences over a period of time and over every transaction in M Banking app Customer engagement helps in improving the usage of banking application to “digital acclaimed” and “mobile active” generation. Engagement can be improved through interactions which could be personalised, building trust, educate the customer, provide loyalty and create high-quality .These personalised interactions helps in content, responsiveness and control(Lee et al, 2015).

To increase efficiency and improve usage of M banking and to provide improved way of doing business, banks have started to address the factors that influence the role and concept of customer innovativeness or new product adoption (Hauser et al 2006;Raju1980;Kirton 1976).Consumer innovativeness is the kind of a construct that deals with the idea of how receptive consumers are to new products.

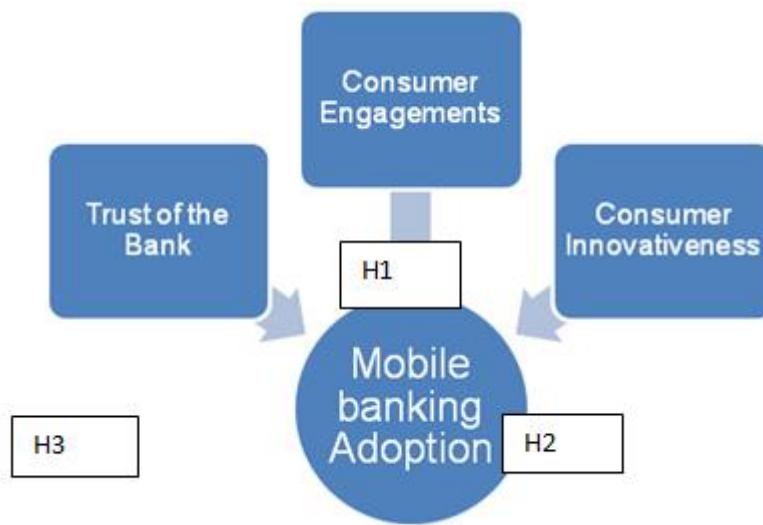
Smartphone compatibility plays an important role in users accepting mobile banking. There are several reasons which include screen size, navigation problems, UX and UI. This has led banks to device certain methods through which customer should be motivated and engaged with the technology. One of the major concerns today are the senior citizens they have shown enough reluctance or scepticism towards adopting innovative delivery channels for banking. This study examines the effect of S-O-R theory on the banking platforms. The research also analyse the effect of consumer innovativeness and engagement on adoption of M-banking as well as the role of trust and security on the adoption pattern .Interaction in a mobile banking app consists of two different variable parts feature orientation and perception orientation (Gao et al 2009) . Perception orientation consist of engagement , Perceived benefits, technology frustration and innovativeness which is concerned with the customers' acceptance of a technology on an app (Shankar et al 2012).It becomes important for banks to understand and device strategies for perception orientation activities so the customer decision journey and experience can lead to future adoption and reduce frustration in the consumers mind over the use of one technology over the other .That refers to using a website over a mobile banking app .

S-O-R model in psychology came from the SR model of stimulus response. The SR model does not consider Organism as a responding person to the stimulus. It was later understood that response can be shaped because of persons feelings and emotions and that was the reason why S-O-R Stimulus Organism Response developed.

S-O-R theory stats that there is a stimulus that triggers a response based on the behaviour of an individual. It triggers an emotion that leads to a response, that response can lead to various internal and external thought process. In 1974 Mehrabian and Russell developed S-O-R theory which can cause two kinds of response or behaviours that are avoidance or participation. These behaviours are result of various cues that individual receive from the environment. If this model is to be applied to a mobile banking app then various cues which customers /users receive from the environment can help them in participating in the adoption process. These cues could be help or training from the banks, navigation process, easy content, easy pin choosing process and operational work. The senior citizens find the usage of the mobile banking app as a major challenge because of poor engagement strategies and no serious help provided by the bank employees in training or creating awareness to this segment.

In the research study interaction works as a stimulus which indirectly is affected by the consumer innovativeness that leads to consumer engagement (response) and is moderated by trust (Organism) which leads to the association towards mobile banking application.

### 3. Hypothesis Development



H<sub>1</sub>: Highly engaged consumers has a favourable impact on M banking adoption as compared to less engaged consumers

H<sub>2</sub>: Highly Innovative consumers has a favourable impact on M banking adoption as compared to less innovative consumers.

H<sub>3</sub>: High trust concerns with the bank has a favourable impact on M banking adoption as compared to less trust concerns

#### 3.1 Engagement on mobile banking adoption

Innovativeness is defined as the degree to which an individual is relatively earlier in adopting an innovation than other members of his time (Roger et al 1962).The innovation adoption is a process not an act of individual(Bert Vandecasteele and Maggie Geuens, 2010) it initiates from processing the knowledge and then leads to persuasion, decision and confirmation. Innovativeness has been classified as consumer innate Innovativeness (Chao et al, 2009) is the degree to which an individual is ready to adopt new ideas or services without communicating it to others .

The study has significant effect on academic and in the corporate world. Academically it gives a construct of building a framework between engagement and innovativeness with adoption of technology with a typical segment of consumers called senior citizens. The impact of demographic factors on consumer engagement with respect to young and adult population has been assessed in diverse context (Carvalho and Fernandes 2018;Meshram and O'cass, 2018). The study extends the literature by adding a dimension of senior adults with respect to engagement, innovativeness and trust . This study utilizes S-O R theory for e-commerce platform and that too for senior citizens. This will help banks in understanding another dimension to a secluded set of customers who are not considered as digital natives and always shy away from either learning or accepting a technology. To large extent it can help these consumers to get better engaged and put forth their voice in front of banks.

#### 3.2 Moderating effect of consumer innovativeness

Past literature has examined the crucial role of consumer innovativeness towards behavioural intention in various context (Koschate Fischer et al ,2018;Hwang et al, 2020).It is a significant moderator to consumer attitude and navigation in service technology (Frimpong et al,2017;Hwang et al,2020). Consumers who are innovative show positive response towards various technology lead platforms. Innovative consumer have more engaged set up with online platform because of several hedonic benefits ,they receive during the transaction process (Jebarajakirthy and Shankar , 2021) .However innovative consumers found m- banking application easy to use because of its search, navigation context ,better computer control as compared to less innovative customers .

### 4. METHOD

Focus group discussions were held with twenty senior citizens. Certain limiting questions were asked so as to segregate the respondents. They were “do they have bank accounts, and do they use smartphone”. They were not disclosed about the bank’s identity. Consumer engagement and innovativeness concerns were

operationalised using a validated scale. Only respondents who said yes to bank account and yes too smart phones were allowed to take the survey. The results of focus group discussions gave striking results which help in the development of the experimental scenario.

#### **4.1 Development of stimuli response process**

In scenario 1 senior citizen were shown highly engaged features of mobile banking app, in the other low engage features were shown. Mobile banking versions were prepared with the help of technological experts. Dummy versions were tested before being used. A total of 10 features were used to manipulate engagements in the study. Out of twenty senior citizens that participated in the study 75% were male and the median age was around 65 years. They were asked to rate the features on the five-point Likert scale.

**The features used in the experimental analysis were**

Font size
colour
Zoom option
FAQs
Images
screen freezing
live chat
complaint tracking and customize menu

During the entire process it was understood that the respondents required help and advice to use and disuse certain features.

#### **4.2 The procedure**

Reason why senior citizens are involved in the study is because the percentage population of senior citizen is growing on year by year basis .At some point of time this population will become a larger chunk .According to Help age India the number of elderly is expected to grow 173 million by 2026 .Banks have always helped youngsters and adults but senior citizens are always left behind. RBI has now devised new mechanisms and ways to help this segment of society .Financial freedom if provided to senior citizens will help them in their standing in the society .There is hardly any literature available which studies the impact of consumer engagement and innovativeness for adoption of mobile banking on senior citizens.

A short introduction of the entire procedure was explained to the respondents. Two scenarios were used high and low engagement and innovativeness. Respondents were asked to inquire about account balances from the dummy app shown on the screen and to transfer amount to their friends as well. The whole scenario was given the feeling of realistic approach. We asked respondents if you would have done it in a real scenario how would you have done it .Senior citizens were then assigned a questionnaire . A total of 100 senior citizens were shortlisted out of which 65% were male and rest female. But only seventy senior citizens filled the questionnaire. They were even helped by volunteers to fill the questionnaire. To a large surprise female wanted to take more participation in the process.

### **5. RESULTS**

The survey was prepared by a scale which was validated previously (see appendix 1).The content of the question were modified so as to suit the Senior citizens and mobile banking .Independent t test was used that indicated a significant difference ( $t(70)=4.36, p<0.001$ ) between high ( $M=3.02, SD=0.69$ )and Low( $M=1.53, SD=1.03$ ) level of engagement .

#### **5.2 Hypothesis testing**

Analysis of Covariance (ANCOVA) was performed for 2(Consumer Engagement, high versus Low) X 2(Consumer Innovativeness high versus low) X 2 (Perceived Trust High Versus Low) to validate the hypothesis. Consumer engagement as a dependent variable and mobile banking adoption as an independent variable was used to test the hypothesis. A one-way ANCOVA was used.Results showed that consumer engagement has a differential effect on mobile banking adoption.

( $F(4.52)=46.79, p<0.001$ ).

**Table 1: Impact of Mobile banking adoption on Consumer Engagement**

Mobile banking Adoption	Consumer Engagement
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	High	Low
High	3.25 (.34)	.91 (.24)
Low	3.15 (.44)	.54 (.37)

High consumer engagement has a more favourable impact on mobile banking adoption as compared to Low consumer engagement this confirms **H1 acceptance**.

Then to prove H2 hypothesis the consumer innovativeness was tested with mobile banking and adoption. The results shown in Table 3 indicate a significant effect ( $F(6.89)=61.56$ ,  $p<0.001$ ) of consumer Innovativeness on Mobile banking Adoption. Consumer showing high Innovativeness shows high acceptance and better adoption of Mobile banking adoption. **Findings support H2.**

**Table 2: Impact of Mobile banking adoption on Consumer Innovativeness**

Mobile banking Adoption	Consumer Innovativeness	
	High	Low
High	4.17 (.68)	3.40(.72)
Low	3.12 (.76)	2.92(.75)

Next to prove H3 the Perceived Trust of the Consumer and Mobile banking adoption was examined. The results showed a significant Impact ( $F (43.56) =83.01$ ,  $p<0.001$ ) of Perceived Trust on mobile banking adoption. A consumer with Low trust shows a different effect of adoption as compared to high trust consumer. Finding in Table 3 shown which proves H3 Hypothesis.

**Table 3 Impact of Mobile banking adoption on Perceived Trust**

Mobile banking Adoption	Perceived Trust	
	High	Low
High	4.07 (.53)	3.40(.69)
Low	3.19 (.76)	2.92(.87)

### 6.3 Common Method Biased

The common latent factor for the study is 0.2 (Podsakoff et al., 2003). The study is free of any discrepancies of CMB.

## 7. DISCUSSION

The study assesses the effect of consumer engagement and innovativeness on mobile banking adoption, even the study examines the role of the trust that a consumer has on the bank which results in positive affirmation to adoption. The result suggested that engagement of the consumer with the application and their innovative tendency helps to accept a relationship. To large extent various previous literatures also suggest the same (Lee et al,2015).The consumer engagements with the app helps them to discover and experiment with various functions, innovativeness leads to exploration and provides them easy access Even better control of user provide easy navigation and functioning .Highly innovative consumer found the application more useful and much more interactive as compared to the less innovative consumer according to previous literature. Innovative consumers are more engaged more productive. Results showed that trust with the banks have led to more transaction and more usage. Customers with high trust with banks perceived less risk and more adoption process as compared to less trusted consumers .

### 7.1 Implications

#### 7.1.1 Theoretical implication

From the point of view of theory, it contributes to consumer engagement literature used in mobile banking adoption. Certain model assumptions could be put forth in consideration where engagements of the application can help in development in other fields of e-commerce.

Secondly the experimental analysis used in this study can be used over different context in human psychology. The manipulation of consumer engagement in the mobile application is another contribution to m- banking context. The S-O-R model used has been applied to various consumer behaviour context. It has been used to understand the environmental stimuli as well as socio- psychological variables that affects the behaviour of an individual . The study examined the moderating effects of consumer innovativeness and Trust. The S-O-R model has also been extended to the technology adoption behaviour .The study provides a base for the mobile banking review and helps in understanding the consumer engagement reviews as well .In previous literature

neither features nor new content orientation has been understood . The study uses moderating features to enhance the overall concept of the study.

Rather than contributing to theory the study will provide managerial thought process and development features to the banks. This research suggests that senior citizens fear in conducting or using mobile banking app rather than online website. They either must be helped or trained or given confidence which should lead to reduce frustration and more trust in the system. Fear is not the only concern but the app functionality its content, context also matters. Language, font size, live chat and demonstrations are all very important. Banks should use more colourful images and should make the entire process hassle free. Senior citizen should also be given loyalty awards for using applications, This segment of senior citizens has to be made more engaged and should be given enough space so that they can conduct transactions with ease. The trust factor of the bank has played a crucial role. Customers feel very inclusive and try new products and new mechanisms because of trust.

## **7.2 Limitation**

The study carries some limitations. Firstly responses were collected from Indian consumers and that to Senior citizens .The respondents of other countries can also be used as well as comparison of India and other countries can also be done .Mobile banking app needs to have a dynamic user interface and interactions .Secondly consumer engagement , consumer innovativeness and trust is used in this Study .In other studies technological readiness and enjoyment can also be used .Researchers can also examine other behavioural outcomes like loyalty, satisfaction and scepticism Mobile banking adoption and consumer engagement play a significant role and they provide striking differences among the Senior citizens group of people .These researches will provide enough information to banks to redesign strategies for targeting specific group of people .

### Appendix 1 -Variable Measurement

#### **Consumer Engagement**

When I am using M banking my time flies away  
 When I use M Banking I felt in Control  
 When I use M Banking there are no distractions  
 When I use M Banking it gives me fun  
 When I use M Banking I get immersed in it  
 When I use M Banking it makes me curious  
 When I use M Banking it arouse my imagination

#### **Consumer Innovativeness**

I always seek new ideas  
 I like people who have new ideas  
 I do not prefer a routine way of life

#### **Perceived Trust**

I trust my Mobile banking app because of my Bank  
 I trust my M banking app because of the help of the Bank employees  
 I trust that M banking app will not be used by the unauthorized third party.

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**A STUDY OF DETECTION OF COVID-19 FROM CT-SCAN SLICES****NIKHELESH BHATTACHARYYA, AJAY SUDHARSHAN SATISH, AKUL MANGAL AND SHAIL SHARAFF****ABSTRACT**

**Purpose** – The purpose of this paper is to study the CT- scan images of several patients, use concepts of image processing and segmentation to filter out the region of interest and by using concepts of deep learning study and apply three universally recognized neural network models (VGG 16, VGG 19 and Inception V3) and modify them using concepts of fine tuning and transfer learning to generate predictions. Following the generation of prediction, we compare their results, discuss their benefits and limitations, and decide which model gives the most accurate predictions

**Design/Methodology/Approach** – The paper is based on two image datasets, 1. Eduardo Soares and Plamen Angelov, “SARS-COV-2 Ct-Scan Dataset.” Kaggle, 2020, doi: 10.34740/KAGGLE/DSV/1199870, and 2. Abu Zahid Bin Aziz, 2020-08-10”, CT Scans for COVID-19 Classification”, Version, 2. Retrieved 30<sup>th</sup> October, 2021 from <https://www.kaggle.com/azaemon/preprocessed-ct-scans-for-covid19>. The data contains CT-Scan slices. Both the images undergo various techniques of image processing mentioned in the paper. The second dataset, after processing, is used to train the model and then the model is tested on the first dataset. The CNN models were created using Keras Libraries and are modified using concepts of transfer learning and fine tuning.

**Findings** – Out of the three models used, VGG 16 gives the highest inter and intra dataset accuracy narrowly followed by InceptionV3 and VGG 19 where they have similar intra dataset accuracy but Inception V3 has higher inter dataset accuracy than VGG 19

**Practical Implications** – This study aims to study the use the concepts of image processing convolutional neural networks to effectively diagnose Covid 19 and also study how convolutional neural networks models can continuously evolve and improve to give highly accurate predictions.

**Originality/Value** – There are several studies on the use of image processing and convolution neural network models in medical field and their applications, this study aims to use concepts of image processing to removes unnecessary features from the images. Following the preprocessing we then apply and compare the predictions generated by the three most recognized CNN architectures, to determine which model can accurately diagnose Covid-19 from the preprocessed CT-Scan images.

**Keywords**— Image Processing, Lung segmentation, CT-Scans, VGG16, VGG19, Inception V3

**INTRODUCTION**

COVID-19 has spread over the world and become a worldwide threat since the end of 2019, prompting the World Health Organization to label the outbreak a pandemic [1,2,3]. There is currently no clinically authorized therapy available [4]. COVID-19 virus travels from person to person, according to the research. COVID-19 must be stopped from spreading by isolating patients, tracking, and isolating close contacts [5]. As a result, research on a rapid and accurate diagnosis procedure that can screen as many images as feasible is required.

Currently, the presence of viral nucleic acid in COVID-19 is determined primarily using a nucleic acid kit for reverse transcription-polymerase chain reaction (RT-PCR) [6]. The ultimate diagnosis of an illness, particularly infectious disorders, must still rely on the aetiology. Despite the fact that RT-PCR is the gold standard for COVID-19 diagnosis, there are still some affecting variables, such as sample collection uniformity and collection time [7]. The ability of RT-PCR to identify COVID-19 is also dependent on the viral load. The nucleic acid test will be prone to false negatives if the sample location does not contain viruses or has a low viral load.[11]

Medical imaging approaches (such as chest X-ray (CXR) and computer tomography (CT)) can play a key role in the diagnosis of COVID-19 since some patients exhibit imaging symptoms, but nucleic acid detection has hysteresis [8, 9]. Furthermore, nucleic acid testing can only determine if a patient has COVID-19. However, it is unable to assess the condition, whereas medical imaging can [10]. The precise monitoring of illness progression is a critical component of disease care for COVID-19 patients. Imaging can be utilized to monitor suspected instances, such as close contacts of COVID-19 patients whose nucleic acid test is negative [8, 9,11].

Medical imaging modalities are generally helpful for diagnosing COVID-19 and monitoring disease development. Doctors need to be able to assess the patient's status in real time in order to decide the most effective treatment options. Doctors can prescribe the proper prescription with the aid of an accurate and quantitative study of the condition.

Doctors' experience is required for traditional imaging diagnosis. COVID-19 is a novel form of infectious illness, and recent study has detailed the disease's imaging features [9]. Typically, a CT scan will have numerous slices. One CT scan takes 5–15 minutes for physicians to evaluate. The doctor's mental tiredness will be caused by repetitive labor. It is impossible to identify and screen on a wide scale and in a timely manner. Doctors can only examine the progression of their patients' diseases using subjective evaluations, which are not intuitive or quantifiable.[11]

Radiomics, machine learning, and deep learning, particularly convolutional neural networks (CNNs), have all been used in advanced medical imaging analysis in recent years. These techniques offer a lot of potential in terms of diagnostic and prognostic uses in the future. CNNs are algorithms that recognize relevant qualities on images and categorize an input item without being specifically constructed. They have been utilized for a range of tasks, including detection (e.g., mammography breast lesions), segmentation (e.g., computed tomography (CT) liver and liver lesions), and diagnosis (e.g., mammogram breast lesions) (e.g., lung lesions on screening low-dose CT).

Approaches have been proposed for improving computer-aided diagnosis with several predefined CNN frameworks. Out of these models VGG 16, VGG 19, Inception V3 are the most famous ones. It must be noted that Doctors and other medical experts cannot be replaced by computer-aided diagnosis technology; the ultimate diagnosis must be made by specialists.

Our contributions to this study may be described as processing images using various image processing techniques, then applying and comparing the three models (VGG 16, VGG 19, InceptionV3) stated above and determining the best suited one using experimental evidence.

## **LITERATURE SURVEY**

COVID-19 is a respiratory illness that was originally discovered in Wuhan (China's Hubei region) and was initially diagnosed as pneumonia [12]. Later, the virus was dubbed SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2), and the condition it caused was dubbed COVID-19. COVID-19 was labelled a pandemic by the World Health Organization (WHO) on March 11th, 2020 [13]. COVID-19 may be transmitted from person to person, which is the most difficult aspect of preventing its spread and achieving an early, correct diagnosis [14]. The two primary types of imaging utilized for the categorization and diagnosis of this condition are chest X-rays and CT scans [15,16]. This section evaluates the available literature on the diagnosis of COVID-19 using CT images, as the focus of this study is on the use of CT scans for the diagnosis of COVID-19.

The application of deep learning algorithms for COVID-19 detection has lately been a hot issue, attracting a lot of interest. Using a transfer learning strategy, Chaudhary and Pachori [14] employed subband images (SBIs) to train numerous pre-trained CNN models. COVID-19 was distinguished from other viral and bacterial pneumonia strains as well as healthy people using a variety of classifiers. Their methodology has a precision of 0.970, accuracy of 0.650.976, sensitivity of 0.970, specificity of 0.965, F-score of 0.970, and AUC of 0.980. For the diagnosis of COVID-19, Wang et al. [17] advocated using a modified COVID-Net architecture. The accuracy, F-score, recall, precision, and AUC for the SARS-CoV-2 CT scan dataset were 0.908, 0.908, 0.858, 0.957, and 0.962, respectively, and the accuracy, F-score, recall, precision, and AUC for the COVID-CT dataset were 0.786, 0.788, 0.797, 0.780, and 0.853, respectively.

Kaur et al. [18] suggested a system based on deep MobileNetv2 architectural characteristics and a parameter-free BAT (PF-BA-T)-optimized fuzzy K-nearest neighbors (PF-FKNN) classifier. Their approach yielded accuracy of 0.993, precision of 0.992, recall of 0.996, F-score of 0.994, and AUC of 0.995. Sen et al. [19] developed a CNN architecture for extracting picture attributes, followed by two steps of feature selection. For the initial screening of the features produced from the CNN model, they used a guided feature selection process that used two filter methods, mutual information (MI) and Relief-F. The dragonfly algorithm (DA) was employed in the second step to choose the most significant attributes.

On the SARSCoV-2 CT scan dataset, their approach had an accuracy of 0.983, while on the COVID-CT dataset, it had an accuracy of 0.900. Carvalho et al. [20] employed a LeNet-5 architecture to extract features from CT scans, and XGBoost was used to classify them. The accuracy, recall, and precision of this approach were all

0.950, with an F-score of 0.950, an AUC of 0.950, and a kappa index of 0.900. The same authors [21] employed histogram equalization and CLAHE to create a pre-processing phase for images, and a simple CNN to extract features from CT scans. After that, different classifiers were used to classify the data. The accuracy was 0.978, the recall was 0.977, the precision was 0.979, the F-score was 0.978, the AUC was 0.977, and the kappa index was 0.957.

The usage of fifteen pre-trained CNN architectures was proposed by Gifani et al. [22]. They created a mechanism for selecting a collection of designs based on voting by the majority of the best combination of outcomes to increase the performance of their approach. This method has a precision of 0.857, an accuracy of 0.850, and a recall of 0.854. He et al. [23] presented Self-Trans, a method for pre-training networks that merged contrasted self-supervised learning with transference learning. For the diagnosis of COVID-19, this scheme received an F-score of 0.850 and an AUC of 0.940.

For the diagnosis of COVID-19, Chen et al. [24] used a prototype network that was pre-trained using a momentum contrasting learning approach [25]. They obtained 0.870, 0.885, 0.874, and 0.932 for accuracy, precision, recall, and AUC, respectively. On the ImageNet [27] dataset, Jaiswal et al. [26] employed learning transfer with a pre-trained DeseNet201 network to diagnose COVID-19, with an accuracy of 0.962, precision of 0.962, recall of 0.962, F-score of 0.962, and specificity of 0.962. For the diagnosis of COVID-19, Hou et al. [28] recommended using a CNN architecture with peripheral recognition augmented by contrasting representation. The accuracy, sensitivity, specificity, and AUC of this technique were 0.981, 0.977, 0.984, and 0.992, respectively. To diagnose COVID-19, Loey et al. [29] combined traditional data augmentation approaches with a conditional generative adversarial network (CGAN) based on a deep transfer learning model, achieving an accuracy of 0.829, a sensitivity of 0.776, and a specificity of 0.876.

### Datasets

Two image datasets have been used in this paper. Both the datasets were taken from Kaggle

#### **CT-Scans for COVID-19 Classification – Abu Zahid Aziz [30]**

### **DESCRIPTION**

The information was gathered from two hospitals: Union Hospital (HUST-UH) and Liyuan Hospital (HUST-LH), both of which are described in depth in this study. Individual CT images were divided into three categories by the authors of this study:

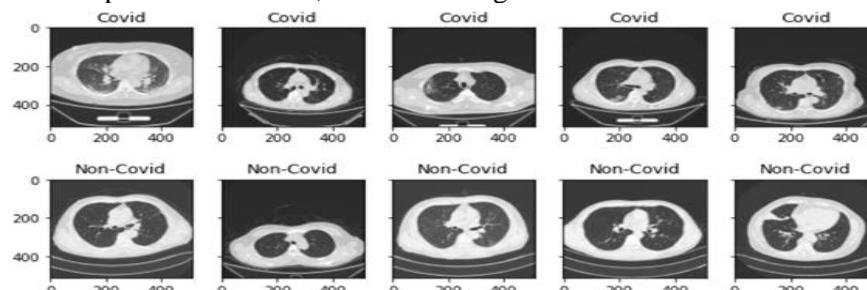
- i. 5705 non-informative CT (NiCT) images, in which the lung parenchyma was not captured for any judgement,
- ii. 4001 positive CT (pCT) images, in which imaging features associated with COVID-19 pneumonia could be unambiguously discerned, and
- iii. 9979 negative CT (nCT) images, in which imaging features in both lungs were irrelevant to COVID

As a result, the initial stage in the paper's methodology was to remove lung parenchyma from CT scans. Using the procedures described in the publication, we retrieved lung parenchyma. The pre-processed CT scans folder contains the extracted pictures, whereas the original CT scans folder contains the raw CT scans. All the photographs have been scaled to fit the page (512x512).

For this paper since the other dataset has only two classes i.e., Covid and Non covid, we do not consider the non-informative CT (NiCT) images while training the model.

### **Sample data**

Fig.1. contains 10 samples of the dataset, random 5 images of COVID and Non-COVID class is taken.



**Fig. 1:** Sample of the first dataset: A CT-Scans for COVID-19 Classification – Abu Zahid Aziz [30]

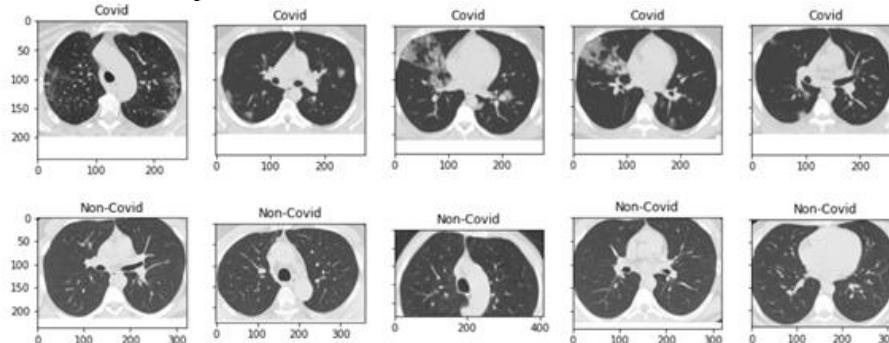
## SARS-COV-2 Ct-Scan Dataset - Eduardo Soares and Plamen Angelov [31]

### DESCRIPTION

The dataset is a public available SARS-CoV-2 CT scan dataset, containing 1252 CT scans that are positive for SARS-CoV-2 infection (COVID-19) and 1230 CT scans for patients non-infected by SARS-CoV-2, 2482 CT scans in total. These data have been collected from real patients in hospitals from Sao Paulo, Brazil. The aim of this dataset is to encourage the research and development of artificial intelligent methods which can identify if a person is infected by SARS-CoV-2 through the analysis of his/her CT scans. The dataset is available at: [www.kaggle.com/plameneduardo/sarscov2-ctscan-dataset](http://www.kaggle.com/plameneduardo/sarscov2-ctscan-dataset)

### Sample data

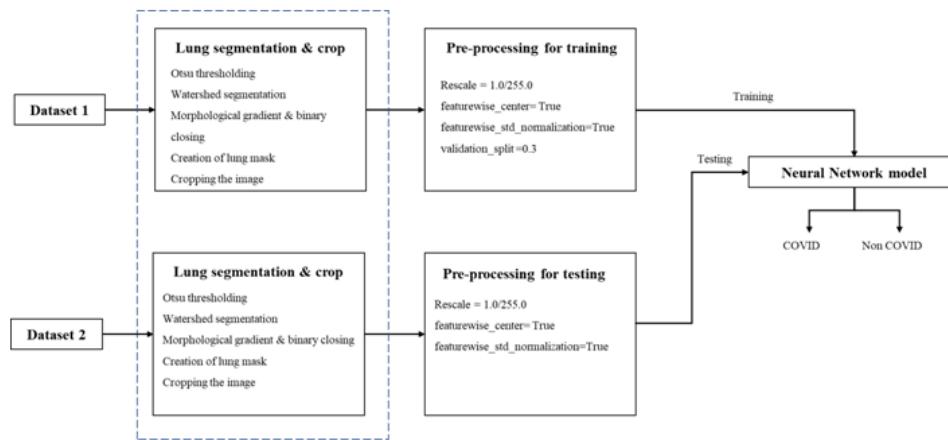
Fig.2. contains 10 samples taken from the dataset, five each of COVID and Non-COVID.



**Fig. 2:** Sample of the second dataset: SARS-COV-2 Ct-Scan Dataset - Eduardo Soares and Plamen Angelov [31]

### Proposed System

The main objective of this paper is to construct models using predefined Convolutional Neural Network frameworks, customize them according to the given dataset using concepts of fine tuning and transfer learning and through comparative and experimental analysis select the most accurate model. The image preprocessing techniques include Binary thresholding using Otsu, Watershed Segmentation, Morphological operations like morphological gradient and binary closing, polygon fill and flood filling. The images also go through rescaling, feature wise centering, feature wise standard normalization and validation split through Image Data Generator. The Validation split is set to 0.3.



**Fig. 3:** Proposed System

### Techniques used

#### Lung Segmentation and Cropping

#### Otsu Thresholding

The first step of extracting the lung area from its surrounding tissues is to apply binary thresholding, which will separate the darker parts of the image from the lighter parts. The intensity of darker parts is assigned as 0 and the lighter parts as 255. When the histogram of an image consists of two peaks i.e., is a bimodal image, a good threshold value is in the valley between the peaks [39]. Otsu's automatically determines an optimal threshold

from the histogram by iterating through all credible values [40] and minimize the spread levels i.e., the weighted sum of the foreground and background variances, in both sides of the threshold [41].

### **Finding Local Peaks**

The Euclidean distance is calculated from each pixel to its nearest pixel which has a zero value and is saved into a co-ordinate list. [42] The local maxima or peak is calculated from the list, where the minimum distance between two peaks is 41 pixels. A label is then assigned to each peak.

### **Watershed Segmentation**

Watershed is a segmentation technique which treats the image as a topography, the method is similar as how a water body will fill a landscape. The lowest points are submerged first. With increasing water-levels, the water starts submerging higher points. The surface is broken in several valleys before being gradually buried in a water bath. Water will flow and begin to fill the valleys. However, water bodies are not permitted to mingle, thus dams must be constructed at the places of initial contact. These dams serve as the boundary of water basins as well as visual objects and segment the image into multiple regions. [43] Here, the negation of the image is used for the segmentation. Hence the markers obtained from the previous step are the lowest points of the image, and the flooding starts from the markers. Hence, watershed algorithm is applied to segment the image into various relevant and irrelevant segments.

### **Removal of irrelevant segments**

The image is segmented into multiple segments; hence the aim of this step is to retain only the relevant segments and remove the rest. Since the input image of the watershed function was the inverse of the actual image, the white part of the image, i.e., the tissue surrounding the lung is treated as the background and is given a default label of zero. Hence the segment with label zero is removed. Similarly, all the corner segments are removed.

### **Morphological Gradient and Binary Closing**

Morphological gradient is the difference between the dilation and the erosion of an image. It returns the outline of the objects remaining in the image. [44] Morphological gradient of A is given by

$$G(I) = (A \oplus B) - (A \ominus B)$$

where  $\oplus$  and  $\ominus$  denote dilation and erosion, respectively.

Binary closing is then applied to the outline to ensure that there are no gaps in the outline. [44] Binary closing of A is given by

$$A \cdot B = (A \oplus B) \ominus B$$

where  $\oplus$  and  $\ominus$  denote dilation and erosion, respectively.

### **Finding contours and extracting largest contours**

Post, morphological operations, there are lines inside the lungs which needs to be removed. Hence, contours are created of the outline. Contours are just a curve that connects all the continuous points (along the border) that are the same colour or intensity. The contours are a useful tool for object detection and recognition as well as form analysis.[45] The largest four contours are extracted, and the remaining contours are discarded. Even though only two contours are required, four contours are taken to ensure that both the outlines of both the lungs are present, which cannot be said when taking only two.

### **Removal of off-centered objects**

Since four contours were taken, there is a high possibility that other objects are present, which is not ideal. It is noticed that the lung area is always centered. Hence if an object is present in the edge of the image and is completely off center, it is removed. This removes all the contours outside the lungs.

### **Plot contours into mask and polygon filling**

The contours remaining after the previous step are plotted and the area bounded by them is filled. This fills most of the lung parts except for a few holes inside the lungs.

### **Filling holes inside lungs**

To fill the part inside the lung which is left, flood filling is done from point (0,0). Flood fill fills all the areas that are connected to the seed pixel, which in this case is (0,0). The part of the lung not filled in the previous step is never connected to the seed pixel. This ensures that the whole image except for the remaining part is white. Hence, negation is done, after which the part which was not filled in the previous step is filled.

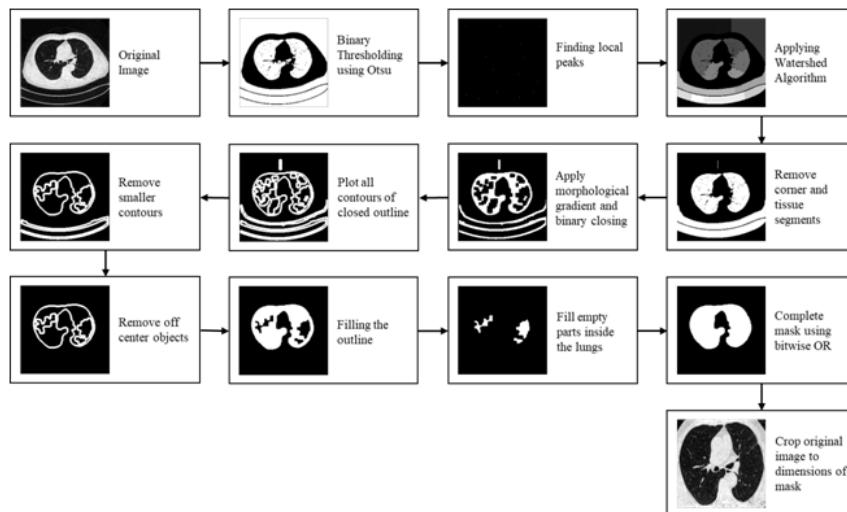
### Creating lung mask

Bitwise OR operator is applied on the output of step 8 and 9 to generate the final mask of the lungs. The mask is a binary image, where 0 (black) is the part that is to be ignored and 1 (white) is the part that is useful.

### CROP IMAGE

The topmost, bottommost, leftmost and the rightmost non-zero points of the mask are extracted, and the original image is cropped to the co-ordinates of these points.

To better illustrate the procedure followed to segment the lungs and crop the image, a sample image is taken and the output of every step is illustrated in fig. 4.



**Fig. 4:** Step by step illustration of lung segmentation and cropping

### Pre-Processing

#### Pixel Normalization

For most image data, the pixel values are integers with values between 0 and 255. Inputs with high integer values can disrupt or slow down the learning process in neural networks, which process inputs with tiny weight values. As a result, it's a good idea to normalize the pixel values such that each one is between 0 and 1. Images with pixel values in the range of 0-1 are legitimate and may be viewed properly. To do this, divide all pixel values by the greatest pixel value, which is 255. Regardless of the actual range of pixel values contained in the image, this is done across all channels.[46] The Formula to represent pixel normalization:

$$Pixel_{normalized} = \frac{Pixel}{255}$$

#### Pixel Centering

Subtracting the mean value from the pixel values is a common picture data preparation procedure. Because the distribution of pixel values is centered on zero, this method is known as centering. Normalization can be done before or after centering. After centering and normalizing the pixels, the pixel values will be centered at 0.5 and in the range 0-1. After normalization, centering will result in pixels with positive and negative values, causing pictures to appear incorrectly (e.g. pixels are expected to have value in the range 0-255 or 0- 1). Centering after normalization is usually preferable. Prior to deducting the pixel values from the mean pixel value, centering necessitates the calculation of a mean pixel value. The mean can be determined in a variety of methods, for example:

- Per image.
- Per mini batch of images (under stochastic gradient descent).
- Per training dataset.

In this study we calculate mean pixel value per image. In the case of color pictures, the mean can be computed for all pixels in the image, referred to as global centering, or for each channel, referred to as local centering.

- Global Centering: Calculating and subtracting the mean pixel value across color channels.
- Local Centering: Calculating and subtracting the mean pixel value per color channel.[46]

Here, Global Centering is used.

### **Pixel Standardization**

The distribution of pixel values is frequently Normal or Gaussian, e.g., bell shaped. This distribution might exist per picture, per mini batch of images, or over the whole training dataset, as well as globally or per channel. As a result, converting the pixel value distribution to a conventional Gaussian distribution, which involves both centering the pixel values on zero and normalizing the values by the standard deviation, may be beneficial. With a mean of 0.0 and a standard deviation of 1.0, the output is a standard Gaussian of pixel values. As with centering, the operation can be performed per image, per mini-batch, and across the entire training dataset, and it can be performed globally across channels or locally per channel. Standardization may be preferred to normalization and centering alone, and it results in both zero-centered values of small input values, roughly in the range -3 to 3, depending on the specifics of the dataset.[46]

### **Validation Split**

When an explicit testing set is not available, Split Validation is used to estimate the fit of a model to a hypothetical testing set. Split Validation also allows you to train on one data set while testing on another explicit data set. The ImageDataGenerator now has a validation split option that allows you to split a section of your training data into a validation set at random by stating the percentage you wish to allocate to the validation set.

### **Neural Network Models**

To learn, convolution operations (the linear application of a filter or kernel to local areas of pixels/voxels in an input image) and down sampling or pooling processes are used (grouping of feature map signals into a lower-resolution feature map). For the final classification or regression operation, higher-level features reflecting a large receptive field are flattened into a single vector.

The design of an algorithm includes phases such as hyperparameter selection, training and validation, and testing. Hyperparameters include the network topology, the number of filters per layer, and the optimization parameters. Throughout the training phase, the dataset of input photographs (divided into training and validation sets) is given to the network on a regular basis to capture the structure of the images that is necessary for the task.

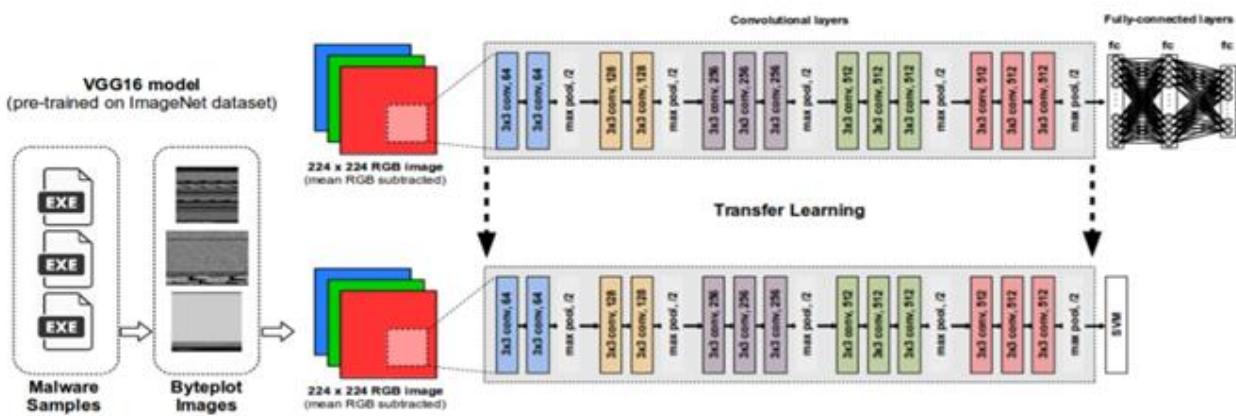
Each artificial neuron's weights are initially selected at random. Then they are modified with each iteration to reduce the loss function, which assesses how close the prediction is to the target class. The performance of the trained model is then evaluated using an independent test dataset. This is also done to see whether any "overfitting" has occurred. The overfitting problem can occur when constrained datasets have too many parameters compared to the dataset size, in which case a model "memorizes" the training data rather than generalizing from it. [36,37]

### **VGG 16**

Simonyan and Zisserman [32] were the first to propose the VGG network design. The VGG models with sixteen layers (VGG 16) and nineteen layers (VGG 19) served as the foundation for the Visual Geometry Group (VGG) team's ImageNet Challenge 2014 entry, which earned them first and second place in the localization and classification categories, respectively. Starting with five blocks of convolutional layers, the VGG 16 architecture, displayed at the top of Figure 2, is followed by three fully connected layers.

To guarantee that each activation map has the same spatial dimensions as the preceding layer, convolutional layers employ thirty-three kernels with a stride of 1 and padding of 1. To minimize the spatial dimension, a rectified linear unit (ReLU) activation is done soon after each convolution, and a max pooling operation is utilized at the conclusion of each block. To ensure that each spatial dimension of the activation map from the previous layer is halved, max pooling layers employ twenty-two kernels with a stride of 2 and no padding. Before the final 1,000 fully connected softmax layer, two fully connected layers with 4,096 ReLU activated units are employed.

The VGG 16 model has the disadvantage of being expensive to assess and requiring a lot of memory and parameters. There are roughly 138 million parameters in VGG 16. The majority of these parameters (about 123 million) are in the fully connected layers, which are replaced in our model by an SVM classifier, greatly lowering the number of parameters required.[33]

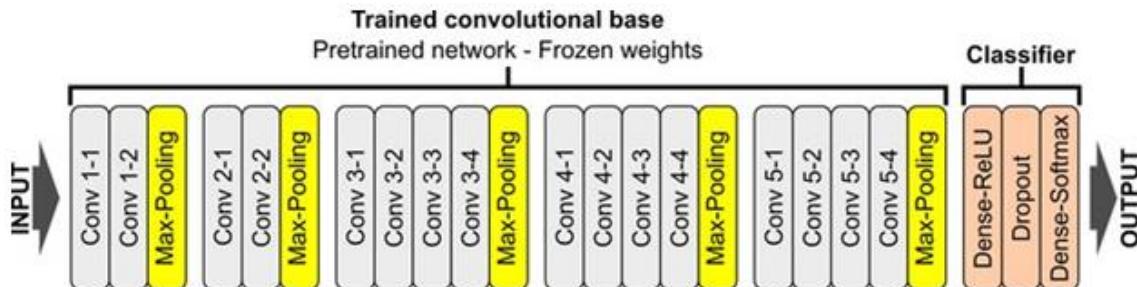


**Fig. 5:** VGG 16 Network Model

VGG 19

The VGG CNN is made up of numerous linked convolutional layers and full-connected layers for each of the six primary components. The input is 224\*224\*3, whereas the convolutional kernel is 3\*3. In most cases, the number of layers is restricted to 16-19. The VGG-19 model structure is shown in Fig.6.

VGG-19 CNN is used as a pre-processing model. Compared to traditional convolutional neural networks, the network depth has been increased. Because it alternates between numerous convolutional layers and non-linear activation layers, it has a better structure than a single convolutional layer. The layer structure allows for improved image feature extraction, downsampling using Maxpooling, and altering the activation function to the linear unit (ReLU), which picks the largest value in the image region as the pooled value of the area. The downsampling layer's expression is given by

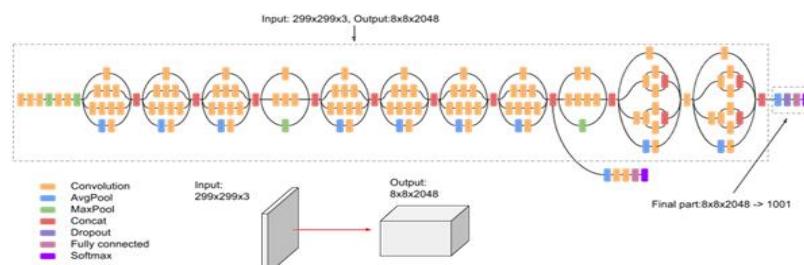


**Fig. 6:** VGG 19 Network Model

## Inception V3

Inception v3 is a widely used image recognition model that has been shown to attain better than 78.1 percent accuracy on the ImageNet dataset. The model is the outcome of a number of researchers exploring various themes across time. It is based on the essay "Rethinking the Inception Architecture for Computer Vision" by Szegedy, et al.

The model's symmetric and asymmetric construction parts include convolutions, average pooling, max pooling, concats, dropouts, and completely connected layers. Batchnorm is used frequently throughout the model and is applied to activation inputs. Loss is calculated using Softmax. The structure of the Inception V3 model is seen in Fig.7. [35]



**Fig. 7:** Inception V3 Network Model

### Basic Model Structure

The basic structure of all the models used is a combination of the predefined CNN architectures as the features extractor and a baseline CNN model for giving prediction.

### Predefined CNN architecture

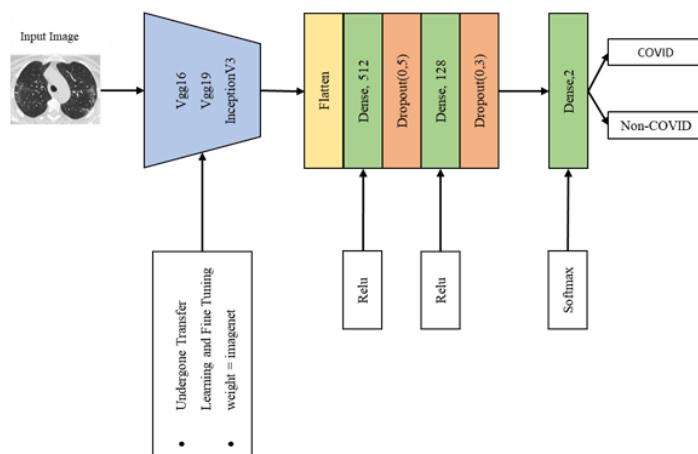
We use the relevant Keras library with the respective input shape to call the layers of the model, and we define 'include top' as True while creating the model. Depending on how many trainable layers we do not want to freeze, we use Transfer Learning and Fine-Tuning concepts to freeze all or part of them (This is sometimes done when we want some of the trainable layers to be updated continuously with training to improve accuracy).

### MODIFIED HEAD

A sequential CNN model is used as the baseline model. After going through the transfer learning and fine tuning outlined below, we add the predefined CNN architecture (VGG 16, VGG 19, Inception V3) to this CNN model. Two dense layers of activation ReLU, two dropout layers, and a final dense layer of 2 units and softmax activation make up the model.

### Additional Features

We utilize ModelCheckpoint to capture and keep the model's best weights, so that only those weights are used during prediction and EarlyStopping with monitor as val loss and patience as 3. This means that if the val loss does not improve for three epochs in a row, the model will stop.



**Fig.8:** Basic Model structure

## RESULTS

In this section we present the result for the binary classification for both the CT-Scans for both the datasets with the following architectures (VGG 16, VGG 19, and InceptionV3). In addition, to check the performance and robustness of each proposed model, several experiments are conducted on both the image datasets. The results are presented separately for each dataset using receiver operating characteristic curve (ROC curve) and confusion matrix.

### Classification results of the proposed architectures

The categorization findings of both image dataset are shown and discussed in this subsection. Let us describe the two parameters we used to investigate and identify the most correct model before discussing the outcomes. A receiver operating characteristic curve (ROC curve) is a graph that shows how well a classification model performs across all categorization levels.

### Two parameters are shown on this curve

- Rate of True Positives
- Rate of False Positives

The True Positive Rate (TPR), which is a synonym for recall, is defined as follows:

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

The following is how the False Positive Rate (FPR) is defined:

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

TPR vs. FPR at various categorization criteria is plotted on a ROC curve. As the classification threshold is lowered, more items are classified as positive, resulting in an increase in both False Positives and True Positives. We might analyse a logistic regression model multiple times with different classification criteria to compute the points on a ROC curve, but this would be wasteful. Fortunately, there is a fast, sorting-based method called AUC that can give us with this information [38]. Furthermore, the confusion matrix depicts in detail what happens to pictures after they are classified.

#### Note in the images below

- D1/ Dataset1: CT-Scans for COVID-19 Classification - Abu Zahid Bin Aziz [30]
- D2/ Dataset2: SARS-COV-2 Ct-Scan Dataset - Eduardo Soares and Plamen Angelov [31]

The model is trained on the D1/ Dataset1 and its inter accuracy is checked. After that to check for intra accuracy, we test the model on the D2 /Dataset2.

#### VGG 16

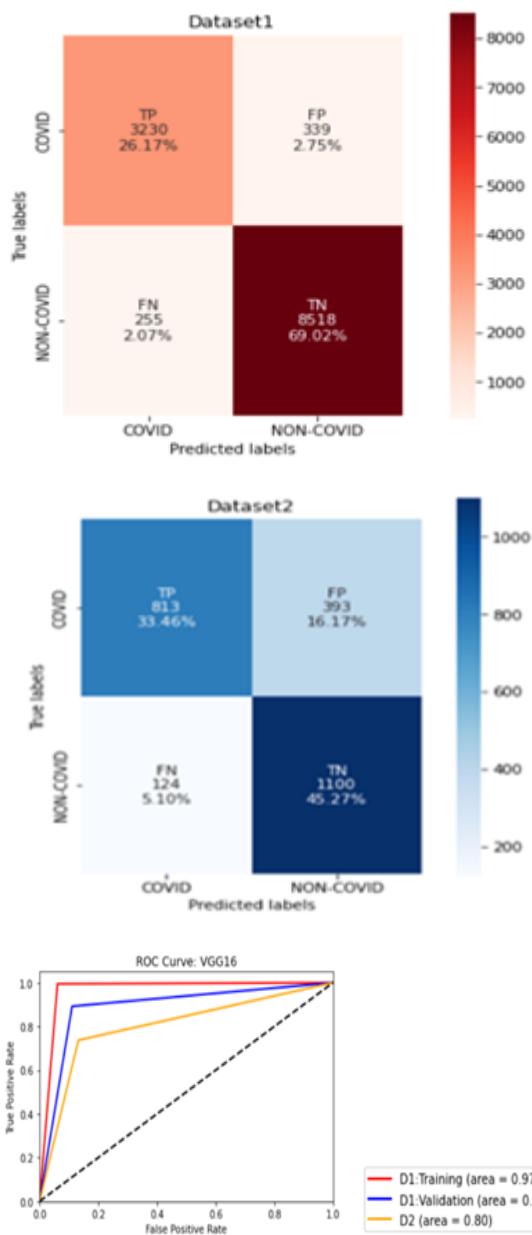


Fig.9. Confusion Matrix and ROC curves of VGG 16

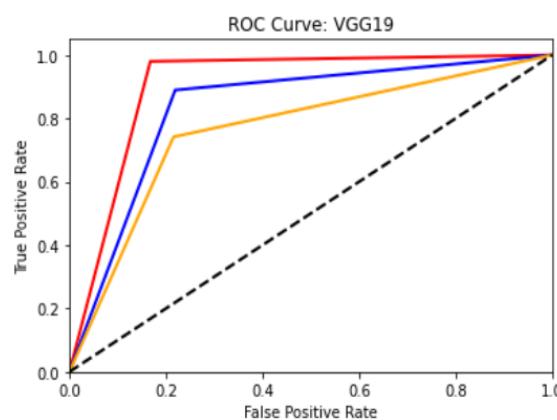
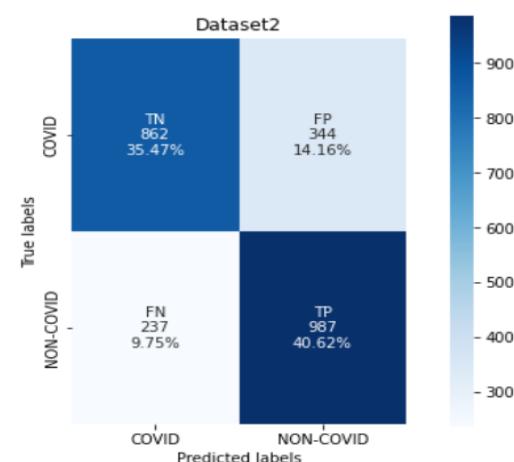
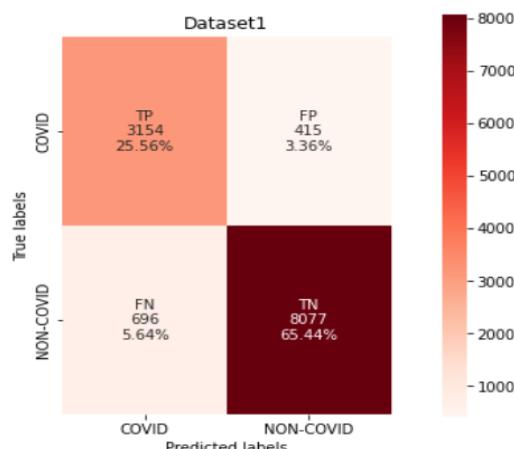
**Fig. 9:** Confusion Matrix and ROC curves of VGG 16

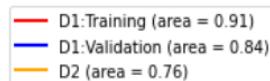
According to the figure above, it is observed that in the roc curve, the train set and the validation set of the first dataset have a high auc of 0.97 and 0.89 while the inter dataset auc is 0.80. It is highest inter dataset auc among all the other models in this study.

From both the confusion matrix in fig 6, it is observed that in the first dataset that the model was able to correctly identify 3230 of the Covid images and 8518 Non-Covid images correctly while it predicted 255 images of Covid and 339 images of Non-Covid incorrectly. In the second dataset the model predicted 813 images and 1100 images of Covid and Non-Covid correctly while it couldn't give correct prediction for 124 images of Covid and 393 images of Non-Covid.

### VGG 19

According to the figure 10, the model accurately identified 3154 Covid photos and 8077 Non-Covid images in the first dataset, while wrongly predicting 696 Covid images and 415 Non-Covid images. In the second dataset, the model successfully identified 862 photos of Covid and 987 images of Non-Covid, while it failed to predict 237 images of Covid and 344 images of Non-Covid.

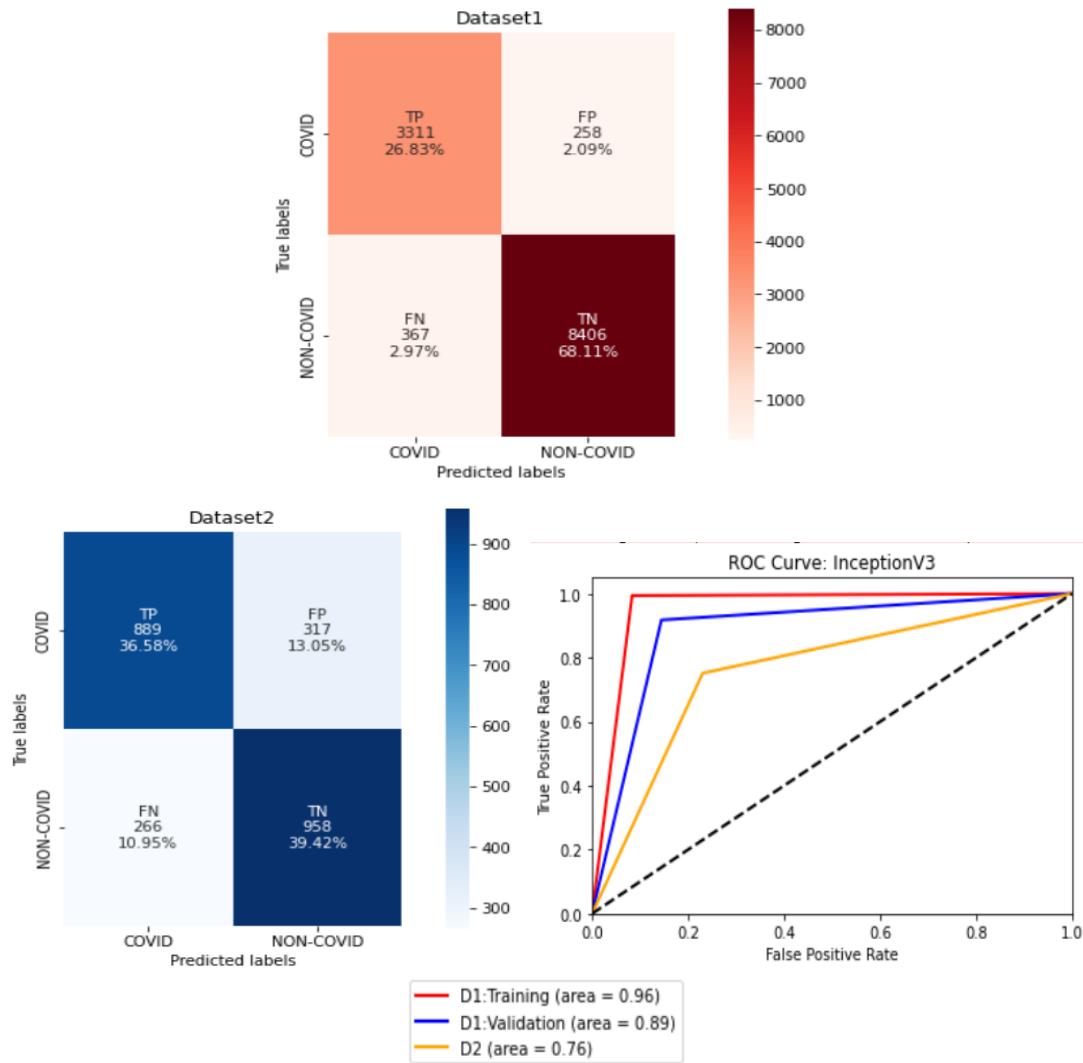




**Fig. 10:** Confusion Matrix and ROC curves of VGG 19

Figure 7 shows that the first dataset's train set and validation set have a high AUC of 0.91 and a substandard AUC of 0.84 in the roc curve. It has an AUC of 0.76 for the second dataset.

### Inception V3



**Fig.11:** Confusion Matrix and ROC curves of Inception V3

According to the figure 11, it is observed that in the roc curve, the train set and the validation set of the first dataset have a high AUC of 0.96 and 0.89 while the inter dataset AUC is 0.76.

From both the confusion matrix in fig 8, it is observed that in the first dataset that the model was able to correctly identify 3311 of the COVID images and 8408 Non-COVID images correctly while it predicted 367 images of Covid and 258 images of Non-COVID incorrectly. In the second dataset the model predicted 889 images and 958 images of Covid and Non-Covid correctly while it couldn't give correct prediction for 266 images of Covid and 317 images of Non-Covid.

### Comparative Study of all models

#### Evaluation Metrics

All the models have been evaluated and compared based on these following metrics taken from the confusion matrix.

- Accuracy =  $\frac{\text{True positive} + \text{True Negative}}{\text{Total Samples}}$

- Precision =  $\frac{\text{True positive}}{\text{True Positive} + \text{False Positive}}$
- Recall =  $\frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}}$
- F1 score =  $2 \times \frac{\text{precision} \times \text{recall}}{\text{precision} + \text{recall}}$
- AUC (Area Under the ROC curve): measures the entire two-dimensional area underneath the entire ROC curve

### Performance Evaluation

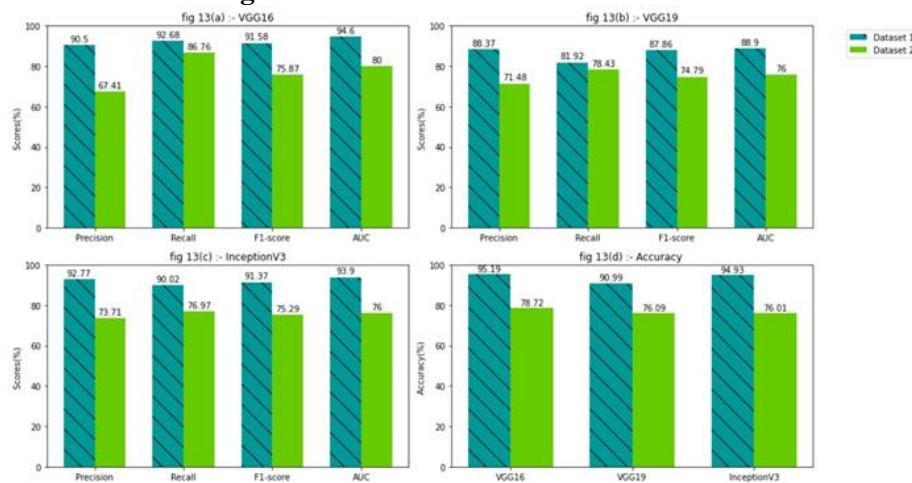
We investigated in this study the binary classification (Covid and Non-Covid) based on CT-Scans images using transfer learning of recent deep learning architectures, to identify the best performing architecture based on the several parameters listed above. We individually compare the deep learning architectures by measuring the accuracies, precision, recall, F1-score and AUC scores.

Fig 12 illustrates a comparison between our different deep learning models used in our experiment in terms of parameters defined above. Fig 13 contains the graphical comparison of all the parameters where in fig 13(a), 13(b) and 13(c) show the bar graphs for precision, recall, F1 score and AUC scores for all the three models with the X axis consisting of the parameters and the Y axis for the scores. Fig 13(d) contains a bar graph showing the accuracy of all the models on both the datasets where X axis contains the models and Y axis contains the accuracy score.

	<b>VGG 16</b>		<b>VGG 19</b>		<b>Inception V3</b>	
	<b>Dataset 1</b>	<b>Dataset 2</b>	<b>Dataset 1</b>	<b>Dataset 1</b>	<b>Dataset 2</b>	<b>Dataset 1</b>
<b>True Positive (TP)</b>	3230	813	3154	862	3311	889
<b>True Negative (TN)</b>	8518	1100	8077	987	8406	958
<b>False Positive (FP)</b>	339	393	415	344	258	317
<b>False Negative (FN)</b>	255	124	696	237	367	266
<b>Accuracy (%)</b>	95.19	78.72	90.99	76.09	94.93	76.01
<b>Precision (%)</b>	90.50	67.41	88.37	71.48	92.77	73.71
<b>Recall (%)</b>	92.68	86.76	81.92	78.43	90.02	76.97
<b>F1 – Score (%)</b>	91.58	75.87	87.86	74.79	91.37	75.29
<b>AUC in (%)</b>	94.60	80.00	88.90	76.00	93.90	76.00

**Fig. 12:** Comparative study of all models

**Fig.13:** Results of all classification models



### CONCLUSION AND FUTURE SCOPE

Diagnosis of Covid 19 from CT-scans is a major challenge in health care systems. The objective of proposed work is to provide a study of different image processing and deep neural networking techniques and to identify the most suitable method. Results shows accuracy, precision, recall ,f1-score and AUC for VGG16, VGG19 & Inception V3 after modifying the model using concepts in fine tuning and transfer learning. Accuracy graph shows that VGG16 model has the highest inter and intra dataset accuracy. While both VGG19 and InceptionV3

have similar intra dataset accuracy, Inception V3 has the higher inter dataset accuracy. The same order is followed for precision, recall, f1-score and AUC. Therefore, VGG16 is the most suitable model in this study

#### **ACKNOWLEDGMENT**

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- Automatic Hierarchical Classification of Kelps Using Deep Residual Features Ammar Mahmood<sup>1,\*</sup>, Ana Giraldo Ospina<sup>2</sup>, Mohammed Bennamoun<sup>1</sup>, Senjian An<sup>3</sup>, Ferdous Sohel<sup>4</sup>, Farid Boussaid<sup>5</sup>, Renae Hovey<sup>2</sup>, Robert B. Fisher<sup>6</sup> and Gary A. Kendrick<sup>2</sup> (PDF) Automatic Hierarchical Classification of Kelps Using Deep Residual Features.
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- How to Manually Scale Image Pixel Data for Deep Learning

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***MARKOV MODELING AND MAINTENANCE URGENCIES OF SCREENING UNIT OF A PAPER MILL****VIKAS MODGIL AND UPENDER DHULL****ABSTRACT**

In the current study Mathematical modeling of a significant functional part of paper mill is done and maintenance priorities/urgencies for various components are being decided. The system includes of four components, i.e. Strainer, Screen, Cleaner and Decker. The equations are derived from the realistic Markov model and solved recursively to attain the performance with normalizing condition. Performance matrices are made with the help of altered parameters of each component. The maintenance urgencies of different components of screening system are decided as per alteration of repair rate. The findings of the study will benefit the management in deciding maintenance strategy and improving the availability of the system.

**Keywords:** Performance Matrices, Markov Modeling, Paper Mill, Screening system

**1. INTRODUCTION**

To achieve and maintain a high level of functional availability of complex industrious system is extremely challenging. It needs huge capital investment and failure of these system may results incatastrophic penalties that may outcome into losses of money, time, repute or sometimes human life that cannot be measured in any aspect. Design of such gigantic complex system requires huge investment which is very difficult for any business concern. In light of the above any businessperson/manufacturer wants that its system operates continuously without any failure and achieve production as per customer necessity. Several researchers, contribute the issue with the use of many techniques. Okafor et al.[1], Kumar and Tewari, [2], Gupta and Tewari [4], Kumar [3], N. Tomsaz et al. [5], and Gupta et al.[6] applied Markov method to make system transition diagram and assess its performance. Singh and Dayal(9) deliberated 1 out of N: G system with common cause failure. Singh I.P. (8) considered the reliability analysis of a system having four kinds of components with pre-emptive priority repairs. Singh and Dayal (7) also discussed the reliability analysis of a repairable system in a changeable atmosphere. In the present study, thorough examination of the performance realistic industrial system of a screening system of paper mill that contains of several dependent subsystem with non-constant failure rates has been considered.

**2. SYSTEM DESCRIPTION**

Paper mill involves numerous number of interrelated systems namely: Chipping, Feeding, Pulping, Washing, Screening, Bleaching and Paper Production located as per designed layout. The screening system is very substantial part of paper mill. it comprises of four major units:

- 1) Strainer (U1): it drains out the dark liquid from the prepared pulp, its failure shuts down the system.
- 2) Screen (U2): it removes the knots and large imported material from the pulp. Its failure causes breakdown of the system.
- 3) Cleaner (U3): Cleaners used to mix water with pulp with centrifugal action. Its failure adversely affect the quality of paper. These are arranged in parallel (3 Nos.). Breakdown of single unit diminishes the system performance.
- 4) Decker (U4): it diminishes the blackness of the pulp.

The plan of Screening Unit is presented in figure1

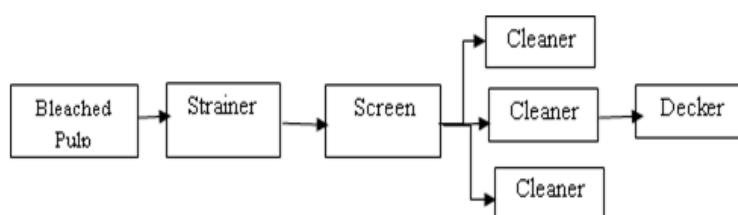


Figure 1: Flow Chart for Screening Unit

## NOTATIONS

- 'o' : The component/Machine is active.
- 'g' : The component/Machine is upright however not working.
- 'r' : The component/Machine is under repair.
- 'qr' : The component/Machine is line up for repair
- $\lambda_i$  : Individual failure rates of U1,U2, U3, U4, ( $i=1, 2, 3, 4$ ).
- $\mu_i$  : Individual repair rates of U1, U2, U3, U4, ( $i=1, 2, 3, 4$ ).
- $\lambda_5$ , : failure rate of unit U3 when it works partly
- $\mu_5$ , : Repair rate of unit U3 when it works partly
- $P_i(t)$  : Probability of the system in the  $i$ th state at time  $t$ .
- Dash (') : Derivatives w.r.t.'t'.

## ASSUMPTIONS

All the component/Machine is in active state initially.

Each component/Machine is as upright as new after repair.

Failure and repair parameters of the component/Machine are constant.

The repair begins instantly after a component/Machine fails.

Based on these notations and assumptions state transition diagram is made which is shown in figure 2:

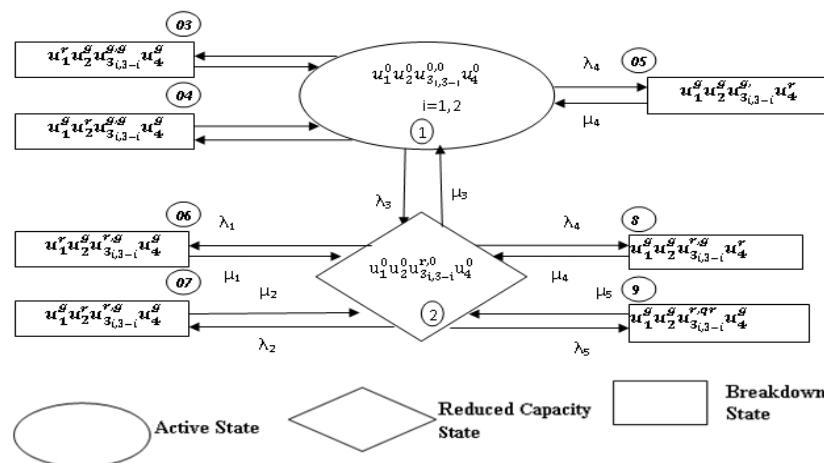


Figure 2: Transition Diagram of Screening Unit

## 3. PERFORMANCE MODELLING

Performance modeling of the unit is performed using Markov method. The differential equations connected with the transition diagram of the Unit under consideration are given as:

$$P_1'(t) + G_1 P_1(t) = \mu_1 P_3(t) + \mu_2 P_4(t) + \mu_3 P_5(t) + \mu_3 P_2(t) \quad (1)$$

$$P_2'(t) + G_2 P_2(t) = \mu_1 P_6(t) + \mu_2 P_7(t) + \mu_3 P_9(t) + \mu_5 P_{11}(t) + \mu_4 P_8(t) + \lambda_3 P_1(t) \quad (2)$$

$$P_i'(t) + \mu_i P_i(t) = \lambda_i P_i(t) \quad \text{for } i=1,2,4 \quad (3)$$

$$P_j'(t) + \mu_j P_j(t) = \lambda_j P_2(t) \quad \text{for } j=6,7,8,9(4)$$

It is anticipated that system will perform for at least fifty years or more, so time taken here as infinite for estimating the system availability in the long run. After doing so, we acquire:

P2=S3P1	P4=S2P1	P5=S4P1
P6=S1P2	P7=S2 S3P1	P8=S4 S3P1
P9=S5 S3P1	P8=S5 S3P1	P9=S5 S3P1

It is considered that initially all the units of the system are in operating condition so the , Availability of the system is full i.e Probability of all state equals to one it gives,

$$1=P1+P2+P3+P4+P5+P6+P7+P8+P9$$

$$P1=1/[(1+ S3+ S1+ S2+ S4+S1S3+S2S3+S4S3+ S5S3)] \quad (5)$$

System availability is sum of all working state which comes out as  $(Av)=P1+P2= [1+S3]P1$ .

The required data for various variables is congregated after discussing with plant personnel. These records are further transformed into the parametric figure as  $(\lambda_1= 0.0001)$ ,  $(\lambda_2=0.0001)$ ,  $(\lambda_3=0.0025)$ ,  $(\lambda_4=0.0003)$ ,  $(\mu_1=0.20)$ ,  $(\mu_2=0.20)$ ,  $(\mu_3=0.025)$ ,  $(\mu_4=0.20)$  for the components. The unit performance attained as 90.71% substituting the above value of variables. Further, the system behavior pattern is studied by varying the various parameters of different sub-systems one by one within a constrained range, considering the other sub-systems parameters constant.

Table 1 demonstrates that the availability is diminished by 0.033% with the raising of failure rate from 0.0001 to 0.0004. Also, the availability is improved by 0.013% with the raising of repair priority from 0.2 to 0.5 and availability can be attained maximum to 90.74%. Other sub-systems parameters are kept constant.

**Table 1: Behavior pattern against the variation in the parameters of Strainer (U1)**

$\lambda_1$	0.0001	0.0002	0.0003	0.0004
0.2	0.9071	0.9067	0.9063	0.9059
0.3	0.9072	0.9070	0.9067	0.9064
0.4	0.9073	0.9071	0.9069	0.9067
0.5	0.9074	0.9072	0.9070	0.9069

Table 2 expresses that, the availability is decreased marginally by 0.06% with the rising of failure events from 0.0001 to 0.00025 of component B. Likewise, it is improved by 0.033% with the changing of repair rate from 0.2 to 0.8 and availability can be attained as 90.74%.

**Table 2: Behavior pattern against the variation in the parameters of Screen (U2)**

$\lambda_2$	0.0001	0.00015	0.0002	0.00025
0.2	0.9071	0.9069	0.9067	0.9065
0.4	0.9073	0.9072	0.9071	0.9070
0.6	0.9074	0.9073	0.9072	0.9072
0.8	0.9074	0.9074	0.9073	0.9073

Table 3 depicts that the availability is reduced by 5.1% with the raising of failure events from 0.0025 to 0.0040. Similarly, the availability gets better by 3.5% with the raising of repair rate from 0.025 to 0.040 and maximum availability can be attained as 93.90%.

**Table 3: Behavior pattern against the variation in the parameters of Cleaner (U3)**

$\lambda_3$	0.0025	0.0030	0.0035	0.0040
0.025	0.9071	0.8910	0.8754	0.8603
0.030	0.9210	0.9071	0.8936	0.8805
0.035	0.9312	0.9190	0.9071	0.8955
0.040	0.9390	0.9281	0.9175	0.9071

Table 3 depicts that the availability is reduced by 0.27% with the raising of failure events from 0.0025 to 0.0040. Similarly, the availability gets better by 0.08% with the raising of repair rate from 0.025 to 0.040 and maximum availability can be attained as 90.79%.

**Table 4: Behavior pattern against the variation in the parameters of Decker (U4)**

$\lambda_4$	0.0003	0.0005	0.0007	0.0009
0.2	0.9071	0.9063	0.9055	0.9046
0.3	0.9075	0.9070	0.9064	0.9059
0.4	0.9077	0.9073	0.9069	0.9065
0.5	0.9079	0.9075	0.9072	0.9069

It is observed in the behavior pattern of Screening system that its performance is highly affected by sub-system (C) and others system marginally affects its availability as shown in table 5.

**Table 5: Behavioral study findings**

System	failure events	Decrease in availability (%age change)	repair priorities	Performance Improvement (%age change)
U1	0.0001 – 0.0004	(0.033%)	0.2 – 0.5	(0.13%)
U2	0.0001 – 0.00025	(0.03%)	0.2 – 0.8	(0.066%)
U3	0.0025 – 0.0040	(5.1%)	0.025 – 0.040	(3.5%)
U4	0.0003 – 0.0009	(0.27%)	0.2 – 0.5	(0.08%)

## 5. CONCLUSIONS

The detailed study carried out here that the Cleaner is the most critical subsystems that need supreme attention when selecting maintenance strategies for screen system in Paper Mill. The rise in its repair level from 0.025 to 0.040 rises its availability by 3.5%. It has also been observed that other system marginally affect the system performance(as revealed table 5).

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***MEASURES FOR DEVELOPMENT OF SUSTAINABLE TOURISM**

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**ABSTRACT**

The present study was conducted in the state of Chhattisgarh to identify the pace of Tourism development, sustainability and its awareness among the tourist visiting the state, the study tries to develop a model to determine the important variables which can contribute towards the development of sustainable tourism at Chhattisgarh state. The tourism industry is helping nations to become economically strong and the growth of this industry is remarkable in last two decades but there are some big threats associated with the unprecedented development of this industry across the globe. Today India and especially Chhattisgarh is rich in every sense be it infrastructure, connectivity, flora and fauna, preserved ancient architect or culture, the shrine places etc bound to attract domestic and global tourists. As a new state Chhattisgarh is trying to explore the developmental possibilities of this industry & it become important to think about the sustainable options to minimize the negative impact of this industry? A tourism strategy is essential which is ecological, economical & socially feasible for long term. A research model was developed and examined with a questionnaire designed using 5-point likert scale. The questionnaire was administered using survey method from tourists of different destinations of Chhattisgarh.

**Keywords:** *Tourism, Sustainability, Government Initiative, Stakeholder Enlightenment, Social Upliftment, Carrying Capacity Reduction, Awareness, Strengthening Economy, Ecological Degradation.*

**INTRODUCTION**

The tourism industry is helping nations to bring big economic fortunes and social reforms (Qin, Luo, Zhao, & Zhang, 2018) but simultaneously it may be a big threat to sustainability across the globe. (Hashemkhani Zolfani, Sedaghat, Maknoon, & Zavadská, 2015). Jockeying for making money is serious issues regarding hazards might have been kept aside (Kshitiz Sharma, 2014). Few studies and available literatures focus the beginning of tourism with respect to time and specific eras. (Walton) Historians have emphasized their focus on the progression of mass tourism.

The first visualisation shows how tourist arrivals have increased since shortly after the Second World War in 1950. The United Nations World Tourism Organization (UNWTO) estimates that internationally there were just 25 million tourist arrivals in 1950. 66 years later this number has increased to 1.2 billion international arrivals per year. This is a 49-fold increase. In 1950 full two-thirds of tourists arrived in Europe. Over the following 66 years the relative importance declined to exactly 50%, but it is still the most important touristic region.

This statistic shows the direct and total economic impact of travel and tourism on the global economy from 2009 to 2018 and expected contribution for the year 2019 and projected for 2029. The direct economic contribution of travel and tourism amounted to approximately 2.75 trillion U.S. dollars in 2018. A highly valuable industry to the global economy, travel and tourism's contribution has steadily increased for over a decade. The direct contribution of Travel & Tourism to GDP may be expected to grow by 3.6% pa to USD4,065.0bn (3.5% of GDP) by 2029. North America makes the largest contribution in this area, closely followed by the European Union and North East Asia. Due to their less developed tourism industries, regions such as North and Sub Saharan Africa make a much smaller impact.

**RELATED WORKS**

In the examination on "Crime as Environmental Externality of Tourism in Florida," (McPheters & Stronge, 1974) observed a direct resemblance between the crime season and the tourist season, recommending that criminal's reaction rises with a rise in the accessibility of crime targets. In the 'Rituals Inversion Theory,' (Graburn, 1983) mentioned that travelers 'aspire to abscond from ordinary routine or typical everyday life and experience nominally non-identical from day to day life is the central rationale beyond travel for tourism.

(Jarvie, 2011) The report highlighted the critical issues related to degradation of environment. (Zurick, 1992) One of the internationally fastest growing tourism is Adventure Travel. Adventure travel is a type of tourism which involves travel to remote or exotic locations in order to take part in physically challenging outdoor

activities (Chris Choi & Sirakaya, 2005) investigated the different environmental changes related to people and region. They identified different vulnerability associated to different regions and how they will cause harm to the environment by degrading it if proper policies are not framed keeping sustainability in mind.

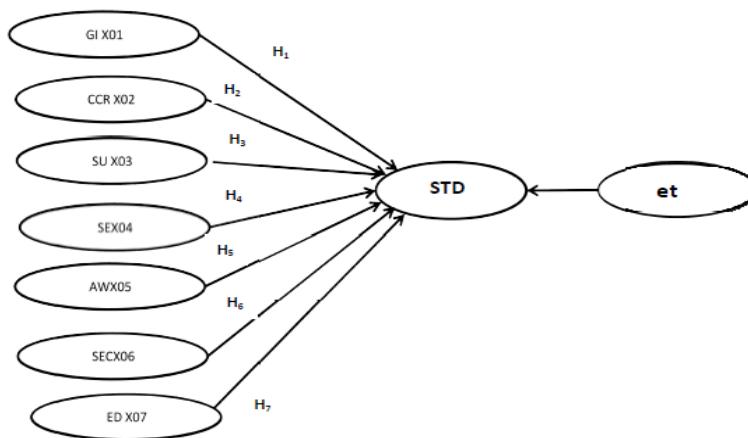
In a research, (Sunlu, 2003) draw the inference that the quality of the natural and man-made environment is very important for tourism (Neto, 2003) Investigate that a suitable balance between the environment, economics, and socio-cultural aspects of tourism development for long period are sustainable in the industry.

**Table 1: Significant Contribution towards Sustainable development Tourism**

S.No	Author	Article Title	Year of Publ.	Journal/Report	Type Of Research
1	World Commission on Environment and Development (WCED)	Our Common Future	1987	Oxford University Press	Exploratory
2	Bramwell, Bill; Lane, Bernard	Sustainable tourism A evolving global approach	1993	Journal of Sustainable Tourism	Empirical
3	Hunter, Colin	Sustainable tourism as an adaptive paradigm	1997	Annals of Tourism Research	Empirical
4	Richard Sharpley	Tourism and Sustainable Development: Exploring the Theoretical Divide	2000	Journal of Sustainable	Exploratory
5	Lucian Cernat and JulienGourdon	Is The Concept of Sustainable Tourism Sustainable	2006	United Nations Conference on Trade and Development	Empirical
6	Saarinen, Jarkko; Manwa, Haretsebe	Tourism as a Socio-Cultural Encounter: Host-Guest Relations in Tourism Development in Botswana	2008	JSTOR	Case Study
7	Richard Sharpley	The Myth of Sustainable Tourism	2010	Centre for Sustainable Development	Literature Review
8	Lane, Bernard; Bramwell, Bill	Critical research on the governance of tourism and sustainability	2011	Journal of Sustainable Tourism	Empirical
9	Corporate, Ambience	Identification of Tourism Circuits across India	2012	Ministry of Tourism Gov. Of India	Case Study

### **Proposed Research Model**

After conceptualizing the variables, the following research model was proposed which is based on causal model in which variables viz. sustainable development as endogenous variable against Government Initiative (GI), Stakeholder Enlightenment (SE), Social Upliftment (SU), Carrying Capacity Reduction (CCR), Awareness (AW), Strengthening Economy (SEC), and Ecological Degradation (ED) are taken to be the exogenous variables. Besides, the demographics like age, experience, education qualification and gender are considered as controlling variables.



**Figure 1: Proposed Research Model**

The frame work developed for the identification and exploration of all those factors which are responsible for sustainable development of tourism in the state of Chhattisgarh. This will be done through a literature review and discussion of ongoing research. It is also aimed to provide recommendations and suggestion for enhancement and development tourism in the state.

### RESEARCH HYPOTHESES

The relationship between stakeholders and Sustainable development of tourism were analyzed with the following research hypothesis:

#### Research Hypothesis

The hypothesis sustainable development of tourism is listed below

**H<sub>1</sub>:** Government Initiative (GI) has significant impact of sustainable development of tourism.

**H<sub>2</sub>:** Carrying Capacity Reduction (CCR)has significant impact of sustainable development of tourism.

**H<sub>3</sub>:** Social Upliftment (SU) has significant impact of sustainable development of tourism.

**H<sub>4</sub>:** Stakeholder Enlightenment (SE) has significant impact of sustainable development of tourism.

**H<sub>5</sub>:** Awareness (AW) has significant impact of sustainable development of tourism.

**H<sub>6</sub>:** Strengthening Economy (SEC) has significant impact of sustainable development of tourism.

**H<sub>7</sub>:** Ecological Degradation (ED) has significant impact of sustainable development of tourism.

**Table 2: Identified Variables**

Variable	Reference	Index
Government Initiatives	Bramwell and Lane (2010), Hall (2011), Torrent (2008)	X01
Carrying Capacity Reduction	Gupta A. et. al 2008, Ismail and Khalil (2010), Sasidharan, Sirakaya, and Kerstetter(2002),	X02
Social Upliftment	Scheyvens (2011), Buckley (2012), Macleod and Todnem (2007)	X03
Stakeholders Enlightenment	Nicholas andThapa (2010)	X04
Awareness	Tosun (2001), Dwyer et al. (2009), Holleran (2008)	X05
Strengthning Economy	Reddy (2008), Bramwell and Lane(2009), Divino and McAleer(2009)	X06
Ecological Degradation	Fortanier and van Wijk (2010), Tan, Liu, and Hu(2012), Choi and Sirakaya (2006),	X07

Where, the independent variable and dependent variables are defined as below

$$X_{01} = \sum_{i=0}^5 X_{1i}; \quad X_{02} = \sum_{i=0}^6 X_{2i}; \quad X_{03} = \sum_{i=0}^3 X_{3i}; \quad X_{04} = \sum_{i=0}^3 X_{4i}; \quad X_{05} = \sum_{i=0}^3 X_{5i}; \quad X_{06} = \sum_{i=0}^3 X_{6i}; \quad X_{07} = \sum_{i=0}^4 X_{7i}; \\ Y = e \sum_{i=0}^3 Y_i$$

### Mathematical Framework

$$Y = \beta_0 + \beta_1 X_{01} + \beta_2 X_{02} + \beta_3 X_{03} + \beta_4 X_{04} + \beta_5 X_{05} + \beta_6 X_{06} + \beta_7 X_{07} + et$$

$$\hat{Y} = \beta_0 + \sum_{i=1}^7 \beta_i X_i + e_t$$

## FACTORS EXPLORATION

This research process follows the research methodology based on earlier research in the concern areas, for which a questionnaire was constructed to measure on a 5-point likert-scale used. A pilot study on a small group of individual is used and for 519 respondents' data is collected.

**Table 3: KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.803
Bartlett's Test of Sphericity	Approx. Chi-Square
	Df
	Sig.

KMO value is 0.803 which  $>0.6$  thus confirms that sample is adequate for exploratory factor analysis (Kaiser, 1974). This indicates that correlations are comparatively compact which will yield distinct factors (Field, 2000). Bartlett's Test of Sphericity is significant as Probability value  $<0.05$ . So we can assume that the correlation matrix (R-Matrix) is not an identity matrix.

To check the data adequacy for each statement, Anti image correlation was used. It was found that the K.M.O. value for each statement was greater than 0.6, therefore data is sufficient for each statement used. Communalities for statement "*Tourism leads to transfer of communicable diseases*" is  $< 0.5$ , therefore this statement is removed as it can produce inflated value of variance (Gorsuch, 1990)

Again KMO and Bartlett's Test is performed to analyse the changes because of omission of one statement as stated above and found adequate.

**Table 4: KMO and Bartlett's Test after Anti Image**

K.M.O. (Measure of Sampling Adequacy)	.811
Sphericity (Bartlett's Test)	Chi-Square
	Dof
	Probability Value

Table 3 summarized the Analysis of Principal Component (PCA) the eigen values for each factors before and after extraction and also after rotation (Field, 2000). Before extraction, there are 27 variables as listed in below table. The below table is presented after considering all steps to remove cross-loadings among statements and factors (Mulaik, 1990).

From eigen values component-1 have 23.11% of total explained variance while component-2 have 11.56% of total explained variance and so on. Under extraction sums of Squared Loadings, the components whose eigen values  $>1$  is listed, there are 7 components which accounts to 63.2% of explained variance. Rotation of the factor axis leads to restructuring of total explained variance. The restructured factors have now changed variance as Factor-1 explains 16.58% of total variance while Factor-2 explains 10.0% variance whereas Factor-7 explains 5.11% variance.

The identified factors through PCA is analysed through Rotated Component Matrix for grouping of statements. All 27 statements are categorized in 7-factors and their reliability was analysed using Cronbach's alpha test for reliability and internal consistency. The below table shows Rotated Matrix of Component shows the loadings of seven identified factors extracted. Higher the absolute value of the loading represents more contribution is by the factor for the variables identified. The loading less than 0.4 is suppressed.

From the rotated component matrix it can be found that the three factors Social Upliftment (SU), Stakeholder's Enlightenment (SE) and Awareness (AW) are converged by the orthogonal rotation as a single factor. These factors represented as Upliftment (SU), Stakeholder's Enlightenment (SE) and Awareness (AW) are combined and renamed as Social Concern (SC).

After orthogonal rotation matrix and factor convergence, hypothesis are revised as below

**H<sub>r1</sub>:** Government Initiative (GI) has significant impact of sustainable development of tourism.

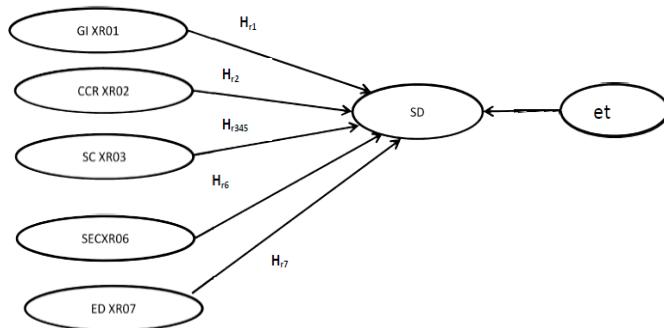
**H<sub>r2</sub>:** Carrying Capacity Reduction (CCR) has significant impact of sustainable development of tourism.

**H<sub>r345</sub>:** Social Concern (SC) has significant impact of sustainable development of tourism.

**H<sub>r6</sub>:** Strengthening Economy (SEC) has significant impact of sustainable development of tourism.

**H<sub>r7</sub>:** Ecological Degradation (ED) has significant impact of sustainable development of tourism.

### Revised Model



**Figure 3: Revised Model**

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_{345} + \beta_6 X_6 + \beta_7 X_7 + et$$

For estimating the relationships between the dependent variable “Sustainable development of tourism” and independent variables as explored Government Initiative (GI), Carrying Capacity Reduction (CCR), Social Concern (SC), Strengthening Economy (SEC), and Ecological Degradation (ED) regression analysis is used.

**Table 5: Regression Model**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.390 <sup>a</sup>	.152	.144	.633	1.885

a. Predictors: (Constant), Xr7, Xr1, Xr2, Xr6, Xr3  
b. Dependent Variable: Y

The model was constituted earlier seven explanatory variables. Three variables were merged together as a single variable, this is how there was 43% reduction in the amount of explanatory variables resulting into five variables. These five constructs explains 15.2% variance of the model. There is no sign of autocorrelation as Durbin-Watson statistics is 1.885 as the value is between range of 0 to 4 (Durbin & Watson, 1950).

**ANOVA Table**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.918	5	7.384	18.404	.000 <sup>b</sup>
	Residual	205.815	513	.401		
	Total	242.733	518			

a. Dependent Variable: Y  
b. Predictors: (Constant), Xr7, Xr1, Xr2, Xr6, Xr3

At 95% confidence level the association is statistically significant as the p-value is less than or equal to the significance level, it is concluded that there is a statistically significant association between the independent variable and dependent variable.

Coefficients <sup>a</sup>							Collinearity Statistics	
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.		
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	1.540	.188		8.201	.000		
	Xr1	.218	.036	.273	6.002	.000	.800	1.249
	Xr2	-.022	.036	-.027	-.631	.528	.913	1.095
	Xr3	.055	.040	.066	1.391	.165	.744	1.345
	Xr6	.091	.033	.124	2.762	.006	.819	1.222
	Xr7	.110	.047	.111	2.347	.019	.743	1.345

a. Dependent Variable: Y

From the coefficients of the above table, out of five explanatory variables namely Government Initiative (GI), Carrying Capacity Reduction (CCR), Social Concern (SC), Strengthening Economy (SEC), and Ecological Degradation (ED), the independent variables Government Initiative (GI), Strengthening Economy (SEC), and Ecological Degradation (ED) are found to have significant impact on sustainable tourism development (STD). Therefore the revised hypothesis  $H_{r1}$ ,  $H_{r6}$  and  $H_{r7}$  are accepted while  $H_{r2}$  and  $H_{r345}$  are rejected as significant value is well above 0.05 at 95% confidence interval.

The collinearity index shows that there are no chances of collinearity as the maximum VIF( Variance inflation factor) value of independent variables in the model fit is 1.345 which is much less than 10 ( Rawlings &Pantula, 1998).

### **PREDICTIONS**

In order to get a Sustainable development of Tourism (STD)for particular *independent variables* values we can use the fitted equation.

$$Y=1.540 + 0.218 X_1 + 0.091X_6 + 0.11X_7 + 0.633$$

Where Y = Sustainable Development of Tourism (STD)

X1= Government Initiative (GI)

X6 =Strengthning Economy (SEC)

X7 = Ecological Degradation (ED)

### **FINDINGS**

1. After factor extraction method, 7-factors have been extracted that accounts to 63.22% of the variation expressed. Identified factors were rotated and thus the total variations expressed by those factors were calculated.
2. By observing the Scree-Plot having the eigen values it can be observed that the seven factors are required to be considered as after 7 factors there is natural bend in the plot and after point 7 the curve gets flattened thus confirming the number of identified factors to be considered.

### **The Seven identified Factors are**

- a. Factor-1: Government Initiatives is considered as first factor which consists of five statements accounting to 16.58% of the total variation having the calculated eigen value of 4.48.
- b. Factor-2: Carrying Capacity Reduction considered as second factor which consists of six statements accounting to 10.0% of the total variation having the calculated eigen value of 2.7.
- c. Factor-3: Social Upliftment considered as third factor which consists of three statements accounting to 9.47% of the total variation having the calculated eigen value of 2.55.
- d. Factor-4: Stakeholder Enlightenment considered as fourth factor which consists of three statements accounting to 9.36% of the total variation having the calculated eigen value of 2.53.
- e. Factor-5: Awareness considered as fifth factor which consists of three statements accounting to 6.55% of the total variation having the calculated eigen value of 1.77.
- f. Factor-6: Strengthening Economy considered as sixth factor which consists of three statements accounting to 6.12% of the total variation having the calculated eigen value of 1.66.
- g. Factor-7: Ecological Degradation considered as seventh factor which consists of four statements accounting to 5.11% of the total variation having the calculated eigen value of 1.38.

From the rotated component matrix it can be found that the three factors Social Upliftment (SU), Stakeholder's Enlightenment (SE) and Awareness (AW) are converged by the orthogonal rotation as a single factor. These factors represented as Upliftment (SU), Stakeholder's Enlightenment (SE) and Awareness (AW) are combined and renamed as Social Concern (SC).The factor "Government Initiative (GI)", with mean value of 2.83 and standard deviation of 1.08 and with regression coefficient of 0.218 has positive impact of sustainable development of tourism in the state of Chhattisgarh.

### **CONCLUSION**

The above study concludes that the sustainability is explained through various stakeholders for this the conceptual model was framed using 7 identified factors and confirmed using confirmatory analysis taking the

required samples and analysed the model fit, sustainable tourism development is a strategic process and it requires efforts from all stake holders but primary responsibility is to device a frame work for this which includes Government initiatives (GI) which will govern according to the options of sustainability and will keep vision of tourism development in the state after the government's intervention the other stake holders (example Visitors & Host Community) must be made aware of the idea of sustainability in Chhattisgarh if efforts can be made as the education level is good the goal can be achieved.

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**VISUALIZATION AND INTERPRETATION OF CNN LAYERS FOR PREDICTIONS IN DENTAL CAVITY CLASSIFICATION****RAHULSINH B. CHAUHAN, TEJAS V. SHAH, DEEPALI H. SHAH AND TULSI GOHIL****ABSTRACT**

*CNN methods are increasingly being used to develop a reliable computer-aided diagnosis, but their difficulties in interpreting and explaining the models' learned behaviour restrict their implementation in real-world applications. The goal of this research is to investigate and provide a better explanation for how effective layer-wise Visualization of Feature Maps and Grad-CAM visualisations work in a CNN-based dental cavity prediction model. To achieve this goal, Python code was framed that trained a CNN to classify cavities as 'deep' or 'shallow'. Eleven x-rays were taken for this study, each of which included the same set of teeth for both categories. We propose an average number of filters method for framed CNN model that is used to visualise feature maps and to superimpose Grad-CAM visualisations on the input images for various layers within the model to reduce overfitting, computational time and memory use. In earlier layers, the model appeared to focus on general features, whereas in later layers, due to the use of average filters, the model appeared to focus on cavity areas in both approaches with an accuracy of 92.20%, which is 4.97% higher than traditional CNN. Since all the images showed similar trends in the visualizations of the various layers, they provided better insight into how the model processes information and suggest that the location and size of the cavities do not affect the model's classification performance. This will assist research groups in tuning model hyperparameters for their dataset and determining the number of actually required layers for accurate classification.*

**Keywords:** Convolutional Neural Networks, Deep Cavities, Dental Diagnosis, Shallow Cavities.

**1. INTRODUCTION**

Oral diseases are the most common non-contagious disease, affecting individuals in a variety of ways throughout their lives, causing pain, disfigurement, irritation, and, in extreme cases, death. Tooth decay, more commonly referred to as Dental caries or cavities, are caused by permanently damaged tooth enamel. In 2010, tooth decay (Untreated decay of primary and permanent teeth, 44%) was the most common condition, affecting nearly half of the world's population, followed by the Tension-Type Headache (21%), Migraine (15%), Severe Periodontitis (11%), Diabetes (8%) and Asthma (5%) diseases [1]. According to the Global Burden of Disease Study 2017, oral diseases affect nearly 3.5 billion people worldwide, with caries of permanent teeth being the most common condition. Globally, it is estimated that 2.3 billion people suffer from permanent tooth caries, with over 530 million children suffering from primary tooth caries [2]. Conventional inspection for caries detection is mainly accomplished using visual inspection, tactile sensation and radiographs. Radiographic examination is extremely useful in detecting caries lesions, particularly when they are not clinically visible [3]. Radiographs are the most commonly used diagnostic tool, and with the advancement of new techniques, a manual analysis of radiographs has been replaced by computer-aided diagnosis to solve many problems. Various types of radiographs are available in dentistry for diagnosis, but all utilise low dose x-ray, which causes noise and artifacts in radiographs and misleads the dental surgeon. To address these issues and obtain accurate dental diagnoses digitally, a variety of image processing-based methodologies, ranging from traditional approaches to machine learning or deep learning-based approaches, have been developed. Several studies have been conducted to demonstrate image processing-based methods for predicting dental caries in various types of radiographs. Bitewing Radiographs, Periapical Radiographs, Panoramic Radiographs, Photographs, and Near-Infrared Light Transillumination Images (NILT) are the most commonly used digital diagnostic tools for dental caries, but the majority of studies have chosen Periapical Radiographs and Panoramic Radiographs for dental caries detection.

Albahbah et al. [4] trained a Back-Propagation Neural Network for diagnosing dental caries using a dataset of Panoramic Radiographs. With an accuracy of 64.91% and an overall precision of 73.7%, the proposed Back-Propagation Neural Network classifies the test image as a decayed or normal tooth. Singh et al. [5] improved accuracy on Panoramic Radiographs to 86% by using Radon Transformation (RT) and Discrete Cosine Transformation (DCT) to classify test images as cavitated or non-cavitated teeth. Haghani et al. [6] used a novel technique based on a Genetic algorithm and a Capsule network (CheXNet) for the first time on Panoramic Radiographs to classify dental caries as healthy, mild caries, and severe caries, achieving 86.05% accuracy. Al Kheraif et al. [7] used a hybrid graph-cut technique for Panoramic Radiograph Segmentation and a Deep

convolution neural network (CNN) for the Classification of the Oral cavity and its tissues with a 97.07% accuracy. Lakshmi et al. [8-9] propose an Alex-net architecture-based Deep convolution neural network approach for Classification of Tooth Decay, with Sobel edge detection and graph-cut segmentation, which achieves an accuracy of 82% and later one with 98.6%.

Geetha et al. [10] propose a study on Periapical Radiographs for dental caries using Back-Propagation Neural Network that yields 97.1% accuracy. Rad et al. [11] proposed a similar Back-Propagation Neural Network-based approach with Initial contour (IC) generation and intelligent level set segmentation method with 98% accuracy, and Sornam et al. [12] proposed Linearly Adaptive Particle Swarm Optimization fused with Back Propagation Neural Network with 99% accuracy. All approaches, however, only classify teeth as good or caries-affected. Deep convolutional neural networks based approach on Periapical Radiographs for dental caries categorization by employing GoogLeNet along with Inception v3 Architecture proposed by Lee et al. [13] and Long Short-Term Memory (LSTM) model for dental caries categorization into six classes based on the location of caries as per G.V Black's rules proposed by Singh et al. [14] yielded 82% and 96% accuracy respectively.

Koutsouri et al. [15] proposed that diagnosing Occlusal Caries from Photographic images has a sensitivity of 92%. Zhang et al. [16] and Sonavane et al. [17] on Photographic images, Srivastava et al. [18] and Cantu AG et al. [19] on Bitewing Radiographs, Schwendicke et al. [20] and Casalegno et al. [21] on Near-Infrared-Light Transillumination (NILT) images proposed deep learning approaches using CNN for dental caries diagnosis. Zhang et al. used VGG-16 Architecture, which provides 85.65% value for Area Under the Curve (AUC), whereas Sonavane et al. provide 71.43% accuracy by classifying teeth as caries or non-caries on photographic images. The model proposed by Srivastava et al. has a sensitivity of 80.5% on Bitewing Radiographs, while the U-net based model proposed by Cantu AG et al. has a sensitivity of 75% on Bitewing Radiographs. Occlusal and Proximal caries classification from NILT images yields 0.73 AUC for the Resnet18 model and 0.74 for the Resnext50 model proposed by Schwendicke et al., with Casalegno et al. improving performance by 0.836 AUC for Occlusal carious lesions and 0.856 for Proximal carious lesions using a semantic segmentation-based approach. These evaluations show that machine learning or deep learning-based models are very effective at detecting dental caries on Periapical Radiographs and Panoramic Radiographs. Previous research, however, clearly shows that there is still a need to improve the accuracy of machine learning or deep learning-based models in classifying dental caries on radiographs.

Machine learning or deep learning is a growing field that has the potential to improve medical care by assisting medical experts with its applications to a wide range of fields, most notably in medical imaging. One example of deep learning that has been found to be useful in medical imaging is a convolutional neural network (CNN), which attempts to mimic how the brain works by streamlining neurons into units connected in layers to categorise visual imagery. Although convolutional neural networks have shown promising results in medical imaging, there is currently scepticism about their usage because the way they translate complex information into decisions is ambiguous, resulting in inaccurate output. As a result, employing computer-aided diagnosis would be an improbable idea because the risks would likely outweigh the benefits.

Our research question is how to visualise the output of the intermediate layer of a CNN model to see how it transforms complex information into decisions. To answer, we used visualisation techniques to try to understand which features the convolutional neural network observes in order to produce its output. Gradient Weighted Class Activation Mapping (Grad-CAM) [22] and visualising a feature map or activation maps are good instances of visualisation techniques that can be used for CNN. These techniques can explain and comprehend why CNN made the incorrect decision, so they can guide modifications to the CNN model's hyperparameters that could be made to achieve the desired result and solve the ambiguous problem. McAllister et al. [23] attempted to understand a CNN based dental x-ray artefact prediction model using Grad-CAM. It visualises various layers within a CNN model and compares the effect of x-rays with artefacts of various sizes and locations on the visualisations of the layers to see if the visualisations provide a glimpse into the interpretability of the features that each layer of the model observes to reach its final classification. Sarki et al. [24] propose a study of Automated COVID-19 Detection Using Chest X-Ray Images Using Convolutional Neural Network. They work on visualising a feature map and Grad-CAM to strengthen their prediction model and achieve 93.75% accuracy.

The objectives of this article are to visualise the Grad-CAM and feature map of all layers within a CNN-based dental x-ray cavity prediction model and evaluate whether the visualisations provide knowledge about the generalizability of the details that each layer of the model is perceiving to reach its final classification, which will assist in tuning hyperparameters and guiding research groups. Grad-CAM and visualising a feature map has

been shown to be useful in providing insight into how the CNN model reaches its final classification in a variety of situations. It may be feasible to use it to modify the hyperparameters in order to eliminate or reduce the inappropriate outputs. It is therefore essential to implement research to determine whether Grad-CAM and visualising a feature map can be used throughout the CNN model to better understand how the model arrives at its final output. To the best of our knowledge, we are the first group to work on two approaches known as Visualization of Feature Maps and Gradient-Weighted Class Activation Map (Grad-CAM) for “deep cavities” and “shallow cavities” for their layer-wise representations, and we proposed an average number of filters method to reduce overfitting, computational time, memory use and increase model accuracy to guide new researchers.

## **2. METHODS**

### **2.1 DATASET AND PRE-PROCESSING**

The dataset for training and validation of our CNN-based dental x-ray cavity prediction model consists of 228 periapical x-ray images, 114 of which had deep cavities and the other 114 of which had shallow cavities and were evaluated and labelled by three dental surgeons. The convolutional neural network model used was developed in Python using the Keras library. To overcome the shortcomings of the small training dataset, we used data augmentation to strengthen our CNN model and reduce bias and generalisation errors. This method generated new samples for training images without altering the image's attributes and increased the number of training datasets. A small volume of training images was visualized to understand the data augmentation, and the dataset was augmented with vertical and horizontal shifts and rotations. To aid model convergence, images were resampled to 224×224-pixel resolutions and normalised for mean.

### **2.2 CONVOLUTIONAL NEURAL NETWORK**

CNNs have recently emerged as the most popular machine learning algorithms for image-based dental diagnosis [25-27]. The reasoning behind this is that when inspecting input images, CNNs retain complex features. Figure 1 depicts the system architecture. This implemented CNN architecture has ten convolution layers and takes as input a dental image tensor of 244×244. Following that, the first convolution layer employs 5×5 kernel filters with stride 1×1, for a total of 32 such filters. After that, the output of the first layer is normalised by subtracting the batch mean and dividing the batch standard deviation. The second layer, which receives the output of the first layer, employs 64 filters, and its output is normalised and passed to a max-pooling layer with a stride of 2×2, reducing the input to half its original size 112×112. The output of the pooling layer is routed through the ReLU activation feature for all layers. The obtained nonlinear output is now fed into the following two identical type convolution layers with 3×3×64 with 128 filters, and the stride value is the same 1×1. The acquired output is passed through a max-pooling layer with the same 2×2 strides, decreasing the input to half its original size 56×56. Following ReLU activation, the output is fed into the fifth to seventh convolution layers, each with 256 filters and a kernel size of 3×3×128 with 1×1 stride. The output is routed through a max-pooling layer, yielding a tensor of shape 28×28. Again, the output goes through ReLU activation before being fed into the eighth to tenth convolution layer, which has 512 filters, a kernel size of 3×3×256, and the same stride of 1×1. The output of the tenth convolution is max-pooled, resulting in a tensor with the shape 14×14×512 and a flattened tensor with 1,00,352 neurons. The weighed values that evolve as neurons show the closeness to the symptoms of deep and shallow cavities. The dropout layer is used here to drop values to control network overfitting; during training, we used a dropout rate of 0.2. The fully connected layer converts the 1,00,352 neuron tensor into neuron numbers corresponding to the number of categories (deep and shallow cavities) to which the dental image belongs. In this article, we implemented conventional CNN initially, afterwards performed layer by layer visualisation and interpretation of its feature Maps and Grad-CAM, and we tuned its hyperparameters by proposing an average filter based approach, which is elaborated with a mathematical formula in the discussion section, and this approach yielded 92.20% accuracy, which is 4.97% higher than traditional CNN.

#### **2.2.1 CONVOLUTION LAYER:**

This layer consists of a filter (kernel) set. It is a process in which we move a small matrix of numbers (referred to as the kernel or filter) over our image, transform it based on the kernel values, and then extract features by creating a new layer. Each layer represents one or more of the input image's significant features or characteristics. Subsequent feature map values are calculated using the following formula, where  $f$  represents the input image and  $k$  represents our kernel [31]. The indexes of the result matrix's rows and columns are denoted by  $m$  and  $n$ , respectively.

$$G[m, n] = (f * k)[m, n] = \sum_i \sum_j k[i, j] f[m - i, n - j] \quad (1)$$

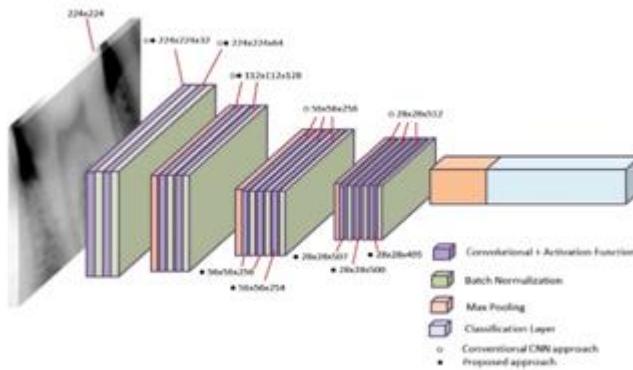


Figure 1: Proposed CNN architecture for Dental Cavity Classification.

### 2.2.2 KERNEL INITIALIZER:

The CNN kernel must begin with some weights and then iteratively update them to better values. The statistical function that will be used to initialise the weights is referred to as the kernel initializer. The purpose of kernel initialization is to protect layer activation outputs from exploding or fading away during a forward pass through a CNN. As a kernel initializer, we used He normal [30]. This method of initialization became well-known after He et al. [29] published a paper on it in 2015. In this approach, the weights are initialised with the prior layer's size in mind, which aids in gaining a global minimum of the cost function quicker and more effectively. It takes samples from a truncated normal distribution with a mean of 0 and a standard deviation ( $\sigma$ ) of as:

$$\sigma = \sqrt{\frac{2}{Fan_{in}}} \quad (2)$$

Where,  $Fan_{in}$  is the number of input units in the weight tensor.

### 2.2.3 RECTIFIED LINEAR UNIT (RELU) LAYER:

This layer is an activation function that reduces the negative input value to zero, optimising and speeding up evaluations and training while also preventing the gradient from disappearing. This is described mathematically as:

$$\text{ReLU}(x) = \max(0, x) \quad (3)$$

In this case,  $x$  is input to the neuron.

### 2.2.4 BATCH NORMALIZATION:

Batch normalisation allows each layer of the network to learn individually from the others. It moreover normalises the previous activation layer's output by subtracting the batch mean and dividing the batch standard deviation to enhance the neural network's stability.

### 2.2.5 MAX-POOLING LAYER:

This Layer employs a sample-based discretization technique. It sub-samples the input along its spatial dimensions by identifying the maximum value for each channel of the input across an input window. This reduces the size of learning parameters while also providing essential interpretation invariance to internal depiction, lowering computation costs even further. During the Max-pooling process, our model used a kernel size of  $2 \times 2$ . The network flattened to one dimension after the final convolution block.

### 2.2.6 FULLY CONNECTED LAYER:

This layer uses the previous layer's output to compute the probabilities for classification into the various groups.

### 2.2.7 Loss Function:

For the final prediction, this layer applies a soft-max function to the input data sample. As a result, the loss function is given as [32]:

$$L_i = -\log \left( \frac{e^{f_j}}{\sum_j^c e^{f_j}} \right) \quad (4)$$

Where  $f_j$  is the  $j^{\text{th}}$  element of the vector of class scores  $f$ ,  $f_j$  is the CNN score for the positive class and  $c$  is classes for each image. The softmax ensures that the prediction probability in the log of the equation is accurate.

**2.2.8 REGULARIZATION:**

An efficient regularisation method known as a dropout, proposed by Srivastava et al. [28], is used. Dropout occurs during the training phase by keeping the neuron active with a certain probability value P or adjusting it to 0. We set the dropout to 0.20 because it produces the most regularisation.

**2.3 MODEL INTERPRETATION**

Two main approaches, Visualization of Feature Maps and Gradient-Weighted Class Activation Map (Grad-CAM), are used to interpret network predictions.

**2.3.1 VISUALIZE FEATURE MAPS:**

The feature maps, also known as activation maps, track the information used with filters, such as image pixels or other feature maps. The main objective of visualising a feature map for specific source images is to understand which attributes in the feature maps are identified or retained. The assumption is that feature maps just next to the input layer detect fine-grained or small information, whereas feature maps close to the model output layer capture more distinctive features. CNN's first layer frequently learns features like edges, lines, and patterns, while the deeper layer network learns more complex features like cavities. Later layers generate their features by combining elements from the previous layer. To quantify the visualisation of feature maps, we created activations using the best performing framework with x-ray, as shown in Figure 1. The activation maps of the model are shown in Figure 2(A) for deep cavities and Figure 2(B) for shallow cavities and are addressed in the results section.

**2.3.2 GRADIENT-WEIGHTED CLASS ACTIVATION MAP (GRAD-CAM):**

A variety of tasks were accomplished in order to make deep learning more practical and explainable. It is also vital to enhance the generalizability of the deep neural network in numerous deep learning applications related to dental imaging. Selvaraju et al. [22] developed a method called Gradient Weighted Class Activation Mapping (Grad-CAM), which offers an illustrative view of deep learning methods. Grad-CAM formed visual explanations from any CNN-based framework by using gradient information from a target class that flowed back into the very last convolutional layer. This method won't require the use of a specific CNN architecture, so it did not necessitate any changes to the existing CNN architecture. Grad-CAM generates a visual summary for any deeply related CNN, which aids in model selection when performing classification or prediction tasks. The proposed model is used as a detection method on a dental cavity x-ray image. Grad-CAM for class C classification was calculated as a weighted sum of all feature maps produced by the CNN's very last convolution layer [33].

$$\text{Grad\_M}_c(a, b) = \text{ReLU}(\sum_k \alpha_k^c f_k(a, b)) \quad (5)$$

Grad-CAM is defined for class C as  $M_c$ , where  $\alpha_k^c$  is the weight gained by calculating the gradient of a prediction score concerning the  $k^{\text{th}}$  feature map and  $f_k(a, b)$  is the activation at the spatial element  $(a, b)$  in the  $k^{\text{th}}$  feature map.

Grad-CAM is implemented to all layers of the proposed network after quantifying the predicted label using the model. Figures 3(A) and 3(B) depict Grad-CAM-based visualisations of deep and shallow cavity images from the proposed model, which are elaborated in the results section.

For both approaches of model interpretation, this study used a variety of layers found in the CNN, ensuring the use of all layers from the beginning, intermediate, and end of the CNN to gain a variation of depths within the model. It could encourage for the comparison of visualisations from various points of the model's layers.

This study included eleven x-rays, each of which included the same set of teeth for deep and shallow cavities. Using the same teeth for each image ensures that any variations in the visualisations of the images can be attributed to varying cavity sizes rather than different images of teeth. The localization and intensity of pixels on the heat maps were used to qualitatively assess the Grad-CAM mapped on the input images at the various layers. The locations were classified into three categories: cavities, other regions of the teeth, and the region around the teeth. The location of the cavities is critical to examine because the researchers who created the model want to know if the approach employs the cavities and if the cavities are deep or shallow, or if the model looks elsewhere to classify.

These assessment methods were used to evaluate how beneficial using Grad-CAM and Visualization of Feature Maps at the specified layer would be in allowing the researcher to understand the area of interest the

model was observed at that point in the CNN.

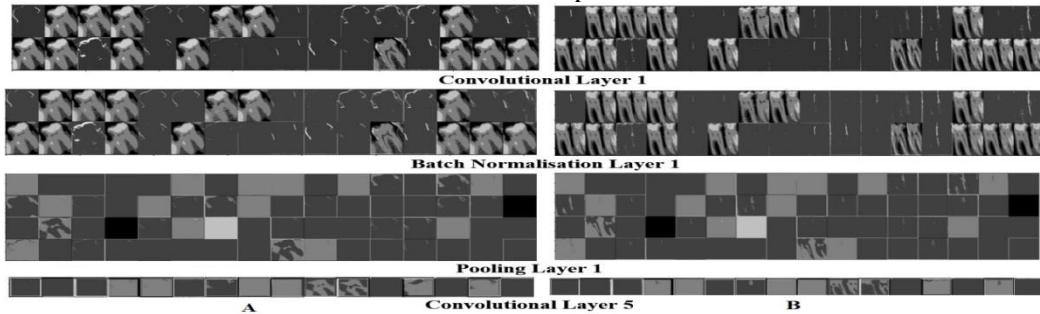
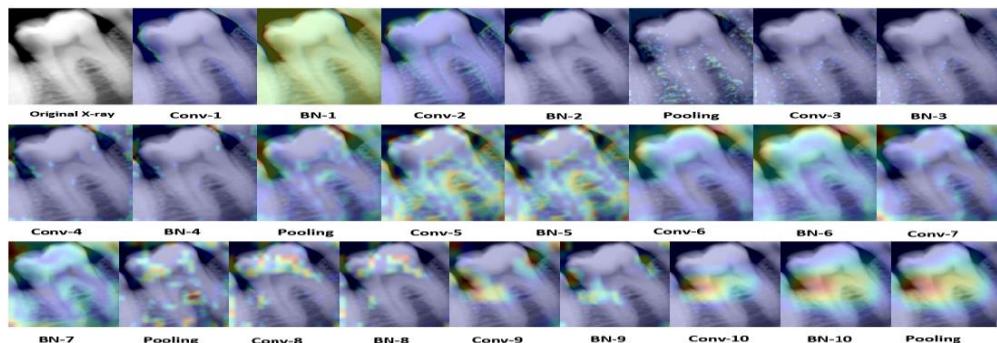


Figure 2: Activation maps for (A) Deep Cavities and (B) Shallow Cavities. (Please note that only 16 of the 256 activation maps are shown for Layer 5.)



(A)

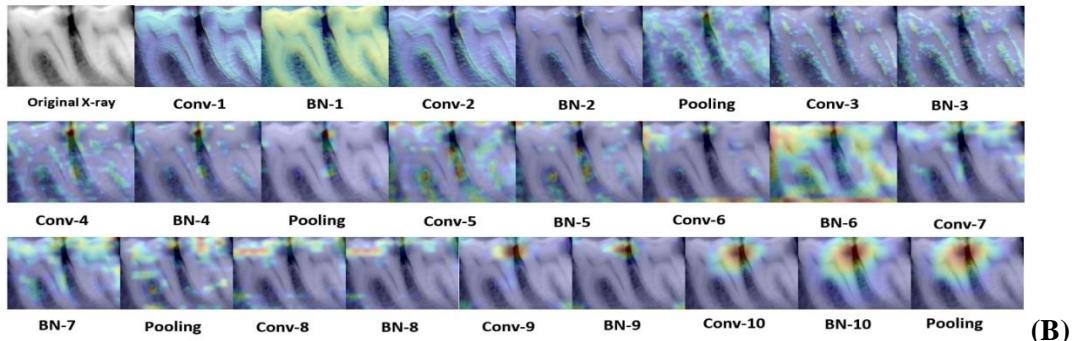


Figure 3: Grad-CAM visualisations of (A) deep cavity images and (B) shallow cavity images. RESULTS

This section focuses on what can be observed for the specified layers of the CNN model from each category. Figures 2 and 3 show the results of one image from each of the two categories.

For the purpose of visualising Feature Maps, Figure 2(A) represents the category of deep cavities and Figure 2(B) represents the category of shallow cavities. Convolutional layer 1, Batch Normalisation layer 1, Pooling layer 1, and convolutional layer 5 were chosen from the earliest to the last layer in the model for Visualization of Feature Maps and to eliminate the use of unnecessary figures in the article. Figure 4(A) depicts the graphical representation of the 32 different filters used on convolutional layer 1, while Figure 4(B) depicts the value of the first filter out of the 32 filters used. If a significant number of filters are applied to the various convolutional layers for both types of cavities, a broad spectrum of feature maps for visualisation is generated. During layer-wise visualisation, 97.92% of feature maps of convolutional layers 1 and 2 in both categories start concentrating on the edge of teeth. In the matter of convolutional layers 3 and 4, 78.13% of feature maps for deep cavities and 76.95% for shallow cavities focus on the edge of teeth, while 20.31% and 21.09% of feature maps focus on gum tissue in deep and shallow cavities, respectively. For convolutional layer 5, 20.70% of feature maps for both categories concentrate on tooth enamel, while 77.73% and 76.95% of feature maps in deep and shallow cavities, respectively, focus on the gum tissue. Enamel is the primary focus for convolutional layers 6, accounting for 67.57% of the deep cavity and 71.09% of the shallow cavity. In layer 7, the focus has shifted from the enamel to the root of the teeth, with 36.71% for deep cavities and 36.32% for shallow cavities. The target location of the cavity, on the other hand, appeared in layer 8 with 27.92% for deep cavities and 20.31% for shallow cavities. Layers 9 and 10 are vital since they primarily focus on the cavity, with 87.30% for deep cavities and 89.55% for

shallow cavities. Each Batch Normalisation and Pooling layers follow roughly the same trends as the preceding convolutional layer. During feature map visualisation, we observed several true blacks and white feature maps in the early layers, which we initially mistook as a dead filter, but when we examined it with unique Colormaps, we noticed a very minute but significant pattern of interest. Figure 5(A) illustrates a feature maps visualisation in a unique colourmap for a filter present in the second row and sixteenth column of Pooling layer feature maps in figure 2(A), whereas Figure 5(B) illustrates a feature maps visualisation in unique colourmap for a filter present in the third row and fourth column of Pooling layer feature maps in figure 2(B). Furthermore, we observed 32 death filters from layers 7 to 10 in the deep cavity and 42 death filters from layers 6 to 10 in the shallow cavity, suggesting that utilisation of excessive filters was unnecessary. CNN's initial layers frequently learn features like lines, edges, and corners, while the middle layers detect object parts and the network's deeper layers learn more complex features like cavities in various shapes and positions. Adding more feature maps will aid in the extraction of more features, but after a certain point, it will lead to the discovery of irregularities in the images and many will become dead feature maps.

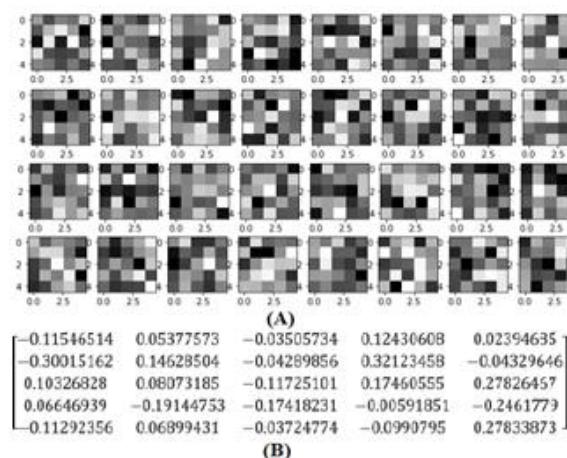


Figure 4: (A) A graphical representation of the 32 different filters used on convolutional layer 1, and (B) the value of the first of the 32 filters used.

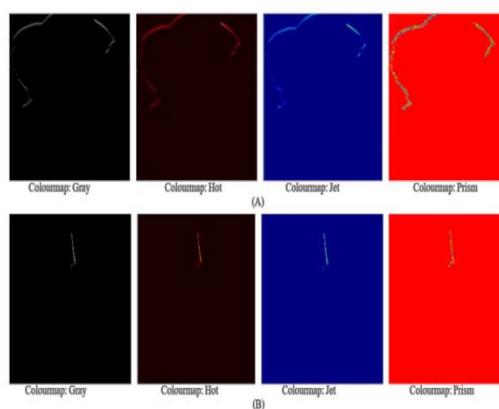


Figure 5: (A) A feature maps visualisation in a unique colourmap for a filter in the second row and sixteenth column of Pooling layer feature maps in figure 2(A); (B) A feature maps visualisation in a unique colourmap for a filter in the third row and fourth column of Pooling layer feature maps in figure 2(B).

Figure 3(A) shows the category of deep cavities on the dental x-ray. Grad-CAM visualisations for this classification initiate in the neighbourhood of the enamel of teeth and gum tissue but switch to deep cavity locations on the image as later layers are passed. Moreover, the visualisations of the convolutional (Conv) layers 1–7 start concentrating on the outline of the teeth, enamel of the teeth, and gum tissue, whereas the subsequent convolution layers 8 and 9 put emphasis on the cavity area, as well as convolutional layer 10 focuses on both the cavity and root area of the teeth. All Batch Normalisation (BN) layers most likely follow a similar pattern as their aforementioned convolutional layers. The Pooling layer shows a thicker band of visualisation around the outline of the teeth as well as on and across the area of deep cavities, but at a higher intensity than the convolutional and Batch normalisation layers.

Grad-CAM visualisations in Figure 3(B) begin in the region of the crown and root of teeth but shift to shallow cavities on the dental image in the final layers. Convolutional layers 1–5 highlight a significant portion of the crown and root area of teeth while placing little emphasis on the area of interest. Furthermore, layers 6–8 in the image focus on both regions known as enamel and shallow cavities, whereas convolutional layer 9 focuses on shallow cavities of both teeth, and the final convolutional layer primarily on shallow cavities. All Batch Normalisation layers exhibit similar trends to their preceding convolutional layer. Early Pooling layer visualisations focus on entire teeth, including shallow cavities, but later layers concentrate only on the cavity area at increasing intensities.

Despite the fact that the cavities vary in location, size, and shape, all of the Grad-CAM outcomes from the varied x-rays that usually contain cavities have some similar characteristics. For each of the x-rays, the convolutional layer is most likely very low in intensity and localization, whereas the batch normalisation and pooling layers have a slightly higher intensity and localization. Convolutional layers 8 to 10 have increasing amounts of intensity and localization in the cavity area, until Layer 8 has very precise localization to x-ray regions where cavities are not visible.

### 3. DISCUSSION

In our studies, we initially assessed the performance of our CNN model, which was used to diagnose deep and shallow cavities in dental images. We then examined its behaviour by visualising Feature Maps and Gradient-Weighted Class Activation Maps (Grad-CAM). We observed that, as demonstrated by both approaches, subsequent layers examined more detailed aspects of the image, providing deeper insight into how the model processes information in order to make classifications. As all of the images of cavities showed similar trends in the visualisations of the various layers, it suggests that the size and location of the cavities have really no effect on the model's pattern recognition and image classification performance.

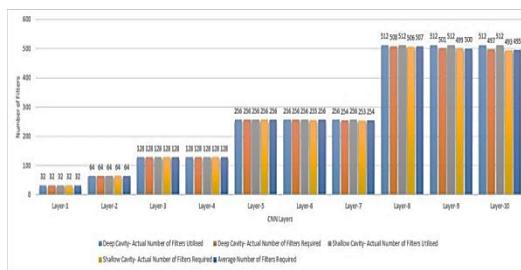


Figure 6: A layer-by-layer comparison of the Actual Number of Filters Used, the Actual Number of Filters Required, and the Average Number of Filters Required.

During the visualisation of Feature Maps, it was observed that the model appeared to concentrate on basic features like lines and edges of the teeth in earlier layers, whereas the model was more engaged in detailed aspects of the image in later layers. We noticed several true black and white feature maps in the early layers, which we at first misidentified as a dead filter, but when we evaluated them with special Colormaps, we found a very small but significant pattern of interest. Even so, we found 32 death filters from layers 7 to 10 in the deep cavity and 42 death filters from layers 6 to 10 in the shallow cavity, implying that using excessive filters was unnecessary because they detect irregularities in the images and many of them would become dead feature maps. Figure 6 provides strong guidance to new researchers on the actual number of filters that must be used in each layer of the CNN model for deep and shallow cavity diagnosis from dental images. As we can see, the number of actual used and needed filters are the same up to layer 6 for deep cavities and layer 5 for shallow cavities, but later layers show true black and white feature maps with no information. To overcome the problem of true black and white feature maps and achieve high classification accuracy, we need to use an average number of filters according to the given formula, which not only protects the model from information loss but also protects it from overfitting and reduces computational time and excessive memory use.

$$F_{\text{require}} = \frac{\sum_{i=1}^n (F_{\text{actual}} - F_{\text{black}} - F_{\text{white}})}{n} \quad (6)$$

Where  $F_{\text{require}}$  is the average number of filters required,  $F_{\text{actual}}$  is the number of filters utilised,  $F_{\text{black}}$  is black feature maps with no information,  $F_{\text{white}}$  is white feature maps with no information, and  $n$  represents the number of classes for classification. Figure 6 also depicts the average number of filters needed to create a highly accurate model.

Gradually for Grad-CAM visualisations, as the x-ray progresses through the layers, the localization and intensity begin to increase to what appears to be the model's area of interest, whether it is the location of the cavities, other regions of the teeth, or the area surrounding the teeth. To categorise the images, the trained CNN uses pattern recognition to evaluate the features it is seeing with those it has already seen in order to diagnosis the image into either the deep or shallow cavity category. It means that the CNN tends to follow a strict procedure in which each layer employs the previous layer's output as input. As a result, the model can almost completely ignore features and regions of the image that it has already seen and considers are insignificant or irrelevant to diagnosis the image.

Table 1 details the Grad- CAM visualisations of each layer for each classification group of images pertaining to the area of the cavities, other regions of the teeth, or the area surrounding the teeth. The convolutional layer appeared to have low intensity and localization in the cavity's region for earlier layers and contrary for later layers, as shown in figures 3(A and B), and it is activating feature detection by shrinking the size and number of pixels to concentrate on those features that appear to be of highest significance to the model. Layer 9 in Figure 3(A and B) is a classic example of this, with the convolutional layer concentrated on cavities close to the frame's centre, indicating that the model considers this to be a feature of interest to the model. The batch normalisation layer was as intense as the convolutional layer, but the Grad-CAM was much more localised to the cavities. The batch normalisation layer weighs pixel values such that they fall within a specific range, preventing features from being handled as extremes. For the pixels containing the Grad-CAM, the batch normalisation 9 (BN-9) layer of Figure 3(A and B) shows similar levels of intensity to the Convolutional layers 9 (Conv-9) layer, but there is a minor shift in localization due to fewer areas of interest as the model smoothed out several of the extreme points in its input, which was the output of the Conv-9 layer. The Pooling layer is summarised to have a high intensity of pixels due to the existence of Grad-CAM in the region of the cavities. By retaining the highest pixel value from each region of the feature map, the Pooling layer tends to reduce feature map dimensions while retaining what the model considers to be the most important features and information that fit a common pattern. As seen in Figure 3(A), there is no intensity of pixels or the existence of Grad- CAM in the region of the cavities up to layer 7, and it is up to layer 5 in Figure 3(B), shows that the model arrived at the conclusion that the areas containing the cavities were of no interest when classifying the image. However, there is a high intensity of pixels in the region of the cavities in layer 9 of Figure 3(A and B), which shows that the model realised the significance of the cavities in order to classify the image. Between Layers 8 and 9, there is a significant increase in intensity and localization, implying that each node must handle more information. Layer 9 will have a similar visualisation but slightly more averaged out pixels because each node now holds information that multiple individual nodes used it to handle because it uses Layer 8's output as its input. Layer 10 appeared to show strong localization and high intensity in cavity regions for both classes of classification, as well as weak localization and low intensity in other regions of the teeth. It represents the beginning of the loss of localization of the cavities, which means that the model is observing areas other than the cavities to classify each image.

Looking towards the Other Regions of The Teeth, the results for each layer for each classification group of images containing cavities were very similar to looking at the Grad-CAM in the areas of the cavities, as shown in Table 1. The minor difference was that Grad-CAM showed localization and intensity of pixels mostly on teeth in the early layers, but there was little or no localization and intensity in the deep layers. This might be because the model assumed that specific areas of the teeth were more useful in classifying each image than other Regions of The Teeth.

Table 1 also includes results summaries for Grad-CAM visualisation of the region surrounding the teeth. When compared with the results found in cavities and other regions of the teeth, the layers produce approximately opposite results for each classification group of images that contained cavities. It has very weak localization and low pixel intensity due to the lack of Grad-CAM visualisations outside of the teeth. This ensures that specific patterns on the teeth were identified and used to categorise the images.

The area of focus of each x-ray will not always be where the cavities are, but rather where the model has identified the location of interest. It is worth noting that later layers in a CNN focus on more complex and detailed parts of its input than earlier layers, and the results of this study support this theory. Later layers appear to be drawn toward more defined areas, which appear to be the model's areas of focus, whereas earlier layers appear to be concentrated on general details of the x-ray that the model is noticing, such as edge, curves and lines. Near the end, it appeared that the model was no longer looking at the cavities, demonstrating that the size

and location of the cavities have no effect on how well the model classifies the image as "deep cavities" or "shallow cavities".

Later layers of the model allow researchers to better understand how well the model classified the x-ray, whereas earlier layers do not show where the model was analysing on the x-ray to reach its firm conclusion. This demonstrates that later layers in CNN models can be understood more smoothly by researchers seeking to understand the specific characteristics of each x-ray used to form the model's classifications. Understanding which aspect of the image the model is evaluating may lead to researchers redesigning their models in order to reduce the number of inaccurate classifications made. A future study should investigate the impact of human intervention on the model because modifying the model's hyperparameter after determining which features are used to classify the input may result in overfitting, causing the model to perform even worse on completely new datasets than before any changes were made to the model.

CNN Layers	Deep Cavity X-ray			Shallow Cavity X-ray		
	Teeth Cavity Region		The Region Around the Teeth	Teeth Cavity Region		The Region Around the Teeth
	Present	Other Regions of The Teeth	Not Present	Present	Other Regions of The Teeth	Not Present
CNN Layer-1	Not Present	Not Localized	Weak Localization	Not Present	Not Localized	Not Present
	Not Localized	No Intensity of Pixels	No Intensity of Pixels	Not Localized	No Intensity of Pixels	No Intensity of Pixels
Batch Normalization-1	Present	Not Localized	Weak Localization	Not Present	Not Localized	Not Present
	Not Localized	No Intensity of Pixels	No Intensity of Pixels	Not Localized	No Intensity of Pixels	No Intensity of Pixels
CNN Layer-2	Not Present	Not Localized	Medium Localization	Not Present	Not Localized	Not Present
	Not Localized	No Intensity of Pixels	Medium Intensity of Pixels	Not Localized	No Intensity of Pixels	No Intensity of Pixels
Batch Normalization-2	Not Present	Present	Weak Localization	Not Present	Present	Not Present
	Not Localized	Medium Intensity of Pixels	Medium Intensity of Pixels	Not Localized	Medium Intensity of Pixels	Not Localized
Pooling	Present	Present	Weak Localization	Present	Present	Present
	Weak Localization	Low Intensity of Pixels	Medium Intensity of Pixels	Weak Localization	Medium Intensity of Pixels	Weak Localization
CNN Layer-3	Not Present	Present	Weak Localization	Present	Present	Not Present
	Not Localized	Medium Intensity of Pixels	Medium Intensity of Pixels	Not Localized	Medium Intensity of Pixels	Not Localized
Batch Normalization-3	Not Present	Present	Weak Localization	Present	Present	Present
	Not Localized	Medium Intensity of Pixels	Medium Intensity of Pixels	Not Localized	Medium Intensity of Pixels	Weak Localization
CNN Layer-4	Not Present	Present	Medium Localization	Present	Present	Present
	Not Localized	No Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Weak Localization
Batch Normalization-4	Not Present	Present	Medium Localization	Present	Present	Present
	Not Localized	No Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Low Intensity of Pixels
Pooling	Present	Present	Weak Localization	Present	Present	Present
	Weak Localization	Low Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Intensity of Pixels	Weak Localization
CNN Layer-5	Present	Present	Strong Localization	Present	Present	Not Present
	Weak Localization	Low Intensity of Pixels	Medium-High Intensity of Pixels	Not Localized	Medium Localization	Not Localized
Batch Normalization-5	Present	Present	Strong Localization	Present	Present	Not Present
	Weak Localization	Low Intensity of Pixels	Medium-High Intensity of Pixels	Not Localized	Medium Localization	Not Localized
CNN Layer-6	Present	Present	Strong Localization	Present	Present	Not Present
	Weak Localization	Low Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Not Present
Batch Normalization-6	Present	Present	Strong Localization	Present	Present	Not Present
	Weak Localization	Low Intensity of Pixels	High Intensity of Pixels	Weak Localization	Medium Localization	Weak Localization
CNN Layer-7	Present	Present	Strong Localization	Present	Present	Not Present
	Weak Localization	Strong Localization	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Not Localized
Batch Normalization-7	Present	Present	Strong Localization	Present	Present	Not Present
	Weak Localization	Medium Localization	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Not Localized
Pooling	Present	Present	Strong Localization	Present	Present	Not Present
	Medium Localization	Medium Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Not Intensity of Pixels
CNN Layer-8	Present	Present	Strong Localization	Present	Present	Not Present
	Medium Localization	Low-Medium Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Not Localized
Batch Normalization-8	Present	Present	Strong Localization	Present	Present	Not Present
	Medium Localization	Medium Intensity of Pixels	Medium-High Intensity of Pixels	Weak Localization	Medium Localization	Not Intensity of Pixels
CNN Layer-9	Present	Present	Strong Localization	Present	Present	Not Present
	Medium Localization	Medium Intensity of Pixels	High Intensity of Pixels	Weak Localization	Weak Localization	Not Localized
Batch Normalization-9	Present	Present	Strong Localization	Present	Present	Not Present
	Medium Localization	High Intensity of Pixels	High Intensity of Pixels	Weak Localization	Medium Intensity of Pixels	Not Localized
CNN Layer-10	Present	Present	Strong Localization	Present	Present	Not Present
	Medium Localization	High Intensity of Pixels	High Intensity of Pixels	Weak Localization	Strong Localization	Not Localized
Batch Normalization-10	Present	Present	Strong Localization	Not Present	Present	Not Present
	Medium Localization	High Intensity of Pixels	High Intensity of Pixels	Weak Localization	Strong Localization	Not Localized
Pooling	Present	Present	Strong Localization	Not Present	Present	Not Present
	High Intensity of Pixels	Low Intensity of Pixels	High Intensity of Pixels	Weak Localization	Strong Localization	Not Localized

## CONCLUSION

The extreme small length differences between "deep cavities" and "shallow cavities" make depth-wise dental cavity classification challenging. Image modality-based classification has gained prominence as a means of improving the reliability of computer-aided disease diagnostic systems. Convolutional Neural Networks (CNN) have made significant advances in extracting and analysing image features with minimal human intervention. However, none of the Deep Learning-based classification methods tried to interpret the internal representations for their prediction results. In this paper, two main approaches, Visualization of Feature Maps and Gradient-Weighted Class Activation Map (Grad-CAM), are implemented for visually describing the learned behaviour of CNN by localising and highlighting features that are the most discriminative in classifying cavity. According to the findings of this study, earlier layers frequently learn features such as the edges of teeth or gums, whereas deeper layers would be more useful in allowing researchers to understand which regions and information of the image are used by the model to achieve its classification, regardless of where the cavity on the image was located. It also implies that using the proposed average number of filters method will not only reduce the

problem of overfitting, computational time, memory use, but will also improve model accuracy and guide a new research group in determining the number of actually required layers for accurate classification as well as aid in tuning model hyperparameters.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***AN EXPLORATORY STUDY ON FACTORS AFFECTING INCREASING UNEMPLOYMENT OF HIGHER EDUCATION TEACHERS IN MAHARASHTRA STATE SINCE OUTBREAK OF CORONA VIRUS****DR. MANOJ W.MEGHRAJANI, MR. ADITYA BAVADEKAR, DR. VISHAL WAGH AND MS. RUCHA DESHPANDE****ABSTRACT**

*Lockdown imposed in 2020 to curb the spread of novel Corona Virus has affected every sector seriously. Irreversible damage has taken place for economy of our country. The unemployment rate also increased since lockdown. The education sector is not an exception to this damage. This paper tries to explore the problems of higher education teachers in Maharashtra because this topic is not exposed so far. The other purpose is to expose the consequences of exploitation of higher education teachers. To achieve the objectives primary data was collected through in depth interview of higher education teachers. Secondary data is also collected from news articles, blogs and internet. The results are shocking. Many teachers have left the profession forever. Those who lost jobs were highly qualified teachers. These teachers are now asking question that what the use of their qualifications is! The consequences on higher education in India are also discussed in brief at the end.*

**Key words-** Higher Education Institutes, Teachers' vacant positions, Covid-19**INTRODUCTION**

A report by Dev and Sengupta (2020) says that unemployment rate went as high as 23% from 9% during the first phase of lockdown in India in May 2020. It rose to 35% by June 2020. Unemployment rate was higher in urban area compared to rural area. By end of the June unemployment rate slide to 11%, however it was still higher as compared with pre-lockdown situation. It is further reported that a large number of firms will find it very difficult to survive in covid-19 pandemic situation as people have changed their lifestyles and are cutting back on expenses due to uncertainty in the market. Therefore the economic condition would be in its bad shape, which would further be causing job cuts. Considering this situation it is most probable that undergraduate students would not go for higher studies. In simple words it is most likely that even in Academic Year 2021-22 most higher education institutes will not get enough number of admission applications and thus it would be very difficult for them to meet the regular expenses such as salaries and maintenance. This will force private institutions to cut the cost wherever possible. Since lockdown was imposed last year in March 2020 higher education institutes did not start the physical classroom sessions because of the restrictions imposed by state government. Further, state universities are not making it mandatory for students to attend certain number of sessions per semester which was mandatory for students in pre-lockdown situation. In addition to this state universities could not conduct final exams as per planning. These exams took place very late- almost 6 months late through virtual mode. Because of these situations there is high uncertainty in education industry. Because of these consequences Institutes could survive even with few permanent teachers till the institutes had to apply for extension of approvals from the affiliating state university and All India Council of Technical Education (for technical professional institutes only). During the process of getting approval for extension of program of higher education institute from the stated bodies the institutes have to maintain sufficient number of teachers as per standard norms laid down by any one or both the bodies. Thus higher education institutes laid off temporary or clock hour based teachers. When few teachers from private institutes were contacted and interviewed they disclosed that they were laid off for some time and were asked to join back after the admission process for fresh students started. The reason for such break in service of temporary/ clock hour based teachers was lack of funds with the institute and high uncertainty in the education sector about schedule of admission process for fresh students and examination of final year students. Some permanent teachers reported that their salaries were cut for about 6 months by 50% during lockdown and first phase of unlock.

**SIGNIFICANCE OF THE STUDY**

There is no such study was conducted which talks about the teachers' problem because of covid-19 pandemic. This paper reveals the exploitation of teachers in higher education institutes in current scenario. The paper also throws light on consequences of higher education institutes' practices on higher education in the State of Maharashtra.

**RESEARCH METHODS**

This study adopts explorative research design. The study collected both primary and secondary data. Few teachers from higher education, technical institutes such as Engineering, MBA and MCA institutes, were personally interviewed. Interviews were conducted without using structured questionnaire. Snowball sampling as well as convenient sampling techniques were used for selecting samples. The conversation between researcher and the teacher was recorded for study purpose after getting the consent from the teacher. Teachers did not want their identity to be revealed, so it was kept confidential. The recording of conversation was referred time and again as and when required. The news articles, blogs were the source of secondary data.

**DISCUSSION BASED ON SECONDARY DATA REVIEW**

Sardeshmukh (2021) published an article in Loksatta.com. This article talks about impact of Covid-19 pandemic on temporary teachers' employment. The interviews of such affected teachers were reported in the article as follows.

Prof. Dr. Sudhir Munishwar was working in a non-granted higher education institute on Clock hour contract basis. He has been awarded with Doctorate of Philosophy in "Optical Filter" domain. He has also got Intellectual Property Right for his research work. Mr. Sudhir is State Eligibility Test and National Eligibility test for teachers qualified. Despite being well qualified and capable teacher, he lost his employment in 2020 because of Covid-19 pandemic. For the survival now he has joined his family profession of farming. When he had joined education industry he was confident that he will conduct a significant research and innovative work, however after spending a decade into this industry he has lost self-confidence and lost all hopes of re-joining as a professor.

Sagar Potdar completed post-graduation in Marathi Language which happens to be the mother-tongue of Maharashtra state. His father and brother both work as a security guards. They somehow managed educational expenses of Sagar. After successfully qualifying the state eligibility test for twice Mr. Sagar was searching for jobs. However due to Covid-19 pandemic and subsequent lock-downs in the country, he could not get any suitable job. He lost his self-confidence and finally decided to join a pharmacy retail store as a helper.

Dr. Ganesh Honrao authored two books based on Indian History. He attended many History based National and International conferences. He has also a Master of Philosophy in History. He is awarded PhD in History subject. He was expecting to get permanent Teaching job in a college and thus he continued to work in the college on clock hour contract basis for couple of years. The payment he was receiving was just a peanuts compared to salary of permanent teacher with same qualification as his. In 2020 due to pandemic he lost his temporary job and now he lost any hope of getting permanent employment in the college. After loosing employment he decided to start a tea shop to earn bread and butter. He approached one of the nationalised banks for the loan and he got the loan under Mudra Scheme of the Government. But unfortunately he has to shut that shop very soon because lockdown was imposed in March 2021. In today's life threatening situation he wonders if education really helps in one's life!

Prof. Nitin Ghope has completed Post Graduation in Geography. He cleared National Eligibility Test also. In 2009 he registered for PhD program. Meanwhile he served as an ad-hoc teacher on clock hour basis. Because of covid-19 pandemic he lost this temporary position in the college and now he is full time farmer. He analysed his own career path and got to know that since 1996 "contract professor" concept was introduced in education industry. This concept helped Institutes and colleges in bypassing the recruitment of full time permanent professors. Institutes and colleges maintained the required number of teaching staff by recruiting clock hour based professors. Government also neglected the issue of non-recruitment of permanent faculty positions. This motivated other institutes also to recruit majority of clock hour based ad hoc faculty members. Further he said that clock hour based faculty can conduct only prescribed number of lectures in a month. Therefore monthly remuneration of these faculty members is limited to only INR. 18,000/- This remuneration is paid after around six months. During pandemic number of total lectures reduced significantly and overall remuneration of contractual faculty members affected negatively. Therefore, clock hour-based faculty members are forced to leave their jobs. In current situation around seventeen to eighteen thousand faculty positions in granted institutes of Maharashtra state are still vacant. Out of these positions 4600 position were to be filled as per proposal given. 1600 positions of approved positions were filled prior to covid-19 outbreak. However, during and after lockdown no additional recruitment for full time permanent faculty were done. Because there are not enough funds available with state government to pay their salaries.

Because of this situation in the state many qualified and eligible teachers are now taking up other part time/ full time jobs. Prof. Vinod Naik sales eggs and meat in his free time. Prof. Swapnil Dhule is into vegetable business

now. Others who have farm land are doing farming. Prof. Gangadhar Gavhane from Marathwada region of the state started Garment business.

### **FINDINGS FROM PERSONAL IN DEPTH INTERVIEW**

One of the associate professor in one of the renowned MBA Institutes in Pune said that professors of his organization are being paid only 50% of their salaries since May 2020 after lockdown was imposed. He further says that it is becoming difficult to manage personal finances now and he is thinking of quitting the job. However no other institutes are currently hiring professors due to uncertainty in the industry, he added. In 2020 also admission processes for MBA got delayed by the policy makers. Thus the fund inflow of all the institutes got affected. This in turn is affecting the salaries of teaching and not teaching staff of the institutes.

The other senior teacher from engineering institute said that the affiliated institutes get partial fees of students from Social welfare department through various other schemes of Maharashtra state. This amount is reimbursed by the State Government after verification of all the documents of students. Once they are verified and approved the scholarship/ freeship amount is paid to the institute. This entire process used to take about 1 to 2 years of time in pre-lockdown environment. Because of pandemic situation the admission process of higher education got delayed, which means the scholarship amount to be received will also get delayed significantly. Due to this fact Institutes perceived that it would be tough for them to manage the expenses when there is no fund inflow and no certainty when it will resume to pre-lockdown level. Institute also fear that as State government being equally badly affected due to lockdown will delay the payment of scholarship amount to the institutes. Thus Institutes have frozen new recruitment processes and also reduced the salaries of existing teachers.

One of the teacher from MCA program said that she got laid off from the institute on the ground that the institute cannot pay her salary until admission process gets completed. That teacher was recruited on ad-hoc basis. So that teacher had to take a break from her job until the institutes asked them to join back her duties. She also said that she was not the only teacher to be laid-off. These teachers were out of employment for about 6 months in 2020. This indicated that some teaching positions in these institutes were vacant.

### **THE OTHER SIDE OF THE COIN-**

A Vice Chancellor of one of the State Universities in Maharashtra State in his interview with one of the new papers said that the problem due to vacant positions of faculties is complex in nature. But vacant positions are not the only issue in Education Industry. The quality of teaching-learning is also a burning issue in the Country he adds. Many Ph.Ds awarded in last few years had not contributed to the society in true sense. He further added that in Pharmaceutical domain many PhDs are awarded in last couple of years, however very few new drug molecules are invented. Honourable VC further stated that merely acquiring PhD is not enough for a faculty; he or she should continue the research work and keep on learning new skills and knowledge from another domain. Only then education will help contract basis and full time faculties to earn a good job.

### **CONCLUSION**

Higher education institutes are equally badly affected due to lockdown as other industries. To cut down expenses due to lack of funds, institutes laid off some teachers, reduced salaries of remaining teachers. There were vacant positions of teachers in most of the institutes. This has affected the teaching- learning quality in these institutes. Although teachers' positions were vacant, the institute was offering online classes to existing students. To cover the entire syllabus non expert teachers conducted sessions of subjects which they had never taught before. Due to this students might have not exposed to the contemporary practices of the Industry and their doubts might have remained unsolved. These students are about to join corporate world sooner or later. Students with lack of core knowledge will always reduce the productivity of the organization and thus will affect entire country in large picture. Therefore State government should not delay the admission process in subsequent years, rather it should be proactive and complete the admission process in time so that institutes and thus in turn teachers will not get affected. Affiliating universities should try to schedule the exams in such a way that it can bring the odd-even semester as per pre-lockdown semester pattern in higher education institutes. State government should also give priority to pay the scholarship amount to the higher education institutes which will help institutes to meet their expenses effectively. In senior non-granted (private) colleges many positions of teachers are still vacant and are not being filled by the state government for several reasons. There is no appropriate system which can come up with innovative strategies to fill these positions. As of now teachers are recruited on clock hour basis and paid very little amount as remuneration. In many institutes even this remuneration is paid after few months. In such conditions the quality of teaching and learning gets affected adversely. This in turn affects the employability of students of higher education. Thus state government should revisit the practices being followed for recruitment and remuneration payment of temporary teachers.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***B-SCHOOLS STUDENTS' READINESS TOWARDS ENTREPRENEURSHIP AS A CAREER OPTION: A CRITICAL ANALYSIS AND REFLECTION****DR. BHARATI RAJIV JADHAV, DR. SONALI PRASAD DHARMADHIKARI AND DR. SHWETA TUSHAR JOGLEKAR****ABSTRACT**

*Entrepreneurship is one of the most critical factors for social and economic growth as it has the potential to create new jobs. During and post pandemic period, its importance has gained a substantial attention. India being developing country with huge population and high unemployment rate need to inculcate the entrepreneurial mindset amongst youth.*

*The current research aims to find out the perception of the B-Schools Students about Entrepreneurship as a career option. The authors are being the educators from the B-School have observed that most of the students prefer jobs as a career option over to entrepreneurship. Hence, the study was carried out to identify the driving factors behind students' willingness towards entrepreneurship. A model for B-schools has been proposed which would enhance the B-School Education resulting into more students opting for Entrepreneurship.*

*Researchers evaluated perception of students on the basis of following factors: Demographic Factors: Gender, Age, Family Profession, Work Experience Educational Factors:Curriculum, Co-curricular and Extra-curricular activities.*

*Institutional factors: Entrepreneurship education, Entrepreneurship awareness programme, Institutional policies towards incubation center for budding Entrepreneurs, awareness schemes*

**Keywords** Entrepreneurship willingness, Entrepreneurial Ecosystem, Perception, Career development, B-School.

**B-SCHOOLS STUDENTS' READINESS TOWARDS ENTREPRENEURSHIP AS A CAREER OPTION: A CRITICAL ANALYSIS AND REFLECTION**

The entrepreneur always searches for change, responds to it and exploits it as an opportunity.” Peter Drucker

**INTRODUCTION:**

Entrepreneurship plays a vital role in building the economy of the nation and entrepreneur is the catalyst in this development. Thus, to boost the Indian economy, we have to encourage the startups and entrepreneur ecosystem. Indian government has launched various schemes to shape businesses in India such as Make in India, Stand up India, Startup India etc. The New Education Policy also supports the innovation and creativity among the students. All these efforts are resulting to make India the third largest startup eco system.

The leading sectors in Indian startups are E commerce, Fintech, Enterprises, Health tech, Logistics.

Source:(Start up India State Start up Ranking 2020)

B-Schools which offer graduate and post-graduate programmes such as BBA and MBA respectively, are also seen as contributing to this Entrepreneurial ecosystem. MBA degree has been perceived as a preferred qualification among the students as well as recruiters. These B- school programmes mainly focus on preparing students with the knowledge , analytical ability and leadership skills which are helpful to create and run business organisations and also able to take strategic decisions.

However, the recent surveys conducted by Tolka reveal downfall in Business students' Start-up Activities. Most of the Students get attracted to salaried jobs over to starting their own business. The current research paper critically analyses this fact and give insights to create more conducive environment in the B-Schools for budding entrepreneurs . Quantitative research was conducted with the help of structured questionnaires administered to students from B-schools. A literature review was conducted to understand the various dimensions of entrepreneurship and student's mindsets

**REVIEW OF LITERATURE:**

(Narubodee Wathanakom, 2020). The research uncovered various aspects affecting innovativeness and attitude on entrepreneurship and its intention and the causal relationship among them. The study used population of undergraduate students from Public Universities.

(Norman Rudhumbu, 2016) The research is carried out in Botswana. The research paper has carried out a study of attitude of students towards entrepreneurship education since entrepreneurship topic is of immense importance. After analysis, it was found that there is a relationship between attitude and entrepreneurship education.

(Liñán, 2004). Business plan and entrepreneurship courses delivered by B schools play a significant role in imparting entrepreneurship knowledge and enhances self-efficacy perceptions. However, the entrepreneur's intentions contributes the most for the decision. The researcher emphasises on understanding entrepreneur's decision to take up venture. This paper focuses on developing questionnaire to know entrepreneurial intention of students of higher education institutions

(Aggarwal, June 2019) The research paper is conceptual in nature and proposed a model on experiences of entrepreneurial intention. The factors were segregated into psychological, social and institutional factors. The researcher coined a term 'Entrepreneurial Potentially' for these factors.

(FATEMEH BAKHSHANDEH HOSSEIN KAZEMI, July 2020) The research paper has identified factors pertinent to sustainable entrepreneurship. Social, economic and environmental sustainability should be considered to have sustainable entrepreneurship. Sustainability culture has to be developed for overall economic development of the nation. The factors considered for developing model are resource preservation, green management, legal requirements, economic benefits, customers and stakeholders, human resource management, culture building and social wellbeing.

(Suranto, 2013) This research paper has developed a model of entrepreneurial incubator for students who are learning entrepreneurship. It includes empowerment of learners, identifying problems and its solution. The model assists students in increasing the independence.

(Beata Krawczyk-Bryłka, 2019) The research article has presented two models of entrepreneurship. Traditional (Casual) and effectuation model. Casual model is based on

strategic planning and competitiveness. In the effectuation model, utilization of available resources, responding to emerging opportunities and building relationships are focused.

(Hao, 2021) A model is developed on a brain computing base innovation and entrepreneurship education for college students. This model is useful for career planning education, team training help to cultivate leadership skills and innovative mindset of students.

Thus, the available literature has focused on various factors leading to entrepreneurial willingness. The researchers have studied the readiness of students to opt entrepreneurship as a career option. After analyzing the primary and secondary data, the researchers have proposed a model to inculcate entrepreneurial mindset among the youth and to choose it as a career path through efforts from B schools.

### **OBJECTIVES:**

To study the entrepreneurship ecosystem provided by Indian B-schools.

To study the perception of B-School students towards entrepreneurship as a career option.

To analyze the driving factors behind their intentions and readiness towards entrepreneurship as a career.

To propose a model enhancing B-School Education to stimulate students to opt for entrepreneurship as a career.

### **RESEARCH METHODOLOGY:**

The research design is descriptive in nature. This was used to understand the respondents' characteristics, perception and intentions.

The population in this study comprises of UG and PG students from B-Schools located in Pune. The method of sampling selected by the researchers is convenience sampling. 305 students perusing undergraduate and post graduate programmes from Business Schools were selected randomly.

Research variables in the study are as follows:

Independent variables: Demographic Factors, B School Education and Institutional Factors

Dependent variable: Entrepreneurship Willingness

Factor	Variables
Demographic Factors	Gender, Age, Family Profession, Experience
B School Education	Curriculum, Entrepreneurship Course, Specialization in Entrepreneurship, Co-curricular Activities, Extra-Curricular Activities, Internship, Entrepreneurship Cell
Institutional Factors	Infrastructural Support, Financial Support, Networking, Awareness of Entrepreneurship schemes

**DATA COLLECTION:**

Secondary data was collected from various journals, books, websites related to entrepreneurship and education.

Primary data was collected through structured questionnaire in which close ended questions were used. 5-point Likert scale starting with Strongly Agree, Agree, Neutral, Disagree and Strongly Disagree was used. The points were assigned a value as Strongly Agree = 5, Agree = 4, Neutral

= 3, Disagree = 2 and Strongly Disagree = 1 for statistical analysis.

The respondents were informed about the purpose of research before administering the questionnaire. The data was collected only from the willing students. Cronbach alpha was applied for testing reliability and validity of the questionnaire. The ( $\alpha$ ) was calculated and the value is 0.88. Thus, the internal consistency was confirmed. The questionnaire was sent to the experts and their recommendations were incorporated and thus the content validity was also taken care of.

The questionnaire was sent to 305 students perusing undergraduate and post graduate programmes from business schools. 290 responses were found to be complete and relevant for the study.

**HYPOTHESIS:**

There exists a significant relationship between Demographic factors and entrepreneurship willingness.

There exists a significant relationship between B School education and willingness towards entrepreneurship.

There exists significant relationship between Institutional factors and entrepreneurship willingness.

**Data Analysis and Findings:**

Descriptive statistics was used to present and analyze the results. Responses from Strongly Agree to Strongly Disagree were weighted in the range of 5 to 1.

Table 1: Demographic Factors:

Demographic Variable	Number of Students (%)
Gender	
Male	63.1%
Female	36.9%
Age	
18 -21	41.7%
22 – 25	56.5 %
25 and above	1.8%
Work Experience	
Yes	6.2%
No	93.8%
Family Background	
Father	
Service	56%
Business	43%
Other	1%

Mother	
Service	17%
Business	4%
Other	79%

Demographic data analysis showed that there were more Male students (63.1%) than Female students (36.9%). It further shows that most of the students were aged between 22 and 25 years, while the least number of students were aged above 25 years. Most of the students were from the Service background (Father 56%, Mother 17%) whereas some of them (43% Father, 4% Mother) belong to Business background.

Table 2: Entrepreneurial Willingness among the Students:

N= 290

What is your plan after you complete your education	
Salaried Jobs	89%
Starting own Business / Joining Family Business	11%

Table 2 reveals that (89%) of the students preferred Salaried Job over to Starting their own Business / Joining Family Business (11%)

Table 3: Reasons for their specific plans (Job / Own Business):

## 3(A): Students Preferring Salaried Jobs

Students Preferring Salaried Jobs:	Responses
Less Risky	14.96%
More Rewarding	19.68%
Fixed Income	39.37%
Good Status	24.40%
Others	1.57%

Respondents preferred salaried jobs mainly due to the security of the fixed income (39.37%) then, the other factors such as its good status in the society (24.40%), more rewards (19.68%), Risk involved (14.96%) in the descending order.

## 3(B): Students Preferring to start own business:

Students Preferring to start own business	Responses
More Rewarding	43.75%
Good Status	25%
Be the Own Boss	35%
Scope for creativity and innovation	6.35%

Respondents who preferred to start own business after their education mainly because of the huge rewards (43.74%) then, the other factors like to be the own boss (35%), Good Status (25%), Scope for Creativity and innovation (6.35%).

Table 4: Association between Demographic Factors of Students and Entrepreneurial Willingness:

Entrepreneurial Willingness (N= 32)

Demographic Factor	Entrepreneurial Willingness
Gender	
Male	72%
Female	28%
Age Group	
18 -21	58%

22 – 25	42%
Work Experience	
Yes	22%
No	78%

Table 3 reveals that Entrepreneurial Willingness is shown more by the Male students (72%) than the Female students (28%). Respondents in the Age group of 18-21 have more willingness towards Entrepreneurship (58%) than those in the Age group of 22 to 25 (42%). Respondents without Work Experience shown more willingness towards Entrepreneurship (78%) than the ones who have work experience (22%).

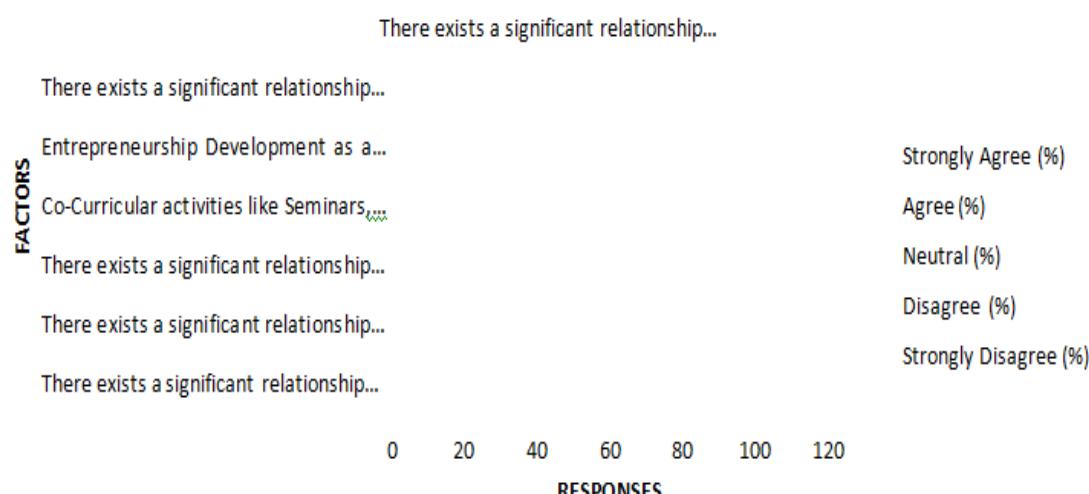
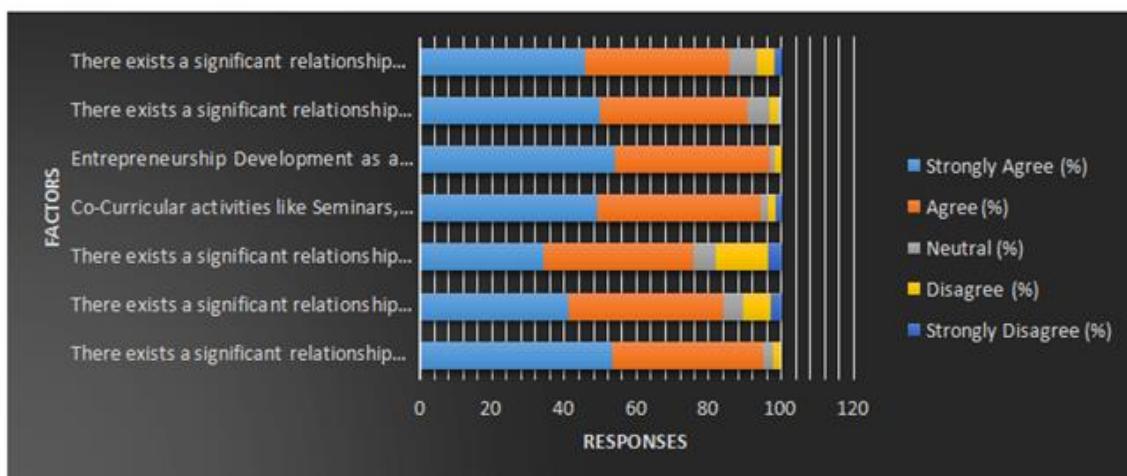
#### HYPOTHESIS TESTING:

H1: There exists a significant relationship between Demographic factors and entrepreneurship willingness.

As shown in the tables 1 to 4 it is found that Demographic Factors like Gender, Age, and Family Background play major role in entrepreneurship willingness of B School students. Hence the hypothesis is accepted. Percentage method was used to analyze the same.

H2: There exists a significant relationship between B School education and willingness towards entrepreneurship.

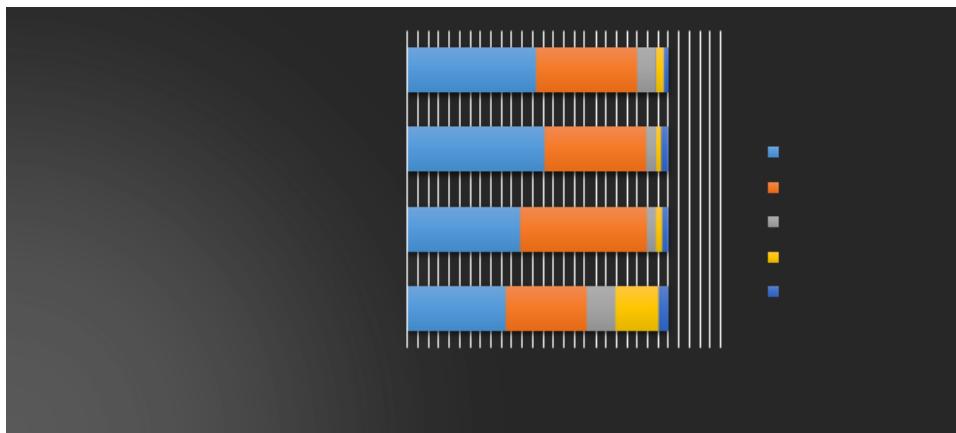
Table 5: B School education components and willingness towards entrepreneurship



Majority of the respondents gave their agreement to existence of significant relationship among various factors such as curriculum, entrepreneurship course, co-curricularactivities, internship activities and willingness towards entrepreneurship.

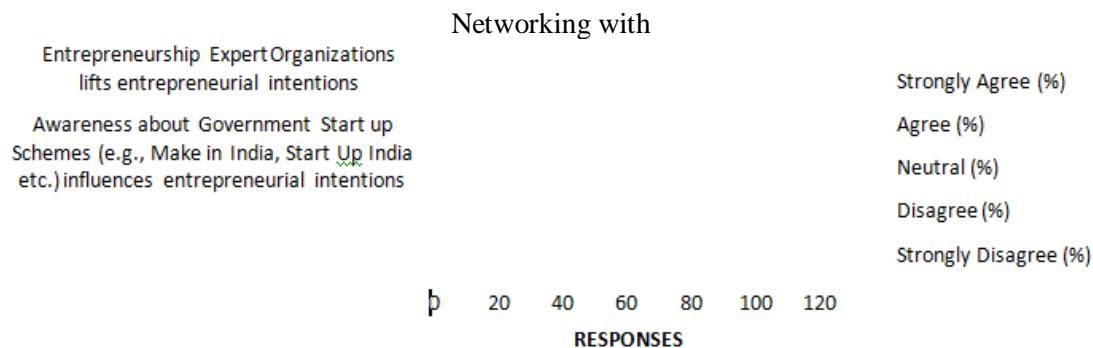
Extra-curricular activities and willingness towards entrepreneurship got lesser agreement as compared to above factors. Thus, hypothesis 2 is accepted.

H3: There exists significant relationship between Institutional factors and entrepreneurship willingness.



Infrastructural support (e.g., provision of office space, innovation labs etc.) provided by institute encourages entrepreneurial...

Funding support provided by institute boosts entrepreneurial intention.



From the above chart, it is observed that majority of the respondents are in agreement to that there exists a significant relationship among Infrastructural support, Funding support, Networking, and willingness towards entrepreneurship. There is lesser agreement level to the factor of awareness programmes and entrepreneurial intention.

Thus, hypothesis 3 is accepted.

Key Finding and Suggestions:

Sr	Findings	Suggestions
1	Male students are more inclined towards entrepreneurship than female students.	By providing support and mentoring to the female students, B Schools can create more female entrepreneurs
2	Age group of 18-21 have shown comparatively more willingness towards entrepreneurship.	In this respect institutions can give early attention to students of this age group to nurture their innovation and entrepreneurship skills
3	B School curriculum plays a very crucial role in encouraging entrepreneurship among students.	During curriculum development and revision more focus be given on contemporary courses which will help students to develop their entrepreneurial acumen and the allied co-curricular and extra-curricular activities will boost their confidence to start their own ventures.
4	Internship plays significant role triggering entrepreneurship willingness.	Internships in start-ups will help the students to explore all the dimensions of the business.
5	ED Cell activities enhance entrepreneurship skills	The ED- Cell of the institute should be able to provide focused mentoring and incubation support to generate more entrepreneurs from the B Schools.
6	Industry specific infrastructural	Facilities in terms of business labs, research labs,

	facilities contributes to entrepreneurship mind-set.	working space, marketing support etc. need to be provided to the budding entrepreneurs.
7	Funding support is essential to boost the start-up activities.	Funding support in the form of seed money, patent registrations etc. be provided.
8	Awareness of Govt. schemes supports entrepreneurship inclination.	Students should be more exposed to various Government schemes for the entrepreneurs so as to take advantages of the support provided.

Thus, after analysing the data, the researcher has come out with the model to be incorporated by B-Schools to increase the willingness of students towards entrepreneurship. The proposed model was discussed with B school authorities, suggestions were taken and incorporated and the model has been validated.

Model: Driving Factors Stimulating B-School Students for Entrepreneurship.



### **CONCLUSION:**

B Schools play very significant role in the entrepreneurial ecosystems and can boost the start-up activities by reframing the curriculum. In their curriculum they need to give more focus on building entrepreneurship knowledge and more application-oriented management aspects. These institutes can enhance their co-curricular and extra-curricular activities that can build relevant skills and overall personality development to take up the business challenges. Intuitive support such as mentoring, incubation, networking with the right resources comes handy for the budding entrepreneurs to take the road ahead and make difference in the society uplifting the economy.

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**ON HOMOGENEOUS CUBIC EQUATION WITH FOUR UNKNOWNS**  

$$(x^3 + y^3) = 7zw^2$$

**S.VIDHYALAKSHMI, T. MAHALAKSHMI, M.A.GOPALAN AND G.DHANALAKSHMI****ABSTRACT**

This paper concerns with the problem of obtaining non-zero distinct integer solutions to homogeneous cubic equation with four unknowns given by  $x^3 + y^3 = 7zw^2$ . A few interesting properties among the solutions are presented.

*Keywords : homogeneous cubic, cubic with four unknowns ,integer solutions*

**INTRODUCTION**

The cubic diophantine equations are rich in variety and offer an unlimited field for research [1,2]. In particular refer [3-24] for a few problems on cubic equation with 3 and 4 unknowns. This paper concerns with yet another interesting homogeneous cubic diophantine equation with four unknowns given by  $x^3 + y^3 = 7zw^2$  for determining its infinitely many non-zero distinct integral solutions through employing linear transformations..A few interesting relations among the solutions are presented.

**METHOD OF ANALYSIS**

The homogeneous cubic equation with four unknowns to be solved is represented by

$$x^3 + y^3 = 7zw^2 \quad (1)$$

Introduction of the linear transformations

$$x = u + v, y = u - v, z = 2u \quad (2)$$

in (1) leads to

$$u^2 + 3v^2 = 7w^2 \quad (3)$$

Different methods of obtaining the patterns of integer solutions to (1) are illustrated below:

**PATTERN: 1**

Let

$$w = a^2 + 3b^2 \quad (4)$$

where a and b are non-zero integers.

Write 7 as

$$7 = (2 + i\sqrt{3})(2 - i\sqrt{3}) \quad (5)$$

Using (4), (5) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = (2 + i\sqrt{3})(a + i\sqrt{3}b)^2 \quad (6)$$

from which we have

$$\left. \begin{array}{l} u = 2a^2 - 6ab - 6b^2 \\ v = a^2 + 4ab - 3b^2 \end{array} \right\} \quad (7)$$

Using (7) and (2), the values of x, y and z are given by

$$\left. \begin{array}{l} x = x(a,b) = 3a^2 - 2ab - 9b^2 \\ y = y(a,b) = a^2 - 10ab - 3b^2 \\ z = z(a,b) = 4a^2 - 12ab - 12b^2 \end{array} \right\} \quad (8)$$

Thus (4) and (8) represent the non-zero integer solutions to (1).

### OBSERVATIONS

1.  $z(a,a+1) - 4y(a,a+1) = 56t_{3,a}$

2.  $z(a,2a-1) - 4y(a,2a-1) = 28t_{6,a}$

3.  $z(a,a) - 4y(a,a) - t_{58,a} \equiv 0 \pmod{3}$

4.  $z(a,a) - 4y(a,a) - t_{34,a} - t_{26,a} \equiv 0 \pmod{13}$

5.  $42[z(a,a) - 4y(a,a)]$  is a nasty number.

### PATTERN 2

Write 7 as

$$7 = \frac{(5+i\sqrt{3})(5-i\sqrt{3})}{4} \quad (9)$$

Using (4), (9) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = \left( \frac{5+i\sqrt{3}}{2} \right) (a + i\sqrt{3}b)^2 \quad (10)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{2}(5a^2 - 6ab - 15b^2) \\ v = \frac{1}{2}(a^2 + 10ab - 3b^2) \end{array} \right\} \quad (11)$$

Using (11) and (2), the values of  $x, y$  and  $z$  are given by

$$\left. \begin{array}{l} x = x(a,b) = 3a^2 + 2ab - 9b^2 \\ y = y(a,b) = 2a^2 - 8ab - 6b^2 \\ z = z(a,b) = 5a^2 - 6ab - 15b^2 \end{array} \right\} \quad (12)$$

Thus (4) and (12) represent the non-zero integer solutions to (1).

### OBSERVATIONS

1.  $x(a,a) - z(a,a) - t_{38,a} \equiv 0 \pmod{17}$

2.  $y(a,a) - z(a,a) = t_{4,2a}$

### PATTERN: 3

Write (3) as

$$u^2 + 3v^2 = 7w^2 * 1 \quad (13)$$

Write 1 as

$$1 = \left( \frac{(1+i\sqrt{3})(1-i\sqrt{3})}{4} \right) \quad (14)$$

Using (4), (5),(14) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = (2 + i\sqrt{3})(a + i\sqrt{3}b)^2 \left( \frac{1+i\sqrt{3}}{2} \right) \quad (15)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{2}(-a^2 - 18ab + 3b^2) \\ v = \frac{1}{2}(3a^2 - 2ab - 9b^2) \end{array} \right\} \quad (16)$$

Using (16) and (2), the values of  $x, y$  and  $z$  are given by

$$\left. \begin{array}{l} x = x(a,b) = a^2 - 10ab - 3b^2 \\ y = y(a,b) = -2a^2 - 8ab + 6b^2 \\ z = z(a,b) = -a^2 - 18ab + 3b^2 \end{array} \right\} \quad (17)$$

Thus (4) and (17) represent the non-zero integer solutions to (1).

#### OBSERVATIONS

$$1.y(a,a) - x(a,a) - t_{18,a} \equiv 0 \pmod{7}$$

$$2.y(b,b) - z(b,b) - t_{b,22} - t_{b,6} \equiv 0 \pmod{2}$$

#### PATTERN: 4

Consider 1 as

$$1 = \left( \frac{(1+i4\sqrt{3})(1-i4\sqrt{3})}{49} \right) \quad (18)$$

Using (4), (5),(18) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = (2 + i\sqrt{3})(a + i\sqrt{3}b)^2 \left( \frac{1+i4\sqrt{3}}{7} \right) \quad (19)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{7}(-10a^2 - 54ab + 30b^2) \\ v = \frac{1}{7}(9a^2 - 20ab - 27b^2) \end{array} \right\} \quad (20)$$

Using (20) and (2), the values of  $x, y$  and  $z$  are given by

$$\left. \begin{array}{l} x = \frac{1}{7}(-a^2 - 74ab + 3b^2) \\ y = \frac{1}{7}(-19a^2 - 34ab + 57b^2) \\ z = \frac{1}{7}(-20a^2 - 10ab + 60b^2) \end{array} \right\} \quad (21)$$

Since our interest is on finding integer solutions, replacing a by 7A, b by 7B in (4) and (21), the corresponding integer solutions to (1) are given by

$$\left. \begin{array}{l} x = x(A, B) = 7(-A^2 - 74AB + 3B^2) \\ y = y(A, B) = 7(-19A^2 - 34AB + 57B^2) \\ z = z(A, B) = 7(-20A^2 - 10AB + 60B^2) \\ w = w(A, B) = 49(A^2 + 3B^2) \end{array} \right\} \quad (22)$$

### OBSERVATIONS

1.  $x(A, A) - z(A, A) + t_{38,A} + t_{22,A} \equiv 0 \pmod{13}$
2.  $y(A, A) - z(A, A) - 7[t_{62,A} + t_{42,A} + t_{26,A} + t_{22,A}] \equiv 0 \pmod{7}$

### PATTERN: 5

Take 1 as

$$1 = \left( \frac{(1 + i15\sqrt{3})(1 - i15\sqrt{3})}{676} \right) \quad (23)$$

Using (4), (5), (23) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = (2 + i\sqrt{3})(a + i\sqrt{3}b)^2 \left( \frac{1 + i15\sqrt{3}}{26} \right) \quad (24)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{26}(-43a^2 - 186ab + 129b^2) \\ v = \frac{1}{26}(31a^2 - 86ab - 93b^2) \end{array} \right\} \quad (25)$$

Using (25) and (2), the values of x, y and z are given by

$$\left. \begin{array}{l} x = \frac{1}{13}(-6a^2 - 136ab + 18b^2) \\ y = \frac{1}{13}(-37a^2 - 50ab + 111b^2) \\ z = \frac{1}{13}(-43a^2 - 186ab + 129b^2) \end{array} \right\} \quad (26)$$

Since our interest is on finding integer solutions, replacing a by 13A, b by 13B in (4) and (26), the corresponding integer solutions to (1) are given by

$$\left. \begin{array}{l} x = x(A, B) = 13(-6A^2 - 136AB + 18B^2) \\ y = y(A, B) = 13(-37A^2 - 50AB + 111B^2) \\ z = z(A, B) = 13(-43A^2 - 186AB + 129B^2) \\ w = w(A, B) = 169(A^2 + 3B^2) \end{array} \right\} \quad (27)$$

### OBSERVATIONS

$$1. z(A, A) - x(A, A) - 13[t_{30,A} + t_{14,A} + t_{10,A}] \equiv 0 \pmod{13}$$

$$2. x(A, A) - y(A, A) + 15[t_{62,A} + t_{16,A}] = 35A$$

### PATTERN: 6

Assume 1 as

$$1 = \left( \frac{(1+i56\sqrt{3})(1-i56\sqrt{3})}{9409} \right) \quad (28)$$

Using (4), (5), (28) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = (2 + i\sqrt{3})(a + i\sqrt{3}b)^2 \left( \frac{1+i56\sqrt{3}}{97} \right) \quad (29)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{97}(-166a^2 - 678ab + 498b^2) \\ v = \frac{1}{97}(113a^2 - 332ab - 339b^2) \end{array} \right\} \quad (30)$$

Using (30) and (2), the values of  $x, y$  and  $z$  are given by

$$\left. \begin{array}{l} x = \frac{1}{97}(-53a^2 - 1010ab + 159b^2) \\ y = \frac{1}{97}(-279a^2 - 346ab + 837b^2) \\ z = \frac{1}{97}(-332a^2 - 1356ab + 996b^2) \end{array} \right\} \quad (31)$$

Since our interest is on finding integer solutions, replacing  $a$  by  $97A$ ,  $b$  by  $97B$  in (4) and (31), the corresponding integer solutions to (1) are given by

$$\left. \begin{array}{l} x = x(A, B) = 97(-53A^2 - 1010AB + 159B^2) \\ y = y(A, B) = 97(-279A^2 - 346AB + 837B^2) \\ z = z(A, B) = 97(-332A^2 - 1356AB + 996B^2) \\ w = w(A, B) = 9409(A^2 + 3B^2) \end{array} \right\} \quad (32)$$

### PATTERN: 7

Using (4), (9), (14) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = \frac{(5+i\sqrt{3})}{2}(a+i\sqrt{3}b)^2 \left( \frac{1+i\sqrt{3}}{2} \right) \quad (33)$$

from which we have

$$\begin{cases} u = \frac{1}{2}(a^2 - 18ab - 3b^2) \\ v = \frac{1}{2}(3a^2 + 2ab - 9b^2) \end{cases} \quad (34)$$

Using (34) and (2), the values of  $x, y$  and  $z$  are given by

$$\begin{cases} x = x(a,b) = 2a^2 - 8ab - 6b^2 \\ y = y(a,b) = -a^2 - 10ab + 3b^2 \\ z = z(a,b) = a^2 - 18ab - 3b^2 \end{cases} \quad (35)$$

Thus (4) and (35) represent the non-zero integer solutions to (1).

#### OBSERVATIONS

$$1. x(b,b) - z(b,b) = 2t_{2b,4}$$

$$2. x(a,a) - y(a,a) + t_{4,2a} = 0$$

#### PATTERN: 8

Using (4), (9),(18) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = \frac{(5+i\sqrt{3})}{2}(a+i\sqrt{3}b)^2 \left( \frac{1+i4\sqrt{3}}{7} \right) \quad (36)$$

from which we have

$$\begin{cases} u = \frac{1}{2}(-a^2 - 18ab + 3b^2) \\ v = \frac{1}{2}(3a^2 - 2ab - 9b^2) \end{cases} \quad (37)$$

Using (37) and (2), the values of  $x, y$  and  $z$  are given by

$$\begin{cases} x = x(a,b) = (a^2 - 10ab - 3b^2) \\ y = y(a,b) = (-2a^2 - 8ab + 6b^2) \\ z = z(a,b) = (-a^2 - 18ab + 3b^2) \end{cases} \quad (38)$$

Thus (4) and (38) represent the non-zero integer solutions to (1).

#### OBSERVATIONS

$$1. x(b,b) - z(b,b) - t_{b,10} \equiv 0 \pmod{3}$$

$$2. y(b,b) - z(b,b) - 2t_{b,14} \equiv 0 \pmod{5}$$

#### PATTERN: 9

Using (4), (9),(23) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = \frac{(5 + i\sqrt{3})}{2}(a + i\sqrt{3}b)^2 \left( \frac{1 + i15\sqrt{3}}{26} \right) \quad (39)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{13}(-10a^2 - 114ab + 30b^2) \\ v = \frac{1}{13}(19a^2 - 20ab - 57b^2) \end{array} \right\} \quad (40)$$

Using (40) and (2), the values of  $x, y$  and  $z$  are given by

$$\left. \begin{array}{l} x = \frac{1}{13}(9a^2 - 134ab - 27b^2) \\ y = \frac{1}{13}(-29a^2 - 94ab + 87b^2) \\ z = \frac{1}{13}(-20a^2 - 228ab + 60b^2) \end{array} \right\} \quad (41)$$

Since our interest is on finding integer solutions, replacing  $a$  by 13A,  $b$  by 13B in (4) and (41), the corresponding integer solutions to (1) are given by

$$\left. \begin{array}{l} x = x(A, B) = 13(9A^2 - 134AB - 27B^2) \\ y = y(A, B) = 13(-29A^2 - 94AB + 87B^2) \\ z = z(A, B) = 13(-20A^2 - 228AB + 60B^2) \\ w = w(A, B) = 169(A^2 + 3B^2) \end{array} \right\} \quad (42)$$

#### PATTERN: 10

Using (4), (9),(28) in (3) and applying the method of factorization, define

$$(u + i\sqrt{3}v) = \frac{(5 + i\sqrt{3})}{2}(a + i\sqrt{3}b)^2 \left( \frac{1 + i56\sqrt{3}}{97} \right) \quad (43)$$

from which we have

$$\left. \begin{array}{l} u = \frac{1}{194}(-163a^2 - 1686ab + 489b^2) \\ v = \frac{1}{194}(281a^2 - 326ab - 843b^2) \end{array} \right\} \quad (44)$$

Using (44) and (2), the values of  $x, y$  and  $z$  are given by

$$\left. \begin{array}{l} x = \frac{1}{97}(59a^2 - 1006ab - 177b^2) \\ y = \frac{1}{97}(-222a^2 - 680ab + 666b^2) \\ z = \frac{1}{97}(-163a^2 - 1686ab + 489b^2) \end{array} \right\} \quad (45)$$

Since our interest is on finding integer solutions, replacing a by 97A, b by 97B in (4) and (45), the corresponding integer solutions to (1) are given by

$$\left. \begin{aligned} x = x(A, B) &= 97(59A^2 - 1006AB - 177B^2) \\ y = y(A, B) &= 97(-222A^2 - 680AB + 666B^2) \\ z = z(A, B) &= 97(-163A^2 - 1686AB + 489B^2) \\ w = w(A, B) &= 9409(A^2 + 3B^2) \end{aligned} \right\} \quad (46)$$

**PATTERN: 11**

(3) is rewritten as

$$u^2 = 7w^2 - 3v^2 \quad (47)$$

in (47), taking  $w = X + 3T, v = X + 7T, u = 2U$  (48)

it leads to

$$X^2 - U^2 = 21T^2 \quad (49)$$

Which is written as the system of double equations as shown in Table 1 below:

**TABLE:1 SYSTEM OF DOUBLE EQUATIONS**

SYSTEM	1	2	3	4
X+U	$T^2$	$3T^2$	$7T^2$	$7T$
X-U	21	7	3	3T

Consider system 1: Solving the pair of equations, note that

$$X = \frac{T^2 + 21}{2}, U = \frac{T^2 - 21}{2}.$$

The choice  $T = 2k + 1$  (50)

gives

$$\left. \begin{aligned} X &= 2k^2 + 2k + 11 \\ U &= 2k^2 + 2k - 10 \end{aligned} \right\} \quad (51)$$

The substitution of (50) and (51) in (48) gives

$$\begin{aligned} u &= (4k^2 + 4k - 20), v = (2k^2 + 16k + 18) \\ w &= (2k^2 + 8k + 14) \end{aligned} \quad (52)$$

In view of (2) one obtains

$$\left. \begin{aligned} x &= (6k^2 + 20k - 2) \\ y &= (2k^2 - 12k - 38) \\ z &= (8k^2 + 8k - 40) \end{aligned} \right\} \quad (53)$$

Thus (52) and (53) represent the non-zero integer solutions to (1).

Consider system 2: Solving the pair of equations, note that

$$X = \frac{3T^2 + 7}{2}, U = \frac{3T^2 - 7}{2}.$$

Using (50) the above equations become

$$\left. \begin{array}{l} X = 6k^2 + 6k + 5 \\ U = 6k^2 + 6k - 2 \end{array} \right\} \quad (54)$$

The substitution of (50) and (54) in (48) gives

$$\begin{aligned} u &= (12k^2 + 12k - 4), v = (6k^2 + 20k + 12) \\ w &= (6k^2 + 12k + 8) \end{aligned} \quad (55)$$

In view of (2) one obtains

$$\left. \begin{array}{l} x = (18k^2 + 32k + 8) \\ y = (6k^2 - 8k - 16) \\ z = (24k^2 + 24k - 8) \end{array} \right\} \quad (56)$$

Thus (55) and (56) represent the non-zero integer solutions to (1).

Consider system 3: Solving the pair of equations, note that

$$X = \frac{7T^2 + 3}{2}, U = \frac{7T^2 - 3}{2}$$

Using (50), the above equations become

$$\left. \begin{array}{l} X = 14k^2 + 14k + 5 \\ U = 14k^2 + 14k + 2 \end{array} \right\} \quad (57)$$

The substitution of (50) and (57) in (48) gives

$$\begin{aligned} u &= (28k^2 + 28k + 4), v = (14k^2 + 28k + 12) \\ w &= (14k^2 + 20k + 8) \end{aligned} \quad (58)$$

In view of (2), one obtains

$$\left. \begin{array}{l} x = (42k^2 + 56k + 16) \\ y = (14k^2 - 8) \\ z = (56k^2 + 56k + 8) \end{array} \right\} \quad (59)$$

Thus (58) and (59) represent the non-zero integer solutions to (1).

Consider system 4. On solving, it is seen that

$$X = 5T, U = 2T.$$

In view of (48), we have

$$u = 4T, v = 12T$$

$$w = 8T \quad (60)$$

Substituting the above values of u and v in (2), we get

$$x = 16T, y = -8T, z = 8T \quad (61)$$

Thus (60) and (61) represent the non-zero integer solutions to (1).

#### PATTERN: 12

It is seen that (49) is satisfied by

$$T = 2rs$$

$$\begin{aligned} U &= 21r^2 - s^2 \\ X &= 21r^2 + s^2 \end{aligned} \quad (62)$$

Substituting the values of T, U and X in (48), we get

$$\begin{aligned} u &= 42r^2 - 2s^2, v = 21r^2 + 14rs + s^2 \\ w &= 21r^2 + 6rs + s^2 \end{aligned} \quad (63)$$

Substituting the above values of u and v in (2), the non-zero distinct integral values of x, y and z are given by

$$\left. \begin{aligned} x &= x(r,s) = 63r^2 + 14rs - s^2 \\ y &= y(r,s) = 21r^2 - 14rs - 3s^2 \\ z &= z(r,s) = 84r^2 - 4s^2 \end{aligned} \right\} \quad (64)$$

Thus (63) and (64) represent the non-zero integer solutions to (1).

#### CONCLUSION

In this paper, we have made an attempt to determine different patterns of non-zero distinct integer solutions to the homogeneous cubic equation with four unknowns. As the cubic equations are rich in variety, one may search for other forms of cubic equations with multivariables to obtain their corresponding solutions.

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**AN ANALYSIS OF STRUCTURAL BREAK IN INDIA'S EXPORT TO AND IMPORT FROM  
BANGLADESH USING BAI AND PERRON TEST**

**DR. ARIFA TABASSUM****ABSTRACT**

*India's trade with Bangladesh has shown gradual increase with time. However, there are fluctuations in the values of India's export to, import from and total trade with Bangladesh. But it is not apparently visible as to when these values changed significantly or the number of structural breaks that exist. Therefore, to ensure the number of structural breaks in the data of India's export to and import from Bangladesh, Bai and Perron (1998) test is used which allows for the detection of multiple structural breaks from the data. The break years in India's export to Bangladesh are 1994, 2003, 2012 and the break years in India's import from Bangladesh are 1995, 2005 and 2011.*

**Keywords:** India, Bangladesh, Export, Import, Structural break.

**1. INTRODUCTION**

Bangladesh is one of India's top export destinations in the world. It was India's 8<sup>th</sup> largest export destination during the year 2017-2018 (Ministry of Commerce and Industry, GoI). During the same year India was the second largest import source for Bangladesh after China. With regard to export of Bangladesh during 2017-18 India was the 5<sup>th</sup> largest export destination. Out of US\$ 36.7 billion, 58.2% was exported to the European Union, 16.3% to the United States, 3.1% to Canada, 3.1% to Japan and 2.4% to India (WTO, 2019). Trade between India and Bangladesh plays an important role in the South Asian region.

Right from the formation of Bangladesh as a separate nation state India has been engaging in trade with it. Both the countries were members of GATT and also became the members of WTO. India has granted MFN status to all the SAARC countries in case of goods as per the obligation under the WTO and in turn all the members except Pakistan have also granted MFN status to India (GoI, 2014). Under the provision of WTO, India and Bangladesh are engaged in different regional trade agreements. This study therefore provides an overview of the evolving trends in India's trade with Bangladesh since 1972 to 2018.

To delve into the trade relation between India and Bangladesh this study shows evolving trends in bilateral trade between India and Bangladesh and checks the presence of structural breaks in India's export and import values with Bangladesh.

**2. METHODS**

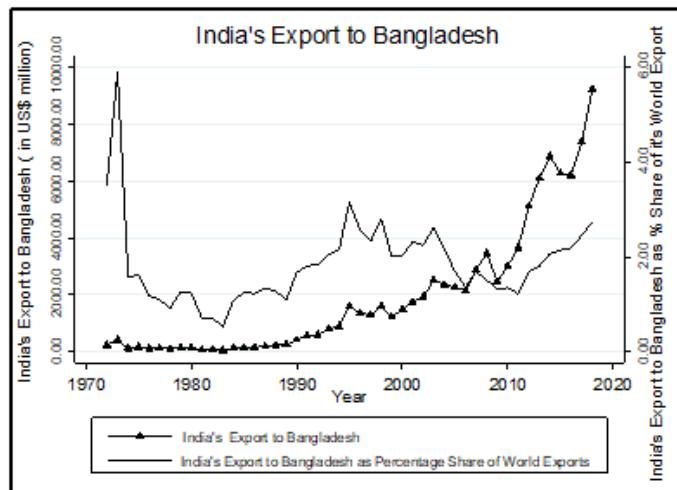
The data to study trends in trade volume and structural break of India's trade with Bangladesh have been collected from the IMF's Dataset, Direction of Trade Statistics (DOTS). The time period to observe the trends in India's trade with Bangladesh is from 1972 to 2018. The data collected have been adjusted for inflation by converting the nominal values into real values by using GDP deflator. A two way line graph is used to observe the trends in India's exports to and imports from Bangladesh in the left side of the graph and its trade with Bangladesh as percentage share of world trade in the right side of the graph. A structural break test is also done using Bai-Perron Test to detect if there is any structural break in the trade values. The results are depicted with the help of graphs.

**3. RESULTS****3.1.1 Trend in India's Export to Bangladesh**

Figure 1.1 shows India's export to Bangladesh. It can be observed that India's exports to Bangladesh increased gradually over the years. India's exports to Bangladesh increased from US\$ 247.38 million in 1972 to US\$ 436.01 million in the year 1973 showing an annual growth rate of 76.25% over 1972.

According to Mathur (2012) India's exports increased by 21.9 percent in 1972-73 and by 20.8 percent in the first eight months of 1973-74 as against an increase of only 4.8 percent in 1971-72, therefore part of the increase in India's overall exports during 1972-73 was due to temporary factors like credit financed exports to Bangladesh.

Figure 1.1: India's Export to Bangladesh



Exports declined to US\$ 133.39 million in the year 1974 and again increased to US\$ 170.85 million in 1975. Mathur (2012) stated that there was an overall growth of the Indian economy during 1975-76 which helped to attain price stability and increase in exports. During 1976-77 there was a lack of domestic demand which compelled the domestic producers to export. In the following years till 1980 the export followed a similar pattern. However, exports decreased to US\$ 73.94 million in 1981. According to Mathur (2012) India's BOP position deteriorated during this time and exports remained sluggish due to unfavorable international environment and internal constraints. India's exports to Bangladesh started to increase from the year 1984 when exports were at US\$ 142.68 million showing an annual growth rate of 128% over 1983 and continued to rise till it reached US\$ 1613.54 million in the year 1995. As per a report by World Bank (2006) during the mid 1980's till the year 1999 the real taka/rupee exchange appreciated by nearly 50 percent which led to the increase in India's export to Bangladesh.

India's exports to Bangladesh started to decline from the year 1996 and in the year 1999 exports decreased to US\$ 1239.98 million from US\$ 1611.58 million in the year 1998 with a remarkable negative annual growth rate of -23.05%. According to Mathur (2010) India's growth of exports during 1996-97 declined because of the decline in international prices of various commodities and the world prices of manufactured goods during 1996-1998 declined by nearly 16%. Gupta (2000) puts forward that the adverse performance of the Indian economy during 1997-98 was partly due to the poor performance of agricultural sector. Mathur (2012) puts forward some reasons behind the weak performance of India's export during the East Asian Crisis which continued to deepen and spread in 1998. One of the international factors which affected India was the massive depreciation of the currencies of the East Asian economies.

Rahman (2005) observed that India was the top import source for Bangladesh from the world during 2003 and during the same year it contributed 94.1% of Bangladesh's import from SAARC. According to Ahmed and Sattar (2004) Bangladesh introduced tariff reforms in its 2002 budget and initiated tariff reductions and the general maximum custom duties as of May 2003 were 32.5% in Bangladesh.

Exports to Bangladesh decreased in the years 2004, 2005 and 2006. But there was an increase in exports in the year 2008 over 2007 by 20.33%. According to Taneja et al. (2013) the main aspect of signing of SAFTA in the year 2006 was the reduction in tariffs by all members under a trade liberalisation programme. There was a remarkable decrease of India's export to Bangladesh in the year 2009 with a negative annual growth rate of -28.57% over the year 2008. According to Acharya and Marwaha (2012) India's exports increased in the year 2008 after which it declined due to the global economic and financial crisis of 2007-08 which impacted Indian exports and therefore its exports to Bangladesh also declined.

From the year 2010 to 2014 exports increased from US\$ 2879.77 million to US\$ 6869.30 million. The year 2012 in between noticed a phenomenal increase in India's export to Bangladesh with annual growth rate of 40.19% over 2011. The export value in the year 2011 was US\$ 3648.29 million and it increased to US\$ 5114.83 million in 2012. According to the Annual Report (2011-12) India's exports recorded a growth of 40.49% during April-March 2010-11. The growth in India's overall exports may be the reason behind the rise in India's export to Bangladesh from the year 2010 to 2014. After 2014 there was a decrease in export for two years and again increased to US\$ 7365.21 million in the year 2017. According to Ghosal (2015) Bangladesh raised customs

duty on tea imports due to which India's exports of tea to Bangladesh fell by 90% in the first six months of the year 2014. Bose (2018) stated that the increase in India's export to Bangladesh in the year 2017 was mainly due to export of equipment and high value machinery for project implementation in Bangladesh. During the years 2017-2018 Bangladesh emerged as the top importer of Indian cotton overtaking China. Though the exports continuously showed ups and downs yet overall the exports showed an increasing trend which is evident from figure 1.1. Figure 1.1 also shows India's exports to Bangladesh as percentage of its total exports to world. The figure shows that the percentage shares of India's export in the year 1972 and 1973 were 3.50% and 5.89% respectively after which it declined to 1.58% in the year 1974. The percentage share remained within a range of 0.53% to 2.80% except the year 1995 when the same was 3.14%.

### 3.1.2 Trend in India's Import from Bangladesh

Figure 1.2 shows India's imports from Bangladesh. The trend line of India's import from Bangladesh shows that India's import from Bangladesh increased to US\$ 57.09 million in the year 1973 from US\$ 6.03 million in the year 1972 showing an annual growth rate of 847.46% over 1972.

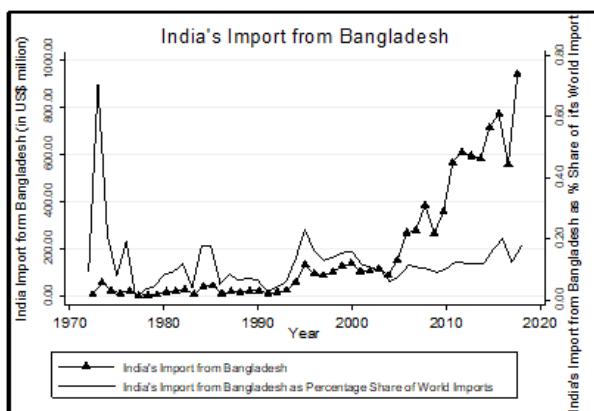


Figure 1.2: India's Import from Bangladesh

Rahman (2005) observed that the increase in imports during 1973 was the consequence of the signing of the first trade agreement on 28<sup>th</sup> March 1972. Mathur (2012) observed that there was severe decline in agricultural production and sharp acceleration in price inflation in India in the year 1973. Ahmed et al. (2007) in their study have put forward that in the same year, that is 1973, exports of agricultural commodities from Bangladesh stood at just over 80 percent of Bangladesh's total exports. However the annual growth rate of imports declined by 60.20% in the year 1974 over 1973. According to Rahman (2005) the trade agreement of 1972 was further extended in the year 1973 for three years to enhance trade between both the countries but this agreement could not achieve the desired level of trade.

The dip in the imports in the year 1977 may be due to the fall in India's overall imports as its domestic output of food and fertilizers increased. As observed by Mathur (2012), during 1976-77 despite India's effort to liberalize imports, it fell by 6.8%. In the following year, i.e. 1977-78 economic growth was without any constraints unlike past wherein shortages of food and foreign exchange acted as hurdles in the Indian economy's development and imports started to increase. Imports continued to increase in the following years due to growth in imports of items like edible oil, artificial fibers, iron and steel, fertilizers and higher cost of petroleum and its products. Imports further increased during 1979-80 as the BOP came under severe pressure because of the sharp increase in the crude oil prices and prices of other imports. There was also a domestic shortage which further necessitated import. The rise in prices of oil aggravated inflation in the world economy which further led to increase in India's import bill by raising prices of items like fertilizers, steel, non-ferrous metal, cement, machinery and chemicals. The BOP situation further deteriorated during 1980-81. The sharp increase in industrial prices since 1979 had added substantially to the import bill. The external trade and BOP situation had been under severe strain since 1979-80. It was also observed that total imports during 1981-82 were six percent higher than those in 1980-81. The import policy of 1981-82 allowed liberal and flexible access to requirements of imports for the aim of strengthening and diversifying the production base of the economy. India's imports from Bangladesh also increased during the same years. It increased from US\$ 5.53 million in 1978 to US\$ 28.01 million in 1982. India's import from Bangladesh saw an increase of 37% in the year 1982 over 1981.

The year 1983-84 saw a strong economic recovery in the Indian economy led by the agricultural sector. BOP position began to improve and exports grew and imports declined. India's import from Bangladesh also declined in the same year to US\$ 8.54 million. India's imports from Bangladesh increased in the mid 1980's. The operation of the first EPZ at Chittagong started in the year 1983-84 (World Bank, 2006). Import values showed a fall in the year 1986 to US\$ 11.77 million as compared to US\$ 44.01 million in 1985. According to Mathur (2012) India's BOP came under pressure during 1987-88 due to decrease in domestic production and increase in imports of essential commodities like edible oil, pulses etc. Imports were also necessitated by droughts. Droughts constrained export of some agricultural products. In the year 1988-89 shortfall in domestic production in India led to increase in imports. Import from Bangladesh also increased during the same years.

Imports were more than doubled in the year 1994 to US\$ 58.96 million as compared to 1993 where the imports were US\$ 24.44 million. Thereby the annual growth rate of imports in the year 1994 was 141.29% over the year 1993. The increase in imports in the year 1994 was the result of drastic tariff reductions of the early 1990's which stalled after 1995-96 (World Bank, 2006). Infrastructural failings such as power shortage, inadequate energy supplies and inadequate port facilities and the problem of floods of devastating nature decreased Bangladesh's export growth from 17.1% in 1997-98 to 2.9% in 1998-99 (WTO, 2000). The decrease in Bangladesh's export growth may be the result of the decrease in India's import from Bangladesh in the year 1996 and 1997. Imports gained momentum after 1997 and showed a gradual rise till 2008 with an exception year 2004 wherein the imports declined to US\$ 88.01 million.

India's imports from Bangladesh reduced from US\$ 138.70 million in the year 2000 to US\$ 103.84 million in the year 2001. According to a report by FAO (2017) this fall was due to the global recession in the year 2001. As per the same report one of the important imports of India across borders with Bangladesh consists of fishmeal and India imports *Hilsa* fish from Bangladesh. During the year 1998 India's exports to Bangladesh declined but imports increased which was mainly due to the fact that 97% of India's import of fresh and frozen fish was received from Bangladesh in the year 1998.

Bangladesh's bilateral trade deficit narrowed for the first time in the year 2005-06 (World Bank, 2006). India's import from Bangladesh was US\$ 88.01 million in the year 2004 and increased by 71.86% in the year 2005 over 2004. In the year 2006 India's import from Bangladesh increased to US\$ 267.98 million from US\$ 151.27 million in the year 2005. Taneja et al. (2013) observed that in the year 2006 India reduced its sensitive list to 25 items from 744 items under SAFTA and Bangladesh received maximum benefit from this reduction. They noted that in the year 2008 India allowed 164 textile items to enter into its market at zero duty from Bangladesh up to a limit of 8 million pieces per year and this limit was raised to 10 million pieces in April 2011. In 2011 India allowed duty free and without quota restrictions 61 items on India's sensitive list for the LDC's, including 46 items from textile category.

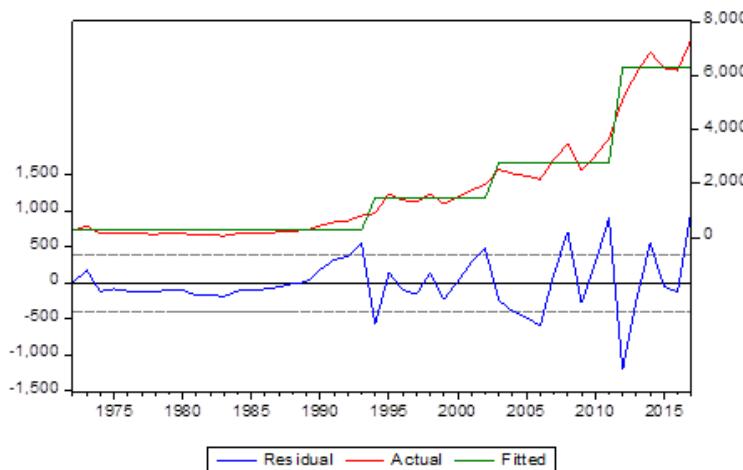
Imports declined in the year 2009 to US\$ 266.56 million as compared to US\$ 384.42 million in the year 2008 showing an annual growth rate of -30.66 over 2008. As per a report by MEA (2017), India has provided duty free and quota free access to Bangladesh on all tariff lines except tobacco and alcohol since 2011 under SAFTA. According to a report by Vaitheesvaran (2019), after the implementation of GST in India, it has removed 12% countervailing duty on imports from Bangladesh and it was observed that during the year 2018-19 there was a surge in textile imports from Bangladesh by 53%. On the other hand, considering India's imports from Bangladesh as a percentage share of its total imports in figure 1.2, it can be seen that even with the gradual increase in imports the percentage share more or less remained in the range between 0.1% and 0.2%. However, a steep rise can be noticed in the year 1973 (0.7%) and the year 1995 (0.23%) which surpassed the aforementioned range.

### **3.2 Structural Break In India's Trade With Bangladesh**

India's trade with Bangladesh has been increasing over time. However, there are fluctuations in the values of India's export to, import from and total trade with Bangladesh. But it is not apparently visible as to when these values changed significantly or the number of structural breaks that exist. Therefore, to ensure the number of structural breaks in the data of India's export, import and total trade with Bangladesh, Bai and Perron (1998) test is used which allows for the detection of multiple structural breaks from the data. It can be noticed from the above mentioned figures that the structural break years of total trade and export are same, that is, during 1994, 2003 and 2012. But the structural breaks in imports are during the years 1995, 2005 and 2011. Therefore it becomes necessary to enquire upon the events that may be the probable reasons for such breaks.

#### **3.2.1 Discussion on Break Years in India's Total Trade and Its Exports to Bangladesh**

The break years for India's exports are during the years 1994, 2003 and 2012 as seen in figures 1.3.

**Figure 1.3: India's Export to Bangladesh (Break years: 1994, 2003, 2012)**

The probable reasons behind the break years are discussed below:

#### **BREAK YEAR - 1994**

Veeramani (2012) observed that the trade and exchange policy regime which was introduced in India for the year 1992-93 eliminated all unnecessary discretionary and administrative controls over foreign trade. In the same year, that is, 1993 the market determined exchange rate regime was also introduced. These reform measures showed further improved results in the year 1993-94. India's BOP position was improved remarkably and inflation was below 8.5 percent in 1994. India's agricultural production also improved due to which the food grains stock was at record levels. Major steps were taken to improve the exports and for the same purpose the Export-Import Policy that was announced on April 1, 1993 amended the policies so as to promote exports in the sectors in which India had comparative advantage, that is in agriculture and labor-intensive sectors. Besides the export promotion schemes, the liberalization of trade policies and the fiscal deficit correction that was achieved in the previous two years also led to the growth in export. A shift in export destinations of India was observed during this period. India previously exported to developed country markets but gradually made a shift in its export destination to emerging markets in Asia and Africa. Nilanjan (2001) states that the various reform measures introduced in the exchange and trade policy led to increased exports by 20.7% in the year 1995-96 over the year 1993-94. However the growth in exports did not last long and there was a decrease in the growth rates to 5.3% in 1996-97 over 1995-96.

#### **BREAK YEAR - 2003**

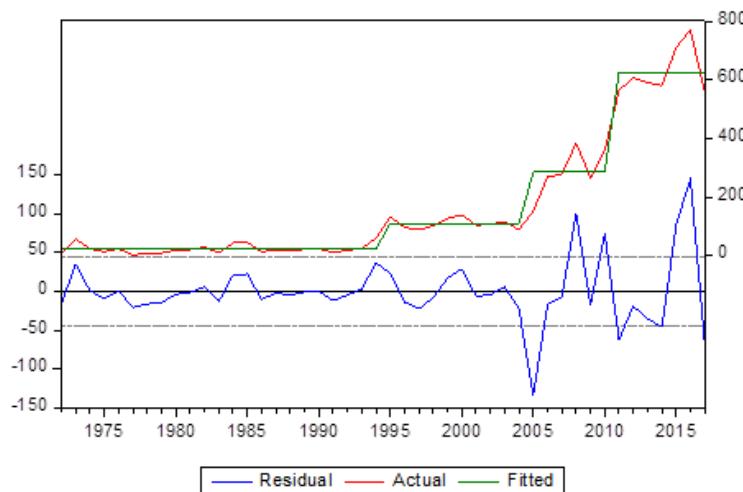
There were tariff reforms in the year 2002 in both India and Bangladesh. Tariff reductions were introduced in Bangladesh's 2002 budget and in India's budget of 2002 and 2003. The general maximum custom duties as of May 2003 were 32.5% in Bangladesh and 30% in India (Ahmed and Sattar, 2004). According to Mathur (2012), besides the trade reforms, India's foreign exchange reserves grew during 2002-03 and the rapid growth was partly attributed to strong current account. India's BOP's current account recorded a surplus after 23 years which was equivalent to 0.3 percent of GDP in 2001-02. There was surge in India's exports which occurred despite the slow pace of global economic recovery. The current account surplus along with expanding capital account continued till 2003-04. Rahman (2005) observed that India was top import source for Bangladesh in 2003 and contributed 94.1% of Bangladesh's imports from SAARC.

#### **BREAK YEAR - 2012**

The years 2008 and 2009 witnessed recession and trade growth collapsed in different countries and the fall in trade was much higher than the fall in GDP. But the trade growth recovered faster than the GDP growth from the year 2010. The government of India and the RBI took trade policy measures in the year 2009-10 and 2010-11 with a focus on export promotion measures and export oriented employment measures (Basher, 2013). The growth rate of India's export to Bangladesh increased to 44.85% in the year 2012 (Musvver, 2017). As per a report by EXIM Bank (2015), Bangladesh's increased dependence on India for cotton and the trade formalization efforts between both the countries had contributed to such increase in trade.

#### **3.2.2 Discussion on Break Years in India's Import from Bangladesh**

The break years for India's imports from Bangladesh are during the years 1995, 2005 and 2011 as seen in figure 1.4 below.



**Figure 1.4: India's Import from Bangladesh (Break years: 1995, 2005, 2011)**

The probable reasons behind the break years are discussed below:

#### BREAK YEAR - 1995

The tariff cuts that were offered by India to SAARC countries under SAPTA led to an increase in imports from SAARC countries by 58% during 1995-1996 and India obtained tariff concessions on 13 items from Bangladesh in December 1995 (Bhargava, 2013). Another report by the Ministry of Finance (1993), revealed that in India's budget 1993-1994 a proposal was made to fully exempt the payment of import duties on Jamdanee saris that were imported from Bangladesh.

#### BREAK YEAR - 2005

The BOP estimates of April 2003-05 showed the emergence of current account deficit. This deficit was the result of large merchandise trade deficit. This deficit continued in the year 2005-06 too and was the result of remarkable import growth but at the same time there was a widening surplus in the capital account (Mathur, 2012).

The break that appeared in India's imports from Bangladesh in the year 2005 is therefore the result of India's increased imports. There was increase in the growth of import of fertilizers; inorganic chemicals; knitted or crocheted fabric; and other man made textile articles, sets, worn clothing etc from Bangladesh in the year 2005 over 2004. Inorganic chemicals constituted 41.7% and other man made textile articles constituted 10.8% of India's total imports from Bangladesh in the year 2005.

#### BREAK YEAR - 2011

In the year 2011 India allowed 164 textile items to enter into its market at zero duty from Bangladesh up to a limit of 10 million pieces. In the same year India also allowed duty free and without quota restrictions 61 items on India's sensitive list for the LDC's, including 46 items from textile category. Further in November 2011 India reduced its sensitive list for LDC's to just 25 items (alcohol and tobacco) with zero tariffs on all remaining items (Taneja et al., 2013).

#### 4. CONCLUSION

The study therefore reveals that there is gradual increase both in India's export to and import from Bangladesh during the period of study, that is, from 1972 to 2018. However, there were certain fluctuations over the years and in order to find if there existed any major change in the export and import values structural break was found for both export and import values. The break years in India's export to Bangladesh are 1994, 2003, 2012 and the break years in India's import from Bangladesh are 1995, 2005 and 2011.

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**GROWTH AND PROGRESS OF LIS EDUCATION IN INDIA****DR. RAJASHEKHAR KUMBAR****ABSTRACT**

The basic aim of this paper is to discuss the historical development of higher education and growth of LIS education in the country. The study is focused on to evaluate and compare the UG and PG level enrollments and pass percentage in LIS education in past one decade in the country. The ultimate purpose of this article is to explore the present scenario and future perspective of LIS education by introducing more pragmatic methods, which aim to strengthen student enrollment and develop expertise in knowledge and competence.

**Keywords:** Higher Education, LIS Education, Libraries, Library Committees

**INTRODUCTION**

Higher education in India has expanded at a phenomenal rate in the last century. The British introduced the European system of education in India in 1857 with the establishment of universities and withdrawal of support for indigenous education. An additional 18 universities were established in India in 1947 after Independence. There were 27 universities in the year 1950-51 when the country launched first five-year plan. The last two decades saw an increase in the number of affiliated private colleges as well as deemed universities. The former became an important source of revenue for universities that charge an affiliation fee. The latter allowed private colleges to operate as universities and award degrees. Therefore, there was a drastic increase in the number of institutions and enrolment in higher education from 2001-2002 to 2011-2012. Enrolment tripled from 8.8 million to 28.5 million, while the GER doubled from 8.1% to 19.4%. The frenetic growth of higher education institutions and enrolment has continued with over 6,000 institutions and six million students being added to the higher education system from 2011-2012 to 2016-2017.

By the end of twelfth five-year Plan (2012-2017) the commission categorically highlighted the need for a strong current and comprehensive data for evidence-based policy making and effective planning. The higher education institutions have been classified into 3 broad categories viz.,

- University and University Level Institutions i.e., the Institutions which are empowered to award degree under some Act of Parliament or State Legislature.
- Colleges/Institutions which are not empowered to provide a degree in its own name and therefore are affiliated/recognized by Universities.
- Stand-alone Institutions (not affiliated with Universities) which are not empowered to provide degree and therefore run Diploma Level Programmes(MHRD, 2018).

The Plan document also took note of the AISHE (All India Survey on Higher Education) initiated by the Ministry of Education and indicated that it can provide useful insights and can be the first step towards creating a comprehensive higher education data management system. As per 2019-20 AISHE annual report, there were 1043 Universities, 42343 Colleges, 11779 Standalone institutions listed under the AISHE and providing higher education in India (MoE 2020). Under the Rashtriya Uchchatar Shiksha Abhiyan 2.0 (RUSA) the Ministry of Human Resource Development has set a target of achieving 32% GER by 2022. Going by the current growth rates, this target is likely to be met in the next few years(Ravi, Gupta, & Nagaraj, 2019).

**Growth Of Lis Education In India**

In India, library science education started in 1911 with the setting up of the Baroda School by WA. Borden. By the time India became independent only 6 departments offered diploma courses in library science. Library science education in India is provided at the higher education level through Bachelor, Master's as well as Doctorate level. About 100 universities under the auspices of the University Grants Commission (UGC) are responsible for disseminating the latest knowledge and define the highest qualifications in professional librarianship. The curriculum for Bachelor and Master's level were largely based on the recommendations of the UGC Review Committee on Library Science at Indian Universities (1965) for a long time. The scheme of subjects recommended by the committee was covered in one way or the other in all the library schools, though there were variations in emphasis, number of lectures and practical for each of the subjects, marks allotted for evaluation, methods of teaching used and the inclusion of some additional subjects. For a long time, there were

no major changes in the LIS curriculum except for some minor changes. The reasons for the same include- lack of adequate resources, lack of qualified instructors in the emerging disciplines and rapid emergence of new technologies.

Keeping in view that LIS is a dynamic and interdisciplinary area of study and the Curriculum must deal with all components of information handling, the UGC appointed the CDC to restructure the courses in LIS, which submitted a report in 1993 emphasizing on the need of professionally educated and trained personnel. In 1995, the CDC report prompted LIS schools to include various aspects of ICT in their curricula. However, due to some constraints a majority of library science schools could not opt for the same. Presently, most of the Indian university curricula is based on the Karisiddappa Committee (2001) constituted by the UGC to formulate model curriculum and prepare the status report with modifications of existing guidelines where necessary. In the curriculum the Panel suggested two-year integrated Master's Degree in LIS giving freedom to individual university to opt for one year BLIS and one year MLIS model. The Committee recommends, LIS education system aiming to meet the global standards with a much wider application and hope to fulfill the user's expectations. The curriculum has been changed aspects of traditional librarianship to IT related issues and applications to librarianship. The phrase library and information science/studies now encompass information and knowledge creation, communication, selection, acquisition, analysis, interpretation, evaluation, synthesis, dissemination and management of information. As a result, the subjects of LIS studies have included the areas like online searching, information retrieval, knowledge management, and implementation, promotion, preservation and conservation of library services based on electronic resources(Rao, Rao, & Reddy, 2004).

## **SCOPE AND METHODOLOGY**

The paper covers various aspects of higher education and growth of library and information science education in India. The study is based on descriptive method, Quantitative analysis of the data collected from secondary sources is carried out using statistical tools. Enrollments and pass percentage in LIS education from 2011-12 to 2019-20 is collected from AISHE annual reports and various sources of information published from higher education proceedings.

## **OBJECTIVES OF THE STUDY**

The main objectives of the study are:

- To highlight the growth of Higher Education studies in India and to create awareness on the LIS studies
- To know the growth and development of LIS education in India.
- To study the growth in UG and PG level enrollments in LIS studies
- To analyze the enrollments and the pass percentage in UG and PG Studies in LIS

## **Analysis Of Student Enrollment And Pass Percentage Trend**

The AISHE annual survey reports consist the data from all the institutions of Higher education in the nation. Every institution is allotted with the unique AISHE Code. All the institutions covered under the survey are broadly categorized as Universities, Colleges and Stand-alone intuitions. As of 2019-20 survey report, there are 1043 universities, 42343 colleges and 11779 stand-alone institutions participated in the survey out of them 1019 universities, 39955 colleges and 9599 stand-alone institutions' data have been considered for the study.

In the AISHE annual survey report, the total student enrollment has been classified in 8 levels viz., – Ph.D., M.Phil., Post Graduate, Under Graduate, PG Diploma, Diploma, Certificate and Integrated courses. In this study only 2 levels, i.e. Post Graduate and Under Graduate students enrolled in various universities, colleges and stand-alone institutions for Library and information science course programme from 2011-20 to 2019-20 are considered for the study. The students enrolled in Ph.D., M.Phil., PG Diploma, Diploma, Certificate and Integrated courses are excluded from the study. As many of the universities in the country offering B.Lib.Sc courses, the students enrolled in B.Lib.Sc. courses are considered in the undergraduate programme. The students' enrollment in UG is listed in table 1.

**Table 1. Trend In Enrolment Of Ug Course In Lis**

Year	Male	Female	Total
<b>2011-12</b>	12577	13259	25836
<b>2012-13</b>	15513	14559	30072
<b>2013-14</b>	18001	16373	34374

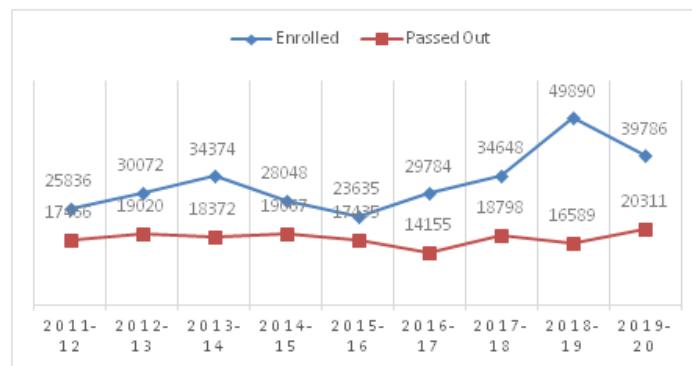
<b>2014-15</b>	13997	14051	28048
<b>2015-16</b>	11061	12574	23635
<b>2016-17</b>	13828	15956	29784
<b>2017-18</b>	17098	17550	34648
<b>2018-19</b>	26230	23660	49890
<b>2019-20</b>	19859	19927	39786

The table 1 shows that more than 50% growth in the enrollment of students from 2011 to 2020 and the average enrollment from 2011 to 2020 is around 32897. The highest enrollment for UG course programme is in the year 2018-19 whereas the least is in the year 2015-16. Students enrollments trend from 2011-12 to 2015-16 is in downward side, whereas from 2015-16 the trend shows in upward side.

**Table 2. Outturn/Pass Out at UG Level in LIS**

<b>Year</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
<b>2011-12</b>	9505	7961	17466
<b>2012-13</b>	9161	9859	19020
<b>2013-14</b>	9004	9368	18372
<b>2014-15</b>	8873	10194	19067
<b>2015-16</b>	8157	9278	17435
<b>2016-17</b>	5768	8387	14155
<b>2017-18</b>	8804	9994	18798
<b>2018-19</b>	7855	8734	16589
<b>2019-20</b>	9531	10780	20311

The table 2 shows that, except year 2011-12 the female pass percentage is higher in all the years. Highest pass out is in the year 2019-20. 16.29% percent increase in the total pass out from 2011 to 2020. The least pass out in female is 5768 in the year 2016-17 and the least pass out in male is 7961 in the year 2011-12. The average passes from 2011 to 2020 male is 8517 and in female is 9395 whereas the average passes in total from 2011 to 2020 is 17912.



**Fig 1: Comparison of enrollment and pass out in UG level programme**

The Fig 1 shows that even there is a higher number of students enrolled during 2018-19 but the pass percentage is 33.25 only which is very less compared to other years. In the year 2015-16 the number of enrollments is very less compared to other year, but the pass percentage is 73.77 which is the highest among all the years and also shows that the pass percentage from 2011-12 to 2019-20 is declined from 67% to 51%. The average pass percentage from 2011 to 2020 is 56.90% which means almost half of the enrolled students from 2011 to 2020 are not completed the UG level programme.

**Table 3. Enrolment trend in M.L.I.Sc course**

<b>Year</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
<b>2011-12</b>	5087	5180	10267
<b>2012-13</b>	5502	5853	11355
<b>2013-14</b>	5176	5760	10936
<b>2014-15</b>	4684	5322	10006
<b>2015-16</b>	4216	4834	9050

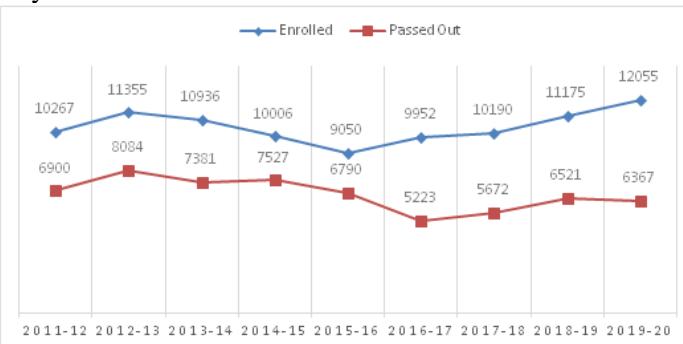
<b>2016-17</b>	4541	5411	9952
<b>2017-18</b>	4879	5311	10190
<b>2018-19</b>	5344	5831	11175
<b>2019-20</b>	5656	6399	12055

The table 3 depicts the number of Post Graduate students enrolled for Library and Information Science for the respective year. There is a significant growth in the enrollment of the MLISc programme from 2011-12 to 2019-20. Highest number of students enrolled in the year 2019-20 whereas the least number of students enrolled in the year 2015-16. The average growth of enrollment from 2011 to 2020 shows that the female enrollment is higher than the male. There is a 17.42% increase in the percentage of students enrolled since for year 2011 to 2020.

**Table 4. Outturn/Pass Out at Post Graduate Level in LIS**

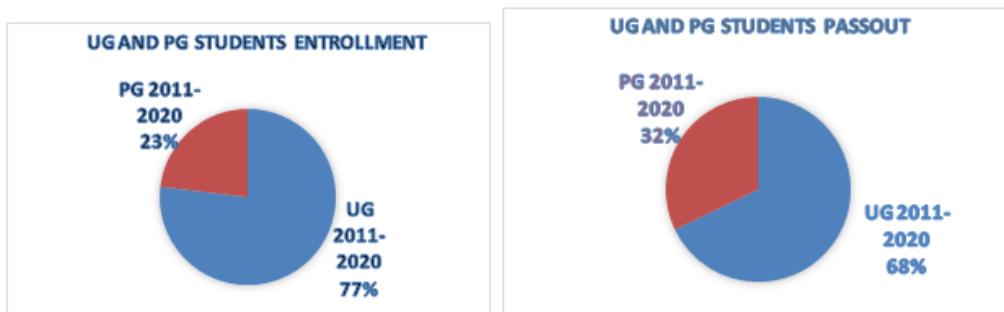
Year	Male	Female	Total
<b>2011-12</b>	3550	3350	6900
<b>2012-13</b>	3911	4173	8084
<b>2013-14</b>	3469	3912	7381
<b>2014-15</b>	3402	4125	7527
<b>2015-16</b>	3000	3790	6790
<b>2016-17</b>	2068	3155	5223
<b>2017-18</b>	2377	3295	5672
<b>2018-19</b>	2593	3928	6521
<b>2019-20</b>	2664	3703	6367

The table 4 shows that there is a decline in the pass out result for MLISc programme from 2011 to 2020. Highest number of students passed out in the year 2012-13 whereas the least number of students passed out in the year 2016-17. The Male students result is declined around 50% from 2011 to 2020. Around 6718 average number of students passed out every year from 2011 to 2020. There is a **7.72%** decrease in percentage of students passed out since the year 2011 to 2020.



**Fig 2: Comparison of enrollment and pass out in PG Programme**

The figure shows that even though the enrollment is increasing in every year from 2011-12 to 2019-20 but, the pass percentage is declining from 67.12% to 52.82% against the enrollments. The highest pass percentage is in the year 2014.15 with 75.22%, followed by 75.03% in the year 2015-16. The least pass percentage is in the year 2016-17 with 52.48%, followed by 52.82% in the year 2019-20. Even the highest number of students are enrolled in the year 2019-20 but the pass percentage is only 52.82%.



**Fig 3: Average Percentage of Students enrolled and Passed out in UG and PG**

The average percentage of students enrolled in UG and PG from 2011-12 to 2019-20 are shown in the above figure 3. If compare the enrollment and pass percentage of UG and PG together it shows that the PG enrollment percentage is less, but the pass percentage is more with 32% whereas the UG enrollment percentage is high with 77% but the pass percentage is less with 68%.

During the last three decades the spectrum of technologies have widened and deepened. The Indian information environment is significant with a dual nature. There are Library & Information Centres (LICs) with new knowledge systems, new tools and adopting successful strategies, contrary to those functioning under the traditional system without any conspicuous growth. The profession is developing horizontally, rather vertically, with hybridization. Hence, the LIS departments have to look inwardly to the situation, to the real world of the LIS professional needs. Further, implied by technologies, there is pressure to have quality assurance in LIS education programmes. Indeed, we can't have a mismatch between the training given to professionals and what is required by various sectors of information society. It is necessary to enhance our efforts on the national stage by offering courses suitable to the profession in contemporary Indian information society, of course, keeping in view the trends in global activities.

## **CONCLUSION**

Higher education is being affected by the developments through globalization, privatization, the information revolution and revolution in ICT. In the present society, the education has shifted towards tradable good and acquired global levels. In the information society/knowledge society, the discipline Library and Information Science which concerned with the information/knowledge organization and dissemination is of greater importance to the present society. This discipline is at a transitional stage and needs to be revamped, reinvigorated and strengthened to withstand to the revolutionary changes taking place around, especially in the field of ICT. There is an urgent need for imparting quality education and training by the LIS departments in the universities, so that the products of these university departments can comfortably fit to manage the modern Library & Information Centres (LICs) and the LIS departments in the universities can survive in the global market. There is an immediate requirement for slanting the syllabi to modern techniques; teaching and training methods and techniques; developing adequate infrastructure and practice-oriented programmes, so that the LIS department in the universities can survive in the competitive world as well as offer the programmes acceptable at international level.

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**THE NON-HOMOGENOUS BIQUADRATIC EQUATION WITH FOUR UNKNOWNNS**

$$xy(x+y) + 30zw^3 = 0$$

**S.VIDHYALAKSHMI, T. MAHALAKSHMI, B.LOGANAYAKI AND M.A.GOPALAN****ABSTRACT**

The Non-homogenous biquadratic equation with four unknowns given by  $xy(x+y) + 30zw^3 = 0$  is analyzed for obtaining different sets of non-zero distinct integer solutions through employing the linear transformations.

*Keywords* Non-homogenous biquadratic , Biquadratic with four unknowns , Integer solutions.

**INTRODUCTION**

The theory of Diophantine equations offers a rich variety of fascinating problems. In particular, biquadratic diophantine equations, homogeneous and non-homogeneous have aroused the interest of numerous mathematicians since antiquity [1-5]. In this context, one may refer [6-17] for various problems on the biquadratic diophantine equations with four variables. However, often we come across non-homogeneous biquadratic equations and as such one may require its integral solution in its most general form. It is towards this end, this paper concerns with the problem of determining non-trivial integral solutions of the non-homogeneous equation with four unknowns given by  $xy(x+y) + 30zw^3 = 0$  is analyzed for obtaining different sets of non-zero distinct integer solutions through employing the linear transformations.

**NOTATION**

$$t_{3,n} = \frac{n(n+1)}{2}$$

**METHOD OF ANALYSIS**

The Non-homogenous biquadratic equation with four unknowns under consideration is,

$$xy(x+y) + 30zw^3 = 0 \quad (1)$$

Introduction of linear Transformation

$$\left. \begin{array}{l} x = u + v \\ y = u - v \\ z = u \end{array} \right\} \quad (2)$$

In (1) leads to,

$$v^2 - u^2 = 15w^3 \quad (3)$$

The above equation is solved for  $u, v$  &  $w$  through various methods. Substituting the values of  $u, v$  in (2) the corresponding integer solutions to the (1) are obtained.

The above process is illustrated below:

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
$v+u =$	$15w^3$	$5w^3$	$3w^3$	$w^3$	$15w^2$	$5w^2$	$3w^2$	$w^2$	$15w$	$5w$	$3w$	$w$
$v-u =$	1	3	5	15	$w$	$3w$	$5w$	$15w$	$w^2$	$3w^2$	$5w^2$	$15w^2$

**SOLUTION FOR SYSTEM : I**

Consider ,

$$v+u = 15w^3$$

$$v-u = 1$$

$$\Rightarrow v = \frac{15w^3 + 1}{2}, \quad u = \frac{15w^3 - 1}{2}$$

Let us take  $w = 2k + 1$

$$v = 60k^3 + 90k^2 + 45k + 8, \quad u = 60k^3 + 90k^2 + 45k + 7$$

$$\therefore x = 120k^3 + 180k^2 + 90k + 15, \quad y = 1, \quad z = 60k^3 + 90k^2 + 45k + 7, \quad w = 2k + 1$$

### SOLUTION FOR SYSTEM : II

Consider ,

$$v + u = 5w^3$$

$$v - u = 3$$

$$\Rightarrow v = \frac{5w^3 + 3}{2}, \quad u = \frac{5w^3 - 3}{2}$$

Let us take  $w = 2k + 1$

$$v = 20k^3 + 30k^2 + 15k + 4, \quad u = 20k^3 + 30k^2 + 15k + 1$$

$$\therefore x = 40k^3 + 60k^2 + 30k + 5, \quad y = -3, \quad z = 20k^3 + 30k^2 + 15k + 1, \quad w = 2k + 1$$

### SOLUTION FOR SYSTEM : III

Consider ,

$$v + u = 3w^3$$

$$v - u = 5$$

$$\Rightarrow v = \frac{3w^3 + 5}{2}, \quad u = \frac{3w^3 - 5}{2}$$

Let us take  $w = 2k + 1$

$$v = 12k^3 + 18k^2 + 9k + 4, \quad u = 12k^3 + 18k^2 + 9k - 1$$

$$\therefore x = 24k^3 + 36k^2 + 18k + 3, \quad y = -5, \quad z = 12k^3 + 18k^2 + 9k - 1, \quad w = 2k + 1$$

### SOLUTION FOR SYSTEM : IV

Consider ,

$$v + u = w^3$$

$$v - u = 15$$

$$\Rightarrow v = \frac{w^3 + 15}{2}, \quad u = \frac{w^3 - 15}{2}$$

Let us take  $w = 2k + 1$

$$v = 4k^3 + 6k^2 + 3k + 8, \quad u = 4k^3 + 6k^2 + 3k - 7$$

$$\therefore x = 8k^3 + 12k^2 + 6k + 1, \quad y = -15, \quad z = 4k^3 + 6k^2 + 3k - 7, \quad w = 2k + 1$$

### SOLUTION FOR SYSTEM : V

Consider ,

$$v + u = 15w^2$$

$$v - u = w$$

$$\Rightarrow v = \frac{15w^2 + w}{2}, \quad u = \frac{15w^2 - w}{2}$$

$$v = 7w^2 + t_{3,w}, \quad u = 7w^2 + t_{3,w-1}$$

Let us take  $w = k$

$$v = 7k^2 + t_{3,k}, \quad u = 7k^2 + t_{3,k-1}$$

$$\therefore x = 15k^2, y = -k, z = 7k^2 + t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : VI

Consider ,

$$v + u = 5w^2$$

$$v - u = 3w$$

$$\Rightarrow v = \frac{5w^2 + 3w}{2}, \quad u = \frac{5w^2 - 3w}{2}$$

$$v = w^2 + 3t_{3,w}, \quad u = w^2 + 3t_{3,w-1}$$

Let us take  $w = k$

$$v = k^2 + 3t_{3,k}, \quad u = k^2 + 3t_{3,k-1}$$

$$\therefore x = 5k^2, y = -3k, z = k^2 + 3t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : VII

Consider ,

$$v + u = 3w^2$$

$$v - u = 5w$$

$$\Rightarrow v = \frac{3w^2 + 5w}{2}, \quad u = \frac{3w^2 - 5w}{2}$$

$$v = w + 3t_{3,w}, \quad u = -w + 3t_{3,w-1}$$

Let us take  $w = k$

$$v = k + 3t_{3,k}, \quad u = -k + 3t_{3,k-1}$$

$$\therefore x = 3k^2, y = -5k, z = -k + 3t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : VIII

Consider ,

$$v + u = w^2$$

$$v - u = 15w$$

$$\Rightarrow v = \frac{w(w+15)}{2}, \quad u = \frac{w(w-15)}{2}$$

$$v = 7w + t_{3,w}, \quad u = -7w + 3t_{3,w-1}$$

Let us take  $w = k$

$$v = 7k + t_{3,k}, u = -7k + t_{3,k-1}$$

$$\therefore x = k^2, y = -15k, z = -7k + t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : IX

Consider ,

$$v + u = 15w$$

$$v - u = w^2$$

$$\Rightarrow v = \frac{w(15+w)}{2}, u = \frac{w(15-w)}{2}$$

$$v = 7w + t_{3,w}, u = 7w - t_{3,w-1}$$

Let us take  $w = k$

$$v = 7k + t_{3,k}, u = 7k - t_{3,k-1}$$

$$\therefore x = 15k, y = -k^2, z = 7k - t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : X

Consider ,

$$v + u = 5w$$

$$v - u = 3w^2$$

$$\Rightarrow v = \frac{5w+3w^2}{2}, u = \frac{5w-3w^2}{2}$$

$$v = w + 3t_{3,w}, u = w - 3t_{3,w-1}$$

Let us take  $w = k$

$$v = k + 3t_{3,k}, u = k - 3t_{3,k-1}$$

$$\therefore x = 5k, y = -3k^2, z = k - 3t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : XI

Consider ,

$$v + u = 3w$$

$$v - u = 5w^2$$

$$\Rightarrow v = \frac{3w+5w^2}{2}, u = \frac{3w-5w^2}{2}$$

$$v = w^2 + 3t_{3,w}, u = -w^2 - 3t_{3,w-1}$$

Let us take  $w = k$

$$v = k^2 + 3t_{3,k}, u = -k^2 - 3t_{3,k-1}$$

$$\therefore x = 3k, y = -5k^2, z = -k^2 - 3t_{3,k-1}, w = k$$

### SOLUTION FOR SYSTEM : XII

Consider ,

$$v + u = w$$

$$v - u = 15w^2$$

$$\Rightarrow v = \frac{w+15w^2}{2}, \quad u = \frac{w-15w^2}{2}$$

$$v = 7w^2 + t_{3,w}, \quad u = -7w^2 - t_{3,w-1}$$

Let us take  $w = k$

$$v = 7k^2 + t_{3,k}, \quad u = 7k^2 - t_{3,k-1}$$

$$\therefore x = k, y = -15k^2, z = -7k^2 - t_{3,k-1}, w = k$$

### METHOD : 2

Taking

$$v = ku, \quad (k > 1) \quad (4)$$

In (3), we have  $(k^2 - 1)u^2 = 15w^3$  which is satisfied by,

$$\left. \begin{aligned} u &= 15^2(k^2 - 1)\alpha^{3s} \\ w &= 15(k^2 - 1)\alpha^{2s} \end{aligned} \right\} \quad (5)$$

And from (4),

$$v = 15^2(k^2 - 1)k\alpha^{3s}$$

Substitute the above values of  $u$  &  $v$  in (2), one has

$$x = (k+1).15^2(k^2 - 1)\alpha^{3s} \quad (6)$$

$$y = -(k-1).15^2(k^2 - 1)\alpha^{3s} \quad (7)$$

$$z = 15^2(k^2 - 1)\alpha^{3s} \quad (8)$$

Where,  $k > 1$

Thus (5),(6),(7)& (8) represents the integer solutions to (1).

### METHOD : 3

Taking

$$w = -v \quad (9)$$

In (3) ,it is written as,

$$u^2 = v^2(15v+1) \quad (10)$$

Assume

$$\alpha^2 = 15v+1 \quad (11)$$

Whose smallest positive integer solution is given by,

$$v = v_0 = 1, \quad \alpha = \alpha_0 = 4 \quad (12)$$

Let  $v_1, \alpha_1$  be the  $2^{nd}$  integer solution to (10) given by,

$$\left. \begin{aligned} v_1 &= 2\alpha_0 + 15 + v_0 \\ \alpha_1 &= \alpha_0 + 15 \end{aligned} \right\} \quad (13)$$

Using the above values in (10) & simplifying we get,

$$h = 2\alpha_0 + 15$$

Where  $h$  is the unknown integer to be determined.

In view of (13), we have

$$\nu_1 = 2\alpha_0 + 15 + \nu_0$$

$$\alpha_1 = \alpha_0 + 15$$

Following the above procedure, one obtains

$$\nu_2 = 2\alpha_1 + 15 + \nu_1$$

$$\alpha_2 = \alpha_1 + 15$$

The repetition of the above process leads to the general solution  $\nu_k, \alpha_k$  of (10) given by,

$$\left. \begin{array}{l} \nu_k = 2k\alpha_0 + 15k^2 + \nu_0 \\ (\text{i.e}) \nu_k = 15k^2 + 8k + 1 \\ \alpha_k = 15k + 4 \end{array} \right\} (14)$$

Substituting (14) in (9), (10) and (2), we have

$$x_k = (15k^2 + 8k + 1)(15k + 5)$$

$$y_k = (15k^2 + 8k + 1)(15k + 3)$$

$$z_k = (15k^2 + 8k + 1)(15k + 4)$$

$$w_k = -(15k^2 + 8k + 1)$$

Where  $k \geq 0$ .

## **CONCLUSION**

In this paper, an attempt has been made to determine non-zero distinct integer solutions to the non-homogeneous biquadratic equation with four unknowns given by  $xy(x+y) + 30zw^3 = 0$ . The researchers in this field may search for other sets of integer solutions to the equation under consideration and other forms of biquadratic equations with four or more variables.

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## **MACHINE LEARNING MODEL FOR DECLINE CURVE ANALYTICS ON CRUDE OIL PRODUCTION**

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### **ABSTRACT**

As rightly mentioned by N. El Bassam there earths are needed by 2050, to fulfil the requirements of energy resources looking at the current resource utilization. Companies produces the oil from wells at a high capacity and after a particular point when the reserve becomes low, the production rate declines. At that time the O&G engineers, apply various methods to increase the oil production. Currently the O&G companies are following the decline curve analysis methods to identify the decline point and then will provide their treatment to improve the oil production. Data Science and Machine learning techniques can be used effectively to predict, that decline point. In our current study, the plan was to review a huge set of data from more than 3800 wells, is proposed to predict the peak value of each oil well from reservoir, so that it will help the petroleum engineers to do required predictive maintenance, to reduce the decline of production and not to have more decline in the curve of the production.

**Keywords** Oil and Gas, Production, Upstream, Artificial Intelligence, Decline analysis curve, Predictive analysis.

### **I. INTRODUCTION**

Any oil well will reach to its maximum level of production after a certain number of drilling operations. Once the decline in production starts a separate process called well completion is performed to make the well ready again for production.

For a better reservoir management, it is important to construct a proper reservoir model, that can estimate the oil reserves, predict the reservoir efficiency, and check the production status. It is important to study the reservoir and set the objectives effectively, for a good reservoir model to get established and while specifying the objectives, it is also to be focused on the recovery mechanisms of the reservoir based on the study conducted on reliable forecast results from production history. [2]

The reservoir modeling is performed in various ways such as laboratory method, mathematical method etc., While modeling, it is important to start with the basic step called reservoir characterization where the data that is needed for the model construction is collected and analyzed. The data that is collected here are “well testing data”, “well logging data”, “seismic data”, “core data”, and “fluid data” and are used in the model construction. These types of data store, the information, and properties from various heterogeneous reservoirs. [2]

Even though there are many proven methods, it is very critical to predict the oil production, with 100% accuracy. One of the most popular method with high percentage of accuracy in predicting the future production rate is the Decline Curve Analysis. For forecasting Oil and Gas, most proven means are the decline curves. The Decline curves uses the production data for plotting and analyzing. These curve models such as exponential, hyperbolic, and hormonic model also analyzes the characteristics of reservoir based on the production data.

The Decline Curve Analysis matches the historical data of the production with the pragmatic equation, that is shown in the following general form.

$$D_i = Kq^b = \frac{-\frac{dq}{dt}}{q} = -\frac{\Delta \ln q}{\Delta t}$$

$$K = \frac{D_i}{q_i^b}$$

where  $D_i$  is the decline rate.

Based on the prediction from this method the rate of decline can be identified.

The architecture presented in this paper introduces another novice method, which can predict the decline, well in advance based on a trained machine learning model. As mentioned above, it may not be 100% accurate, as the prediction trends may vary from reservoir to reservoir or from the geographical regions. The plan of the study is to measure the peak value of the wells and do the treatments that are needed to improve the well production in advance, instead of waiting for the well to reach the saturation point. The machine learning model shown in this system used various algorithms such as correlation, linear regression, etc.,

A huge collection of datasets taken from more than 300 reservoirs and a large set of oil wells, the study was conducted using python and many of the libraries such as Pandas, Sci-Kit Learn, numpy, seaborn etc.,

## **II. LITERATURE REVIEW**

Jamshidnezhad, M (2015) et al [2] has discussed the reservoir modeling in detail in chapter number 2 and as mentioned there, the reservoir model in general consists of certain major elements such as defining objectives, data analysis, build model, matching history, forecasting the scenarios, reporting etc., Referring to various literatures, the chapter has also defined microscale, macroscale, mega scale and giga scale type reservoir modelling. It was also summarized through various sources with reservoir modeling such as sources of dynamic and static data and these sources provide structures, logging data, geometry, geophysical data, raw data with various types of analysis. In further sections, all the types of data are explained in detail with mathematical equations. It was highlighted that the reservoir engineers must make sure that the solutions that they have got with the outputs of the simulation methods used, are to be most possible closest to the solutions of the mathematical models.

Belyadi, H et al. (2017) [3] in their study about decline curve analysis has mentioned that the “Decline Curve Analysis” is one of the popular and age-old analytical method to predict the future production of Oil and Gas. The different types of decline curve models such as exponential, harmonic and hyperbolic decline curves. The exponential decline happens when the production rate versus time is plotted on a semi-log plot and if it is a straight line and this is also known as constant-rate decline. The hyperbolic decline rate depends on the reservoir and well where the oil is produced. The decline rate will be sharper if the production is with high pressure and is hard production, and if the decline rate is shallower with minimum pressure and is slower production. When the hyperbolic exponent value (b) is equal to one with a constant of change in decline rate the harmonic decline occurs.

Blasingame T A (1971) [4] in his study on decline curve analysis has presented a technique that can be utilized to dissect variable-rate/variable strain drop creation information utilizing a steady tension simple time work. The most critical result is that of the limit overwhelmed time change for consistent rate or steady strain stream. This change, given by Equation for relation using test analysis permits an examiner to figure a comparable time for steady strain creation, rapidly and effectively, in light of the boundaries m and b, acquired utilizing constant rate analog relation. For gas wells this system is less direct and requires an iterative arrangement created. We considered four unique strategies to change variable rate information into the consistent tension arrangement profile. We considered three recursion formulae which register the consistent pressure identical time work, temp. by board summations based on trapezoidal principal integration and limited distinction developments. Every one of these relations was applied effectively to change over the consistent rate dimensionless arrangement into the steady tension dimensionless arrangement. Nonetheless, McCray tracked down that use of the trapezoidal standard mix strategy gives poor results when applied to unpredictable information or information with extended shut-ins. This conduct makes the overall utilization of these recursion formulae troublesome, best-case scenario. The fourth strategy created was a thorough character which compares the limit ruled answers for steady rate and consistent strain creation. The subsequent two-boundary connection might be utilized for dimensionless arrangements or field information applications. At the point when the m and b boundaries are not really set in stone utilizing the techniques information disperse ought to have little impact on the upsides of the boundaries on the grounds that a best fit pattern is set up. These qualities make the limit overwhelmed stream technique the most valuable result of this work.

M.J. Fetkovich (1987) et al [5] have published their research article collaborating with Phillips petroleum company and have mentioned that decline curve analysis should work since it is established on basic fluid flow standards similar standards utilized in pressure-transient examination. The issue most specialists have had and will keep on having with decline curve analysis is not correct, sporadic, or lacking information. Cautious thoughtfulness regarding acquiring exact stream rates, streaming tensions, also personal time should assist with taking care of the issue. A decent rate time analysis is not exclusively will give similar outcomes as regular pressure-transient investigation, yet in addition will permit a gauge to be made straightforwardly at no expense

in lost creation. For low-porousness animated wells, specifically, pressure-development testing could be disposed of by and large as being of little worth or monetarily baseless in view of the subsequent creation misfortune when thought about with what can be acquired from appropriately directed constant wellbore-pressure drawdown tests.

Lucas Downey et al [6] has explained in detail about the decline curves and the methods to determine the “estimated ultimate recovery” on any oil & gas reserve. The curve will help in identifying or estimating or predicting the O & G production rate. It was highlighted in the article that the decline curve analysis is not accurate than simulated methods, as it depends on the historical data and the method will not count the labor, equipment, where it could effect the production rates.

Md. Shahin Alom et al [7] has presented a new and numerically thorough strategy to examine reduction in gas creation and its pressure information utilizing “type curve”. The pseudo boundaries, for example, pseudo-total creation, pseudopressure and a pseudotime work interestingly to break down rate-time curve. The pseudotime work gives an advantageous way to deal with handle varieties in thickness compressibility esteems all the more thoroughly with strain since consistency compressibility proportion is a component of aggregate creation. The proposed technique depends on using of the new equilibrium pseudotime( $T_a$ ), called the rate standardized pseudototal capacity. Another calculation is introduced to figure the gas set up, and repository properties like penetrability, supply waste region, and the pseudosteady satisfy consistent. This technique is likewise skilled to examine the conduct of creation information all the more thoroughly for consistent variable rate/variable strain drop, bottomhole pressure, and solid exhausted supply ailment. The proposed strategy is an immediate use of pseudosteady state connection that evades emphases and extrapolation of information during analysis. At long last, detail analysis and understanding techniques are introduced for both recreated and field information. The results acquired are in great concurrence with recently revealed outcomes. The proposed technique is totally legitimate for limit ruled stream system in gas repositories. The work is exhibited by three models and contrasted and past investigations by different scientists. It is observed that the outcomes got contrast well and those got by different analysts.

Mohammed Hossein Dehghail et al., [8] has mentioned that in regression models ordinarily, both of information and boundaries are considered as fresh. Yet, sometimes, for working on the forecast, the researchers have planned to use a model such as regression, with uncertain factors. For this situation the typical models of regression are not appropriate, so fluffy regression may be reasonable substitution options. In this paper it was considered that the techniques of least outright deviation and least square are the most recognizable techniques to look at the notice models. In exemplary regression both, information and boundaries are thought of as fresh. In any case, now and again, the noticed information related to at least one factors are uncertain. In cases similar to these, the researchers recommend fluffy regression models to supplant exemplary regression.

Dietrich Stoyan et al [9] explained that Orthogonal linear regression which is a statistical technique, that is generally used to “fit a line” with the data points  $x_i$  and  $y_i$  within a scatter plot, where it is considered that both the variables  $x_i$  and  $y_i$  have errors. The research has shown that the orthogonal linear regression analysis revels finds its origin in applied geodesy. The whole study has proven meaningful as both coordinates that are processed and recorded by the sensors are subject to errors in the measurement.

### **III. Methodology & Practical Implementation**

The OSEMN methodology was planned to use in this case study, to apply the machine learning algorithm and predict the decline point of the well.



**Figure 1: The OSEMN Framework [10]**

As mentioned in the figure 1, the following are the major stages that are followed to predict the decline point in any well.

1. Obtain: This is the first phase of the framework, where the data is acquired from the sources. For the current case study, the data was acquired from various reservoirs and many number of oil wells. The data collected was in various formats and a variety of database tasks were performed, using different languages such as Python and PHP.
2. Scrub: The data that was obtained through Step 1 was cleaned and filtered, by avoiding the irrelevant and no meaning data. All the data was again converted in to .CSV format and created a single data repository for analysis and processing. For the convenience, in further stages, additional columns were created to identify the reservoirs and wells separately. PHP code was used to this process.

The following image shows some of the sample records from the huge data set that is taken from more than 2500 oil wells. This is read from the .csv file that is read and worked with Python functions.

	pSeq	wellNo	pYear	pMonth	pLiquid	pGas	pRatioGasOil	pWater	pPercentWater	pDaysOn
count	402000.000000	402000.000000	402000.000000	402000.000000	402000.000000	402000.000000	402000.000000	402000.000000	402000.000000	402000.000000
mean	20100.000000	6.178967	2016.350507	6.642321	3399.448576	7142.587204	3.583985	2842.020201	1.446228	27.059249
std	116047.549444	4.775887	1.335163	0.478284	4087.314127	8198.045298	28.354489	4154.878111	25.919079	7.496935
min	1.000000	0.000000	2007.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25%	100500.750000	1.000000	2016.000000	4.000000	1103.000000	2106.000000	1.007070	537.000000	0.285714	28.000000
50%	201000.500000	8.000000	2016.000000	7.000000	2111.000000	4337.000000	1.712085	1663.000000	0.964466	30.000000
75%	301500.250000	10.000000	2017.000000	10.000000	4008.000000	6861.000000	3.238370	3457.000000	1.342073	31.000000
max	402000.000000	22.000000	2016.000000	12.000000	88624.000000	18181.000000	6741.000000	134201.000000	6865.000000	31.000000

**Figure: 2 the major variables planned to use in the model before filtering.**

The following are the data types of the key columns that are used in this project.

	1 petrol.dtypes
pSeq	int64
wellNo	int64
pYear	int64
pMonth	int64
pLiquid	int64
pGas	int64
pRatioGasoil	float64
pWater	int64
pPercentwater	float64
pDaysOn	int64
pCategory	object
pStatus	object
dtype:	object

**Figure: 3: The data types of each variable used in the model.**

There are two non numerical or categorical columns. The idea in this example also is to use the Linear regression and it supports only the numerical data. So it was decided to drop the pCategory and pStatus columns.

3. Explore: The data inspection was done in this phase and identified the various properties that are lying in the data that is cleaned. Identification of the business objective is important in this step. In the current case study, the aim is to predict the point, where the decline of the oil effectively starts. Some of the variables that are highlighted after the exploratory data analysis are wellno, pyear (production year), pmonth (production month), pLiquid (produced Oil), pGas (Produced Gas), pwater(Produced Water), pdays (Number of Days worked on the well to produce oil or gas) etc., The exploratory data after plotting it looks like the images shown below.



**Figure 4: Exploratory data plotted**

4. Model: Even though this is the mainstage, but the OSEMN model is more successful when the first 3 phases are completed effectively. This is the stage where the actual work will be implemented.

The data that was collected from various wells from more than 3500 reservoirs which was in raw format, has got processed into a readable and usable format. Simple programming was done in PHP using the database MySQL to make it readable and certain columns such as wellnumber, reservoircode, productionstatus (to know whether it was a starting point(S) or if there is any increase in the production from the previous day value (I) or if there is any decrease in the production from the previous day value(D), or if the value is the peak or maximum production value (P) of the well) etc., were added to use them effectively with the machine learning model.

After processing the data using the PHP program, a CSV file was created with a huge dataset and have filtered the data to identify various variables that will be used in the model as part of the feature engineering. The details about the model are further discussed in the results and discussion section of this paper.

5. Interpret: The last stage is to interpret the data and is considered the most critical stage of the whole project where the prediction output will be generalized and can be tested further with any input that will be supplied with. Data visualization will happen here after completing the interpretation of the data and reports can be generated. The details of interpretation and data visualization are discussed further in Results and Discussion section of this paper.

#### IV. RESULTS AND DISCUSSION

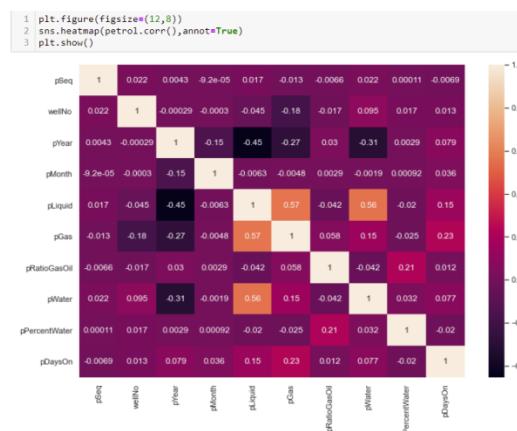
To develop the machine learning model, using python code, from the large set of data, the columns that are required were taken and the columns that are not needed were dropped.

As usual the correlation is applied to identify the relationship among the variables an the following correlation matrix was generated.

1 petrol.corr()											
pSeq	wellNo	pYear	pMonth	pLiquid	pGas	pRatioGasOil	pWater	pPercentWater	pDaysOn		
1.000000	0.021577	0.004300	-0.00092	0.017253	-0.012507	-0.006593	0.021980	0.001095	-0.005942		
wellNo	0.021577	1.000000	-0.000290	-0.000303	-0.045183	-0.181014	-0.016522	0.095247	0.016826	0.013320	
pYear	0.004308	-0.000290	1.000000	-0.151360	-0.453419	-0.266314	0.029710	-0.305451	0.002900	0.079499	
pMonth	-0.00092	-0.000303	-0.151360	1.000000	-0.006279	-0.004826	0.02917	-0.019133	0.00092	0.035991	
pLiquid	0.017253	-0.045183	-0.453410	-0.006279	1.000000	0.568358	-0.042029	0.056249	-0.019615	0.147506	
pGas	-0.012507	-0.181014	-0.266314	-0.004826	0.568358	1.000000	0.057786	0.150126	-0.024767	0.225048	
pRatioGasOil	-0.006593	-0.016522	0.029710	-0.042029	-0.042029	0.057786	1.000000	-0.019159	0.211059	0.011930	
pWater	0.021980	0.095247	-0.305451	-0.001933	0.562491	0.150126	-0.041959	1.000000	0.031659	0.077293	
pPercentWater	0.001095	0.016826	0.002902	0.005922	-0.019615	-0.024767	0.211055	0.031659	1.000000	0.019699	
pDaysOn	-0.005942	0.013320	0.079499	0.035991	0.147506	0.225048	0.011930	0.077293	-0.019699	1.000000	

**Figure 5: Correlation matrix**

The correlation graph also shows that the relation is positive and strong among many of the variables identified.



**Figure 7: Correlation Graph**

As shown in the graph above, the darker regions demonstrate stronger relationships. There are very few areas in the graph have lighter colors, making the correlation model significant.

The dependent variable pLiquid is dropped from the dataset as to maintain the collection of independent variables using python statement.

x=petrol.drop(['pLiquid'], axis = 1).

The dependent variable will be kept separately to use it with y.

y=pLiquid

Now the data was split into 70% training and 30% testing sets, for both the variables x and y using the api `train_test_split` that comes from `ski-learn` on a random seeding. The Linear Regression model is created and is trained with the independent variables.

The following figure shows the training data sample after dropping the not required columns along with the pCategory column. This column is dropped temporarily to do the linear regression and then it will be added later to the data, to categorize the peak value predicted per well.

1	pCategory=X_train['pCategory']				
1	X_train=X_train.drop(['pCategory'], axis = 1)				
2					
1	X_train				
	pGas	pRatioGasOil	pWater	pPercentWater	pDaysOn
32249	2127	1.417060	2448	1.630910	29
300815	7131	1.802120	1305	0.329795	27
21747	1031	0.682781	1042	0.690066	30
263798	12829	4.552520	3715	1.318310	30
258525	0	0.000000	0	0.000000	0
...	...	...	...	...	...
359783	2753	0.785001	4766	1.359000	30
358083	1251	0.635994	4158	2.113880	31
152315	13376	5.750640	689	0.296217	30
117952	1116	0.837838	7589	5.697450	31
305711	8073	2.474860	3381	1.036480	30

**Figure 8: Training Dataset excluding pCategory and other non-required columns.**

The remaining data is considered for testing the model as test data set. The following figure shows the test DATA SET, where pCategory is also dropped still.

1	X_test				
	pGas	pRatioGasOil	pWater	pPercentWater	pDaysOn
196896	939	1.481070	620	0.977918	31
102189	748	0.374374	4157	2.080580	30
328692	2655	1.510240	3632	2.065980	30
132209	1238	0.603608	4595	2.240370	28
396794	7173	2.445620	1135	0.386976	31
...	...	...	...	...	...
271162	26149	23.059100	89	0.078483	30
347417	5909	1.127460	1343	0.256249	17
366871	595	0.439439	2739	2.022900	24
146458	747	0.645078	633	0.546632	30
227251	2724	0.644124	4004	0.946796	30

**Figure 9:** Test Dataset after dropping the non-required columns.

The model is then trained with the data and using the Python built in library function `LinearRegression()`, which performs the linear regression.

The Data frames are used to store the predicted results as an array format. The code was further improved to add the well category after predicting the Crude oil. This predicts the peak value from each well that is guided by the trained model.

At last the model is evaluated using various regression metrics by comparing the model's predictions against the ground reality. We first called the predict() function by passing the X\_test split of test. The returned predictions for each of the examples in the X\_test array is saved in y\_pred array.

We then passed the `y_pred` array along with the ground reality to the scoring functions `mean_squared_error()` and `R2_score` to calculate the mean squared error MSE, the root mean Squared error (RMSE) and the coefficient of determinations. These metrics provide some hint of the performance of the LinearRegression model on the given data set.

```

1 mse = mean_squared_error(y_test, res)
2 print(f"mse = {mse:.2f}")
3
4 rmse = mean_squared_error(y_test, res, squared=False)
5 print(f"RMSE = {rmse:.2f}")
6
7 r2score = r2_score(y_test, res)
8 print(f"R2 Score = {r2score:.2f}")

MSE = 7364998.63
RMSE = 2713.85
R2 Score = 0.55

```

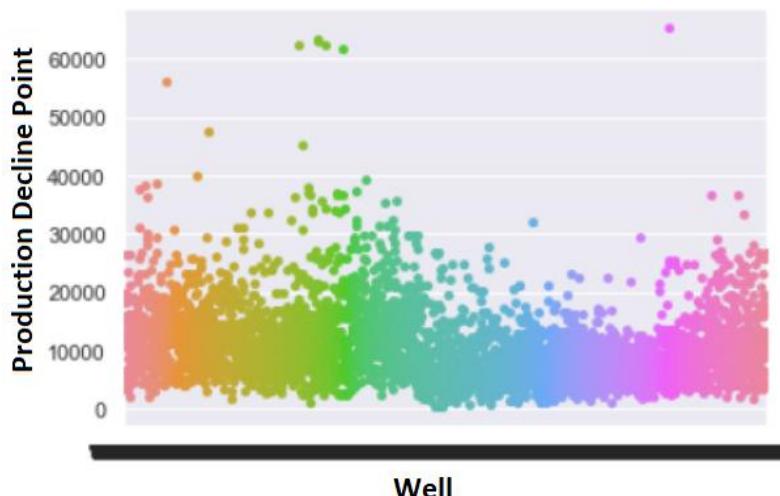
**Figure 10: MSE, RMSE and R2 Scores**

The mean squared Error MSE is measure of quality and is positive which means that the estimated measures are between the actual values and predicated values. The Root Mean Square Error (RMSE) measures is smaller and it shows that the predicted values are closed to the actual observations. The R2 Score is 55% and it defines the proportion of variance on the dependent variable that was used to predict based on the various independent variables that we have supplied. A 55% of R2 Score means that model is valid and can be used.

## V. CONCLUSION & FUTURE SCOPE

The model can be applied on any exploratory well data and can predict the peak value for the production, and before the production curve gets into declined route, the treatment can be started by the oil and gas experts.

The final plotting of Production decline point with each well is shown in the figure given below.



**Figure 11: The final plotting of decline point for each and every well**

**VI. The density in the image shows that the prediction is more accurate and the model can be used to predict the decline point and the well can be processed further by the specialist engineers to improve the production of the well further.**

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**ON THE BI-QUADRATIC DIOPHANTINE EQUATION WITH FOUR UNKNOWNS**

$$xy(x+y) = 3zw^3$$

**E. PREMALATHA , J.SHANTHI AND M.A. GOPALAN****ABSTRACT**

The non homogeneous biquadratic equation with 4 unknown given by  $xy(x+y) = 3zw^3$  is analyzed for its patterns of non – zero distinct integral solutions. A few interesting relations between the solutions and special polygonal numbers are exhibited.

**KeyWords** Bi-quadratic equation with 4 unknowns, non homogeneous biquadratic, Integer solutions, Special polygonal numbers, Centered polygonal number

**Mathematics Subject Classification 2010: 11D25****1. INTRODUCTION**

Biquadratic Diophantine equations, homogeneous and non- homogeneous, have aroused the interest of numerous Mathematicians since antiquity as can be seen from [1-7]. In the context one may refer [8-24] for varieties of problems on the Diophantine equations with two, three and four variables. This communication concerns with the problem of determining non-zero integral solutions of yet another biquadratic equation in 4 unknowns represented by  $xy(x+y) = 3zw^3$ . A few interesting relations between the solutions and special polygonal numbers are presented.

**NOTATIONS USED**

1. Regular Polygonal Number of rank  $n$  with sides  $m$ :  $t_{m,n} = n[1 + \frac{(n-1)(m-2)}{2}]$
2. Pyramidal Number of rank  $n$  with sides  $m$ :  $p_n^m = \frac{1}{6}[n(n+1)][(m-2)n + (5-m)]$
3. Centered Polygonal Number of rank  $n$  with sides  $m$  :  $Ct_{m,n} = \frac{1}{2}[mn(n+1)] + 1$
4. Pronic Number of rank  $n$  :  $pr_n = n(n+1)$
5. Star Number of rank  $n$  :  $S_n = 6n(n-1) + 1$
6. Pentatope Number of rank  $n$  :  $pt_n = \frac{n(n+1)(n+2)(n+3)}{24}$

**2. METHOD OF ANALYSIS**

The Diophantine equation representing the biquadratic equation with four unknowns under consideration is

$$xy(x+y) = 3zw^3 \quad (1)$$

The substitution of the transformations

$$x = u + v, y = u - v, z = 2u \quad (2)$$

in (1) leads to  $u^2 - v^2 = 3w^3$  (3)

We present below different methods of solving (3) and thus obtain different patterns of integer solutions to (1).

**PATTERN -1**

Write (3) as the system of double equations as shown in Table 1 below:

**Table 1: System of double equations**

System	1	2	3	4
$u+v$	$3w^3$	$w^3$	$3w^2$	$w^2$
$u - v$	1	3	$w$	$3w$

Solving each of the system of equations in Table 1, the corresponding values of  $u$ ,  $v$  and  $w$  are obtained. Substituting the values of  $u$ ,  $v$  and  $w$  in (2), the respective values of  $x$ ,  $y$ ,  $z$  and  $w$  are determined. For simplicity and brevity, the integer solutions to (1) obtained through solving each of the above system of equations are exhibited.

**System :1**

$$x = 24T^3 + 36T^2 + 18T + 3$$

$$y = 1$$

$$z = 24T^3 + 36T^2 + 18T + 4$$

$$w = 2T + 1$$

**System:2**

$$x = 8T^3 + 12T^2 + 6T + 1$$

$$y = 3$$

$$z = 8T^3 + 12T^2 + 6T + 4$$

$$w = 2T + 1$$

**System :3**

$$x = 12T^2$$

$$y = 2T$$

$$z = 12T^2 + 2T$$

$$w = 2T$$

$$x = 12T^2 + 12T + 3$$

$$y = 2T + 1$$

$$z = 12T^2 + 14T + 4$$

$$w = 2T + 1$$

**System :4**

$$x = 4T^2$$

$$y = 6T$$

$$z = 4T^2 + 6T$$

$$w = 2T$$

$$x = 4T^2 + 4T + 1$$

$$y = 6T + 3$$

$$z = 4T^2 + 10T + 4$$

$$w = 2T + 1$$

A few interesting properties observed are as follows:

1.  $x(T) + y(T) - z(T) = 0$
2.  $x(T) + z(T) - w(T) \equiv 0 \pmod{24}$
3.  $6\{z(T) - x(T) + w(T(T+1)) - 4t_{3,T} + 1\}$  is a nasty number:
4.  $x(T) + y(T) - z(T) + w(2T)$  is a square integer.

**PATTERN -2**

Substitute  $w = v$  in (3) , we get

$$u^2 = (3v+1)v^2$$

As our interest centers on finding integer solutions, it seen that  $u$  is an integer, when  $v = 3n^2 \pm 2n$

Hence in view of (2), the corresponding solutions of (1) are given by

$$x = (3n^2 \pm 2n)(3n \pm 1 + 1)$$

$$y = (3n^2 \pm 2n)(3n \pm 1 - 1)$$

$$z = 2(3n \pm 1)(3n^2 \pm 2n)$$

$$w = 3n^2 \pm 2n$$

**Remarkable Observations:**

➤ Let  $(u, v, w)$  be any integer solution of (3). Define

$$r = \frac{u+v}{2}, s = \frac{u-v}{2},$$

Treating  $r, s$  as the generators of the Pythagorean triangle  $(\alpha, \beta, \gamma)$ , it is noted that this triangle is such that  $18\alpha$  is a cubical integer.

➤ Consider  $x, y$  and  $z$  to be the length, breadth and length of the diagonal of a rectangle R respectively, where A=area,

P=perimeter,

Then it is noted that

i)  $AP \equiv 0(\text{mod } 6)$

ii)  $\frac{AP}{6L}$  is a cubical integer.

➤ Employing the positive integer solutions of (1) and (3), the following expressions among the special and pyramidal numbers are given below.

$$1. \left[ \frac{3P_u^3}{t_{3,u+1}} \right]^2 - \left[ \frac{4Pt_{v-3}}{P_{v-3}^3} \right]^2 \text{ is a cubical integer.}$$

$$2. \left[ \frac{3P_{u-2}^3}{t_{3,u-2}} \right]^2 - 3 \left[ \frac{6P_{x-2}^3}{Pr_{x-2}} \right]^3 \text{ is a perfect square.}$$

$$3. 6 \left[ \frac{2P_{u-1}^5}{t_{4,v-1}} \right]^2 - 18 \left[ \frac{36P_{w-2}^3}{S_{w-1}-1} \right]^3 \text{ is a Nasty number.}$$

$$4. \left[ \frac{4P_x^5}{Ct_{4,x}-1} \right]^2 \left[ \frac{P_y^5}{t_{3,y}} \right] + \left[ \frac{12P_y^5}{s_{y+1}-1} \right]^2 \left[ \frac{6P_{x-2}^3}{Pr_{x-2}} \right] \equiv 0(\text{mod } 3)$$

### CONCLUSION

To conclude, one may search for other patterns of solutions and their corresponding properties.

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**AN ASSESSMENT OF PUBLIC DEBT SUSTAINABILITY OF SUB-NATIONAL GOVERNMENT:  
THE CASE OF ASSAM IN INDIA**

**MRINMOYEE BAISHYA AND PROFESSOR GAYATRI GOSWAMI**

**ABSTRACT**

*Assam is very much dependent on state finances as there is less investment by private sectors due to various infrastructural and geographical factors. The implementation of Assam Fiscal Responsibility and Budget Management Act (AFRBM), 2005 helped in reviving the poor fiscal situation of Assam to a great extent. This paper analyses the issue of debt sustainability for Assam after the implementation of the AFRBM act. For this purpose Domar stability condition, indicator based approach and co-integration technique has been used. Domar stability condition showed that the sustainability condition was fulfilled but the solvency condition was not fulfilled. Whereas indicator approach as well as time series analysis showed Assam's public debt to be sustainable. The state not only enjoyed surpluses in its revenue and primary account after the implementation of the AFRBM act which helped in maintaining the sustainability of the debt situation.*

**Keywords:** debt, sustainability, AFRBM, indicator approach

**JEL Classification:** H62, H63

**1 INTRODUCTION**

Over the years debt sustainability has been frequently used in academic literature, as well as in policy formulations. Both advanced, as well as developing countries have recognized debt sustainability as a precondition for financial stability. Especially in case of developing countries, where expenditure commitments are more as compared to the volume of revenue collections, the government's deficit increases and hence resorts to borrowings. Borrowings are not harmful as long as it is used for productive purposes. But it may lead to macroeconomic instability if there is too much of debt accumulation. From various research analysis on debts and deficits it has been come to an agreement that the debt should be controlled instead of removing it which involves an economic cost. In this context debt sustainability is an important matter of concern. Sustainability refers to the government's ability to service its debt (RBI, 2005).

The high public debt and debt sustainability has been a source of concern for India. There was once a time, when public debt was considered desirable for any developing country because, it was assumed that the funds received from borrowing could be used for capital investment. But neither the state government nor the central government could fulfill such assumption. The country's debt situation has worsened considerably from the mid-1990s onwards, both at the centre and state. The state government's fiscal indicators deteriorated and the public debt increased tremendously which led to macroeconomic instability of the country. And that is why; one of the main purposes of the Twelfth Finance Commission was to examine the debt sustainability of states. Since the mid-1980s, the state governments of India have been facing severe fiscal stress. Such fiscal stress emerges because of the receipts unable to meet expenditures, low level of tax and non-tax receipts, losses suffered by state government enterprises and delaying movement of center's resources (Patnaik *et al.*, 2003). These factors have resulted in the worsening of state finances. The responsibilities of the state governments are varied and they are entrusted with the job of smooth distribution of goods and services towards its public. In doing so the associated expenditures are usually higher in comparison with its revenues and the central transfers. The important thing to consider here is whether the states are capable enough to fund its borrowings. That is why evaluating debt sustainability of states is an important topic of concern.

The issue of sustainability is more significant in case of the poorer Indian states like Assam which has been facing with a slow development pace in comparison to the rest of the country. Assam is a special category state which is gateway to the Northeast India. Although the Fourteenth Finance Commission has removed the special category status but Assam was given the special category status along with the other north eastern states and the state enjoyed fiscal relief for quite some time. The per capita growth rate of Assam was once higher than the national average during times of independence but the growth kept on slowing down and it fell below the national average for the time period 2000 to 2014 (World Bank Report, 2017). It is very much dependent on public spending as private investments are considerably poor due to various geographical and infrastructural bottlenecks. Assam has been witnessing high fiscal deficits and public debt since the 1990s. High level of revenue deficits was one of the significant reasons for this rise in public debt. With changes in the pay

commission the state's expenditure burden increased to such an extent that it had to borrow money to finance its committed expenditures resulting in late payments of salaries, pensions and other developmental commitments. Because of the state government's constant reformatory initiatives throughout that time, Assam's budgetary situation improved significantly in 2005-06. To correct the unsustainable fiscal shift of the central government and as a measure of fiscal consolidation the Fiscal Responsibility and Budget Management Act, 2003 (FRBM Act) was enacted by the Indian government. The national FRBM legislation was supposed to be repeated for all individual states in order for them to fulfill the same set of objectives in their budgets, putting them on a path of fiscal consolidation (Barua *et al.*, 2018). Accordingly Government of Assam also enacted the Assam Fiscal Responsibility and Budget Management Act (AFRBM), 2005 and Assam Fiscal Responsibility and Budget Management Act (Amendment), 2011 with an aim of managing the state finances in a better way, achieving fiscal sustainability and overall improving the social structure of the state (Government of Assam, 2005). The implementation of the AFRBM Act in 2005 changed Assam's budgetary position significantly and the state was able to achieve some targets as specified in the AFRBM act. In this backdrop the current study attempts to examine Assam's debt sustainability position in light of the implementation of AFRBM Act.

## **2 LITERATURE REVIEW**

Numerous studies on debt and fiscal sustainability have been undertaken. Some of them are discussed in brief here.

In the international context the studies undertaken by Hamilton and Flavin (1985), Wilcox (1989) etc. made significant impact in the literature of sustainability. They used the unit root test and co-integration to measure sustainability. Hamilton and Flavin (1985) studied the sustainability of U.S budget deficit from 1964 to 1982 and found the sustainability of U.S budget deficits to be weak. Again Wilcox (1989) examined the sustainability of public debt for U.S covering the same time period as Hamilton and Flavin (1985) and found it to be unsustainable. Baglioni and Cherubini (1993) examining the stationarity of public debt concluded the public debt of Italy to be unsustainable.

Blanchard (1990) developed a set of sustainability indicators based on the inter temporal budget constraint and applied it to the OECD countries and found many countries enjoying a sustainable debt position. Haug (1991) used unit root tests and co-integration techniques to study the debt sustainability of U.S government and found that debt financing was not done by issuing new debt and concluded the debt situation to be sustainable. Afonso (2004) used co-integration analysis and found unsustainable debt situation of the European Union countries for the time period 1970-2003. Kiran (2011) found the fiscal deficit of Turkey to be sustainable using co-integration techniques.

In the Indian context studies tried to analyse the sustainability issue in the national as well as sub-national levels. Pattnaik *et al.* (2003) assessed the fiscal sustainability of India's public debt using Domar's model, indicator approach, intertemporal budget constraint and also model based approach. All of the four approaches, more or less showed the debt situation to be unsustainable. Dholakia and Karan (2005) examined the debt sustainability from 1989-90 to 2003-04. Using a criterion of nominal growth rate and nominal effective interest rate to the study they found out that the non-special category states were more sustainable than the special category states. Olekalns and Cashin (2000) used co-integration of central government tax collection and expenditure to assess India's fiscal sustainability and concluded that it was unsustainable in the long run. Kaur *et al.* (2018) examined empirically the debt situation of Indian states with inter temporal budget constraint and fiscal policy response function and found them to be sustainable in long run. Using Domar stability condition Nayak and Rath (2009) found out that apart from Arunachal Pradesh, India was successful in achieving debt sustainability in all its states during the time period 1991-2009. Misra *et al.* (2020) investigated the debt sustainability of India's state governments by using indicator approach and fiscal policy response function. Results showed that the states were not in a favourable position as there existed signs of unsustainability.

Dutta and Dutta (2014) examined the debt and fiscal situation of Assam using Domar stability condition and co-integration technique. The results showed sustainability of the debt situation. Makin and Arora (2012) investigated the sustainability of public debt of the Indian states from 1990-91 to 2009-10. To measure sustainability the authors calculated primary balance which will be required to stabilise debt levels and results showed that public debt to GSDP had stabilised for most of the Indian states. Maurya (2013) examined Uttar Pradesh's debt sustainability using indicator approach and present value budget constraint approach and the results showed that the state achieved debt sustainability in the post FRBM period.

The review of the empirical literature shows that, there has been limited number of studies focusing on the sub-national debt sustainability of India and only one study has been undertaken in the context of Assam. It is

important to analyse the debt sustainability of an underdeveloped state like Assam since it is very much dependent on central loans and borrowings. Most of the state enterprises in the state are either not functional or working in losses. State government guarantees, which constitute off-budget borrowings, have been increasing for the state. Also in the earlier study the implementation of the AFRBM act and its consequent effect on the fiscal position of Assam was not given much attention.

### **3 METHODOLOGY**

The above analysis of the various empirical literatures reveals that the issue of debt sustainability is basically measured by the indicator approach and applying econometrics techniques like stationarity tests and co-integration analysis. Keeping this in mind, in the present study, Domar stability condition, indicator based approach and co-integration analysis is used. The present study is entirely dependent on secondary sources of information and time period taken is from 2005-06 to 2018-19 considering the implementation of AFRBM act. The data is accumulated from various publications such as Handbook of Statistics on Indian Economy- Reserve Bank of India, State Finances: A Study of Budgets- Reserve Bank of India (multiple years), Directorate of Economics and Statistics, Government of Assam.

The debt to GSDP ratio and the interest payment to revenue receipt ratio are calculated to assess the burden of public debt.

Debt sustainability and solvency can be understood by examining indicators like GSDP growth, average interest rate and public debt growth rate, among others (Dutta and Dutta, 2014). Domar (1944) was the first one to develop a framework to measure debt sustainability. The Domar stability condition states that the growth rate of income must be greater than the interest rate on public debt. Or it can be expressed as-

$$Y-R>0$$

$$\text{And } R = (IP)_t / (D)_{t-1}$$

where,  $Y$ = growth of income or GDP

$R$ = interest rate

$(IP)_t$ = interest payment at time period t

$D$  = outstanding debt at time period (t-1)

According to Domar (1944), one of the most necessary conditions for a country's debt to be sustainable is "growth rate of income must be greater than interest rate given primary balance is zero or positive". Domar's criteria for public debt solvency and sustainability is  $k \leq r \leq g$  i.e.

*growth rate of public debt ≤ interest rate ≤ growth rate of GSDP* when a sub national economy operates on the basis of mounting primary deficit.

The indicator based approach considers the borrower's creditworthiness with the use of indicators. The indicator approach considers a set of indicators that aid in determining the government's ability to repay and cover interest payments. The intertemporal budget constraint is the basis for these indicators (Marini and Piergallini, 2007; Misra et al., 2020). According to the intertemporal budget constraint the initial debt stock equals the projected present value of future primary surpluses. The prerequisite for sustainability is - public debt growth rate should not exceed GDP growth rate and primary balance should be positive. Although these are the basic indicators which indicates the sustainable position, but other indicators have been incorporated in the indicator based approach. These indicators give a picture of the growth, liquidity and serviceability of debt. Some of the examples of such indicators are interest payment to current revenue ratio, as well as the difference between rate of increase in debt and the rate of nominal GDP growth (Misra et al., 2020). All the indicators hold a significant meaning and can be interpreted as follows-

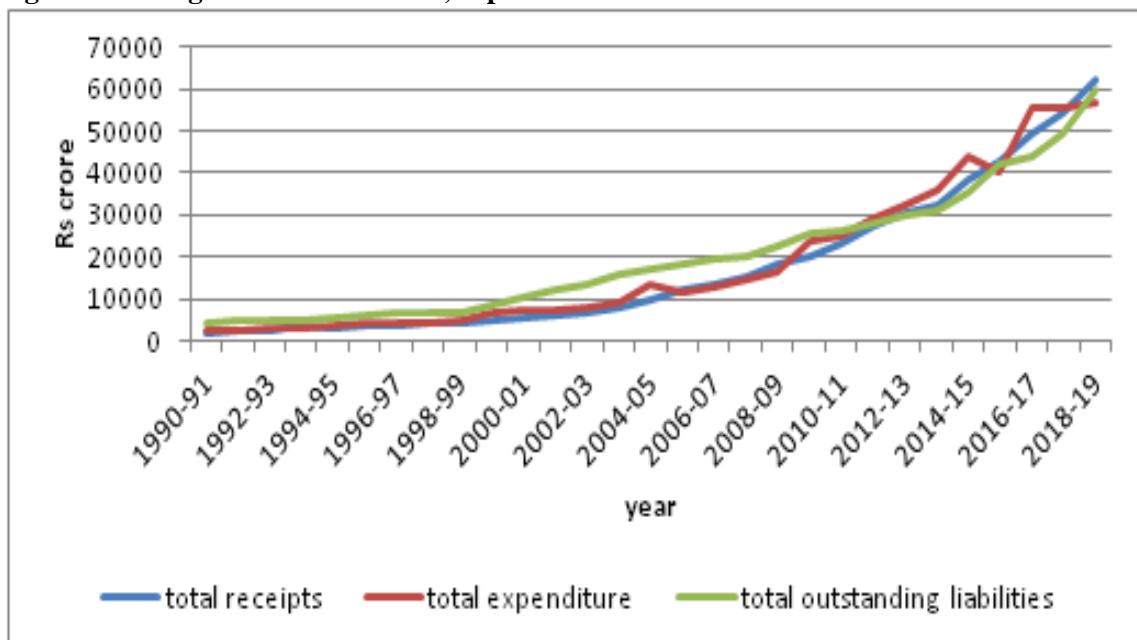
The indicator growth rate of GDP should be greater than growth rate of debt measures sustainability in absolute terms. Primary balance is an important indicator of sustainability. If a government is able to service all the outstanding debts by creating primary surpluses from future budgetary outcome then the debt situation is said to be sustainable according to inter temporal budget constraint. This is in line with Domar's stability condition. Higher revenue receipts as a percent of GDP will reflect a better financial position for the economy. The indicator debt to revenue receipts shows how much of the income earned by the government is used for borrowing. Meanwhile interest payment as a percentage of revenue expenditure and revenue receipts are debt servicing indicators since they show how much money is spent for giving away the interest payments.

Co-integration technique is used to check if there is any relationship among the fiscal variables in long duration and measure sustainability. Hamilton and Flavin (1986), Trehan and Walsh (1988), Wilcox (1989), Bohn (1989) pioneered in using the unit root test and co-integration techniques for assessing sustainability. According to the unit root test if public debt is stationary then it will imply sustainability. The co-integration between the government revenue and government expenditure is also checked. If there is any long run relationship between these two variables then it means, the government's spending plans are based on the revenue it generates.

#### 4 RESULTS AND DISCUSSION

Public debt comprises of all the financial liabilities of the government. The term sustainability in relation to public debt refers to the ability of the government to pay back their debt. If government is not able to bring about enough current revenues to service its debt then it will either have to borrow more or it will become defaulter which is detrimental for the fiscal health of the economy. When a government is unable to repay its loan then it becomes insolvent and that is why debt sustainability emphasises on the government's ability to service its obligations. Before diving into debt sustainability it's vital to look into the state government's revenue, expenditure and debt trends. Among all the revenue sources, the share of central taxes is highest in the state. Being a special category state Assam has been enjoying special grants. In spite of it the revenue resources of the state are always deficient and borrowings are high. The following figure shows the trends of Assam's revenue, expenditure and debt.

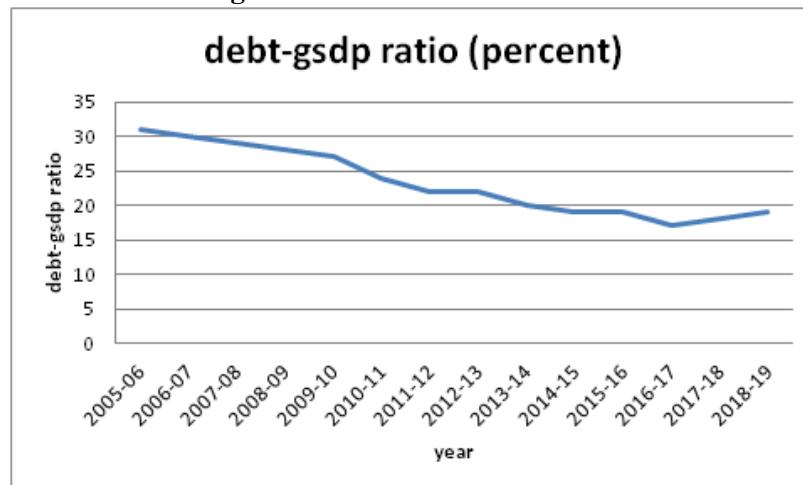
**Fig1: Trend of government revenue, expenditure and debt of Assam from 1990-91 to 2018-19**



In figure 1 the time period taken is from 1990-91 to 2018-19 taking into consideration the reform period. Along with the whole nation, Assam too went under the reformatory process. In respect to the receipts of the state, Assam's dependency on central taxes is very high and after the AFRBM act was implemented its dependency increased more. One of the problems faced by the state in recent years is inadequacy of own tax revenue as well as deterioration in the buoyancy of own tax revenue. Growth of total expenditure of Assam was high post AFRBM specially the year 2009 saw an unexpected growth of 43.4 percent. This can be attributed to the state's new pay commission. The outstanding liabilities have been increasing tremendously in Assam after liberalisation. The liabilities increased from Rupees 4341 crores in 1990-91 to Rupees 59796 crores in 2018-19 exhibiting a compound annual growth rate of 9.46%. The liabilities were always higher than the receipts and expenditure of the state, but after 2010-11 the liabilities started falling in comparison to receipts and expenditures.

Analysing a country's debt to GDP ratio over through a period of time also gives an indication of its sustainability. Although it is difficult to determine a debt to GDP ratio that is sustainable, the Twelfth Finance Commission proposed a debt to GDP ratio of 28 percent as an acceptable level (Twelfth Finance Commission, 2004). Another important thing to consider in determining sustainability is the ratio of interest payments to revenue receipts. And the Finance Commission suggested 15 percent to be acceptable level. The debt-GSDP ratio and the ratio of interest payments to revenue receipt of Assam of the study period is given as follows-

**Fig 2: Debt-GSDP ratio of Assam**



**Fig 3: Interest payment to revenue receipts ratio of Assam**

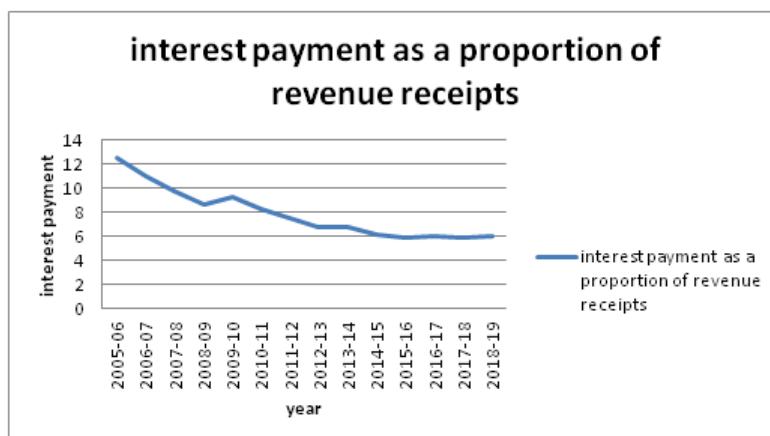


Fig 2 and 3 shows that the debt to GSDP ratio along with the interest payments to revenue receipts ratio of Assam have significantly declined following the implementation of AFRBM act. The policies of fiscal consolidation have helped to bring down these ratios improving the fiscal health of the state which was not in a good shape earlier. Although the debt-GSDP ratio has shown some increase during 2017-18 and 2018-19 but remains significantly below the prescribed limit of the Twelfth Finance Commission which is a good sign for the economy.

The average interest rate of Assam for the study period is calculated and shown in the following Table 1

**Table 1: Growth rate of GSDP and Average interest rate of Assam**

Year	Growth rate of GSDP (%)	Growth rate of public debt (%)	Average interest rate (%)	Primary deficit
2005-06	11.2	7.9	8.2	-1866
2006-07	8.9	5.9	7.8	-2227
2007-08	9.9	3.6	7.5	-2302
2008-09	14.1	12.9	6.9	-3000
2009-10	18.4	12.3	7.1	2211
2010-11	17.4	3.3	7.2	78
2011-12	11.7	5.6	7.4	-428
2012-13	9.9	6.1	7.1	-598
2013-14	15.2	4.5	7.1	1584
2014-15	15.3	14.5	6.6	3096
2015-16	23.1	18.3	6.3	-5624
2016-17	12.4	4.9	6.7	3162
2017-18	11.3	11.9	6.5	6087
2018-19	11.6	21.3	6.4	5566

Source: Computed. Data taken from State Finances: A study of budgets, various issues, RBI

Note:  $\text{average interest rate} = \text{interest payments/liabilities of previous year}$  (Pattnaik et al., 2003, Rath, 2005; Jadhav, 2006).

Looking at the trend of the given variables in table 1 it is clear that the state's debt position is sustainable. The growth rate of GSDP is higher as compared to average interest rate and the primary balance is in surplus except a few years. Since the growth rate of GSDP (g) exceeds the interest rate (r), the sustainability condition is fulfilled. The solvency condition has not been fulfilled since in many years the growth rate of public debt exceeds the interest rate. The high growth rate in 2009-10, 2017-18 and 2018-19 is due to persistent borrowing needed to fulfill the expenditure needs of the state. It arised because of the change in pay commission and its resultant expenditure commitments.

The state's debt sustainability is measured using the indicator approach which is shown in Table. The entire time span is divided into three phases viz. 2005-06 to 2009-10, 2010-11 to 2014-15 and 2015-16 to 2018-19.

**Table 2: Debt sustainability of Assam-Indicator based approach**

SI No.	Indicators	Symbolic Representation	2005-06 to 2009-10	2010-11 to 2014-15	2015-16 to 2018-19
1(a)	Rate of growth of debt should be lower than rate of growth of nominal GDP	D-G<0	-5.61	-7.27	4.27
1(b)	Rate of growth of debt should be lower than effective interest rate*	D-i<0	12.6	9.59	13.67
2(a)	Primary balances should be in surplus	PB/GDP>0	-2.24	0.39	0.29
2(b)	Primary revenue balance should be in surplus	PRB/GDP>0	-6.56	-2.61	-2.03
3(a)	Revenue receipts as a percent of GDP should increase over time	RR/GDP ↑↑	21.2	21.06	19.5
3(b)	Debt to revenue receipts ratio should decline over time	D/RR↓↓	1.35	1	0.92
3(c)	Debt to own tax revenue ratio should decline over time	D/TR↓↓	5.56	3.82	3.57
4(a)	Interest burden defined by interest payment as a percent of GDP should decline over time	IP/GDP↓↓	2.16	1.52	1.17
4(b)	Interest payment as a percent of revenue expenditure should decline over time	IP/RE↓↓	11.78	7.2	6.3
4(c)	Interest payment as a percent of revenue receipts should decline over time	IP/RR↓↓	10.24	7.1	5.15

Source: Calculated. Data taken from State Finances: A study of budgets, various issues, RBI

\*effective interest is the current interest payments as a percent of outstanding debt (Kaur et al., 2014)

The indicator analysis reveals that the growth rate of debt was less in comparison to nominal GDP in the first two phases but higher in the third phase. This was the outcome of huge fiscal deficit of the state in 2016-17 which increased the debt burden. The weight of committed expenditure increased as a result of the new State Pay Commission, and the state's budgetary imbalance increased. The fiscal deficit of the state went up to 7.85 percent in 2016-17.

Primary balance was maintained for the two phases and hence the sufficient condition of sustainability is fulfilled. For all the three phases the primary revenue balance was not in surplus.

Revenue receipts as a percentage of GDP shows to be declining over time but the rate of decline is not much significant. The adoption of AFRBM act brought about an improvement in the fiscal situation of Assam by achieving revenue surpluses from 2006-07 to 2008-09 and later in the years 2010-11, 2011-12, 2012-13 and 2013-14. There has been improvement in the tax collection of the state government although collection of non-tax revenue was not up to the mark. Debt to revenue receipts ratio and debt to own tax revenue ratio have been declining over the study period. Overall the indicators indicate towards the sustainable debt position of the Assam.

Another way of checking debt sustainability is to look at the relationship between the variables empirically. The co-integration technique has to be used to find out the long term relationship between the fiscal variables. For this, first stationarity test or unit root test has to be used for all the variables and after that co-integration method has to be applied. Table 3 shows the results of the Augmented Dickey Fuller test.

**Table 3: Augmented Dickey Fuller Unit Root Test for Revenue Receipt, Revenue expenditure and Total expenditure (1980-81 to 2018-19)**

Variables	t-statistic	1% level	5% level	10% level	P value
LNRE	-1.366905	-3.615588	-2.941145	-2.609066	0.5881
LNRR	0.045326	-3.615588	-2.941145	-2.609066	0.9569
LNTE	-1.297826	-3.621023	-2.943427	-2.610263	0.6203
First Difference					
LNRE	-6.698724	-3.621023	-2.943427	-2.610263	0.0000
LNRR	-8.660566	-3.621023	-2.943427	-2.610263	0.0000
LNTE	-8.185202	-3.621023	-2.943427	-2.610263	0.0000

Source: Author's own calculation using EViews 12

It is evident from Table 3 that the variables are integrated of the first order. So now the Johansen cointegration test will be applied for revenue expenditure and revenue receipts and revenue receipts and total expenditure, which is shown in table 4 and table 5

#### Johansen Cointegration Test

**Table 4: Unrestricted Cointegration Rank Test (Trace) between Revenue Expenditure and Revenue Receipts**

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. **
None *	0.291253	16.59190	15.49471	0.0341
At most 1*	0.098931	3.854399	3.841465	0.0496

Source: Author's own calculation using EViews 12

**Table 5: Unrestricted Cointegration Rank Test (Trace) between Revenue Receipts and Total Expenditure**

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.5 Critical Value	Prob. **
None*	0.411935	22.35792	15.49471	0.0040
At most 1*	0.070725	2.713978	3.841465	0.0995

Source: Author's own calculation using EViews 12

The Johansen cointegration test suggests that co-integration exist between the variables, revenue expenditure and revenue receipts and revenue receipts and total expenditure. Since long run relationship exists between the variables the short run analysis is studied by using the error correction model. The error correction model involves the following equations.

$$DLNRR_t = \alpha_1 + \rho_1 ECT1_{t-1} + \beta_{11} DLNRR_{t-1} + \gamma_1 DLNTE_{t-1} + \varepsilon_{1t} \quad 1$$

$$DLNTE_t = \alpha_2 + \rho_2 ECT2_{t-1} + \beta_{21} DLNTE_{t-1} + \gamma_2 DLNRR_{t-1} + \varepsilon_{2t} \quad 2$$

$$DLNRE_t = \alpha_3 + \rho_3 ECT3_{t-1} + \beta_{31} DLNRE_{t-1} + \gamma_3 DLNRR_{t-1} + \varepsilon_{3t} \quad 3$$

$$DLNRR_t = \alpha_4 + \rho_4 ECT4_{t-1} + \beta_{41} DLNRR_{t-1} + \gamma_4 DLNRE_{t-1} + \varepsilon_{4t} \quad 4$$

Where  $DLNRR_t, DLNTE_t, DLNRE_t$  represents the first difference of logarithm of revenue receipts, total expenditure and revenue expenditure respectively.  $ECT1_{t-1}, ECT2_{t-1}, ECT3_{t-1}, ECT4_{t-1}$  are the error correction terms.  $\alpha, \beta, \gamma$  are short run coefficients and  $\varepsilon_t$ s are the residual terms.

Now according to all the lag selection criteria like Akaike information criterion, Schwarz information criterion, Hannan-Quinn information criterion the appropriate lag is 1. The result of the error correction model is given below

Table 6: Result of error correction model

Dependent variable	Variables	Coeffecient	Standard error	t statistic	Probability
$DLNRR_t$	$\alpha_1^*$	0.161837	0.020978	7.714500	0.0000
	$ECT1_{t-1}^*$	-0.501438	0.130950	-3.829224	0.0003
	$DLNRR_{t-1}^{**}$	0.102688	0.109912	0.934273	0.3536
	$DLNTE_{t-1}^{**}$	-0.282710	0.131760	-2.145651	0.0356
$DLNTE_t$	$\alpha_2^*$	0.156448	0.033612	4.654562	0.0000
	$ECT2_{t-1}^{**}$	-0.254184	0.221107	-1.149598	0.2545
	$DLNTE_{t-1}^{**}$	-0.169775	0.211108	-0.804210	0.4242
	$DLNRR_{t-1}$	-0.076266	0.176103	-0.433074	0.6664
$DLNRE_t$	$\alpha_3^*$	0.138179	0.031139	4.437530	0.0000
	$ECT3_{t-1}^{**}$	-0.339268	0.175779	-1.930084	0.0579
	$DLNRE_{t-1}$	0.040808	0.193694	0.210680	0.8338
	$DLNRR_{t-1}$	-0.078841	0.137721	-0.572472	0.5689
$DLNRR_t$	$\alpha_4^*$	0.141692	0.026939	5.259778	0.0000
	$ECT4_{t-1}^{**}$	-0.337969	0.148280	-2.279257	0.0259
	$DLNRR_{t-1}$	0.036397	0.119146	0.305482	0.7610
	$DLNRE_{t-1}$	-0.053825	0.167570	-0.321207	0.7491

Source: Author's own calculation using EViews 12. \* (\*\*) implies 5% and (1%) level of significance

Table 6 shows the result of error correction model which is based on the equations 1, 2, 3 and 4. It is evident from the table that the coefficient of the error correction term of the revenue receipts variable is significant and negative. It implies that any deviation of the revenue receipts series from the long run gets corrected automatically at 50%. The coefficient of the error correction term of the total expenditure is negative and significant and the deviation from the long run equilibrium is corrected at 25%. Similarly the error correction term of revenue expenditure and revenue receipts are negative and significant and the deviations from the long run equilibrium gets corrected at 33.9% and 33.7% respectively. The significance of the error terms signifies that there is relationship between revenue receipts and total expenditure and revenue expenditure and revenue receipts in the short run. It can be concluded from the above analysis that Assam's fiscal position is stable.

## 5 CONCLUSION

The implementation of AFRBM act revived the ailing fiscal situation of Assam. Assam is very much dependent on central government funds and borrowings but with the reformatory measures adopted by the state it has been able to lower down its share in central government borrowings. The above discussion shows that implementation of the act not only brought surpluses in the state's revenue account but also helped the state to maintain a sustainable debt position which is an important indicator of fiscal prudence. Throughout the study period, the state was able to maintain a stable debt to GSDP ratio and one of the reasons is the primary surplus achieved by the state. Overall the incentives provided by the Twelfth and Thirteenth and Fourteenth Finance Commissions and the overall reformatory measures undertaken by the state government helped in achieving a sustainable debt situation of Assam. Both the indicator based approach as well as time series analysis revealed that Assam maintained a sustainable debt position.

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**ON THE HOMOGENEOUS CONE  $z^2 = 14x^2 + y^2$** **J. SHANTHI, T. MAHALAKSHMI, S. VIDHYALAKSHMI AND M.A. GOPALAN****ABSTRACT**

The homogeneous ternary quadratic equation given by  $z^2 = 14x^2 + y^2$  is analysed for its non-zero distinct integer solutions through different methods. A few interesting properties between the solutions are presented. Also, formulae for generating sequence of integer solutions based on the given solution are presented.

**Keywords:** Ternary quadratic, Integer solutions, Homogeneouscone.

**NOTATION**

$$t_{m,n} = n \left[ 1 + \frac{(n-1)(m-2)}{2} \right]$$

**INTRODUCTION**

It is well known that the quadratic Diophantine equations with three unknowns (homogeneous or non-homogeneous) are richin variety [1, 2]. In particular, the ternary quadratic Diophantine equations of the form  $z^2 = Dx^2 + y^2$  are analysed for values of D=29,41,43,47, 53, 55, 61, 63, 67in [3-11]. In this communication, yet another interestinghomogeneousternary quadratic diophantine equation given by  $z^2 = 14x^2 + y^2$  is analysed for its non-zero distinct integer solutions through different methods. A few interesting properties between the solutions are presented. Also, formulas for generating sequence of integer solutions based on the given solution are presented.

**METHODS OF ANALYSIS**

The ternary quadratic equation to be solved for its integer solutions is

$$z^2 = 14x^2 + y^2 \quad (1)$$

We present below different methods of solving (1):

**METHOD: 1**

(1) Is written in the form of ratio as

$$\frac{z+y}{14x} = \frac{x}{z-y} = \frac{\alpha}{\beta}, \beta \neq 0 \quad (2)$$

which is equivalent to the system of double equations

$$14\alpha x - \beta y - \beta z = 0$$

$$\beta x + \alpha y - \alpha z = 0$$

Applying the method of cross-multiplication to the above system of equations,

$$x = x(\alpha, \beta) = 2\alpha\beta$$

$$y = y(\alpha, \beta) = 14\alpha^2 - \beta^2$$

$$z = z(\alpha, \beta) = 14\alpha^2 + \beta^2$$

which satisfy (1)

**PROPERTIES**

- $z(\alpha, 1) - t_{30,\alpha} \equiv 1 \pmod{13}$
- $z(\alpha, \beta) + y(\alpha, \beta) - 14x(\alpha, 1) + \alpha = t_{58,\alpha}$

- $z(\alpha, \beta) + y(\alpha, \beta) - t_{26,\alpha} - t_{34,\alpha} \equiv 0 \pmod{26}$

**NOTE: 1**

It is observed that (1) may also be represented in the form of ratio as below:

$$(i) \frac{z+y}{2x} = \frac{7x}{z-y} = \frac{\alpha}{\beta}, \beta \neq 0$$

The corresponding solutions to (1) are given as:

$$x = 2\alpha\beta, y = 2\alpha^2 - 7\beta^2, z = 2\alpha^2 + 7\beta^2$$

$$(ii) \frac{z+y}{7x} = \frac{2x}{z-y} = \frac{\alpha}{\beta}, \beta \neq 0$$

The corresponding solutions to (1) are given as:

$$x = 2\alpha\beta, y = 7\alpha^2 - 2\beta^2, z = 7\alpha^2 + 2\beta^2$$

**METHOD: 2**

(1) Is written as the system of double equation in Table 1 as follows:

**Table: 1 System of Double Equations**

System	I	II	III	IV
$z+y =$	$14x$	$x^2$	$7x^2$	$7x$
$z-y =$	$x$	$14$	$2$	$2x$

Solving each of the above system of double equations, the value of  $x, y$  &  $z$  satisfying (1) are obtained. For simplicity and brevity, in what follows, the integer solutions thus obtained are exhibited.

**SOLUTIONS FOR SYSTEM: I**

$$x = 2k, y = 13k, z = 15k$$

**SOLUTIONS FOR SYSTEM: II**

$$x = 2k, y = 2k^2 - 7, z = 2k^2 + 7$$

**SOLUTION FOR SYSTEM: III**

$$x = 2k, y = 14k^2 - 1, z = 14k^2 + 1$$

**SOLUTION FOR SYSTEM: IV**

$$x = 2k, y = 5k, z = 9k$$

**METHOD: 3**

Let  $z = y + 2k, k \neq 0$

$$\therefore (1) \Rightarrow 4ky = 14x^2 - 4k^2 \quad (3)$$

Assume

$$x = 2k \quad (4)$$

$$\therefore y = 13k \quad (5)$$

In view of (3)

$$z = 15k \quad (6)$$

Note that (4), (5), (6) satisfy (1)

**METHOD: 4**

(1) Is written as

$$y^2 + 14x^2 = z^2 = z^2 * 1 \quad (7)$$

Assume z as

$$z = a^2 + 14b^2 \quad (8)$$

Write 1 as

$$1 = \frac{(13 + 2i\sqrt{14})(13 - 2i\sqrt{14})}{15^2} \quad (9)$$

Using (8) & (9) in (7) and employing the method of factorization, consider

$$(y + i\sqrt{14}x) = (a + i\sqrt{14}b)^2 \cdot \frac{13 + 2i\sqrt{14}}{15}$$

Equating real & imaginary parts, it is seen that

$$\begin{aligned} x &= \frac{1}{15} [2a^2 - 28b^2 - 26ab] \\ y &= \frac{1}{15} [13a^2 + 182b^2 - 56ab] \end{aligned} \quad \left. \right\} \quad (10)$$

Since our interest is to find the integer solutions, replacing  $a$  by 15A &  $b$  by 15B in (8) & (10), the corresponding integer solutions to (1) are given by

$$\begin{aligned} x &= x(A, B) = 15[2A^2 - 28B^2 - 26AB] \\ y &= y(A, B) = 15[13A^2 + 182B^2 - 56AB] \\ z &= z(A, B) = 15^2[A^2 + 14B^2] \end{aligned}$$

**PROPERTIES:**

- $\frac{5x(A, 1)}{15} - t_{22, A} \equiv -1 \pmod{139}$
- $\frac{5y(A, 1)}{15} - t_{132, A} \equiv 210 \pmod{280}$
- $\frac{y(A, 1)}{15} - t_{28, A} \equiv 6 \pmod{44}$

**NOTE :2**

It is worth to observe that, one may write 1 in general as

$$1 = \frac{[(14r^2 - s^2) + i\sqrt{14} \cdot 2rs][(14r^2 - s^2) - i\sqrt{14} \cdot 2rs]}{(14r^2 + s^2)^2} \quad (11)$$

For the above choice, the corresponding values of x, y, z satisfying (1) are given below:

$$\begin{aligned} x &= 14r^2 + s^2 [2rs(A^2 - 14B^2) + 2AB(14r^2 - s^2)] \\ y &= (14r^2 + s^2)[(14r^2 - s^2)(A^2 - 14B^2) - 56ABrs] \\ z &= (14r^2 + s^2)^2(A^2 + 14B^2) \end{aligned}$$

The choice  $r = 1, s = 1$  in (11) leads to (9). However, in this case, there is an another representation for 1 given by

$$1 = \frac{(5+i2\sqrt{14})(5-i2\sqrt{14})}{9^2}$$

For the above choice, the corresponding value of  $x, y, z$  satisfying (1) are given below:

$$x = 9[2A^2 - 28B^2 + 10AB]$$

$$y = 9[5A^2 - 70B^2 - 56AB]$$

$$z = 9^2[A^2 + 14B^2]$$

The readers of this paper may attempt for finding integer solution to (1) by considering other values of  $r$  and  $s$  in (11).

#### METHOD: 5

(1) Is written as

$$z^2 - 14x^2 = y^2 = y^2 * 1 \quad (12)$$

Assume  $y$  as

$$y = a^2 - 14b^2 \quad (13)$$

Write 1 as

$$1 = \frac{(9+2\sqrt{14})(9-2\sqrt{14})}{5^2} \quad (14)$$

Using (13) & (14) in (12) and employing the method of factorization, consider

$$(z+14x) = (a+\sqrt{14}b)^2 \cdot \frac{(9+2\sqrt{14})}{13}$$

Equating rational and irrational parts, it is seen that,

$$\begin{aligned} x &= \frac{1}{3}(9a^2 + 126b^2 + 56ab) \\ z &= \frac{1}{3}(2a^2 + 28b^2 + 18ab) \end{aligned} \quad (15)$$

Since our interest to find the integer solution, replacing  $a$  by 3A &  $b$  by 3B in (13)& (15), the corresponding integer solutions to (1) are given by

$$x = x(A, B) = 3[2A^2 + 28B^2 + 18AB]$$

$$y = y(A, B) = 3^2[A^2 - 14B^2]$$

$$z = z(A, B) = 3[9A^2 + 126B^2 + 56AB]$$

#### NOTE: 3

In addition to (14), 1 can be represented as follows,

$$(i) \quad 1 = \frac{(15+2\sqrt{14})(15-2\sqrt{14})}{13^2}$$

For the above choice, the corresponding values of  $x, y, z$  satisfying (1) are given below:

$$x = 13[2A^2 + 28B^2 + 30AB]$$

$$y = 13^2[A^2 - 14B^2]$$

$$z = 13[15A^2 + 210B^2 + 56AB]$$

$$(ii) \quad 1 = \frac{(2k^2 + 7 + 2k\sqrt{14})(2k^2 + 7 - 2k\sqrt{14})}{(2k - 7)^2}$$

For the above choice, the corresponding values of  $x, y, z$  satisfying (1) are given below:

$$x = (2k - 7)[2kA^2 + 28kB^2 + (4\sqrt{14}k^2 + 4\sqrt{14})AB]$$

$$y = (2k - 7)^2[A^2 - 14B^2]$$

$$z = (2k - 7)[(2k + 7)A^2 + (28k^2 + 98)B^2 + 56kAB]$$

$$(iii) \quad 1 = \frac{(14k^2 + 1 + 2k\sqrt{14})(14k^2 + 1 - 2k\sqrt{14})}{(14k^2 - 1)^2}$$

For the above choice, the corresponding values of  $x, y, z$  satisfying (1) are given below:

$$x = (14k^2 - 1)[2kA^2 + 28kB^2 + (28k^2\sqrt{14} + 2\sqrt{14})AB]$$

$$y = (14k^2 - 1)^2[A^2 - 14B^2]$$

$$z = (14k^2 - 1)[(14k^2 + 1)A^2 + (14 + 196k^2)B^2 + 56kAB]$$

$$(iv) \quad 1 = \frac{(14r^2 + s^2 + \sqrt{14}(2rs))(14r^2 + s^2 - \sqrt{14}(2rs))}{(14r^2 - s^2)^2}$$

For the above choice, the corresponding values of  $x, y, z$  satisfying (1) are given below:

$$x = (14k^2 - s^2)[2rsA^2 + 28rsB^2 + (28r^2 + 2s^2)AB]$$

$$y = (14r^2 - s^2)^2[A^2 - 14B^2]$$

$$z = (14r^2 - s^2)[(14r^2 + s^2)A^2 + (14s^2 + 196r^2)B^2 + 56rsAB]$$

### GENERATION OF SOLUTIONS

Different formulas for generating sequence of integer solutions based on the given solution are presented below:

Let  $(x_0, y_0, z_0)$  be any given solution to (1)

### FORMULA: 1

Let  $(x_1, y_1, z_1)$  given by

$$x_1 = 3x_0, \quad y_1 = 3y_0 + h, \quad z_1 = 2h - 3z_0 \quad (16)$$

Be the 2<sup>nd</sup> solution to (1). Using (16) in (1) and simplifying, one obtains

$$h = 2y_0 + 4z_0$$

In view of (16), the values of  $y_1$  and  $z_1$  are written in the matrix form as

$$(y_1, z_1)^t = M(y_0, z_0)^t$$

where

$$M = \begin{pmatrix} 5 & 4 \\ 4 & 5 \end{pmatrix} \text{ and } t \text{ is the transpose}$$

The repetition of the above process leads to the  $n^{th}$  solutions  $y_n, z_n$  given by

$$(y_n, z_n)' = M^n (y_0, z_0)'$$

If  $\alpha, \beta$  are the distinct eigen values of M, then

$$\alpha = 1, \beta = 9$$

We know that

$$M^n = \frac{\alpha^n}{(\alpha - \beta)} (M - \beta I) + \frac{\beta^n}{(\beta - \alpha)} (M - \alpha I), I = 2 \times 2 \text{ Identity matrix}$$

Thus, the general formulas for integer solutions to (1) are given by

$$x_n = 3^n x_0$$

$$y_n = \left( \frac{9^n + 1}{2} \right) y_0 + \left( \frac{9^n - 1}{2} \right) z_0$$

$$z_n = \left( \frac{9^n - 1}{2} \right) y_0 + \left( \frac{9^n + 1}{2} \right) z_0$$

## FORMULA: 2

Let  $(x_1, y_1, z_1)$  given by

$$x_1 = h - 15x_0, y_1 = h - 15y_0, z_1 = 15z_0 \quad (17)$$

be the  $2^{nd}$  solution to (1). Using (17) in (1) and simplifying, one obtains

$$h = 28x_0 + 2y_0$$

In view of (17), the values of  $y_1$  and  $z_1$  are written in the matrix form as

$$(x_1, y_1)' = M(x_0, y_0)'$$

where

$$M = \begin{pmatrix} 13 & 2 \\ 28 & -13 \end{pmatrix} \text{ and } t \text{ is the transpose}$$

The repetition of the above process leads to the  $n^{th}$  solutions  $x_n, y_n$  given by

$$(x_n, y_n)' = M^n (x_0, y_0)'$$

If  $\alpha, \beta$  are the distinct eigen values of M, then

$$\alpha = 15, \beta = -15$$

Thus, the general formulas for integer solutions to (1) are given by

$$x_n = \frac{14\alpha^n + \beta^n}{15} x_0 + \frac{\alpha^n - \beta^n}{15} y_0$$

$$y_n = \frac{14}{15} (\alpha^n - \beta^n) x_0 + \frac{\alpha^n + 14\beta^n}{15} y_0$$

$$z_n = 15^n z_0$$

**FORMULA: 3**

Let  $(x_1, y_1, z_1)$  given by

$$x_1 = x_0 + h, \quad y_1 = y_0, \quad z_1 = 4h - z_0 \quad (18)$$

be the 2<sup>nd</sup> solution to (1). Using (18) in (1) and simplifying, one obtains

$$h = 14x_0 + 4z_0$$

In view of (18), the values of  $x_1$  and  $z_1$  are rewritten in the matrix form as

$$(x_1, z_1)^t = M(x_0, z_0)^t$$

where

$$M = \begin{pmatrix} 15 & 4 \\ 56 & 15 \end{pmatrix} \text{ and } t \text{ is the transpose}$$

The repetition of the above process leads to the  $n^{th}$  solutions  $x_n, y_n$  given by

$$(x_n, y_n)^t = M^n(x_0, z_0)^t$$

If  $\alpha, \beta$  are the distinct eigen values of M, then

$$\alpha = 15 + 4\sqrt{14}, \quad \beta = 15 - 4\sqrt{14}$$

Thus, the general formulas for integer solutions to (1) are given by

$$x_n = \left( \frac{\alpha^n + \beta^n}{2} \right) x_0 + \left[ \frac{\alpha^n - \beta^n}{2\sqrt{14}} \right] z_0$$

$$y_n = y_0$$

$$z_n = \frac{7}{\sqrt{14}} (\alpha^n - \beta^n) x_0 + \left( \frac{\alpha^n + \beta^n}{2} \right) z_0$$

**FORMULA:4**

Let  $(x_1, y_1, z_1)$  given by

$$x_1 = x_0 + h, \quad y_1 = y_0 + h, \quad z_1 = 4h - z_0 \quad (19)$$

be the 2<sup>nd</sup> solution to (1). Using (19) in (1) and simplifying, one obtains

$$h = 28x_0 + 2y_0 + 8z_0$$

In view of (19), the values of  $x_1, y_1$  and  $z_1$  are rewritten in the matrix form as

$$(x_1, y_1, z_1)^t = M(x_0, y_0, z_0)^t$$

where

$$M = \begin{pmatrix} 29 & 2 & 8 \\ 28 & 3 & 8 \\ 112 & 8 & 31 \end{pmatrix} \text{ and } t \text{ is the transpose}$$

The repetition of the above process leads to the  $n^{th}$  solutions  $x_n, y_n, z_n$  given by

$$(x_n, y_n, z_n)^t = M^n(x_0, y_0, z_0)^t$$

where,

$$M^n = \begin{pmatrix} \frac{14Y_{n-1} + 1}{15} & \frac{Y_{n-1} - 1}{15} & X_{n-1} \\ \frac{14}{15}(Y_{n-1} - 1) & \frac{Y_{n-1} + 14}{15} & X_{n-1} \\ 14X_{n-1} & X_{n-1} & Y_{n-1} \end{pmatrix}$$

in which

$$Y_{n-1} = \frac{1}{2} \left[ (31 + 8\sqrt{15})^n + (31 - 8\sqrt{15})^n \right],$$

$$X_{n-1} = \frac{1}{2\sqrt{15}} \left[ (31 + 8\sqrt{15})^n - (31 - 8\sqrt{15})^n \right], \quad n = 1, 2, 3, \dots$$

### OBSERVATION:

Let  $x, y, z$  be any known solution of (1). Let  $p, q$  be two distinct non-zero positive integers such that

$$p = x + z, \quad q = x$$

Treat  $p, q$  as the generators of the Pythagorean triangle  $(\alpha, \beta, \gamma)$ . Consider

$$\alpha = 2pq, \quad \beta = p^2 - q^2, \quad \gamma = p^2 + q^2$$

Then it is seen that  $7\beta - \alpha - 6\gamma$  is a perfect square.

### CONCLUSION

In this paper, an attempt has been made to obtain non-zero distinct integer solutions to the ternary quadratic Diophantine equation  $z^2 = 14x^2 + y^2$  representing homogeneous cone. As there are varieties of cones, the readers may search for other forms of cones to obtain integer solutions for the corresponding cones.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***GROWTH ANALYSIS OF LARGE CAPITAL COMPANIES WITH REFERENCE TO THE PHARMACEUTICALS AND FOOD & BEVERAGE SECTOR****MS. MANISHA K, DR. S. MANIKANDAN, DR. A. SAKTHIVEL AND PROF KM RAVI KUMAR****ABSTRACT**

This study aims to ascertain the growth analysis of potential in two different sectors is compared by selecting the two companies from each sector, two large capital companies of that particular sector is taken for the analysis. The purpose of the study is to analyze the two large capital companies of Pharmaceuticals and Food & Beverage sector and the determine which company has high risk and returns and low risk and returns, To regulate which is the best performed company and the stability of the growth in returns and risks of the company in that sectors will be having in the future can be determined. The study also focuses understanding about the performance of large-capital in both the pharmaceuticals and food and beverage sector. The analyze is procured using the Market Price, EPS and PE- Ratio and PEG-Ratio and PB Ratio of large-capital companies in each sector the descriptive statistics, correlation and ANOVA is generated to check the effectiveness and statistical significance. Hence comparison of Pharmaceutical and food & beverage sector results where to invest based on the returns and risk.

**Keywords:** Large capital, Market Price, EPS and PE- Ratio and PB-Ratio and PEG-Ratio.

**INTRODUCTION**

This study aims to determine the growth potential of two different sectors is compared by selecting the two companies from each sector; both the companies are large capital of that particular sector. The purpose of the study is to analyze the growth potential of each of the company in both the Pharmaceuticals and Food & Beverage sector and to determine the stability of the growth that in each company of that sectors by using PEG-ratio, PE-ratio, EPS, Market Price the analysis is done and then it results what will be having in the future can be determined. The study focuses on the comparison of two large capital companies in both pharmaceutical and food & beverage sector is determined by the analysis according to the returns and risks. And it will also determine whether the companies are having effective relationship among variables and the statistical significance is determined. The study also focuses understanding about the performance of large-capital companies in both the pharmaceuticals and food and beverage sector.

**LITERATURE REVIEW**

An organization's future ability of growth potential is to generate larger profits, expand its work force and increase production [1]. This research deals with the comparative growth potential in two different sectors. Now this study aims to analyze the growth of two sectors that are Pharmaceutical [2] and Food & Beverage [3&7] using Market price, Price to earnings ratio, Price to book value and Earnings per share. These values are used to determine the growth using large capital companies in both the sectors. The primary goal of this analysis is to find out the consistency of the growth in large capital companies in both the sectors and also to ascertain the company in which the sector will be having better growth[6], determine the effectiveness and statistical significance of each companies in both the sector and discover the future PE ratio[5] by finding the regression equation. The analysis is done using the coefficient of variance [4] which is used to determine the consistency in determining the growth and mean which is used to determine the performance of the companies.

**RESEARCH PROBLEM AND QUESTION**

- To ascertain the company in which the sector will be having better growth.
- To determine the effectiveness and statistical significance of each companies in both the sector
- To discover the future PE ratio by finding the regression equation and also the trend line representation of PE ratio.

**RESEARCH METHODOLOGY****Sampling and Data Collection:**

This research paper is an outcome of two different sector growths of stocks. The sample of the study consists of two companies from each large capital of Pharmaceutical and Food & Beverage sectors. Sample taken from Divis Laboratories and Dr.Reddy's Laboratories from Pharmaceutical industry and Nestle and Britannia from

Food & Beverage sector. All the data are secondary in nature and are collected from the Money Control portal. The samples taken from the period for the study is 2011 to 2020 and base year is 2010.

This article is an attempt to identify the determinant of P/E Ratio and PEG Ratio. So Price/Earnings Ratio and Price Earning Growth ratio are the dependent variable for this study. We have selected two factors i.e. Market share Price (MP) and Earnings per Share (EPS) for P/E Ratio and EPS Growth for PEG Ratio.

#### **Dependent Variable:**

Price-earnings ratio (P/E ratio): The price-earnings ratio (P/E ratio) measures its current share price relative to its per-share earnings. The price-earnings ratio is also sometimes known as the price multiple or the earnings multiple.

$$\text{Price-Earnings ratio (P/E ratio)} = \frac{\text{Market Share Price}}{\text{Earnings per Share}}$$

$$\text{Price Earnings Growth ratio (PEG ratio)} = \frac{\text{Price per Earning Ratio}}{\text{Earnings per Share Growth}}$$

#### **Independent Variables:**

##### **Market Price:**

A share price – or a stock price – is the amount it would cost to buy one share in a company. The price of a share is not fixed, but fluctuates according to market conditions. It will likely increase if the company is perceived to be doing well, or fall if the company isn't meeting expectations.

##### **Earnings per Share:**

Earnings per share or EPS are an important financial measure, which indicates the profitability of a company. It is calculated by dividing the company's net income with its total number of outstanding shares. It is a tool that market participants use frequently to gauge the profitability of a company before buying its shares.

#### **Procedure of Data Analysis:**

In this study, different statistical tools have been applied. SPSS Software used to find descriptive statistics, correlation and regression. Descriptive statistics has been performed to postulate statistical characterization of the variables. Correlation matrix executes the inter relationship among the variables whereas regression analysis is used to evaluate the determinative relationships of independent variables with the dependent variable. SPSS Software used to find the various

#### **Generation of Hypothesis:**

According to the objectives, and taking into account the previous research, the research hypotheses that this study investigates are:

HO1: There is no significant relationship between Market Price (MP) and P/E ratio.

HO2: There is no significant relationship between Earnings per share (EPS) and P/E ratio.

#### **RESULT AND DISCUSSION:**

#### **PHARMACEUTICAL SECTOR ANALYSIS:**

##### **Descriptive Statistics**

**Table-1: DIVIS**

	N	Minimum	Maximum	Mean	Std. Deviation
MARKET PRICE DIVIS	10	332.870	1857.730	9.08267E2	488.656494
EPS	10	32.900	63.820	4.61220E1	10.432620
Return in percentage DIVIS	10	-32.053	40.673	2.06707E1	23.964156
EPS Growth DIVIS	10	-34.441	54.237	8.74295	24.895801
PE RATIO DIVIS	10	9.500	35.829	1.99681E1	10.328463
PEG Ratio DIVIS	10	-4.340	20.515	1.83768	6.797462

\*Base Year 2010

Table -1 depicts the descriptive statistics of Divis Laboratories which includes minimum, maximum, mean and standard deviation. Market share Price describes a mean value of 908.3 with standard deviation of 488.7. Mean value of Earnings per Share is 46.1 and standard deviation 10.4. Mean value of return in percentage is 20.7 and

standard deviation of 23.9. Average growth of Divis Laboratories for years 2011 to 2020 is 8.7 and standard deviation 24.9. Mean of PE ratio is 19.9 and standard deviation 10.3. Average of PEG Ratio is 1.8 and standard deviation 6.8.

Mean Market Price of 2011 to 2020 is 908.3( $\pm$ 488.7) is lesser than current Market Price of 4989.9 shows positive growth and the average PE ratio for 2011-2020 of Divis Laboratories is 19.9 which is less than the current PE ratio of 62.6 will not be the good sign of growth performance. Current PEG ratio of Divis Laboratories is 1.280 which is lesser than the average PEG for the period 2011 to 2020 is 1.8; this represents positive sign of growth. However, the average EPS for the period 2011 to 2020 is 46.1 is less than current EPS of 77.20 which represents the good growth indication, but average EPS growth of Divis Laboratories is 8.7 which is lesser than 48.89, it indicates positive growth.

**Table-2: Dr.Reddy's**

	N	Minimum	Maximum	Mean	Std. Deviation
MARKET_PRICE	10	1649.980	3243.060	2.54269E3	615.186858
EPS	10	34.190	177.230	8.45500E1	39.856739
Return in Percentage	10	-21.049	38.389	1.07615E1	18.636125
EPS Growth Reddys	10	-58.832	130.229	2.68056E1	61.198554
PE RATIO Reddys	10	16.789	73.467	3.44699E1	15.374594
PEG Ratio Reddys	10	-2.481	16.030	2.87090	6.370850

\*Base Year 2010

Table -2 depicts the descriptive statistics of Dr.Reddy's Laboratories which includes minimum, maximum, mean and standard deviation. Market share Price describes a mean value of 2542.7 with standard deviation of 615.2. Mean value of Earnings per Share is 84.6 and standard deviation 39.9. Mean value of return in percentage is 10.8 and standard deviation of 18.6. Average growth of Dr.Reddy's Laboratories for years 2011 to 2020 is 26.8 and standard deviation 61.2. Mean of PE ratio is 34.5 and standard deviation 15.4. Average of PEG Ratio is 2.9 and standard deviation 6.4.

Mean Market Price of 2011 to 2020 is 2542.7( $\pm$ 615.2) is lesser than current Market Price of 4658.25 shows positive growth and the average PE ratio for 2011-2020 of Dr.Reddy's Laboratories is 34.5 which is less than the current PE ratio of 47.45 will not be the good sign of growth performance. Current PEG ratio of Dr.Reddy's Laboratories is -1.1553 which is lesser than the average PEG for the period 2011 to 2020 is 2.9; this represents positive sign of growth. However, the average EPS for the period 2011 to 2020 is 84.6 is less than current EPS of 104.44 which represents the good growth indication, but average EPS growth of Dr.Reddy's Laboratories is 26.8 which is higher than -41.07, it indicates negative growth.

The average return in percentage of Divis Laboratories of the sample for ten years from 2011 to 2020 is 908.3( $\pm$ 488.7) and Dr.Reddy's Laboratories is 2542.7( $\pm$ 615.2). The average of Dr.Reddy's Laboratories is higher than Divis Laboratories, though Dr. Reddy's performing better than Divis Laboratories but standard deviation of Dr.Reddy's Laboratories higher than Divis Laboratories, so it would be more risk than Divis Laboratories. These results infer that the investor should take risk to maximize the profit. Dr.Reddy's Laboratories will give more profit under more risk whereas Divis Laboratories will give less profit comparatively under less risk.

## REGRESSION ANALYSIS

### Divis Laboratories

**Table-3 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.981 <sup>a</sup>	.962	.951	2.293630
a Predictors: (Constant), EPS, MARKET_PRICE_DIVIS				

R-value represents the relation between the dependent and independent variable. shows, R-value is 0.981 (98.1%) which is higher for further analysis. R-square shows the total variation for the

Table – 3

dependent variable that could be explained by the independent variables. R-Square value is 0.962(96.2%) which is good, so this model is effective enough to determine the relationship

**Table-4 ANOVA<sup>b</sup>**

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	923.269	2	461.635	87.751	.000 <sup>a</sup>
	Residual	36.825	7	5.261		
	T Total	960.094	9			
a Predictors: (Constant), EPS, MARKET_PRICE_DIVIS						
bDependent Variable: PE_RATIO_DIVIS						

The above Anova table shows, the variance of Market Price and Earning per Share on PE Ratio. In this result, F (87.751) the significant value of p is 0.000 (i.e.) less than the alpha value (0.05). So the null hypothesis is rejected. Therefore, there is a statistical significant. These results estimate that as the p-value of the ANOVA table is below the tolerable significance level, So Null Hypothesis failed to accept.

**Table-5 Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error			
1	(Constant)	17.584	3.515		5.002	.002
	MARKET_PRICE_DIVIS	.021	.002	1.000	13.129	.000
	EPS	-.365	.075	-.368	-4.835	.002
aDependent Variable: PE_RATIO_DIVIS						

Table – 5 shows, the significance value of p is less than alpha value of 0.05 of both variables so there is an impact of MP and EPS on PE ratio. Linear regression equation is

$$\text{PE Ratio} = 17.584 + (0.021) \text{ MP} + (-0.365) \text{ EPS}$$

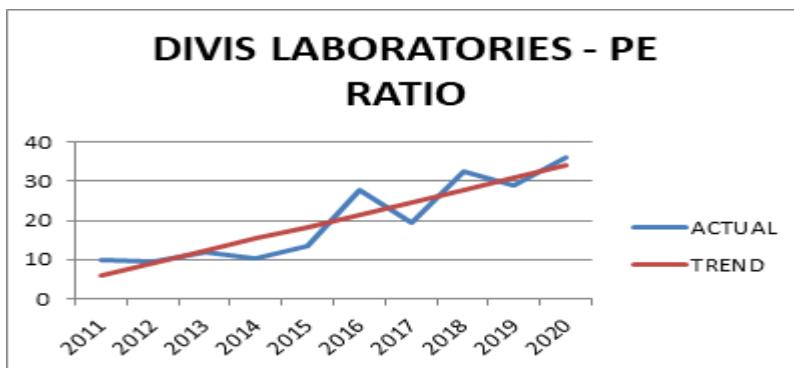
#### TREND LINE FOR DIVIS LABORATORIES BASED ON PE-RATIO:

**Table-6 Trend line calculation**

YEAR	DIVIS LABORATORIES	
	PE RATIO	
	ACTUAL	TREND
2011	10.12	5.967
2012	9.5	9.079
2013	11.93	12.191
2014	10.18	15.303
2015	13.39	18.415
2016	27.55	21.527
2017	19.6	24.638
2018	32.6	27.75
2019	28.97	30.862
2020	35.83	33.974

#### TREND LINE IN GRAPHICAL REPRESENTATION

**Graph 1-Divis trend line**



- Through the above table, it is clear that the trend value is calculated for PE-Ratio from 2011 to 2020 of Divis laboratories, and the graphical representation is shown.

**Dr. Reddy's**

**Table-7 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.823 <sup>a</sup>	.677	.584	9.9119513

a. Predictors: (Constant), EPS, MARKET\_PRICE

R-value represents the relation between the dependent and independent variable. Table – 7 shows, R-value is 0.823 (82.3%) which is higher for further analysis. R-square shows the total variation for the dependent variable that could be explained by the independent variables. R-Square value is 0.677(67.7%) which is good, so this model is effective enough to determine the relationship

**Table-8 ANOVA<sup>b</sup>**

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1439.676	2	719.838	7.327	.019 <sup>a</sup>
	Residual	687.727	7	98.247		
	Total	2127.403	9			
a. Predictors: (Constant), EPS, MARKET_PRICE						
b. Dependent Variable: PE RATIO Reddys						

The above Anova table shows, the variance of Market Price and Earning per Share on PE Ratio. In this result, F (7.327) the significant value of p is 0.019 (i.e.) less than the alpha value (0.05). So the null hypothesis is rejected. Therefore, there is a statistical significant. These results estimate that as the p-value of the ANOVA table is below the tolerable significance level, So Null Hypothesis failed to accept.

**Table-9 Coefficients<sup>a</sup>**

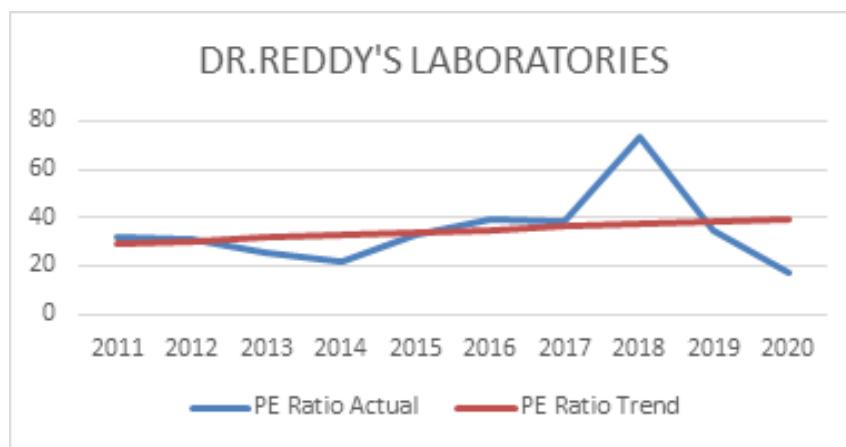
Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error			
1	( Constant)	30.720	14.016		2.192	.065
	MARKET_PRIC E	.014	.006	.540	2.194	.064
	EPS	-.362	.095	-.938	-3.809	.007
Dependent Variable: PE RATIO Reddys						

Table – 9 shows, the significance value of p is less than alpha value of 0.05 of both variables so there is an impact of MP and EPS on PE ratio. Linear regression equation is

$$\text{PE Ratio} = 30.720 + (0.014) \text{ MP} + (-0.362) \text{ EPS}$$

**TREND LINE FOR Dr.Reddy's LABORATORIES BASED ON PE RATIO:****Table 10- Trend line calculation**

Year	DR. Reddy's	
	Actual	Trend
2011	31.98	29.435
2012	30.65	30.552
2013	25.28	31.67
2014	22.14	32.787
2015	32.89	33.904
2016	38.89	35.022
2017	38.31	36.139
2018	73.47	37.257
2019	34.31	38.374
2020	16.79	39.491

**TREND LINE IN GRAPHICAL REPRESENTATION****Graph2- Dr.Reddy'sTrend line**

- Through the above table, it is clear that the trend value is calculated for PE-Ratio from 2011 to 2020 of Dr Reddy's, and the graphical representation is shown.

**FOOD & BEVERAGE SECTOR:****Descriptive Statistics****Table-11 BRITANNIA**

	N	Minimum	Maximum	Mean	Std. Deviation
MARKET_PRICE	10	201.330	3096.640	1349.95	1141.666821
EPS Britannia	10	12.160	78.960	45.1490	24.173524
Return in percentage Britannia	10	-7.146	109.493	38.3504	38.225682
EPS Growth Britannia	10	-40.843	68.124	22.6512	29.578953
PE RATIO BRITANNIA	10	12.994	66.295	26.6165	17.682104
PEG Ratio Britannia	10	-1.623	2.394	.84467	1.139036

Table -11 depicts the descriptive statistics of Britannia which includes minimum, maximum, mean and standard deviation. Market share Price describes a mean value of 1349.95 with standard deviation of 1141.67. Mean value of Earnings per Share is 45.14 and standard deviation 24.17. Mean value of return in percentage is 38.35 and standard deviation of 38.22. Average growth of Britannia for years 2011 to 2020 is 22.65 and standard deviation is 29.58. Mean of PE ratio is 26.61 and standard deviation 17.682104. Average of PEG Ratio is 0.84 and standard deviation 1.14

Mean Market Price of 2011 to 2020 is 1349.95 ( $\pm 1141.67$ ) is lesser than current Market Price of 3695.5 shows positive growth and the average PE ratio for 2011-2020 of Britannia is 26.6 which is less than the current PE ratio of 55.3 will not be the good sign of growth performance. Current PEG ratio of Britannia is 3.731 which is higher than the average PEG for the period 2011 to 2020 is 0.84; this represents negative sign of growth. However, the average EPS for the period 2011 to 2020 is 45.15 is less than current EPS of 70.9 which represents the good growth indication, but average EPS growth of Britannia is 22.65 which is higher than 14.818, it indicates negative growth.

**Table-12 Nestle**

	N	Minimum	Maximum	Mean	Std. Deviation
MARKET PRICE Nestle	10	3831.520	14480.0	6949.91	3396.802668
EPS	10	58.420	215.980	131.775	49.488155
Return in percentage Nestle	10	-11.421	53.402	20.6369	19.498174
EPS Growth Nestle	10	-52.454	64.498	14.2897	29.638575
PE_RATIO	10	36.502	108.188	54.2828	21.141775
PEG Ratio Nestle	10	-2.063	11.702	3.78215	4.233537

Table -12 shows the descriptive statistics of Nestle which includes mean, standard deviation, minimum and maximum. Average Market Price of Nestle for the duration 2011 to 2020 is 6949.91 and standard deviation 3396.8. Mean value of Earnings per Share is 131.78 and standard deviation 49.49. Mean value of return in percentage is 20.64 and standard deviation of 19.49. Average growth of Nestle for years 2011 to 2020 is 14.29 and standard deviation 29.63. Mean of PE ratio is 54.28 and standard deviation 21.14. Average of PEG Ratio is 3.8 and standard deviation 4.2.

Mean Market Price of 2011 to 2020 is 6949.91( $\pm 3396.8$ ) is lesser than current Market Price of 18900 shows positive growth and the average PE ratio for 2011-2020 of Nestle is 54.28 which is lesser than the current PE ratio of 85.24 will not be the good sign of growth performance. Current PEG ratio of Nestle is 13.78 which is higher than the average PEG for the period 2011 to 2020 is 3.78; this represents negative sign of growth and the average EPS for the period 2011 to 2020 is 131.77 is less than current EPS of 229.34 which represents the good growth indication, but average EPS growth of Nestle is 14.29 is higher than current EPS growth 6.186 which indicates negative sign in growth.

The average return in percentage of Britannia of the sample for ten years from 2011 to 2020 is 1349.95 ( $\pm 1141.67$ ) and Nestle is 6949.91( $\pm 3396.8$ ). The average of is Nestle higher than Britannia, though Nestle performing better than Britannia but standard deviation of Nestle higher than Britannia, so it would be more risk than Britannia. These results infer that the investor should take risk to maximize the profit. Nestle will give more profit under more risk whereas Britannia will give less profit comparatively under less risk.

### Regression Analysis

#### Britannia

**Table-13 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.986 <sup>a</sup>	.972	.964	3.367435

a. Predictors: (Constant), EPS Britannia, MARKET\_PRICE

R-value represents the relation between the dependent and independent variable. Table – 13 shows, R-value is 0.986 (98.6%) which is higher for further analysis. R-square shows the total variation for the dependent variable that could be explained by the independent variables. R-Square value is 0.972(97.2%) which is good, so this model is effective enough to determine the relationship

**Table-14 ANOVA<sup>b</sup>**

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	2734.534	2	1367.267	120.574	.000 <sup>a</sup>
	Residual	79.377	7	11.340		
	Total	2813.911	9			
aPredictors: (Constant), EPS_Britannia, MARKET_PRICE						
bDependent Variable: PE_RATIO_BRITANNIA						

The above Anova table shows, the variance of Market Price and Earning per Share on PE Ratio. In this result, F (120.574) the significant value of p is 0.000 (i.e.) less than the alpha value (0.05). So the null hypothesis is rejected. Therefore, there is a statistical significant. These results estimate that as the p-value of the ANOVA table is below the tolerable significance level, So Null Hypothesis failed to accept

**Table-15 Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Beta	t	Sig.
		B	Std. Error			
1	(Constant)	17.488	2.365		7.395	.000
	MARKET_PRICE	.020	.001	1.301	14.293	.000
	EPS Britannia	-.400	.067	-.547	-6.013	.001
aDependent Variable: PE_RATIO_BRITANNIA						

Table – 15 shows, the significance value of p is less than alpha value of 0.05 of both variables so there is an impact of MP and EPS on PE ratio. Linear regression equation is

$$\text{PE Ratio} = 17.488 + (0.020) \text{ MP} + (-0.400) \text{ EPS}$$

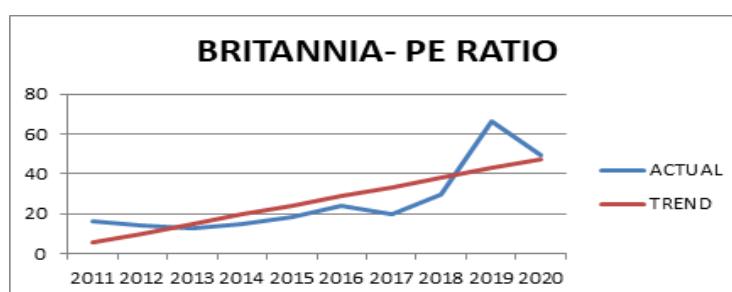
#### TREND LINE FOR DIVIS LABORATORIES BASED ON PE-RATIO:

**Table 16- Trend line calculation**

BRITANNIA			
YEAR	PE RATIO		TREND
	ACTUAL		
2011	16.56	5.716	
2012	14.25	10.359	
2013	12.99	15.001	
2014	14.73	19.644	
2015	18.36	24.286	
2016	23.83	28.928	
2017	20.03	33.571	
2018	29.45	38.213	
2019	66.3	42.856	
2020	49.67	47.498	

#### TREND LINE IN GRAPHICAL REPRESENTATION

##### Graph 3- Britannia Trend line



- Through the above table, it is clear that the trend value is calculated for PE-Ratio from 2011 to 2020 of Britannia, and the graphical representation is shown

**Nestle:**

**Table 17 Model Summary**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.959 <sup>a</sup>	.920	.897	6.793154

aPredictors: (Constant), EPS, MARKET\_PRICE\_Nestle

R-value represents the relation between the dependent and independent variable. Table – 17 shows, R-value is 0.959 (95.9%) which is higher for further analysis. R-square shows the total variation for the dependent variable that could be explained by the independent variables. R-Square value is 0.920(92.0%) which is good, so this model is effective enough to determine the relationship

**Table- 18 ANOVA<sup>b</sup>**

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3699.743	2	1849.872	40.087	.000 <sup>a</sup>
	Residual	323.029	7	46.147		
	Total	4022.772	9			
a. Predictors: (Constant), EPS, MARKET PRICE Nestle						
bDependent Variable: PE_RATIO						

The above ANOVA table shows, the variance of Market Price and Earning per Share on PE Ratio. In this result, F (40.087) the significant value of p is 0.000 (i.e.) less than the alpha value (0.05). So the null hypothesis is rejected. Therefore, there is a statistical significant. These results estimate that as the p-value of the ANOVA table is below the tolerable significance level, So Null Hypothesis failed to accept

**Table-19 Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error			
1	(Constant)	74.144	6.462		11.475	.000
	MARKET PRICE Nestle	.011	.001	1.755	8.724	.000
	EPS	-.727	.086	-1.701	-8.458	.000
aDependent Variable: PE_RATIO						

Table – 19 shows, the significance value of p is less than alpha value of 0.05 of both variables so there is an impact of MP and EPS on PE ratio. Linear regression equation is

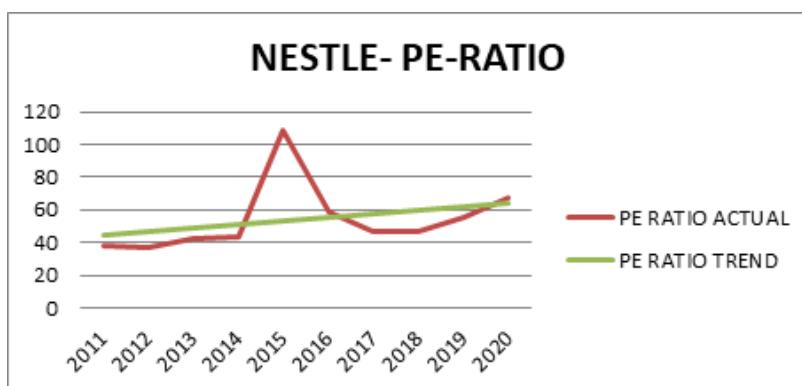
$$\text{PE Ratio} = 74.144 + (0.011) \text{ MP} + (-0.727) \text{ EPS}$$

#### TREND LINE FOR NESTLE BASED ON PE-RATIO:

**Table 20- Trend line calculation**

YEAR	NESTLE	
	PE RATIO	
	ACTUAL	TREND
2011	38.42	44.226
2012	36.5	46.461
2013	42.47	48.696
2014	43.38	50.931
2015	108.19	53.166
2016	58.26	55.401
2017	46.84	57.636

2018	46.74	59.871
2019	55.01	62.106
2020	67.02	64.341

**TREND LINE IN GRAPHICAL REPRESENTATION****Graph 4- Nestle trend line**

- Through the above table, it is clear that the trend value is calculated for PE-Ratio from 2011 to 2020 of Nestle, and the graphical representation is shown.

**RESULTS AND CONCLUSION**

In pharmaceutical sector by comparing both large capital companies

- Dr. Reddy's laboratories will give more profit with more risk it is effective to determine the relationship and statistically significant.
- Divis laboratories will give less profit with less risk it is effective to determine the relationship and it is statistically significant

Regression equation to find future PE ratio is

- Dr Reddy's PE Ratio =  $30.720 + (0.014) MP + (-0.362) EPS$
- Divis laboratories PE Ratio =  $17.584 + (0.021) MP + (-0.365) EPS$

In Food and Beverage sector by comparing both large capital companies

- Nestle will give more profit under more risk it is effective enough to determine the relationship and it is statistically significant
- Britannia will give less profit under less risk it has effective enough to determine the relationship and it is statistically significant

Regression equation to find future PE ratio is

- Britannia PE Ratio =  $17.488 + (0.020) MP + (-0.400) EPS$
- Nestle PE Ratio =  $74.144 + (0.011) MP + (-0.727) EPS$

In this paper, the comparison of two large capital companies in both pharmaceutical and food & beverage sector is determined by the analysis according to the returns and risks. And it has also been determined whether the companies are having effective relationship among variables and the statistical significance is determined. This study reveals that in Future works, the analysis can be done for all the large capital companies in these sectors and it can also be done for all the sectors.

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**THE BRAND AWARENESS OF CONSUMERS IN RELATION TO ELECTRONIC PRODUCTS  
WITH SPECIAL REFERENCE TO THE KARAIKAL DISTRICT, PUDUCHERRY**

**MRS. V. KOKILA AND DR. N. SAMPATHLAKSHMI****ABSTRACT**

*Over the years, academics and marketing professionals have looked into brand awareness, which is regarded as one of the most significant factors influencing consumer preferences. The current study looked into consumer awareness of electronic products such as computers including laptops, televisions and mobile phones in the Karaikal region. To assess brand awareness, data was collected using acceptable market research methods and analysed using spearman correlation and the independent test of chi-square. Brand awareness was found to be high on computers and mobile phones, but low on television, according to the findings of the study.*

**Keywords:** *Brand Awareness, Consumer Behaviour, Electronic Products*

**INTRODUCTION**

In the past, modifying to novel environments was enough for businesses to ensure their survival and sustainability. Now is the day, but choosing the right approach to transformation is just as essential for the determination and the adopting decision. Numerous major companies consider their world as uncontrollable, and they attempt to change the way they work. Many studies indicate, however, that businesses that can create brand awareness and company image are able to win. The capacity of an organisation to manufacture high-quality products and services, build strategic thinking, and retain a market position is primarily dependent on ensuring that their brand stands out from the competition. For companies, brand is extremely relevant, and it is a major factor that influences customer buying decisions. As a result, it's common to hear that companies build "products," while customers purchase "brands."

**AWARENESS ABOUT BRANDS AND ITS CONCEPTS**

Consumers' ability to remember and appreciate a specific brand is referred to as brand awareness. This knowledge can positively or negatively affect consumer purchasing decisions. As a result, organizations that have a good brand experience will expand their share of the market (Huang and Sargöllü, 2012, p. 92; Moisescu, 2009; Bertch and Ostermann, 2011). This data assists in the success of a brand and is widely used as a marketing technique (Macdonald and Sharp, 2000). According to Hombur (2010) and Woodward (2000), the ability of organisations and companies to build brand awareness will result in an increase in earnings growth or share. Consumers' expectations of quality and their trust in products or services are both affected by brand awareness, according to Oh (2000). In addition, according to Aaker (1996), the market success of companies is measured by their brand ranking, which is one of the four key factors that decide brand awareness. Brand dependency, visual consistency, and brand memory are the other three variables. Brand acceptance can be assured by growing customer awareness. For this reason, branding requires that the brand have a positive impact on consumers and hold it in their minds. On the other hand brand awareness is made by the knowledge, good and bad, one has in relation to a specific brand (Valkenburg and Buijen, 2005,

p. 461). Consumers are more interested in brands they see than in brands they have never heard of. If a brand is among a group of brands / brands that consumers are interested in, the decision to choose that brand over others would be based on the brand information. Unknown brands, or with poor brand knowledge, are not interested to be selected by buyers (Gilbert, 2003: 319). A brand's ability to add value to a product or service by addressing particular organisational and emotional requirements is a distinguishing attribute. (Crimmins, 1992, p. 14). The visual efficiency and trustworthiness combined with a brand reflect customer satisfaction with regard to the suitability of a particular brand or service for their needs (Keller, 2003). When compared to brands they are unfamiliar with, consumers show more interest in the brands they see. If a brand is among a group of brands / brands that consumers are interested in, the decision to choose that brand over others will be based on the brand information. Unknown brands, or with poor brand knowledge, are a lesser probability to be chosen by customers (Gilbert, 2003: 319). A brand's ability to deliver additional brand value or service that addresses unique organisational and psychological aspects is a distinguishing attribute. (Crimmins, 1992, p. 14). A brand's visual quality and commitment are connected and to reflect customer satisfaction with regard to the suitability of a particular brand or service for

**RESEARCH OBJECTIVES**

The main aim of this study is to analyze the characteristics and buyer's behaviors and also to know their level of brand awareness with the electronic brands. The analysis, therefore, is directed at the following aims.

To examine the relationship between socio demographic variables and brand awareness of electronic products

**HYPOTHESES OF THE STUDY**

Based on the objectives, the hypotheses have been derived and tested for this analysis.

**H0:**"The level of brand awareness towards the various attributes of electronic products among the consumers does not differ significantly".

**RESEARCH METHODOLOGY**

The focal point of this analysis was to test brand information by consumers in relation to electronic products, which are considered to be the evolutionary economy, in respect of electronic products. Here, the electronic products were tested in three different categories, namely: Computers, Televisions and Mobile phones. The objective was to find brands related to brand information that were superior to one of these products and to determine items that influence customer preferences. To analyses the brand awareness, a well framed questionnaires was employed after the first questionnaire was made, there were 50 respondents were used for pilot study. Questions with questions that were intended to be ambiguous or difficult to understand during the application process were properly addressed.

The level of confidence of this study was examined by Cronbach's alpha test. According to Cronbach's alpha test results, a value of 0.626 was found. That figure showed that the questionnaire was within acceptable time frame. Research data was assessed, interpreted and reported by using descriptive statistics, such as percentage, frequency, distribution, average and standard deviations. In addition to this, significant differences between socio demographic characteristics and brand awareness were assessed by using the chi-square test. The relationship between the brands that first came to mind and the brands they bought was actually tested using Spearman correlation. The present study was used Cronbach's alpha test to determine the confidence level. According to Cronbach's alpha test results, a value of 0.626 was found. This figure shows that the questionnaire was within acceptable time frame. Research data was assessed, interpreted and reported using descriptive statistics, like as frequency, percentage, average value and standard deviations. Furthermore, the chi-square independence test was used to determine major differences between demographic characteristics and brand awareness. The inter link between the brands that first came to mind and the brands that they purchased was calculated by using test of Spearman correlation.

**FINDINGS****Table 1: Socio - Demographic Information of Respondents**

Details	Frequency	%	Valid Percentage	Cumulative Percentage
<b>Gender</b>				
Male	270	54	54	54.0
Female	230	46	46	<b>100.0</b>
<b>Age</b>				
18 – 25	140	28	28	28.0
26 – 35	160	32	32	60.0
36 – 45	120	24	24	84.0
Above 45	80	16	16	<b>100.0</b>
<b>Occupation</b>				
Public sector	80	16	16	16.0
Private sector	110	22	22	38.0
Business	60	12	12	50.0
Farmer	40	8	8	58.0
Student	110	22	22	80.0
Housewife	50	10	10	90.0
Other occupations	50	10	10	<b>100.0</b>
<b>Monthly Income</b>				
Less than 10000	145	29	29	29.0
10001-30000	120	24	24	53.0
30001-40000	160	32	32	85.0

40001-50000	45	09	09	94.0
Above 50000	30	06	06	<b>100.0</b>
<b>TOTAL</b>	500	100	100	

**Table 2 - Spearman Correlation Results**

Spearman Correlation		Computer The brand that comes to mind first	Television The brand that comes to mind first	Mobile phone The brand that comes to mind first	Purchased Computer brands	Purchased Television brands	Purchased Mobile phone brands
Computer The brand that comes to mind first	coefficient of correlation Sig. (two-tailed) N	1 .500					
Television The brand that comes to mind first	coefficient of correlation Sig. (two-tailed) N	0.065 0.061 500	1 .500				
Mobile phone The brand that comes to mind first	coefficient of correlation Sig. (two-tailed) N	0.161 (**) 0 500	0.170(**) 0 500	1 .500			
Purchased Computer brands	coefficient of correlation Sig. (two-tailed) N	0.475(**) 0 500	0.126(**) 0.001 500	0.091(*) 0.014 500	1 .500		
	coefficient	*0.141(**) 0 500	0.04 0.299	0.362(**) 0 500	0.147(**) 0 500	1 .500	
Purchased of Television brands	correlation Sig. (two-tailed) N	0		0	0	.	
Purchased Mobile phone brands	coefficient of correlation Sig. (two-tailed) N	0.128(**) 0 500	0.06 0.105 500	0.107(**) 0.004 500	0.136(**) 0 500	0.112(**) 0.004 500	1 .500

During the study, the respondents were first asked to name the brands of computers, TVs, and mobile phones that first came to mind first (meaning they knew better). The subjects were then asked to name the computer, TV and mobile phones they had bought or did not have. Spearman integration was employed to find whether there was a correlation between two variables. The results of these analyzes are presented in Table - 2. Centered on the results gained from the analysis, an average of 0.475 equals between computer brands came to mind first and purchased computer brands, showing positive and important relationships. Similarly, the estimated inclusion of mobile brands was 0.07, which also showed a favorable and positive association between the brands that come to mind first and brands purchased. However, in Television, no significant association between the brands that come to mind first and purchased brands.

A chi square independence test was employed to assess the disparities in perceptions regarding acceptance, reliability, quality, assurance, durability, performance and price

**Table - 3 shows the Test of Chi-Square (Gender)**

Variables	Products		
	Computer	Mobile Phone	Television
Acceptance	00.086	00.342	00.134

Reliability	00.243	00.098	00.870
Quality	00.463	00.037	00.098
Assurance	00.095	00.014	00.067
Durability	00.691	00.546	00.089
Performance	00.064	00.647	00.237
Price	00.000	00.000	00.000

in relation to various socio - demographic characteristics. The outcomes of these tests mentioned in below tables. (**Bold indicate = P ≤ 0.05**)

In terms of gender (e.g., between men and women), there was no statistically significant difference regarding perceptions of acceptance, durability, reliability, and performance, with greater than 50% respondents in both sexes consider these factors was most essential. However, while 80 % of male considered mobile phone quality is most important, 58% of female participants kept in mind it are most crucial. The ratio of female participants who thought cell phone quality as in significant was 5% and the ratio of those who were not concerned about the quality of mobile phones was 8%. In addition, 63% of male respondents considered assurance on mobiles were most important, while 48% of female respondents considered it the most vital. The differences in opinion about the price of computers, televisions and mobiles about sex were mathematically significant. The male respondents were not as concerned with the price of the brand as the female participants, indicating that women's are more attentive on price than the men.

**Table - 4 shows the Chi-Square Test of Independence (Age)**

<b>Variables</b>	<b>Products</b>		
	<b>Computer</b>	<b>Mobile Phone</b>	<b>Television</b>
Acceptance	00.172	00.160	00.143
Reliability	00.067	00.015	00.043
Quality	00.218	00.249	00.386
Assurance	00.365	00.358	00.736
Durability	00.004	00.469	00.083
Performance	00.000	00.312	00.000
Price	00.762	00.163	00.295

There is no notable difference among the different age groups in respect of acceptance in all brands. The ratio of students who considered acceptance as most essential to television, computers and mobiles was 41%, 43% and 42%, respectively. There were significant statistical variation was noted between the various ages in respect of their perceptions about the mobile phones reliability and the differences in reliability of computers and televisions were not associated. For mobiles, 45% of respondents between the ages of 36-45 consider reliability as the most essential, while 60% respondents of all age groups consider trustworthy was more important. There is no notable variations were found among age groups in respect of the importance given to loyalty to television and computers. Thus, 54% of respondents from all ages considered reliability as essential to computers, but 53% marked it as important for television.

There is no notable trustworthiness were observed between the different age bundle in respect of quality. Among all age groups, the proportion of quality is the most important for computers, televisions and mobile phones is 74%, 70%, and 72% respectively. In respect of quality, there were no major variations found between the ages ranging. In all age groups, the proportion of students who kept in mind assurance important in television, computers and mobile phones was 50%, 53% and 54%, respectively. In terms of their views of computer, substantial statistical variations were observed among the different ages, while differences in intensity on television and mobile phones were not significant.

On computers, durability was rated first by 55 percent of subjects between the ages of 26 and 35, 51 percent of respondents between the ages of 36 and 45 and over 70 % of respondents in all other age respondents. There was no significant variance in the importance given to intensity on television and mobile phones among the various age groups. As such, 61% of Subjects from all ages have defined durability as important in television, while 65% have identified it as important for mobile phones.

There were no major variations between age groups or factors affecting the buying of electronic products in this sample. In case of computers and televisions brand, the performance has significance for different age groups. Particularly for small groups they see performance as the most important thing. In order to attract various age groups of respondents sellers may emphasize various functions and performance of electronic items.

**Table - 5 shows the Chi-Square Test of Independence (Occupation)**

Variables	Products		
	Computer	Mobile Phone	Television
Acceptance	<b>00.352</b>	<b>00.004</b>	<b>00.014</b>
Reliability	<b>00.020</b>	<b>00.298</b>	<b>00.048</b>
Quality	<b>00.000</b>	<b>00.000</b>	<b>00.024</b>
Assurance	<b>00.078</b>	<b>00.364</b>	<b>00.096</b>
Durability	<b>00.093</b>	<b>00.108</b>	<b>00.037</b>
Performance	<b>00.284</b>	<b>00.079</b>	<b>00.001</b>
Price	<b>00.000</b>	<b>00.016</b>	<b>00.001</b>

In terms of computer and television reliability, substantial statistical variations were found between different groups occupations, whereas differences in mobile phone reliability were not significant. Other occupants and housewives were less important in computer reliability; while housewives and private sector employees ignore the need of being honest on television. On the other side, some professional groups are more important than the reliability of computers and television and also nearly 59% of respondents from all occupation emphasis mobile reliability to be the most important. Significant statistical differences were found between different occupational groups in respect of their perceptions of quality in all products. In terms of work, some employees and government employees consider quality as more essential in computers, televisions and mobile phones; but in case of employees of private sector and housewives were less important to the quality aspects. There no notable variations were observed between the functional groups in terms of their assumptions regarding the brand. Of all the occupational groups, the proportion of students who considered the assurance to the most essential in computers, Televisions and mobile phones was 53 %, 54 % and 66 % respectively.

There is positive correlation was found among the various occupational groups in respect of their perceptions of durability in television, while variation in the durability of mobile phones and computers were not significant. In case of public sector employees, students take less computer-based power than other work groups. Durability in television was less important to housewives but other occupational groups considered durability in television as more important. All other occupations groups consider durability of mobile phone to be the more important factor. Significant variations were noted between different occupational groups in respect of their perceptions of television performance, while differences in computer and mobile phone performance were not positive. Students, public sector and other professions were less important in computer performance than other work groups.

Working on Television was less important for housewives and employees, while some work groups considered working on television as more important. All employee groups consider working on mobile phones as very vital. Statistical different have been obtained between various occupation groups in terms of their perceptions of price over all products. Women and Farmers consider price to be the most vital element of all products; while price was not considerable element and ignore that element among the other employees, public sector employees, students, and private sector employees.

From the findings of this study it is clear that occupation is the most important factors influencing a consumer purchase decision. In particular, the factors that make a consumer decision to buy on televisions vary greatly in different occupations. The purpose of using these products may differ depending on the function, and this effect may occur. As a result, companies should create and deliver various features and benefits to various occupational classes.

**Table - 6 shows the Chi-Square Test of Independence (Monthly Income)**

Variables	Products		
	Computer	Mobile Phone	Television
Acceptance	00.652	00.003	00.521
Reliability	00.004	00.000	00.015
Quality	00.000	00.000	00.000
Assurance	00.000	00.000	00.000
Durability	00.000	00.000	00.000
Performance	00.000	00.000	00.000
Price	00.000	00.000	00.000

There were significant statistical differences between the groups varying degrees of earning in terms of their acceptance on mobile phones, while differences regarding computer and television acceptance were not significant. For mobile phones, the perceived value of acceptance is reduced in proportion to the increase in monthly income. In terms of the value placed on the quality of computers and televisions, no significant differences were found between groups with variant stages of income. Thus, 38% of respondents among all groups described quality as the most important for computer, while 42% defined it as the most critical aspect on Television.

In terms of their views on reliability, significant statistical variations were noted between groups across all brand groups. For computers, the value given by reliability has gradually decreased with groups and monthly income between Rs. 10001 and 30000, while the value given reliability increased gradually in groups with monthly income between Rs. 30001 and 40000. On televisions, the value given to reliability decreases gradually with groups with a monthly income between Rs. 10001 and 30000, While reliability was given a slightly higher value in groups with monthly incomes between Rs. 10001 and Rs. 50000, it was given a slightly lower value in groups with monthly incomes between Rs. 10001 and 50000. For mobile phones, the value given by reliability has gradually decreased by groups and the monthly income between Rs. 10001 and 20000, while the value of reliability on fidelity increased slightly in groups with monthly income between Rs. 10001 and Rs. 50000.

Price differences between the different revenue groups in each brand group were found to be statistically significant. The value given to computers, TVs, and mobile phones has declined in line with rising monthly income. The findings reveal that the level of income is the most substantial distinction. Even when price is essential for groups at the lower end of the income scale, the importance of other groups grows as income rises. This effect can be easily explained by the perception of strong economic demands. As a result, whereas factors such as quality and performance should respond to high-income groups, price may respond to low-income groups.

## **CONCLUSION**

The correlation between first-thought computer brands and purchased computers is 0.475, indicating a positive, significant, and highly correlated relationship between the two variables. As a result, it was decided that when it came to computers, the participants had a clear and consistent response based on the brand viewpoint. This has demonstrated that the right companies' brand-related activities have, by their very nature, produced desirable advertising results. However, there is no discernible connection between the Televisions that come to mind first when thinking about the subjects being examined and the Televisions purchased.

The correlation coefficient between first came to mind of mobile brands and purchased mobile brands is rated at 0.107, indicating a substantial and constructive relationship between the two variables. The reaction to the appearance of the brands was spoken on mobile phones. This also demonstrated that the relevant companies' brand-related efforts generated favorable marketing outcomes, with high levels of brand awareness on computers and cell phones but low levels of brand awareness on television. The cause for this can be attributed to the fact that Televisions are a brand compared to the fact that all these electronic items do not have a large enough space for large consumer use.

The researchers used statistics to determine the relationship between the two variables in the study's second part in subject matter factors and their views regarding acceptance, quality, reliability, assurance, durability, performance and price of brands using an independent test of chi-square. This is achieved so that essential mathematical relationships can be discovered. The test results, as well as the necessary comments and explanations of the data, are detailed in the results section. Based on the results of these experiments, it was discovered that men usually set the benchmark for quality, while women were more sensitive to brand price.

The researchers also discovered that for groups of all ages, acceptance and consistency were the most important factors, and that performance gains declined with age. One of the findings regarding this study is that the high in the monthly earnings of the study courses has led to similar growth in the value they give to quality, durability, performance and self-assurance also an a rise in monthly earnings is related to a decrease in the price item's value.

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*Received: 28th October 2021**Revised: 30th November 2021**Accepted: 15th December 2021***TRADITIONAL AND STATE-OF-THE-ART EDGE DETECTORS****GHANSHYAM D. PARMAR, DEEPALI H. SHAH, TEJAS V. SHAH AND BHAVIN S. SEDANI****ABSTRACT**

Edges are the key important feature in the representation and analysis of any image. The algorithms and techniques for image analysis and understanding uses edges as preliminary tool. Edge modeling and edge detection are the basic steps involved in the image edge detection. In this paper the basic of edge, edge modeling and edge detection process is mentioned. The traditional edge detector methos as well the state-of-the-art edge detectors are also discussed in this paper. The challenges and limitations involve in the process of edge detector are also discussed in this paper.

*Index Terms—Edge, Edge Modeling, Edge Detector*

**I. INTRODUCTION**

EDGE is one of the key feature of the characteristic representation and analysis of the objects and image. As the surface characteristics of the object make the difference with the background, the edges separate the object from their back ground. Also, the edges characterize the inter object boundaries as well the textures within the object itself. In the semiautomatic or fully automatic analysis and understanding of the image, edges play a significant role in the representation and detection process. In the representation of shape of the object the edges are used as the prominent characteristic feature. [1-3]

In section II we present the basic definition of the edge, the phenomenon of appearance of edges in the image, different models used to model the edge like step, ramp, line and roof edge models. In section III we present some of the well-known traditional edges detectors like Roberts Edge Detector, Prewitt Edge Detector, Sobel - Feldman Edge Detector, Canny Edge Detector And Laplacian Of Gaussian Edge Detector as well state of art and cutting-edge edge detectors like Holistically-Nested Edge Detector, Richer Convolutional Features Edge Detectior, Bi-Directional Cascade Network For Perceptual Edge Detector and Dense Extreme Inception Network Edge Detector.

IN section IV we present some of the major challenges in the process of the edge detection. The challenges described in this section could give the researchers the direction for improvement of the edge detection process as well propose their methos to overcome the limitations of the current edge detectors.

**II. EDGE**

Image is defined as the two (or three) dimensional function of intensity with respect to the spatial coordinates. These intensities are distributed over the spatial coordinates to represent any three-dimensional object or the scene. hence the physics of the object or the objects in the scene and the background causes discontinuity in the intensity distribution function. This discontinuity in the intensity level of the image is called Edge. Edge is any change of the intensity value with respect to the neighboring pixel's intensities. Higher the change results in significant edges. And, lower the change results in spurious edges. The significant edges are considered to be one of the important feature for image characteristics representation and spurious edges may represent very low intensity variation, low level texture or noise in the image. The spurious edges increases as the noise level in the image increases. Hence, the significant edges increases in the image after low-pass filtering of the image.[1-3,5]

Edges in the image appears due to one of the three phenomena namely physical, geometrical and non-geometrical events. The image of the physical object with the background causes the edges between the object and the background. Here, the resulting edges are due to the phenomenon of physical events. The object boundary, discontinuity in the object surface and textures also appears as edges in the image. Here, the resulting edges are due to the phenomenon of geometrical events. The shadows, internal reflections and secularity also results as edges in the image. Here, the resulting edges are due to the phenomenon of non-geometrical events.

**A. EDGE MODELS**

Edges represent one of the key characteristics of the image representing the object or scene. It is significant to identify and detect the edges in the image. As the mathematical representation of these edges involve the complexity of representation increasing with increasing number of pixels, makes the representation computationally complex in terms of representation and calculation as well practical implementation and detection. To simplify the complexities involved in representation of these edges, edges are modeled with the

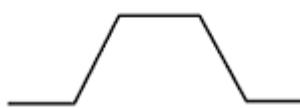
simplified and minimal representational and computational expenses involved. Based on the intensity profile these edges are modeled. These simplified models are step, ramp, line and roof edge model.

**STEP EDGE**

A step edge model is the characterization of intensity profile of the neighboring pixels with step change in the intensities. The step edge occurs in the image as a result of sharp and significant discontinuity. This edge model represents a clean and ideal edge, which results after significant preprocessing on the obtained raw image.

**RAMP EDGE**

A ramp edge model is the characterization of intensity profile of the neighboring pixels with ramp like monotonically increasing or decreasing change in the intensities. The ramp edge occurs in the image as the result of blur or defocused object. This edge model represents the degree to which the discontinuity is blurred in the image.

**LINE EDGE**

A line edge model is the characterization of intensity profile of the pixels with bumped line intensity profile with respect to their neighboring pixels. The line edge occurs in the image as the result of strip, road or ridge like objects or structures.

**ROOF EDGE**

A roof edge model is the characterization of intensity profile of the neighboring pixels with two conjugate ramp like monotonically increasing or decreasing with decreasing or increasing change in the intensities. The roof edge occurs in the image as a result of pipes, digitization of line drawings, satellite images with road like structures.

In real life the edges will be the mixture of above-mentioned model with added with different noises and bias. The addition of noises and bias in the image cause the task of edge detection to be non-trivial.

### **III. EDGE DETECTOR**

The operator or algorithm used to detect the edge in the image is known as edge detector. In simple terms, the process to detect the edge in the image is known as edge detector. It could be as simple as a differential operation or the difference operation. Also, it could be a highly complex algorithm with machine learning and deep learning techniques. Here, we describe some of the well-known traditional edges detectors as well state of art and cutting-edge edge detectors.

- A. Roberts edge detector
- B. Prewitt edge detector
- C. Sobel - feldman edge detector
- D. Canny edge detector

- E. Laplacian of gaussian edge detector
- F. Holistically-nested edge detector
- G. Richer convolutional features edge detectior
- H. Bi-directional cascade network for perceptual edge detector
- I. Dense extreme inception network edge detector

Above mentioned algorithms for the edge detection are briefly discussed in the next portion.

#### **A. ROBERTS EDGE DETECTOR**

The Roberts cross-gradient operator proposed by Lawrence Roberts in 1965 [3]. It is a discrete two-dimensional differential operator used to emphasize and detect the gradient of the intensity function of image. The operator computes the gradient of an image through discrete differentiation, achieved by calculating the sum of the squares of the differences between diagonally adjacent pixels. The result of this operator corresponds either to the intensity gradient or the norm of the intensity gradient in the image. This is based on convolution of the image with two separable and integer valued horizontal and vertical operators, frequently known as masks. Given the input image  $I(x,y)$  of size  $m$  by  $n$ , where  $x=1,2,\dots,n$  and  $y=1,2,\dots,n$  are horizontal and vertical indices of the image [3]–[5].

$$RF_x = \begin{bmatrix} +1 & 0 \\ 0 & -1 \end{bmatrix} \text{ and } RF_y = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

Where  $SF_x$  and  $SF_y$  are derivative approximation in horizontal and vertical direction respectively. They are separable and integer valued small filters in horizontal and vertical directions. By convolving the  $I(x,y)$  with  $G_x$  and  $G_y$  we obtain two different images with horizontal and vertical edge approximation

$$G_x = I(x,y) * RF_x \text{ and } G_y = I(x,y) * RF_y$$

Where  $*$  is the convolution operator and  $G_x$  and  $G_y$  are the horizontal and vertical edge approximations respectively. The final edge image is obtained by computing the gradient approximation with equation:

$$E(x,y) = \sqrt{G_x^2 + G_y^2}$$

The resulting image  $E(x,y)$  is known as Roberts Edge approximation of original image  $I(x,y)$ . Due to the separable, integer valued and small size nature of this edge detection approximation, it is relatively inexpensive in computations. Also, it produces significant behavior in the high frequency and sharp discontinuity intensity variation in the image. Although the formulation of Roberts edge detector approximation generally used form two dimensional images, this edge detector approximation can be further extended to other higher dimensions in case we have the higher dimensional image for the purpose of multi-dimensional edge detection [1-3,5].

#### **B. PREWITT EDGE DETECTOR**

Prewitt edge detector approximation was proposed by J.M.S.Prewitt presented the idea of an 3x3 Image Gradient Operator in 1970 [10]. It is a discrete two-dimensional differential operator used to emphasize and detect the gradient of the intensity function of image. The result of this operator corresponds either to the intensity gradient or the norm of the intensity gradient in the image. This is based on convolution of the image with two separable and integer valued horizontal and vertical operators, frequently known as masks. Given the input image  $I(x,y)$  of size  $m$  by  $n$ , where  $x=1,2,\dots,n$  and  $y=1,2,\dots,n$  are horizontal and vertical indices of the image [1]–[5],[10].

$$PF_x = \begin{bmatrix} +1 & 0 & -1 \\ +1 & 0 & -1 \\ +1 & 0 & -1 \end{bmatrix} \text{ and } PF_y = \begin{bmatrix} +1 & +1 & +1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix}$$

Where  $PF_x$  and  $PF_y$  are derivative approximation in horizontal and vertical direction respectively. They are separable and integer valued small filters in horizontal and vertical directions. By convolving the  $I(x,y)$  with  $G_x$  and  $G_y$  we obtain two different images with horizontal and vertical edge approximation

$$G_x = I(x,y) * PF_x \text{ and } G_y = I(x,y) * PF_y$$

Where  $*$  is the convolution operator and  $G_x$  and  $G_y$  are the horizontal and vertical edge approximations respectively. The final edge image is obtained by computing the gradient approximation with equation:

$$(x, y) = \sqrt{G_x^2 + G_y^2}$$

The resulting image  $E(x,y)$  is known as Prewitt Edge approximation of original image  $I(x,y)$ . Due to the separable, integer valued and small size nature of this edge detection approximation, it is relatively inexpensive in computations. Also it produces significant behavior in the high frequency and sharp discontinuity intensity variation in the image. Although the formulation of Prewitt edge detector approximation generally used form two dimensional images, this edge detector approximation can be further extended to other higher dimensions in case we have the higher dimensional image for the purpose of multi-dimensional edge detection [1-3], [10].

### C. SOBEL - FELDMAN EDGE DETECTOR

Sobel-Feldman edge detector approximation was proposed by Irwin Sobel and Gary Feldman, colleagues at the Stanford Artificial Intelligence Laboratory (SAIL). Sobel and Feldman presented the idea of an "Isotropic 3x3 Image Gradient Operator" at a talk at SAIL in 1968. It is a discrete two-dimensional differential operator used to emphasize and detect the gradient of the intensity function of image. The result of this operator corresponds either to the intensity gradient or the norm of the intensity gradient in the image. This is based on convolution of the image with two separable and integer valued horizontal and vertical operators, frequently known as masks. Given the input image  $I(x,y)$  of size  $m$  by  $n$ , where  $x=1,2,\dots,n$  and  $y=1,2,\dots,n$  are horizontal and vertical indices of the image [8-9].

$$SF_x = \begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix} \text{ and } SF_y = \begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

Where  $SF_x$  and  $SF_y$  are derivative approximation in horizontal and vertical direction respectively. They are separable and integer valued small filters in horizontal and vertical directions. By convolving the  $I(x,y)$  with  $G_x$  and  $G_y$  we obtain two different images with horizontal and vertical edge approximation

$$G_x = I(x,y) * SF_x \text{ and } G_y = I(x,y) * SF_y$$

Where  $*$  is the convolution operator and  $G_x$  and  $G_y$  are the horizontal and vertical edge approximations respectively. The final edge image is obtained by computing the gradient approximation with equation:

$$E(x, y) = \sqrt{G_x^2 + G_y^2}$$

The resulting image  $E(x,y)$  is known as Sobel-Feldman Edge approximation of original image  $I(x,y)$ . Due to the separable, integer valued and small size nature of this edge detection approximation, it is relatively inexpensive in computations. Also it produces significant behavior in the high frequency and sharp discontinuity intensity variation in the image. Although the formulation of Sobel-Feldman edge detector approximation generally used form two dimensional images, this edge detector approximation can be further extended to other higher dimensions in case we have the higher dimensional image for the purpose of multi-dimensional edge detection[1-5], [8-9].

### D. CANNY EDGE DETECTOR

The Canny cross-gradient operator proposed by John F Canny in 1986 [11]. Canny edge detector is a multistage edge detection. Here the final edge is obtained after different steps in the algorithm. The main stages of canny edge detector include pre-processing, gradient calculation, non-maxima suppression and thresholding with hysteresis. As the edge detectors are sensitive to noise the canny edge detector in the pre-processing step removes the noise with gaussian low pass filter. The gaussian low pass filter blurs the image and hence the high frequency noise is removed causing the removal of noise and making the edge detector less sensitive to the external noise sources. The size of the low pass gaussian filter mask will control the amount of smoothing as well the blurring of the image. Also the standard deviation of the gaussian low pass filter mask will also control the amount of smoothing and blurring of the image. [11], [8], [1-5].

In the next step the gradient values are calculated. The gradient magnitude and directions are calculated at every single point in the image. The magnitude of the gradient will reflect the edge of the image. The higher value of gradient magnitude will refer to the strong edge value in the image. And the direction of gradient will refer to the orientation of the edge in the image. The gradient of image is calculated using the standard sobel edge detector approximation [8], [1-5]

The next step in the canny edge detector algorithm is to perform non-maximum suppression. Here, the pixel value is suppressed if the pixel value is not the maximum. The gradient direction is always perpendicular to the edge. Along the edge there will not be the significant change in the intensity values, but across the edge there will be major change in the intensity variation. After the non-maximum suppression the result image has thin edge like structures which may not be continuous at all points in the edge region in the image [8], [1-5].

The next step in the canny edge detector after the non-maximum suppression is the thresholding with hysteresis. From the magnitude gradient which has the value higher than the upper threshold will be marked. Also, the direction information of the gradient image and the lower threshold value  $s$  are used to grow the edges which are marked by the upper threshold and the magnitude value of the gradient. For all the pixels the values are checked for the edge value or not. Depending on this value the edge value perpendicular to the gradient direction and the edges are obtained. The edges obtained by this algorithm are known as canny edge detection and the detector is known as canny edge detector [9].

#### **E. LAPLACIAN OF GAUSSIAN EDGE DETECTOR**

The Laplacian operator highlights the regions of rapid intensity changes in an image and hence is often used as an edge detection operator. As the Laplace of an image detects the noise along with the edges in an image, the image is smoothed first by convolving by a 2-D Gaussian [20]. It is a discrete two-dimensional differential operator used to emphasize and detect the gradient of the intensity function of image. The operator computes the gradient of an image through discrete differentiation, achieved by calculating the sum of the squares of the differences between diagonally adjacent pixels. The result of this operator corresponds either to the intensity gradient or the norm of the intensity gradient in the image. This is based on convolution of the image with two separable and integer valued horizontal and vertical operators, frequently known as masks. Given the input image  $I(x,y)$  of size  $m$  by  $n$ , where  $x=1,2,\dots,n$  and  $y=1,2,\dots,n$  are horizontal and vertical indices of the image [12].

$$G(x,y) = \exp^{-\frac{x^2+y^2}{2\sigma^2}}$$

Where  $G(x,y)$  is the gaussian kernel with the standard deviation of  $\sigma$ . It is small filters in both spatial directions  $x$  and  $y$ . By convolving the  $I(x,y)$  with  $G_x$  and  $G_y$  we obtain two different images with horizontal and vertical edge approximation

$$G_{x,y} = I(x,y) * G(x,y)$$

Where  $*$  is the convolution operator and  $G_{x,y}$  is the gaussian smoothing of the image  $I(x,y)$ . The Laplacian of this gaussian image can be obtained with equation:

$$LoG(x,y) = -\frac{1}{\pi\sigma^4} \left[ 1 - \frac{x^2 + y^2}{2\sigma^2} \right] \exp^{-\frac{x^2+y^2}{2\sigma^2}}$$

The resulting image  $LoG(x,y)$  is known as Laplacian of Gaussian Edge approximation of original image  $I(x,y)$ . Due to the, integer valued and small size nature of this edge detection approximation, it is relatively inexpensive in computations. Also, it produces significant behavior in the high frequency and sharp discontinuity intensity variation in the image. Although the formulation of Laplacian of Gaussian edge detector approximation generally used for two dimensional images, this edge detector approximation can be further extended to other higher dimensions in case we have the higher dimensional image for the purpose of multi-dimensional edge detection [12], [1-5].

#### **F. HOLISTICALLY-NESTED EDGE DETECTOR**

Holistically-nested Edge Detector (HED) performs image-to-image prediction by means of a deep learning model. Deep learning model leverages fully convolutional neural networks and deeply-supervised nets. HED automatically learns rich hierarchical representations. Hierarchical representations (guided by deep supervision on side responses) that are important in order to approach the human ability resolve the challenging ambiguity in edge and object boundary detection [13].

#### **G. RICHER CONVOLUTIONAL FEATURES EDGE DETECTOR**

In 2017, Liu, Yun, Ming-Ming Cheng, Xiaowei Hu, Kai Wang, and Xiang Bai proposed edge detector based on Richer Convolutional Features. Richer Convolutional Features Edge Detector (RCF) Edge detector using richer convolutional features (RCF). Objects in nature images have various scales and aspect ratios, the automatically learned rich hierarchical representations by CNNs are very critical and effective to detect edges.

The convolutional features gradually become coarser with receptive fields increasing. Use of multiscale and multi-level information to perform the image-to-image edge prediction by combining all of the useful convolutional features into a holistic framework [14].

#### **H. BI-DIRECTIONAL CASCADE NETWORK FOR PERCEPTUAL EDGE DETECTOR**

In 2019, He, Jianzhong, Shiliang Zhang, Ming Yang, Yanhu Shan, and Tiejun Huang proposed edge detector based on H. Bi-Directional Cascade Network. Exploiting multi-scale representations is critical to improve edge detection for objects at different scales. To extract edges at different scales, authors proposed a Bi-Directional Cascade Network (BDCN) structure. Here an individual layer is supervised by labeled edges at its specific scale, rather than directly applying the same supervision to all CNN outputs. Authors introduced a Scale Enhancement Module (SEM) which utilizes dilated convolution to generate multi-scale features. These encourage the learning of multi-scale representations in different layers and detect edges that are well delineated by their scales [15].

#### **I. DENSE EXTREME INCEPTION NETWORK EDGE DETECTOR**

In 2020, Poma, Xavier Soria, Edgar Riba, and Angel Sappa proposed edge detector based on Dense Extreme Inception Network. Authors proposed a Deep Learning based edge detector. Which is inspired on both HED (Holistically-Nested Edge Detection) and Xception networks. Xception by Google, stands for Extreme version of Inception, a modified depth wise separable convolution. This edge detector generates thin edge-maps that are plausible for human eyes. Thin edge-maps can be used in any edge detection task without previous training or fine tuning process [16].

#### **IV. CHALLENGES IN EDGE DETECTION**

As the task of edge detection is non-trivial, researchers propose methods to overcome the limitation of the previously available edge detectors. The challenges in the edge detection process are false edge detection, noise, spurious edges detected because of noise, significant edges removed because of noise filtering, missing the low contrast edges, computational complexities and the high computational time. The edge detector working very well on certain type of dataset may not necessarily work on the other type of datasets, makes the unavailability of universal edge detector [1-5,8].

#### **V. CONCLUSION**

The paper presented the basic of edge and edge models. It also presented different edge detectors. The edge detectors presented here are traditional well known edge detectors as well the state of art and cutting edge edge detectors.

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**ORGANIZING LIBRARY DATA USING BIG DATA TECHNOLOGY: A RE-READING****DR. K. BALAMURUGAN AND DR. N. RAJESH****ABSTRACT**

*Libraries play an important role at the intersections of government, universities, research institutes, and the public since they are storing and managing digital assets. The large amount of data and those data in library need to be transformed into information or knowledge which then be used by researchers or users. Librarians might need to understand how to transform, analyze, and present data in order to facilitate knowledge creation. For example, they should know how to make big datasets more useful, visible and accessible. With new and powerful analytics of big data, such as information visualization tools, researchers/users can look at data in new ways and mine it for information they intend to have. In this work, we discussed the characteristics of datasets in library.*

**INTRODUCTION**

Libraries have collected a large amount of data, such as books, research articles and reports, both in physical and electronic formats. The library collection was originally for researchers or public users to find necessary information they need. However, this data becomes so large and the format is so various which might affect the efficient use. Although a lot of library data has been digitalized, most of them have not been used for data mining or big data technology. For example, the Geological Library of China for which one author works has 710,000 records of physical and electronic books and journals, recordings, maps, and field trip notes, however, most of these individual records remain isolated from the Web, requiring a detailed study how this data could be effectively exposed for use with current big data and other technologies.

Big data is a popular term. The three common characteristics of big data include high-volume, velocity and/or variety information. Although a few researches have linked library data into big data, some researchers raise questions about that since there is no clear characteristics of velocity. In addition, based on the current terminology, it seems that the database management systems is enough for storing and processing library data, thus does not require big data technology such as distributed systems for analysis or processing. Therefore, it might worth to clarify this doubt. Moreover, it seems that there is no much general review work s on the research for library “big data”.

The library big data could also more effectively serve researchers or ordinary users better. In addition, library big data research just started. Librarians are not sure how to integrate it into library data. Librarians need to possess a deep understanding of how to transform, analyze, and present data to facilitate knowledge creation. On the other hand, the ability to leverage library big data could make it possible to better understand how users perform research.

**IS LIBRARY DATA BIG DATA?**

“Big data” is one of the most popular terms these days. The hospitals, manufacturers, colleges, banks, retailers and governments are all collecting those so called “big data”. Libraries are also doing it. Of course, the ultimate goal for doing this is to use these data to provide new useful services or to improve efficiency.

The concept of “Big data” was first coined by Laney in 2001 in his research note Laney described the characteristics of big data as which cannot be processed by traditional data management tools. Three Vs were first used to characterize the big data. With further study on big data, the “Three V’s” have been expanded to “Five V’s”: volume, velocity, variety, veracity (integrity of data), value (usefulness of data) and complexity (degree of interconnection among data structures) by some researchers. However, the most important are still the first three.

If we only consider the static collection in libraries, it might be hard for us to relate it to big data. In addition, the database management systems should be enough to store and to process library data, therefore, based on the definition of big data, there is no need for big data technology such as distributed systems to analyze the data in library.

**VOLUME**

According to Wikipedia, ‘Big data’ refers to data sets whose size is beyond the ability of traditional software tools for capturing, managing, and processing the data. However, the actual size is a moving target, which could range from a few dozen terabytes to many petabytes of data. The size of big data varies depends on the discipline.

Some recently developed big data applications include healthcare, transportation, and entertainment, all of which involve enormous collections of data. It seems to us that each library has limited collections. For example, the National Geological Library of China has only 710,000 collections which are much smaller than those in other fields.

On the other hand, library collects a lot of “small research data”, which are created by individual researchers. Those tens of thousands of small-data producers in aggregate may well produce as much data (or more, measured in bytes) as the big data.

Moreover, library collections have a close tie to the linked data which forms larger web of big data. British library studied the linked data of library collections and tried to model the people, events, places which are related to holdings in the library. On the other hand, data schema could be created from library collections. For example, the relationships from coauthors, citations, geo-location, dates, named entities, subject classification, institution affiliations, and publishers could be easily extracted based on the books or journals. Those relationships could then be connected to other works, people, patents, events, etc. Creating, processing and making available this graph is big data.

The library could also collect the data that users search or use the library data, and such data certainly could have a volume similar to that of Twitter and others. As the size of collection volumes and the number of collection attributes increase, it could allow us to more rapidly extract and subsequently analyze patterns buried in the data. The so called “big data” in library could be used in many ways, such as improving usability, helping users to find the interesting patterns they need.

In general, the data stored in library certainly can be classified as large since it has hundred years of collections on one hand, contains tens of small research data as well and the data captured during users using the library service.

**VELOCITY**

The velocity characteristics of big data could also be found in the data from library. Library maintains multiple copies of files on servers and on tape, in geographically distributed locations. Therefore, there are movements of files between and within organizations. There are more and more researches going on and the research data come in and join the dataset dynamically. On the other hand, the library data need to be processed fast so that researchers could use it with value and ordinary users could receive the search results they need right away.

**VARIETY**

In general, libraries contain different types of data: books, journals, reports, notes, maps, films, pictures, audios etc. Some are unstructured. Unstructured data consists of language-based data (e.g., notes, twitter messages, books) and non-language-based data (e.g., pictures, slides, audios, videos). Even for digital research data, they have every imaginable shape and form, from scans of historical negative photographs to digital microscope images of unicellular organisms taken hundreds at a time at varying depths of field.

On other hand, as a matter of course libraries collect a host of usage and transactional data created by users as they interact with their systems and services. They are awash with this type of data-and are waking up the potential value that can be extracted from what at the moment is largely, unstructured data. Therefore, the characteristics of variety the big data obtains could also be found in the library data.

Besides those mentioned characteristics, the library data also have other properties.

**DATA LESS ORGANIZED**

It appears to us that the data such as books, journals in library are well organized since users could use categories to look for what they need. However, the situation is different for those research data stored in libraries. The research data in libraries seem to be disorganized, less described, and in formats poorly suited to long-term reuse . Researchers are used to their own process to produce these unorganized data. Those data are often managed by the project. Once projects complete with publication of articles or reports, research data are often locked into digital closets being unorganized.

**NON-STANDARD DATA AND DATA FORMAT**

Research data often lack of standard and format. They depend on the disciplines and individual libraries. Although a few disciplines might have created data standards, due to a strong centralized data repository, such as political and social research, in most disciplines, there often do not exist data standards, particularly for those researches which are individualized: i.e. each researcher defines the parameters which are important to the project.

The data format is another issue. Researchers use their own format for the data they collect. Even for the same researcher, different data formats might be used for different projects, which pose difficulty to integrate those data.

**ISSUES WITH BIG DATA IN LIBRARY**

It is clear now that library contains big data which is valuable. However, the big data is different from the data in other fields such as hospitals, business, as mentioned above. Big data research in library is relatively new. Therefore, there might exist some issues or difficulty in the process of data transformation, curation, analysis, and presentation. At less, the technology used in library big data might be different from that in other areas such as storage, software and personnel. One example is that should we create full-text indexes for millions/billions of files to support full discovery in library? Can library staff develop the expertise to provide guidance to researchers in using analytical tools? In order to apply data science efforts in library collections, there are some works which should be done, such as, but not limited to:

- Central data repositories, where data are stored, maintained, and cataloged;
- Data standards, to which collected data should follow;
- Data communities, which collect, maintain, and curate data;
- Analysis tool

There are some issues which are common to library big data research as listed below.

**ABILITY OF ADOPTING BIG DATA**

Big data comes in various fields. However, a lot of companies are not ready for it. According to the study, more than half of organizations could not handle the big data currently due to lack of personnel and platform. Research of library big data is even much slower than that in other disciplines. The key reason is that the digital libraries tend to be self-contained organizational units and they try to stay back from new technology.

**TECHNICAL CHALLENGES**

Big data involves techniques such as capturing, storing, processing and presenting data. Data in the library have different types and might be in various statuses. Some data might be waiting for digitalization. For geological data, data capturing often face challenge. For example, digitalizing field trip notes and geological maps is still an issue. On the other hand, a large set of data often contains some dirty or false data. Therefore, correctly removing those data needs some work.

Due to heterogeneous types and formats of research data, integrating them become a very tough job. For example, the challenge of integrating earth science data is obvious in geological library, since data across multiple disciplines (geology, geography, biology, and hydrology) has been collected, managed, and documented in very different ways.

Many types of research data are considerably less usable when they are in their raw state than after they have had filters or algorithms or other processing performed on them. Those work need budget to build tools and provide other supports as well.

**PRIVACY**

Big data is mining the data and discovering knowledge. There should be a privacy issue. On the other hand, new risks of system intrusions might arise due to the accessibility of a large amount of data. Data security issues have not been well considered for library big data research.

**BIG DATA NOT FOR ALL ORGANIZATIONS**

It is clear that the organizations that plan to use big data need to have a relative large investment in IT infrastructure and personnel. Therefore, small library without enough budget support might need to share the resource with other organizations. On the other hand, big data is relative new and traditional analytic approach still dominates majority of organizations.

With regards to the individual research data, small library might not have enough resource to support direct interaction with research faculty. Therefore, it might be hard to integrate all the data from all researchers in the organization.

### **WHAT CAN WE DO WITH LIBRARY BIG DATA**

Big data is a hot topic during these days. While businesses are analyzing big data looking for improved ways of selling products and services, governments are analyzing telecommunication and financial data to track money launderers and terrorists. Hospitals use it to prevent illness. The financial industry uses it to detect credit card fraud. Airlines use it to fill seats. What can it do for library?

From the DBMS's view, it would make sense for library to find a tool to store the data, another one for indexing it, and yet another to run queries against it. In addition to those traditional features, more functions could be added. For example, with library big data, we might be able to advise local business owners seeking market information, help students run statistics for a project, help researchers to manage large datasets effectively. It is clear that those features are similar to mining the financial data or transaction data. However, since users are using the library to conduct search for references, mining user behaviors might give insight for providing better service. That means that two aspects of data mining could be achieved: one is using data stored in the library and another is using the data collected during the process when users use the library service. Some of those are listed as below.

### **DATA-DRIVEN FOR DECISION MAKING**

Data-driven approach, which takes the data as the basis, to make decision or recommendation, is a common method used in many areas. For example, it is used in the database design or software design. It is now the key approach for library big data. Based on the data, the decision could be more useful. For example, based on the loan transactions customers borrow or search, the library could use collaborative data mining techniques and text analytics to optimize the collections (books or journals) to generate better search results and to make recommendation for the books. At the end, this approach would improve the customer satisfaction by providing better service, and efficient usage of library resources.

### **NEW DATA FORMAT**

Sharing data and make data accessible is one of the important goals of library. However, a lot of data need to be re-done, particularly those data collected in old time. Digitalizing them is the first step, by scanning or microfilming. Other efforts critical to increased data access and reusability involve building tools and infrastructure.

On the other hand, reformatting library data is important so that it can work with other online resources that users might intend to connect with. Library data could become linked data in order to achieve interoperability on the Web.

### **LIBRARY DATA VISUALIZATION**

Library data could be selected and visualized by tools such as Tableau dashboard, to present to users as user's need. On the other hand, librarian in the university library could use data visualization to compare sections of the library collection, expenditures in those areas, with the number of majors in them. The possible unbalance in the collections or budgeting in those areas might be able to determine and then provide planning advice.

### **USER BEHAVIOR STUDY**

As mentioned previously, the information of library collections could be mined through big data technology. On the other hand, it is possible to record and track library user's activity and to store that data in large-scale data storage, and then conduct data analysis. The result could then be used to potentially improve the overall user experience, and user's satisfactory of library service.

### **CONCLUSION**

Data is not just generated by satellites, or Twitter. We have Big Data in our libraries. Big data in library might have less challenge to study, but more challenge to engage with it due to budget and technical issues. Big data can certainly help libraries make more cost-effective, innovative decisions or recommendations that users wish to have.

The research data are increasing very fast, and more and more researchers wish to use collections as a whole, mining and organizing the information in novel ways. Without big data analysis, some patterns might not be easily found. The data collected when library users use the service are very helpful in improving the overall user experience, and user's satisfactory of library service.

The ability to collect and analyze massive amounts of data will be a competitive advantage across all industries, including library. The big data currently might be suitable only for those organizations with large set of data and funding. The traditional DBMS or data analytics might be still a dominant approach.

In future, we will survey the actual platforms or technologies used in library big data.

**WORKS HELPED TO THIS ARTICLE**

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