



DELHI INSTITUTE OF ADVANCED STUDIES

Plot No. 6, Sector-25, Rohini, Delhi-110085

Re-Accredited with 'A' Grade by NAAC

(Approved by AICTE & Affiliated with GGSIP University for B.Com(H), BBA, MBA & MBA (FM) Programmes)

(An ISO 9001:2015 Certified Institution)



Annexure 5 (b)

LIST OF PUBLICATIONS

2024 onwards

ARTICLES/RESEARCH PAPERS / PUBLISHED IN JOURNALS

NAME OF THE FACULTY	TITLE/ RESEARCH PAPER/ ARTICLE PUBLISHED	NAME, VOLUME, YEAR OF THE JOURNAL	S.No.
Dr. N. Malati	Customer Satisfaction Influencers: An Empirical Investigation of Online Banking Services	DIAS Technology Review, Vol. 19, No.2, Issue 38 th October 2022- March 2023 (published in December 2024). ISSN 0972-9658	1.
Dr. N. Malati	Effect of Social Media Influencer's Creditability on Brand Awareness, Brand Image and Consumer's Purchase intention with Reference to Electronic Gadgets	DIAS Technology Review, Vol. 20, No.1, Issue 39 th April-September 2023 (published in April 2025). ISSN 0972-9658	2.
Dr. N. Malati	Doctoral Abstract of Ms. Veena Rani, Research Scholar of Kumar Mangalam University, Gurgaon. "The Impact of Emotional Intelligence, Emotional labour and Job Stress on Employee's Health and Performance: A Study in Hardware Industry"	DIAS Technology Review, Vol. 20, No.1, Issue 39 th April-September 2023 (published in April 2025). ISSN 0972-9658	3.
Dr. N. Malati	Doctoral Abstract of Rohit Mahajan, Research Scholar of Amity University, Noida "Factors Affecting Customer Satisfaction: An Empirical Investigation of Online Banking Services"	DIAS Technology Review, Vol. 20, No.1, Issue 39 th April-September 2023 (Published in April 2025). ISSN 0972-9658	4.
Dr. Pratiksha Tiwari	Relationship amongst the factors formulating investor perception towards investment in crowd funding	International Journal Business Competition and Growth, Vol. 9, Nos. 3/4, 2024, UGC Care List , DOI: 10.1504/IJBCG.2024.10068887. ISSN: 2042-3853 (Online) / 2042-3845 (Print)	5.
Dr. Pratiksha Tiwari	On Use of Entropy Function for Validating Differential Calculus Results	Mathematics and Statistics 12(3): 283-291,2024 http://www.hrpub.org DOI: 10.13189/ms.2024.120308. Published in August 2024. Scopus Indexed	6.
Dr. Pratiksha Tiwari	Optimizing Sampling Techniques Using Fuzzy Set Theory: A Comprehensive Approach	Research & Reviews: Discrete Mathematical Structures. Vol. 12, Issue-1, Jan-April 2025 Impact Factor (SJIF): 6.209, ISSN(e): 2394-1979	7.



DELHI INSTITUTE OF ADVANCED STUDIES

Plot No. 6, Sector-25, Rohini, Delhi-110085

Re-Accredited with 'A' Grade by NAAC

(Approved by AICTE & Affiliated with GGSIP University for B.Com(H), BBA, MBA & MBA (FM) Programmes)

(An ISO 9001:2015 Certified Institution)



NAME OF THE FACULTY	TITLE/ RESEARCH PAPER/ ARTICLE PUBLISHED	NAME, VOLUME, YEAR OF THE JOURNAL	S.NO.
Dr. Pratiksha Tiwari	Investigating the Application of Fuzzy Logic and Uncertainty Handling in Case-Based Decision Making	Nanotechnology Perceptions, Vol. 20, S16 (December 2024), ISSN: 1660-6795 Scopus Indexed	8.
Dr. Pratiksha Tiwari	Comparative Study of Inventory Models to Lower Overall Inventory Cost	International Research Journal of Mathematics, Engineering and IT ISSN: (2349-0322) Association of Academic Researchers and Faculties (AARF) Impact Factor- 7.132 , Volume 11, Issue 06, June 2024.	9.
Dr. Meenakshi Kaushik	The Impact of Remote Work on Employee Engagement and Well-being: A Comparative Analysis Before and After the COVID-19 Pandemic	Trinity Journal of Management, IT & MEDIA, (Jan-Dec), 2024, Vol. 15 No. 1 DOI: https://doi.org/10.48165/tjmitm.2024.15.03 ISSN: 2320-6470	10.
Dr. Meenakshi Kaushik	AI-Driven Transformations in Higher Education: A Citation and Co-citation Analysis	International Journal of Experimental Research and Review (IJERR), Vol. 45, ISSN: 261-273 (Nov.2024), DOI: https://doi.org/10.52756/ijerr.2024.v45spl.021 https://orcid.org/0009-0002-1646-4056 Scopus Indexed	11.
Ms. Neetu Chadha	Tech Tides: Analyzing Foreign Investment Flows and Volatility in the Information Technology Sector	European Economic Letters, Vol 14, Issue 2 (2024), ISSN 2323-5233 http://eelet.org.uk Impact Factor: 3.8	12.
Ms. Neetu Chadha	FPI in IT Sector: Navigating Investment Flows and Market Volatility	Journal of Informatics Education and Research, Vol 4 Issue 2 (2024), ISSN: 1526-4726 . ABDC	13.
Ms. Neetu Chadha	Volatility in the Banking Sector: A Multivariate Study of FPI and Key Economic Indicators	DIAS Technology Review, (Vol. 20, No.2, Issue 40 th , October 2023- March 2024), ISSN 0972-9658	14.
Dr. Divya Jain	“Sentiment-Driven Market Dynamics: Evidence from Google Trends and Indian Stock Indices”	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	15.
Ms. Dimpay Jindal	OntoFuzz: An Information Retrieval Model in a Multi-Tenant Cloud Environment using Neuro-Fuzzy and Ontological-based Approach	Journal of Scientific & Industrial Research, Vol. 83, August 2024, pp. 856-863, DOI: 10.56042/jsir.v83i8.812 ISSN: 0022-4456, Scopus Indexed Impact Factor of JSIR is 0.8	16.
Ms. Dimpay Jindal	Cloud-based mechanized method for developing semantically rich ontologies and planning analogies for E-Comfort bids.	DIAS Technology Review, Vol. 20, No.1, Issue 39 th April-September 2023 (published in April 2025). ISSN 0972-9658	17.



DELHI INSTITUTE OF ADVANCED STUDIES

Plot No. 6, Sector-25, Rohini, Delhi-110085

Re-Accredited with 'A' Grade by NAAC

(Approved by AICTE & Affiliated with GGSIP University for B.Com(H), BBA, MBA & MBA (FM) Programmes)

(An ISO 9001:2015 Certified Institution)



NAME OF THE FACULTY	TITLE/ RESEARCH PAPER/ ARTICLE PUBLISHED	NAME, VOLUME, YEAR OF THE JOURNAL	S.NO.
Ms. Aanchal Gupta	“Traditional wealth and Asset Management in Indian Households: A Generational Study”	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	18.
Ms. Asha Kumari	“Traditional wealth and Asset Management in Indian Households: A Generational Study”	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	19.
Ms. Asha Kumari	“Determinants of FII Flows in India”	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	20.
Ms. Aanchal Gupta	The Impact of Neurodiversity Management on Organizational Commitment and Citizenship Behaviour: Evidence from Indian Corporate Sector	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	21.
Ms. Sonali Taneja	The Impact of Neurodiversity Management on Organizational Commitment and Citizenship Behaviour: Evidence from Indian Corporate Sector	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	22.
Ms. Neha Yadav	Assessing the Impact of Digital Banking Innovations on Transaction Speed and Financial Service Accessibility for Entrepreneurs: Challenges and Perspectives in Delhi, NCR, India.	International Journal of Innovation Studies, Vol. 9, No.1, 2025, Page No. 587-599, ISSN NO: 2096-2487 Link: https://ijistudies.com/index.php/IJIS/article/view/153/150 Scopus Indexed	23.
Ms. Neha Yadav	The Role of Leadership Styles in Organizational Performance and Employee Motivation	Journal of Research Administration, Society of Research Administrators International, Vol. 6, No. 2, 2024, Page No. 985-1005. ISSN:1539-1590, E-ISSN:2573-7104 Scopus Indexed https://journalra.org/index.php/jra/article/view/2055	24.
Dr. Pooja Gupta	Sustainability Through CSR and Its Impact on Financial Performance (A Case Study of Tata Consultancy Services)	DIAS Technology Review, Vol. 39 th Issue April-September 2023 (published in April 2025). ISSN 0972-9658	25.
Ms. Radhika Garg	“Determinants of FII Flows in India”	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	26.



DELHI INSTITUTE OF ADVANCED STUDIES

Plot No. 6, Sector-25, Rohini, Delhi-110085

Re-Accredited with 'A' Grade by NAAC

(Approved by AICTE & Affiliated with GGSIP University for B.Com(H), BBA, MBA & MBA (FM) Programmes)

(An ISO 9001:2015 Certified Institution)



NAME OF THE FACULTY	TITLE/ RESEARCH PAPER/ ARTICLE PUBLISHED	NAME, VOLUME, YEAR OF THE JOURNAL	S.No.
Dr. Komal	Does Regime-Dependent Volatility Drive Dynamism in Investor Herding?	Colombo Business Journal- International Journal of Theory & Practice, Vol.15, Issue 1, 2024 E-ISSN-2579-2210 Print ISSN: 1800-363X https://cbj.sjoi.info/articles/169/files/667f70b1808da.pdf DOI: https://doi.org/10.4038/cbj.v15i1.169	27.
Dr. Komal	Herding in Factor Portfolios: A Regime-Switching Perspective on the Indian Market	DIAS Technology Review, 40 th Issue, Vol. 21, No. 2 (October 2023-March 2024) ISSN 0972-9658	28.
Ms. Jyakshi Sharma	Effect of Social Media Influencer's Creditability on Brand Awareness, Brand Image and Consumer's Purchase intention with Reference to Electronic Gadgets	DIAS Technology Review, Vol. 39 th Issue April-September 2023 (published in April 2025). ISSN 0972-9658	29.
Ms. Neha Solanki	The Impact of Decentralized Finance (DeFi) on Traditional Banking Systems: Opportunities and Challenges	Pranjana, Vol. 27, No. 1 & 2, January-December 2024 ISSN: 0971-9997 (Print); 0974-0945 (Online)	30.
Ms. Neha Solanki	"Development of an Early Warning System for Slop Instability in Opencast Coal Mines Using Geo-Spatial AI"	DIAS Technology Review, 41 st Issue, Vol. 22, No. 1 (April 2024- September 2024) ISSN 0972-9658	31.
Dr. Komal	The Dividend Enigma: Deciphering the Effect on Indian ETF Performance in Stress and Normal Periods	International Journal of Trade and Global Markets Submission ID: IJTGM-237964 ISSN online: 1742-755X ISSN print: 1742-7541 Scopus Indexed	32.
Ms. Ruchi Gupta	AI Driven Disruption and Opportunity : A Sectoral Study of Employment Trends in India	International Engineering Journal for Research and Development, Vol. 10, Issue-2, July 2025, ISSN: 2349-0721	33.

OntoFuzz: An Information Retrieval Model in a Multi-Tenant Cloud Environment using Neuro-Fuzzy and Ontological-based Approach

Dimpy Jindal^{1*}, Manju Kaushik¹ & Barkha Behl²

¹Amity University, Rajasthan, Jaipur 303 002, India

²Trinity Institute of Professional Studies, Delhi 110 075, India

Received 23 April 2023; revised 18 April 2024; accepted 05 July 2024

There is a tremendous amount of data present on the web and accessing useful/relevant information from a cluster of random documents is a tedious and time-consuming task. Traditional information retrieval techniques and information management systems are not that intelligent to extract relevant information from pre-defined datasets or documents. This necessitates the researchers to create and enhance a sophisticated information retrieval system. Also, the similarity between information is equipped with uncertainties due to its computing measures. Keeping these issues in mind, a neuro-fuzzy and ontological-based model in a multi-tenant cloud environment is proposed in this research study. The model comprises modules like query expansion, the weighting of terms and queries, and hashing function to ease the retrieval process followed by validation of the dataset using a neuro-fuzzy network to retrieve relevant information from the cloud service provider. The simulation results prove the validation of the proposed model in terms of higher accuracy and better retrieval performance as compared to traditional models (support vector machines and deep neural networks) as well as existing recent works.

Keywords: Cloud computing, Information retrieval, Multi-tenancy, Neuro-fuzzy, Ontology

Introduction

Information extraction is a critical step in cloud computing because it permits the storage and recovery of useful information from the local host to the cloud server and vice versa. The system for managing information experiences a significant transformation in a short time due to the availability of resources and technological innovation. With its cutting-edge web-based information management solutions, technology has also begun removing the last vestiges of conventional information management techniques. Similarly to this, the demand for information management systems is continually growing as a result of modern advanced search engines, internet-based services, network mediums, and electronic libraries. With its cutting-edge web-based information management solutions, technology has also begun removing the last vestiges of conventional information management techniques. Similarly to this, the demand for information management systems is continually growing as a result of modern advanced search engines, internet-based services, network mediums, and electronic libraries. This necessitates

the researchers to create and enhance a sophisticated information retrieval system.

Problem Statement and Significance of the Study

The significance of information retrieval is demonstrated by the way it extracts the material from databases that are most appropriate for a given query. But the question is: How can the relevant data for the query to be retrieved? The precision and recall will increase when information is extracted based on semantics instead of traditional text-based keywords. According to the query, a big group of documents is separated into smaller sets for this reason to extract data mining's ultimate objective to gather data based on patterns that can be recovered to gain crucial knowledge from the massive amounts of data that have been stored. The best example of information management nowadays is cloud computing, which is based on pay per usage policy and is extensively used by both large and small enterprises. The cloud provides services based on needs, reducing substantial expenses for businesses because they do not have to pay for hardware or environment setup. Because cloud computing is widely used, users can easily expand or decrease storage capacity as needed, which further lowers organizational costs. Hence, this

*Author for Correspondence
E-mail: dimpy.jindal23@gmail.com

research work attempts to provide an efficient and reliable means of retrieving relevant information in the context of user queries using the fuzzy and ontological-based approach in a multi-tenant cloud environment.

Related Works

This section summarises relevant research on information retrieval that has already been done to identify potential problems with retrieval system implementation. Jiaying *et al.*¹ analyze the data mining and information retrieval system. The survey provides in-depth information regarding applications of information retrieval systems in the cloud environment. Yongjun *et al.*² identified problems with the bibliographic information retrieval system's natural language interface since database management systems have trouble organizing data in natural language, it is difficult to perform information retrieval using natural language. In their research, Andrei *et al.*³ describe a ranking-based information retrieval technique. When calculating model ranks based on document description and phrase frequency, the user request is taken into account. The research employs a modified genetic algorithm and offers helpful data immediately. A genetically based map criterion and ranking models are used in the proposed method to lessen the structural complexity of conventional information retrieval. However, the fact that the recommended system is unable to react to questions posed in natural language is regarded as a model restriction. Issues with the multimodal retrieval method for getting document images are reported by Datta *et al.*⁴ Graphs are used to represent the words in a text, which makes it easier to assess how similar the words are. Synonymy and a semantic index are added to the similarity measure to improve performance by obtaining the data required for the user query. The studies by Tajeddine *et al.*⁵ and Yang *et al.*⁶ employing distributed databases for information retrieval discovered similar models which increase retrieval performance and data security. A cluster-based information retrieval paradigm was put forth by Djenouri *et al.*⁷. Based on the user question, the suggested approach determines the frequency of the information and returns the most common things as results. The recommended approach has advantages because it returns to the user the most well-liked terms that are frequently used by others. This model's weakness is the incorporation of unnecessary data, though. Angelini *et al.*⁸ proposed

multimedia information retrieval exchange based on a case-based dataset. Information processing problems in a multi-cloud context were reported by Jennifer *et al.*⁹. Due to its interface, service delivery, and technology, data upkeep in a multi-cloud context is a difficult procedure. Joby *et al.*¹⁰ performed an information retrieval process with traditional deep learning models like Support Vector Machines (SVM) and Convolutional Neural Networks (CNN). It produces repetitive results due to a lack of filtering and expansion of queries entered by the user. Chandrika *et al.*¹¹ perform accessing of data in a multi-tenant environment using an Elliptic Curve Cryptography (ECC) algorithm but its limitation is that the data is not refined with relevant results. It does not make use of any deep learning and ontological-based methodology to refine the retrieval process. Krishnaraj *et al.*¹² devised a model based on semantic indexing for large-scale image retrieval in a cloud environment. It does not involve the expansion of terms and text-based keywords which may lead to higher precision and retrieval efficiency of entered data. In addition to this, a concise view of some extra literature review studies is presented in Table 1.

Ontology in Cloud

A hierarchical representation of data in the form of classes, properties, and instances to make it more meaningful and representable is termed Ontology. Ontology is treated as the formal, explicit specification of a shared conceptualization.¹⁶ Besides its formal nature, philosophical aspects, and handling of real-world scenarios, it also acts as a medium for linking humans and machines.¹⁷

Proposed Model

It begins with the expansion of the input query entered by the user. Query expansion involves pre-processing data sources, term extraction, term weighing and ranking, term selection, and query rephrasing. It is described as follows.

Pre-processing of Sources of Extraction of Terms and Data

The main objective of this stage is to retrieve from the data source a list of phrases that significantly broadens the user's initial query. It includes extrapolation of text from the data source (full-text extraction from the particular data source utilized for query expansion), tokenization (technique of word-by-word splitting of a text stream), and stop words elimination (removing terms that are used frequently, such as articles, adjectives, prepositions, etc.).

Table 1 — Detailed insights of a few selected papers

Author	Year	Description	Shortfalls indicated in referred articles	Algorithm/ Technique used
Jiaying <i>et al.</i> ¹	2019	Detailed information about information retrieval processes in a cloud environment.	Not suited for domain-specific applications and training datasets.	Not applicable
Yongjun <i>et al.</i> ²	2017	Identified issues with existing information retrieval systems.	Cannot validate dataset on any simulation platform	Natural language processing
Andrei <i>et al.</i> ³	2017	Calculates model ranks based on document description and phrase frequency.	The model is unable to react to queries in natural language	Genetic algorithm
Datta <i>et al.</i> ⁴	2017	Semantic indexing of queries is done to improve the retrieval process	No algorithm and training dataset validation	Learning graphs
Tajeddine <i>et al.</i> ⁵	2018	Uses distributed databases for information retrieval	Although it provides high security and higher efficiency, failed to provide validation of results.	Not applicable
Yang <i>et al.</i> ⁶	2018	Uses distributed databases for information retrieval	Although it provides high security and higher efficiency, failed to provide validation of results.	Not applicable
Djenouri <i>et al.</i> ⁷	2019	Performs retrieval based on the frequency of terms entered by the user.	Does not consider the user's previous preferences	Cluster-based approach
Angelini <i>et al.</i> ⁸	2018	Works on the assumed dataset by computing similarity measure	Low accuracy	Visual analytics approach
Jennifer <i>et al.</i> ⁹	2019	Data is accessed through cryptographic and hash functions in a cloud environment	Irrelevant search results	Computational intelligence
Joby <i>et al.</i> ¹⁰	2020	Identified security issues in multi-tenant cloud systems by computing similarity measure	No concept of semantic indexing and ontology is being used	Probabilistic and vector space model
Chandrika <i>et al.</i> ¹¹	2021	Self-adaptive system	It does not make use of any deep learning and ontological-based methodology to refine the retrieval process	Elliptic curve cryptography algorithm (ECC)
Krishnaraj <i>et al.</i> ¹²	2021	Image-based retrieval only	It does not involve the expansion of terms and text-based keywords	Semantic indexing
Babu <i>et al.</i> ¹³	2022	Secure deduplication in Multi-tenant cloud	No concept of semantic integration and ontology is used	Hashing technique
Ubaidullah <i>et al.</i> ¹⁴	2023	Virtual machine trusted cloud computing	Does not perform validation in testing phase	Elliptic cryptography
Vajpayee & Hossain ¹⁵	2024	Risk prediction through multi-tenant cloud	No official dataset is taken into consideration	Homomorphic encryption

Ranking and Weighing the Terms used in Query Expansion

The inputs for this step include the user's query and the texts that were obtained from the data sources in the preceding stage. The relevance of the phrases in the expanded query is shown by the assigned weights, which are subsequently applied to the documents that have been retrieved to score them. Romano *et al.*¹⁸ divide the strategies into three groups based on how the expansion features and query terms interact.

(a) *One-to-One relationship*: -Connect each enlarged term to at least one query phrase. The use of a glossary is necessary. One of the most well-known thesauruses is WordNet.¹⁹ WordNet is used to map each query phrase to its synonyms and a related set of terms in the expanded query. For instance, the term "java" has three synsets in WordNet, each with a

distinct sense: place. According to the common understanding of word similarity, two terms are semantically similar if they exist in the same text. Like this, texts are judged comparable if they include similar language. There are various methods for figuring out word similarity. The degree of phrase similarity between WordNet synsets is assessed using path length-based metrics.

Let t_1 and t_2 be the specified terms, and let ' len_s ' stand for the length of the shortest path in WordNet between t_1 and t_2 . Then, the definition of the "Shortest Path Similarity Score"²⁰ is:

$$SimPath(t_1, t_2) = 1 \div len_s \quad \dots (1)$$

The similarity between the terms t_1 and t_2 is also computed by the Cosine similarity measure defined as:

$$Sim_{cosine} = C_{t1, t2} \sqrt{\sum_{d \in j} w \times w(t1, j) \cdot \sum_{d \in j} w \times w(t2, j)}$$

... (2)

where $C_{t1, t2}$ denotes similarity between terms $t1$ and $t2$; $w(t1, j)$ and $w(t2, j)$ are the weight of terms $t1, t2$ in j^{th} document

(b) One-to-many relationship:-In this, a candidate term is included in the enlarged query if it is linked to numerous terms from the original query.

(c) Query Language Modelling:- It involves selecting the most likely growth terms and developing a quantitative approach for the inquiry. This method is also known as the model-based technique. The likelihood that a document will be among the top results is as follows:

$$log_p(Tr \downarrow \theta q) = \sum_{\substack{D \in t1 \\ D \in t2}} C(t1, t2, D) log(\mu(t \downarrow C) + (1 - \mu)(t, \theta q))$$

... (3)

where, Tr is the set of top-ranked documents; θq is the query model; $C(t1, t2, D)$ is the number of occurrences of terms in Document D ; μ is the weighing parameter having a value between 0 and 1

Selecting the Query Expansion Terms

The selection of the expansion terms based on the ranks assigned to each term has been recommended using a variety of techniques that utilize the additional information. A system that chooses the most popular terms for each query while utilizing a variety of term rating methods was proposed by Carpineto *et al.*²¹ To do this, corpus papers must be reexamined, and new questions must be created that relate to the original one. Fang *et al.*²² suggested an impact-sorted indexing method that makes use of a specific index data model and improves information retrieval scoring systems.

Query Rephrasing

The larger query is modified in the final stage of the expansion process to deliver better results when utilized to fetch pertinent documents. Query reweighting is the process of reformulating the query based on the weights given to each distinct term in the extended query. It can be formulated as:

$$RW_{t,q} = (1 - \mu) \cdot W_{t1} + \mu \cdot W_{t2}$$

... (4)

where, $RW_{t,q}$ is the reweighting of term t of the query q ; W_{t1} = weight assigned to term $t1$; W_{t2} = weight assigned to term $t2$; μ is the weighing parameter having a value between 0 and 1

After query expansion, it is fed into the Cloud Service Provider (CSP). The model is proposed in a distributed multi-tenant cloud environment comprising a pre-defined domain-specific dataset. The query is inputted by the user related to the dataset. Using the hash function, a hash table is created to maintain a database for easy retrieval of information. Hamming distance is calculated to map the queries of the same class with similar codes. Once it is identified, the data is set to train and validate using a neuro-fuzzy network based on fuzzy logic splicing and parallelization. As soon as a query is entered by a user, the relevant information from the trained dataset is mapped from a Cloud Service Provider (CSP) and provided to the user in form of ontologies (hierarchical structure of relevant results). With ontology, a user can easily identify classes, properties, and instances related to the entered query. The process is illustrated in algorithms as shown below:

Algorithm 1: Query expansion

Input: Query entered by the user

Output: Reformulated query

Step 1. Pre-processing of query

1.1 Extrapolation of text

1.2. Word-by-word splitting of text

1.3. Stop words elimination

1.4 Stemming of words

Step 2. The weighting of terms. Let terms be $t1, t2$, and weights associated with them be $w(t1)$ and $w(t2)$

2.1. Computing similarity between terms $t1$ and $t2$ using cosine similarity measure using Eq. 2:

2.2 Selecting the most likely occurring terms in the query using Eq. 3

Step 3. Ranking of selected terms

Step 4. Reformulation of query based on weights associated with each term using Eq. 4

Algorithm 2: Hashing function

Input: Expanded query features

Output: Binary codes, hamming distance

Step 1. After the expansion of the query, it is mapped by hash codes, and a mediator function is introduced to achieve better similarity between pairs of terms.

Step 2. Let $q1, q2$, and $q3$ be the pairs for the given query (Q)

Step 3. Let hash codes associated with pairs are $h1, h2, h3$ having range of n bit binary codes $\{+1, -1, +1\}^n$

Step 4. for $n \leq$ length of terms do

map $\{(h1, q1), (h2, q2) \text{ and } (h3, q3)\}$

compute mediator function M_f as

$M_f(h1, h2, h3, Q) = \frac{1}{2} (1-q) d_h(h1, h2, h3)$ where d_h is hamming distance computed to obtain similar pairs of terms with 0 code and dissimilar pairs with 1

Algorithm 3: Fuzzy logic splicing

Step 1. The neuron-activated function in the neuro-fuzzy model is used to set the threshold based on M_f computed in the above step. It works on the same codes for similar terms and binary codes for dissimilar terms.

Step 2. The similar terms are spliced using fuzzy rules and are computed as:

$$F_1(n_w \wedge o) = (I \div M_f) \sum_{n=1} w(t1) + (I \div Ln_w) \sum_{n=1} w(t2) - (2 \div Ln_w) n_w, o \quad \dots (5)$$

where, F_1 = Fuzzy logic function, n_w = neuron weight, o = output function, Ln_w = neuron length

3. This neuro-fuzzy function will process either similar or dissimilar results at one time thus blocking the irrelevant results to the user.

The layout of the proposed model is presented in Fig. 1

Implementation Process

Hardware requirements: i3/i5/i7 processor with 2.2 GHz with 4 GB RAM or higher

Operating system: Windows 64 bit

IDE: NetBeans 8.2, Java Development Kit (JDK)

Simulator: CloudSim 3.03 version and MATLAB R2023a

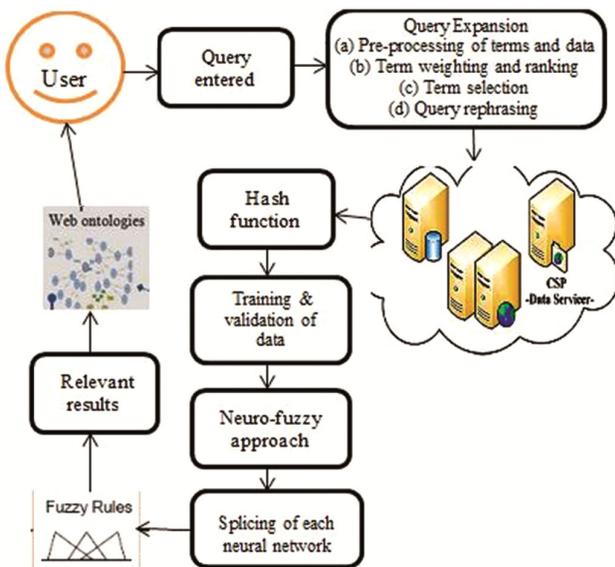


Fig. 1 — OntoFuzz- Proposed information retrieval model

Experimental Dataset

The proposed OntoFuzz algorithm for information retrieval in a multi-tenant cloud environment is experimentally verified in CloudSim²³ and MATLAB²⁴ and validated on the annual rainfall dataset taken from the Kaggle database.²⁵ The efficiency and retrieval performance of the proposed model is estimated using Precision, Recall, and f-measure. Conventional support vector machine (SVM) information retrieval systems and deep neural network models are compared with the proposed OntoFuzz system.

Precision (P) is calculated as $t_p \div (t_p \pm f_p) \quad \dots (6)$

Recall (R) is calculated as $t_p \div (t_p \pm f_n) \quad \dots (7)$

F-measure is calculated as $\frac{2 \times P \times R}{P + R} \quad \dots (8)$

The dataset has many training samples in the form of periods, a few of them are depicted in Table 2. In the dataset, S denotes seeded, U denotes unseeded, NC denotes rainfall in the north-central area, SC denotes rainfall in the south-central area, NWC denotes rainfall in the northwest-central area and TE denotes east target areas.

Simulation of Model in its Training and Testing Phase

The dataset used in the study initially has 10,000 training samples, 100 numerical attributes and 500 testing samples. Suppose a user enters a query ‘Plot the rainfall intensity wave graph in north-central area and south-central area during AUTUMN season’. The simulation of our proposed model is done in MATLAB and CloudSim and the results are shown in Fig. 2 and Fig. 3.

Results and Discussion

In Table 3, the proposed model results are collated with the conventional models^{26,27} and recent studies.¹²⁻¹⁵

It can be seen that the proposed OntoFuzz model outperforms the conventional models as well as recent studies in terms of precision, recall and f-measure. Also, the retrieval efficiency of the individual proposed OntoFuzz model is depicted in Fig. 4. It implies that performance increases even as the number of queries rises in the system.

Better accuracy is seen in the proposed OntoFuzz model as compared to traditional information systems as depicted in Fig. 5. The accuracy of the SVM system based on the number of queries is around 67–76%, and that of the Deep neural network is around 56–83%.

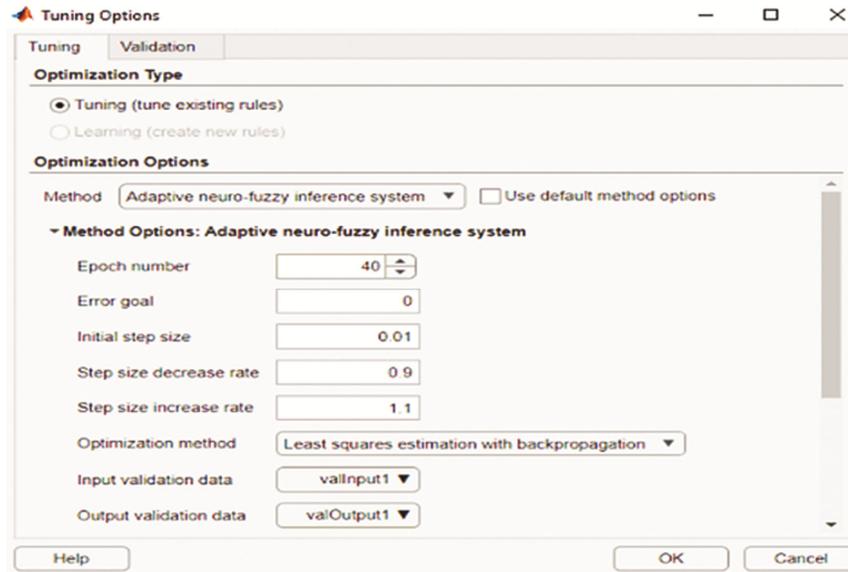


Fig. 2 — Tuning training and testing parameters using Neuro-fuzzy approach

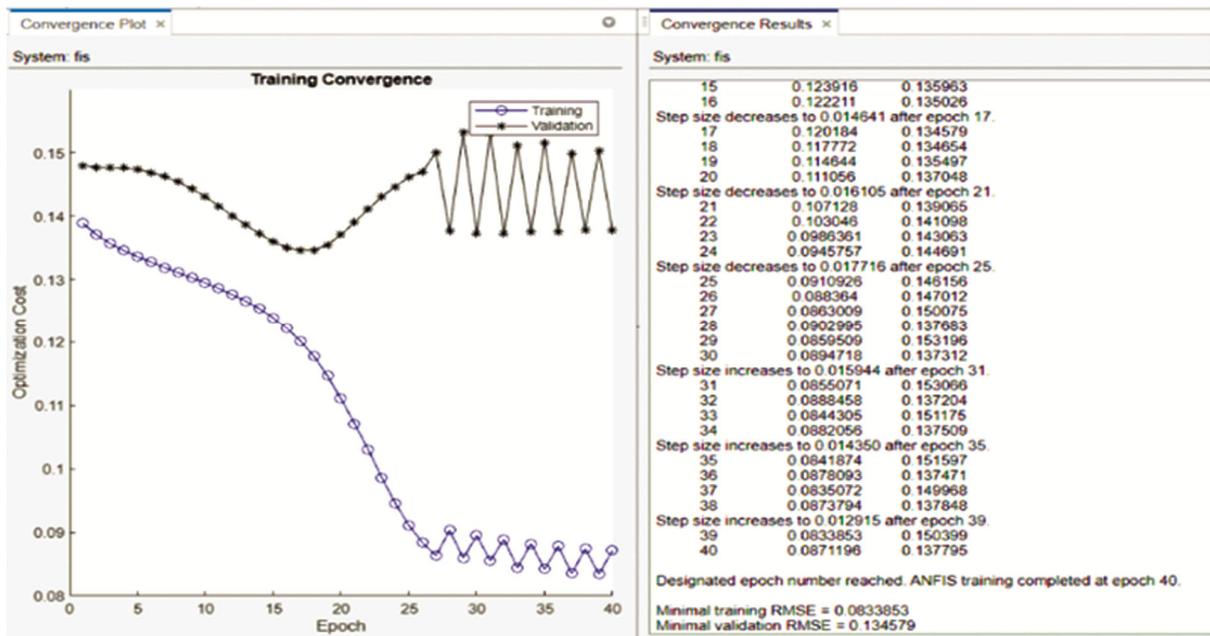


Fig. 3 — Splicing or convergence of neural network and generation of fuzzy rules

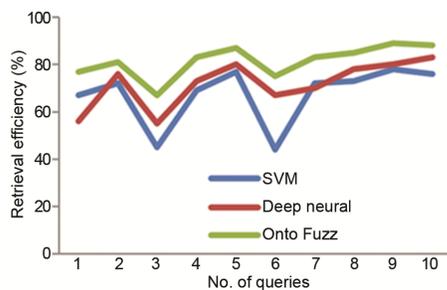


Fig. 4 — Information retrieval efficiency of the combined systems

Table 3 — Comparative analysis of the proposed model with conventional models and recent studies

Approaches/Models	Precision (%)	Recall (%)	f-measure (%)
Krishnaraj <i>et al.</i> ¹²	65.67	64.33	66.78
Babu <i>et al.</i> ¹³	68.23	69.55	69.76
Ubaidullah <i>et al.</i> ¹⁴	72.44	73.55	74.67
Vajpayee & Hossain ¹⁵	78.48	79.12	78.66
SVM-based system ²⁶	76.45	75.34	77.65
Deep neural network ²⁷	82.34	84.23	84.61
Proposed OntoFuzz system	85.67	86.54	85.49

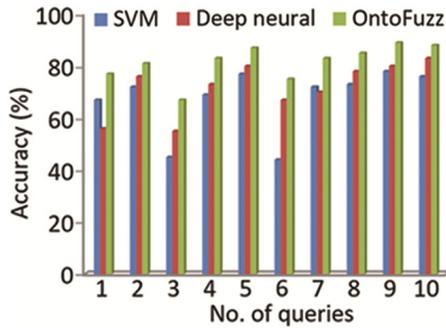


Fig. 5 — Accuracy of combined systems based on the number of queries

OntoFuzz system is having an accuracy of around 77–89% thereby retrieving more relevant results.

Conclusions

Validated on CloudSim using an annual rainfall dataset from the Kaggle repository. It is compared with traditional Support Vector Machine (SVM) information retrieval systems and deep neural network systems based on evaluation metrics including precision, recall, f-measure, and accuracy. The results found to be better. However, Optimization of hyper-parameters involved in neuro-fuzzy approach may involve higher processing time which lead to overlapping of fuzzy rules and distorted results. Sometimes, the integration of ontology with the cloud server provider requires higher application cost for the users. As a future scope, ontology can be designed using ontology editors like PROTÉGÉ, HOZO, etc. and the results from the designed ontology are required to produce inferences based on semantic web rule language and ontology web language. In this way, the results from enhanced ontology are added to the Software-as-a-Service (SaaS) layer of the cloud.

References

- Liu J, Kong X, Zhou X, Wang L, Zhang D, Lee I, Xu B & Xia F, Data mining and information retrieval in the 21st century: A bibliographic review, *Comput Sci Rev*, **34** (2019) 1–15, <https://doi.org/10.1016/j.cosrev.2019.100193>.
- Zhu Y, Yan E & Song Y, A natural language interface to a graph-based bibliographic information retrieval system, *Data Knowl Eng*, **3** (2017) 73–89, <https://doi.org/10.1016/j.datak.2017.06.006>.
- Kulunchakov A S & Strijov V, Generation of simple structured information retrieval functions by a genetic algorithm without stagnation, *Expert Syst with Appl*, **85** (2017) 221–230, <https://doi.org/10.1016/j.eswa.2017.05.019>.
- Datta D, Varma S, Chowdary R & Singh S K, Multimodal retrieval using mutual information based textual query reformulation, *Expert Syst Appl*, **68** (2017) 81–92, <https://doi.org/10.1016/j.eswa.2016.09.039>.
- Tajeddine R, Gnilke O W & Rouayheb S E, Private information retrieval from MDS coded data in distributed storage systems, *IEEE Trans Inf Theory*, **64(11)** (2018) 7081–7093, doi: 10.1109/ISIT.2016.7541531.
- Yang H, Shin W & Lee J, Private information retrieval for secure distributed storage systems, *IEEE Trans Info Forensics Security*, **13(12)** (2018) 2953–2964, doi: 10.1109/TIFS.2018.2833050.
- Djenouri Y, Belhadi A, Viger P F & Lin J C W, Fast and effective cluster-based information retrieval using frequent closed itemsets, *Info Sci*, **453** (2018) 154–167, <https://doi.org/10.1016/j.ins.2018.04.008>.
- Angelini M, Fazzini V, Ferro N, Santucci G & Silvello G, CLAIRE: A combinatorial visual analytics system for information retrieval evaluation, *Info Proces Mgmt*, **54(6)** (2018) 1077–1100, <https://doi.org/10.1016/j.ipm.2018.04.006>.
- Raj & Jennifer S, Efficient information maintenance using computational intelligence in the multi-cloud architecture, *J Soft Comp Paradigm*, **1(2)** (2019) 113–124, doi: 10.36548/jscp.2019.2.006.
- Joby D P P, Expedient information retrieval system for web pages using the natural language modeling, *J Artif Intell*, **2(2)** (2020) 100–110, doi: 10.36548/jaicn.2020.2.003.
- Chandrika S U & Perumal T M, Modified ECC for Secure data transfer in multi-tenant cloud computing, *Int J Comput Net Info Sec*, **6** (2022) 76–88, doi: 10.5815/ijcnis.2022.06.06.
- Krishnaraj N, Elhoseny M, Lydia E L, Shankar K & Dabbas O A L, An efficient radix trie-based semantic visual indexing model for large-scale image retrieval in a cloud environment, *Soft: Pract Exp*, **51(3)** (2021) 489–502, <https://doi.org/10.1002/spe.2834>.
- Babu B S & Jothi K R, Secure deduplication with dynamic updates in multi-tenant cloud environment, *Proc Int Conf Adv Comput Tech Appl* (IEEE) 2022, 1–4, doi: 10.1109/ICACTA54488.2022.9752987.
- Kashif U L, Memon Z A, Ghanghro S A, Channa W A & Soomro A, Centralized accessibility of vm for distributed trusted cloud computing, *Proc Int Conf Comput, Math Eng* (IEEE) 2023, 1–6, doi: 10.1109/iCoMET57998.2023.10099351.
- Vajpayee P & Hossain G, Multi-tenant cloud security- risk prediction through cyber-value-at-risk (CVaR), *Proc Int Conf on Digital Forensics and Security* (IEEE) 2024, 1–7, doi: 10.1109/ISDFS60797.2024.10527323.
- Singh G & Jain V, Information retrieval (IR) through Semantic Web (SW): An overview, *Proc Int Conf on Confluence* (IEEE) 2012, 23–27.
- Yadav U, Narula G S, Duhan N & Jain V, Ontology engineering, and development aspects: A survey, *Int J Edu Manag Eng*, **6 (3)** (2016) 9–19, <https://doi.org/10.5815/ijeme.2016.03.02>.
- Carpineto C & Romano G, A survey of automatic query expansion in information retrieval, *ACM Comput Surv*, **44(1)** (2012) 1–50, <https://doi.org/10.1145/2071389.2071390>.

- 19 Pal D, Mitra M & Datta K, Improving query expansion using wordnet, *J Assoc Inf Sci Technol*, **65(12)** (2014) 2469–2478, <https://doi.org/10.1002/asi.23143>.
- 20 Zingla M A, Chiraz L & Slimani Y, Short query expansion for microblog retrieval, *Procedia Comput Sci*, **96** (2016) 225–234, <https://doi.org/10.1016/j.procs.2016.08.135>.
- 21 Carpineto C, Romano G & Giannini V, Improving retrieval feedback with multiple term-ranking functions combination, *ACM Trans Inf Syst*, **20(3)** (2002) 259–290, <https://doi.org/10.1145/568727.568728>.
- 22 Chen F, Fang H & Wang M, Exploiting entity relationship for query expansion in enterprise search, *Information retrieval*, **17(3)** (2014) 265–294, <https://doi.org/10.1007/s10791-013-9237-0>.
- 23 Sundas A & Panda S N, An introduction of cloudsims simulation tool for modelling and scheduling, *Proc Int Conf on Emerg Smart Comput and Informat* (IEEE) 2020, 263–268, doi: 10.1109/ESCI48226.2020.9167549.
- 24 <https://matlab.mathworks.com/> (20 May 2024)
- 25 <https://www.kaggle.com/datasets/> (20 May 2024)
- 26 Shukla A K & Sharma A, Cloud base intrusion detection system using convolutional and supervised machine learning, *Proc Int Conf on Info Syst and Compu Netw* (IEEE) 2023, 1–5, doi: 10.1109/ISCON57294.2023.10112007.
- 27 Yan H, Yu P & Long D, Study on deep unsupervised learning optimization algorithm based on cloud computing, *Proc Int Conf on Intelligent Transportation, Big Data & Smart City* (IEEE) 2019, 679–681, doi: 10.1109/ICITBS.2019.00168.



DELHI INSTITUTE OF ADVANCED STUDIES

Plot No. 6, Sector-25, Rohini, Delhi-110085 (INDIA)

Re-Accredited with 'A' Grade By NAAC

(Approved by AICTE and Affiliated with GGS Indraprastha University for B.Com(H), BBA, MBA, MBA(FM) Programmes)

Ph. : 011-27932742, 9355990931, 9355990933, 9355990934

Website : <https://www.dias.ac.in> / E-mail : dias@dias.ac.in



Ref. No. DIAS/2024-2025/

04.06.2025

Dr. Komal Gupta
Assistant Professor
Delhi Institute of Advanced Studies
Plot No. 6, Sector-25, Rohini
Delhi – 110 085

komaljindal2468@dias.ac.in

Dear Madam,

We are pleased to inform you that your article titled **“Herding in Factor Portfolios: A Regime-Switching Perspective on the Indian Market”** has been accepted and is being published in the 40th Issue (October 2023 – March 2024) of DIAS Technology Review. We also take immense pleasure in informing you that the Journal is included in the database of Social Science Research Network.

You are requested to send (i) Brief bio-data of author, (ii) a passport size photograph of author and (iii) Declaration by author as given below for our records.

DECLARATION

The Article **“Herding in Factor Portfolios: A Regime-Switching Perspective on the Indian Market”** accepted for publication in the journal DIAS Technology Review is original and has not been published or submitted elsewhere. I/We also hereby give my/our consent that my/our article may be made available on the website of Social Science Research Network at www.ssrn.com.

Name(s) and Signature(s):

Designation(s):

E-mail:

May we submit that in the absence of above we may not be in a position to further process the article for its publication.

With warm regards,

Dr. S. N. Maheshwari
Chief Editor – DTR



Does Regime-Dependent Volatility Drive Dynamism in Investor Herding?

Komal Jindal^a ✉, Meera Bamba^b, Mamta Aggarwal^c

^{a,c}Department of Commerce, Indira Gandhi University, India

^bDepartment of Commerce, Chaudhary Bansi Lal University, India

Abstract

The existing literature on herding often uses the static model to test herd behaviour in the Indian market context. Hence, the objective of this paper is to investigate the dynamic herd behaviour for S&P BSE 500 from 2009-2023 using the Markov Regime Switching model. Results exhibit the occurrence of three regimes, namely, high, low, and extremely volatile regimes. Findings suggest that the Indian market moves into the order of low, high, and extreme volatility (LHC), similar to other developed countries. This has implications for investors to either exit from the market or reframe their portfolio through hedging techniques before the market enters into extreme volatility. Moreover, the results exhibit anti-herding in high and low-volatile regimes. Our study discloses the presence of herding in crashes or extremely volatile regimes, showing that Indian investors start following each other during crash-like situations. This research is significant for individual investors, portfolio managers, and stock market regulators.

Keywords: Dynamic Herding, Indian Equity Market, Three Regime-Switching Model, Volatility Regime, Markov Model

Received:
28 August 2023

Accepted revised version:
11 March 2024

Published:
30 June 2024

Suggested citation: Jindal, K., Bamba, M. & Aggarwal, M. (2024). Does regime-dependent volatility drive dynamism in investor herding? *Colombo Business Journal*, 15(1), 54-79.

DOI: <https://doi.org/10.4038/cbj.v15i1.169>

© 2024 The Authors. This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

✉ komal.comm.rs@igu.ac.in

 <https://orcid.org/0000-0001-9544-2722>

Introduction

The most common type of bias in the financial market is herd instinct or herd behaviour. In general terms, herding means following other investors with superior information while suppressing their beliefs. Many causes behind herd behaviour can be deduced from the theoretical literature. As many previous studies have explained, herding can arise due to reputational concerns, informational cascade effect, superiority of information, and a complex informative structure environment (Avery & Zemsky, 1998; Bikhchandani et al., 1992; Scharfstein & Stein, 1990). Moreover, these types of behavioural biases can cause volatility to be high and extreme market situations in the equity market (Litimi, 2017). Analysing herding is very important because it can cause high volatility in the market, enlarging the gap between the market price and fundamental price of any stock and creating a bubble-like situation in the stock market (Bikhchandani et al., 1992; Chiang & Zheng, 2010). This encourages the investors to make correct decisions, resulting in an efficient market. An understanding of herd behaviour enables better investment decisions with portfolio diversification. With this objective, we investigate herding in the Indian stock market. There are multiple reasons for choosing the Indian stock market. First, emerging economies like India have the presence of herding due to cultural differences, incomplete enforcement laws, and uneducated and uninformed investors (Chang et al., 2000; Kanojia et al., 2022; Lao & Singh, 2011). Second, India is the fastest-growing economy in emerging markets, with more relaxed regulations related to foreign capital. This, in turn, led to an enormous flow of foreign institutional investment in India. So, it is observed that during extreme market situations, investors start following Foreign Institutional Investors (FIIs) and move in the same direction.

This research adds multiple insights into the herding literature. First, the existing study applies the Regime Switching constant probability model with three Markov states for the Indian stock market in which herd behaviour may or may not exist. In the case of volatile situations, the investors have become risk averse and start following the market trend to avoid excess risk. However, other types of investors exploit the benefits of an extremely volatile market by earning higher excess returns. Hence, it might be possible that investors react differently in various volatile situations. So, it is highly important to address the dynamic herding along with dynamic volatility. Herding can also be addressed through other linear models like structural break or Autoregressive Moving Average (ARMA) models. However, we have chosen the regime model to identify the hidden Markov states as it divides the market into multiple regimes based on the stochastic process. This model easily captures the dynamic pattern of complex time-series data (Shakya et al., 2017). The

three-regime model enables us to investigate the dynamic nature of cross-sectional dispersion and how structural breaks or events move the series into different regimes or states where herd behaviour can be observed (Balcilar et al., 2013). This is because linear models cannot capture the time-varying properties of any non-linear series (Chauhan et al., 2020; Choi & Yoon, 2020; Garg & Gulati, 2013; Lao & Singh, 2011). Second, less research has considered the significant autocorrelation property of cross-sectional absolute deviation in time-varying models, and this study includes two lag terms of explained variables in the Regime Switching model. Third, we establish the role of volatility in driving the dynamic herding in the Indian financial market.

The present study examines herding using both linear and non-linear models. First, the results are calculated through a linear herding model. Then, the non-linearity is tested in the financial time series, and several regimes are identified. After that, the Markov Regime Switching model is applied to investigate the dynamic herding in multiple regimes. We identified the existence of three regimes in the Indian market with high, low, and extreme volatility. Here, an extremely volatile regime means changing prices suddenly or abruptly by moving the series to a very high or very low. However, there is a bidirectional shifting of high and extreme volatile regimes, identical to the study of Balcilar and Demirer (2015), motivating the market regulators to make a mechanism to stop the market transitions from high to extreme volatile regimes.

The paper is ordered as follows: Section 2 contains the related studies. The data and empirical framework are presented in Section 3. Section 4 examines the results and analysis, and Section 5 presents the conclusion and implications of the study.

Literature Review

Theoretical Background

Many previous studies have examined the concept of herding and the factors that can lead to a herd-like situation in the stock market (Avery & Zemsky, 1998; Bikhchandani et al., 1992; Spyrou, 2013; Wermers, 1999). Furthermore, Herding is an irrational behaviour that persuades investors to make decisions based on others' information. Market participants can cause herding for various reasons; for example, managers do herding out of reputational concern (Scharfstein & Stein, 1990). They present a learning model where the labour market can update the understanding of managers' abilities due to their investment decisions. This behaviour may be socially inefficient but is rational from the managers' standpoint. Likewise, Bikhchandani et al. (1992) exhibit an informational cascade as the cause behind local conformity and

the fragility of mass behaviour. An informational cascade occurs when it is optimal for the individual to observe the actions of others while ignoring their private information. However, it can soon be fragile when new information arrives in the market. In their theoretical model, Avery and Zemsky (1998) explain that herding behaviour is not possible in the long run in a simple informational structural environment. However, the more complex informative structure can lead to herd behaviour and the creation of a price bubble in the short run in the case of multidimensional uncertainty. Literature suggests two types of herding, which investors can reflect on. One is rational herding, and another is irrational herding. Rational herding is unintentional or spurious based on the fundamental information available to all (Bikhchandani & Sharma, 2000; Galariotis et al., 2015). Irrational herding is intentional and based on information unavailability (Shiller et al., 1984; Trueman, 1994).

Herding in the Financial Market

Earlier empirical studies have primarily relied on two strands of methodology to measure herd behaviour. Lakonishok et al. (1992) has checked out the impact of institutional trading on stock prices. As an institutional trader, they have taken the trading of money managers to measure herding in the equity funds. Their model is based explicitly on the buying and selling order of money managers for a particular stock in a quarter. The other technique that measures flocking toward market consensus using the famous Cross-Sectional Standard Deviation (CSSD) and Cross-Sectional Absolute Deviation (CSAD) was proposed and modified by Chang et al. (2000) and Christie and Huang (1995), respectively. Many empirical studies employ the CSSD to assess the herding. Tan et al. (2008) applies the linear model in the Chinese market and observes significant herding. Chiang and Zheng (2010) explore uniformity at the global level using CSAD, showing important herding in advanced stock markets and Asian markets. Rompotis (2018) checks the uniformity in exchange-traded funds with the help of a linear model and exhibited no herding in Exchange-Traded Funds (ETFs). Choi and Yoon (2020) study uniformity in the Korean equity market using a cross-sectional absolute deviation approach and find herding behaviour during down market returns. Moreover, some studies also investigate herding during or after the outbreak of COVID-19. Nguyen and Vo (2023) examine the herding in the Vietnamese stock market during and after the pandemic. Results reveal the existence of herd behaviour during and after the pandemic, stating that these crisis-like situations exacerbate the similarity in the financial market. Likewise, recently published Tauseef (2023) studies herd behaviour in the Pakistan

stock market during the financial crisis and COVID-19. They report significant herding during the COVID-19 period and the financial crisis. Ferreruela and Mallor (2021) describe herding before and after the global financial crisis but no herding during the pandemic. They also observe significant evidence of herding during the pandemic but during the time-high volatile periods only.

Later, the studies on herding shift their analysis to more advanced econometric models to identify the time-varying nature of herding. Hwang and Salmon (2004) first propose a model measuring dynamic herding that relies on monthly betas using Kalman filter's state-space model. Similarly, Arjoon and Bhatnagar (2017) study herding behaviour in Frontier markets. They examine both static and dynamic herding, as well as herding during times of volatility. To analyse time-varying herding, they utilise a state-space model. Their findings suggest that herding evolves as the behaviour of investors changes with fluctuations in information flow. Recently published Yang and Chuang (2023) examine dynamic herding in highly volatile US, Taiwan, and China markets. They have applied the Kalman filter model and the GARCH model for analysis. Results explain the similarity among the market investors in volatile periods during the financial crisis but low herding during the pandemic. From the above studies, it can be observed that researchers have shifted their interest toward dynamic herd behaviour. Schmitt and Westerhoff (2017) have clearly stated that a speculator's herd behaviour increases the volatility clustering in the market using the agent-based market model. Blasco et al. (2012) check out the impact of herding on volatility in the Spanish stock market. Results indicate the presence of a linear relationship between herding and volatility. Likewise, Fei and Liu (2021) also analyse the role of herding in stimulating volatility in the Chinese stock market. Findings exhibit that herding can stimulate volatility but to a different degree. The above-stated studies on herding and volatility signify a significant relationship between volatility and herding. Hence, the present study chooses to investigate the role of herding with particular reference to volatility in the Indian stock market. Herding is generally a short-lived phenomenon prominent in extreme market situations, which is measured by using daily or intraday data (Gleason et al., 2004). Hence, by considering the short-term presence of herding, Klein (2013) explains the dynamic herding using the Markov Switching SUR model and reveal herd behaviour during high volatility. Several empirical studies use a regime-switching model with two or three regimes to address the herding impact. Balcilar et al. (2013) propose a three-regime Markov model and tested the herd mentality in the Gulf Arab Stock Market. They show herd behaviour in the Crash regime. Balcilar and Demirer (2015) investigate the herding in Borsa Istanbul by applying the dynamic

transition probability Regime-Switching model. They arrive at the same result of herding in extreme/highly volatile regimes, consistent with previous studies. Similarly, using the Regime-Switching model, Babalos et al. (2015) check dynamic herding in the US Real estate market. They imply significant herding in the crash regime and the evidence of negative herding in low/high volatility. Likewise, Kabir and Shakur (2018) investigate herding in various international markets using a smooth transition regression model. Their study indicated that most countries, including India, herd in highly volatile regimes. Akinsomi et al. (2018) examine herd behaviour in the real estate investment trust in the UK. They divide the market into three regimes: low, high, and extreme volatile periods. They find no herding using the static model and exhibit significant herding in the low volatile periods compared to anti-herding in high volatile periods. Fu and Wu (2021) investigate the herd mentality among Chinese market investors and find that herding is regime-dependent in high-volatile regimes. Similarly, Ah Mand and Sifat (2021) establish evidence of prominent herding in high-volatile regimes in Bursa Malaysia. Javaira et al. (2023) establish a relationship between volatility and dynamic herding in the energy sector during COVID 19. They find that herding is significantly affected by three volatility measures: global volatility, oil market volatility, and pandemic volatility.

Indian-Specific Evidence on Herding

Many studies related to herding have also been conducted in the Indian financial market. Lao and Singh (2011) discover a herd-like situation in the Indian financial market during market uncertainty using the CSAD static model from 1999-2009. Similarly, Garg examine uniform behaviour in normal and extreme market conditions from 2000-2013. The results convey the message that no imitation by investors in either type of situation. A study by Poshakwale and Mandal (2014) investigate herd mentality using the Kalman filter in the National Stock Exchange of India. They exhibit that herding increased due to market volatility after allowing time-varying variables. Kumar et al. (2016) document no uniformity among the Indian market participants in both normal and uncertain market situations for 2008-2015. Ganesh et al. (2017) investigate the uniform behaviour in the Indian bourses for 2005-2015 and find evidence of no herding overall except in 2011 and 2014. Ansari and Ansari (2021) have recently measured herding for 2007-2018 using the static model in normal and bull/bear phases. Their findings show the anti-herding among Indian market participants in all market conditions. Similarly, Kanojia et al. (2022) exhibit no herding for the Indian market using the CSAD methodology for the period 2009-2018. The evidence depict no herding in any market conditions. Shrotryia and Kalra

(2022) have studied herding in Brazil, Russia, India, China and South Africa (BRICS) using a quantile regression approach. The evidence of their study discloses anti-herding in the Indian financial market.

Research Gap

From the above discussion, it is discovered that literature on Indian herding has shown evidence of no herding or anti-herding in the Indian stock market. Still, some studies show that herding may be present during crisis periods. All studies have used the static approach to measure herding by skewing towards analysing herding in up/down market conditions. Although the regulations regarding investment have been considerably improving after liberalisation in the Indian stock market. However, India is still an emerging country with more small retail investors who behave irrationally in extreme market situations (Ansari & Ansari, 2021). Moreover, the Indian stock market has involved the greater entry of foreign institutional investors in the recent decade, making the Indian market vulnerable to various investor sentiments like herd behaviour and positive feedback trading (Mukherjee & Tiwari, 2022). Furthermore, various unprecedented events like COVID-19 increased the inefficiency in the Indian stock market (Bhatia, 2022). Domestic investors started following the foreign investors in a similar manner. All these reasons mentioned above make the study interesting to explore whether, with time, herding behaviour has evolved or vanished in the Indian market. Our study differs from the recent study of Ansari and Ansari (2021) in several ways. First, they test herding in the up/down market, but we have analysed flocking with particular reference to volatility. Second, they have used a static model to measure the herding., We explore the dynamic nature of herding in a three-regime specification. The study of Poshakwale and Mandal (2014) investigate herd mentality using the Kalman filter in the National Stock Exchange of India. They rely on monthly beta rather than daily or intraday. Kabir and Shakur (2018) explore uniformity in high- and low-volatile regimes in multiple countries, including India, using the smooth transition model. However, our study differs from their methodological framework as we incorporate a three-regime specification using the Markov regime-switching model. As many previous studies indicate, the Markov regime switching model provides more flexibility with the point of time as compared to other non-linear models like GARCH or Kalman filter (Akinsomi et al., 2018; Babalos et al., 2015; Balcilar & Demirer, 2015; Fu & Wu, 2021; Kabir & Shakur, 2018; Mand & Sifat, 2021). It is suitable for the time series, the behaviour of which is not permanent, but reverts repeatedly. The Markov regime switching model captures even a tiny shift in a series and estimates time-varying coefficients more accurately. Hence, there is a trend that various studies shifted their

focus towards the Markov regime switching models over time. Moreover, the results of past studies depict that CSAD has properties of regime-switching. To the best of our knowledge, no research in India has explored dynamic herd behaviour in the Indian market context using the Markov-Regime Switching framework. Against this backdrop, the objective of the present study is to assess the presence or absence of dynamic herd behaviour in the Indian stock market using the Markov regime switching Model.

Data and Econometric Framework

Data

Data comprises daily stock-adjusted closing prices of individual stocks listed in S&P BSE 500 for 1/01/2009 to 31/03/2023 in the Indian equity market. Daily data can be considered high-frequency data in some contexts because it provides more precision than weekly or monthly data (Hung, 2019; Jebran & Iqbal, 2016). Information is lost in weekly or monthly data because it averages out the daily effect. Although many studies have considered intraday data as high-frequency data due to time and data availability constraints, we have taken daily data as the next best alternative to high-frequency data, which can depict volatility more clearly than other low-frequency data. Data has been collected using the Prowess IQ database from CMIE (Centre for Monitoring Indian Economy). We selected the study period from 2009 because, before that period, more than 50% of companies were excluded from the study 500 due to a high number of missing observations. First, those companies registered after the 1st of January 2009, are excluded from the study to match the number of observations of all companies. Later, the companies with missing data up to 10% of the total number of observations during the period are replaced using the linear interpolation method (Mertler et al., 2021). The total number of observations is 3531, and sample companies included in the analysis are 338 out of 500. After screening and cleaning the data, the cross-sectional individual and market returns are calculated. We have calculated our market return proxy by giving equal weights to each stock in the portfolio, as also calculated by many numbers of studies (Chang et al., 2000; Chiang & Zheng, 2010; Garg & Gulati, 2013; Kanojia et al., 2022). As such, we have not used value-weighted returns in CSAD calculation. For applying Markov Regime Switching models, it is necessary to test whether financial time series have a regime-switching framework or not. Hence, we applied the Linearity likelihood ratio, and Davies tests to check the same. Lastly, the results are calculated using the Regime and Static models. The analysis work has been performed using Ox-metrics 7.0.

Econometric Framework

This section explains the models used for the analysis work. Specifically, we started with the calculation of stylised facts of the variables used in the study. It provides the direction in which time series variables are going on. Next, for analysing the herding, the baseline model of Chang et al. (2000) is used. As the presence of structural breaks in high-frequency time series data and after finding the evidence of fat-tail, volatility clustering, and non-normal distribution in the studied variable, it is necessary to address these issues aptly. Hence, the appropriate regime-switching model is used to address these issues and analyse dynamic herding. However, before applying this model, we checked for non-linearity in the model through the likelihood ratio test and Davies upper bound test. Next, various information criteria are used to know the exact number of regimes. Lastly, the regime model specification is applied to measure time-varying herding in multiple regimes with the exact number of regimes to be known.

Static Model

The model to measure herd behaviour is CSSD, introduced by Christie and Huang (1995), and CSAD, improved by Chang et al. (2000). The methodology relies on the conditional Capital Asset Pricing model which describes the association of firm-level dispersion and the absolute market return is positive and linear. This relationship becomes negative and non-linear if herding occurs in the financial market.

The Firm return dispersion is calculated as follows:

$$CSAD_t = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{m,t}| \quad (1)$$

Here, N is the total number of sample companies included in the study and $R_{i,t}$ is the returns of individual stock on a day t. $R_{m,t}$ is the equally weighted average market returns of all sample companies on a day t.

$$CSAD_t = \gamma_0 + \gamma_1 |R_{m,t}| + \gamma_2 (R_{m,t} - \overline{R_m})^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \varepsilon_t \quad (2)$$

The negative and significant value of γ_2 represents the herd behaviour. The idea behind the CCK (Chang, Cheng, and Khorana) model is that absolute market return and dispersion have a positive and linear relationship. Due to the presence of herd behaviour, this relationship becomes non-linear and negative. Investors start acting similarly while purchasing stocks, and the returns of stocks gather around the market return, leading the dispersion series to decrease or increase at a decreasing rate. The presence of absolute and squared market returns in the same model leads to high multicollinearity, which becomes a problem in the OLS models. Hence, to remove the multicollinearity, we follow the study of Yao et al. (2014), which deducts the

mean of market return from the squared market return to remove multicollinearity. Moreover, the study incorporates the two-lag term of the dispersion variable in the model to address the strong autocorrelation quality of dispersion. The study includes only two lag terms because higher-order lag does not improve the results (Lao & Singh, 2011). Many empirical studies included the lag term in their model to remove the autocorrelation. The study uses the heteroscedasticity and autocorrelation consistent standard errors of Newey and West (1987) and adds the lag term of the dependent variable to obtain the regression coefficients.

Regime Switching Framework

The behaviour of many financial time series may change over time permanently (known as structural breaks), or may shift from one type to another type and revert (known as regime shifts). The regimes here are unobservable. One of the most widely used methodologies to model this type of non-linearity is Markov Regime-Switching model (Brooks, 2008) in which, regime-switching may occur at the error term's mean and standard deviation. Hamilton (1989) proposed an algorithm based on the discrete-state regime shifts in the Markov process., This study also follow the same approach and models herding using the Regime-Switching model.

Through formal testing, the study found three regimes in the Indian market by following the seminal work of Balcilar et al. (2013) and Fu and Wu (2021). Equation (2) is extended by dividing the series into three regimes shifting across intercept and standard deviation, as shown in equation (3). All the variables vary across regimes except lags of the dependent variable.

$$CSAD_t = \gamma_{0,r_t} + \gamma_{1,r_t}|R_{m,t}| + \gamma_{2,r_t}(R_{m,t} - \overline{R_m})^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \sigma_{r_t} \varepsilon_t \quad (3)$$

Here, $\varepsilon_t \sim N(0,1)$ is the innovation term, and σ_{r_t} is the standard deviation, a measure of volatility. r_t is discrete regime variable that can take the values $r_t = [0,1,2, \dots, m]$ by following the three-state first order Markov process. The Markov property is based on the transition probabilities, which are constants across states and represented by the following specifications:

$$P(r_{t+1} = i | r_t = j) = p_{ij} \quad (4)$$

with

$$\sum_{j=1}^m p_{ij} = 1, \text{ where } j = 0,1,2, \dots, m \text{ and } 0 \leq p_{ij} \leq 1$$

where p_{ij} is the constant transition probabilities in regime i at a time $t+1$. The estimation method used for the regime switching model is the maximum likelihood, and robust standard error is calculated using Hessian and OPG matrices. The study used Excel, E-views 9.0, and Ox-metric 7.0 statistical software for the analysis.

Empirical Results and Discussion

This part explains the analysis of both linear and Regime-Switching models. First, we describe the variables' characteristics using stylised facts on return and dispersion. After that, results of both linear and Regime Switching models are shown with non-linear testing of the time series before applying the switching model.

Stylised Facts

Table 1 explains the stylised facts of market return and cross-sectional dispersion. The mean of CSAD (1.54%) is more significant than the market return (0.07%), suggesting higher variations in dispersion series than market returns. The standard deviation of the CSAD (0.36%) is less than the market return (1.14%), highlighting the volatility clustering in the dispersion series. Skewness is negative for market returns, indicating the high negative returns, while the skewness is positive for CSAD. Moreover, the kurtosis is very high for both the series representing Fat-tails. Furthermore, the Jarque-Bera statistics are significant, showing a non-normal distribution. The Augmented Dickey-fuller test is performed on intercept only to check the stationarity of the data. The stationarity test (Augmented Dickey-Fuller test) shows that the variables are stationary at level.

Table 1: Stylised Facts

Statistics	CSAD	R _m
Mean	1.54%	0.07%
Std. Dev.	0.36%	1.14%
Skewness	2.39	-1.10
Kurtosis	13.96	13.60
Observations	3531	3531
ADF Test	-7.802 ***	-19.86 ***
Jarque-Bera test	21055.95 ***	17275.15 ***
ACF1	0.785	0.159
ACF5	0.627	0.051
ACF20	0.421	-0.000

Notes: 1. *** $p < 0.01$. Jarque-Bera is for testing normality in the series.

2. ACF is the autocorrelation function up to n lags. ADF is the Augmented Dickey-Fuller test to check stationarity.

The Auto-correlation function at different lags for the CSAD series is significant. It implies that the dispersion series is positively auto-correlated to higher levels of lags and shows signs of volatility clustering. The ACF of market returns is almost significant at higher lags, and the series has no trend. This means the market returns have a lower serial correlation with their previous values than the cross-sectional dispersion. These findings are in tune with various earlier studies that applied the Regime Switching models for fat-tails, volatility clustering, and higher serial correlation (Balcilar et al., 2013; Cont, 2010; Fu & Wu, 2021; Sen & Subramaniam, 2019; Singh & Singh, 2017).

Results of Herd Behaviour in Static Model

Here, Table 2 (second column) reports the estimates of the linear OLS (Ordinary Least Square) model put forth by Chang et al. (2000). First of all, the outcomes of the static model from Equation (2) state that the coefficient γ_2 that measures the herd behaviour is insignificantly positive, showing the absence of herding in the overall market in the Indian market when linear OLS regression is used.

Table 2: Estimation Results of Static and Markov Three Regime Switching Model

Coefficients	Static Model Result	Regime Model Result
γ_{00}	0.003 (0.0002) ***	0.006 (0.0003) ***
γ_{01}	NA	0.004 (0.0002) ***
γ_{02}	NA	0.005 (0.0004) ***
γ_{10}	0.151 (0.0158) ***	0.081 (0.025) ***
γ_{11}	NA	0.107 (0.0080) ***
γ_{12}	NA	0.227 (0.0369) ***
γ_{20}	0.379 (0.4652)	2.516 (0.2320) ***
γ_{21}	NA	1.450 (0.190) ***
γ_{22}	NA	-0.529 (0.2861) *
γ_3	0.503 (0.0204) ***	0.443 (0.0191) ***
γ_4	0.197 (0.020) ***	0.147 (0.0168) ***
σ_0	0.0018***	0.0017 (0.000) ***
R^2	0.75	NA
σ_1	NA	0.0012 (0.000) ***
σ_2	NA	0.0036 (0.0001) ***
P_{00}	NA	0.95
P_{11}	NA	0.97
P_{22}	NA	0.74 (Contd.)

Coefficients	Static Model Result	Regime Model Result
N_0	NA	806
N_1	NA	2473
N_2	NA	250
N	3529	3529
τ_0	NA	29.85
τ_1	NA	41.92
τ_2	NA	4.31
AIC	-9.778	-10.022
LOG L	17258.58	17704.55
LR test	-	891.94***
Davies test	-	0.000***

- Notes: 1. The table reports the result of two models i.e., Static model: $CSAD_t = \gamma_0 + \gamma_1 |R_{m,t}| + \gamma_2 (R_{m,t} - \bar{R}_m)^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \varepsilon_t$. Regime-Switching model : $CSAD_t = \gamma_{0,r_t} + \gamma_{1,r_t} |R_{m,t}| + \gamma_{2,r_t} (R_{m,t} - \bar{R}_m)^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \sigma_{r_t} \varepsilon_t$
2. Standard error is shown in parenthesis. The standard errors of the linear model are estimated using Newey and West HAC standard errors.
3. For the regime model, robust-standard errors are calculated with the BFGS Algorithm.
4. AIC is the Akaike information criterion.
5. Log L is the log-likelihood of the model. LR is the likelihood ratio test with their respective p -values and Davies test p -values.
6. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Many previous Indian research studies find similar results of no herding at the overall market level using the static model (Garg & Gulati, 2013; Kanojia et al., 2022; Lao & Singh, 2011). However, it is possible that these studies did not detect herding using a static model due to the time-varying nature of the return dispersion series. Moreover, both lag term coefficients are significant, which supports using two lagged values of the dependent variable to overcome the autocorrelation problem in the return dispersion series (Benkraiem et al., 2021; Yao et al., 2014). The study has also calculated the results by incorporating three lags of the dependent variable in Equation (2). However, the results do not improve much; hence, only two lag terms are included in the static model.

Results of Herd Behaviour in the Regime Switching Model

Before selecting the regime switching model for dispersion series, it is essential to identify the non-linearity in the time series. It is better to know before testing whether the regime switching model is a superior fit to the data. To check the non-linearity, by referring to Babalos et al. (2015) and Balcilar et al. (2013), the present study has calculated the standard likelihood ratio test statistic using log-likelihood

values which follows χ^2 distribution with q degree of freedom of regimes. However, in the Markov Regime Switching model, unidentified nuisance parameters exist under the null hypothesis (Brooks, 2008), and therefore, standard distribution does not apply to it. Hence, we also reported the p -values calculated using the approximate upper bound test proposed by Davies (1987).

Table 3 depicts the rejection of the static model at a 1% level of significance in favour of the regime-switching model. It means that the dispersion series is non-linear and has the presence of multiple regimes. Moreover, in deciding the exact number of regimes, the LR and Davies test strongly reject two regime-switching models against a three-regime- model at a 1% level of significance.

Table 3: Likelihood Ratio Test for Different Models

H₀: static H₁: MS (2)	H₀: static H₁: MS (3)	H₀: MS (2) H₁: MS (3)
703.96***	891.94***	187.98***
(0.000) [0.000]	(0.000) [0.000]	(0.000) [0.000]

- Notes: 1. Static model shows OLS regression using Equation (2).
 2. MS (s) is the regime-dependent intercept variance model with r number of regimes.
 3. *** $p < 0.01$.
 4. Linearity Likelihood ratio test is used to calculate test statistics.
 5. The chi-square p -values are reported in parenthesis along with the p -values of Davies (1987) in square brackets.

Table 4 shows the log-likelihood and Akaike information criteria of the various estimated models with multiple regimes. It is clearly shown in the Table that the highest log likelihood is of the three-regime model, along with the lowest Akaike Information criteria. From the above criteria and formal tests, the study found that three regime models fit the study.

Table 4: Best-Fitted Model Measures

	Linear	MS (2)	MS (3)
Log Likelihood	17258.58	17610.56	17704.55
AIC	-9.778	-9.973	-10.022

- Notes: 1. AIC shows Akaike information criteria.
 2. The static model shows OLS regression using Equation (2).
 3. MS is the regime-dependent variance model for 2 and 3 regimes in Equation (3).

Studies have stated that the Markov model is more suitable for explaining dynamic herding and its various states (Balcilar et al., 2013; Mand & Sifat, 2021). Moreover, there are studies in the past that extend the CSAD approach in the Regime framework and explain the non-linearity in the CSAD model in both developed and emerging economies (Akinsomi et al., 2018; Babalos et al., 2015; Balcilar et al., 2013; Mand & Sifat, 2021)., The results of our study also exhibit the presence of different regimes in the CSAD model, and the information criteria are lower for the regime model than the static model. Hence, the study has applied the regime specification for modeling non-linear properties of herding specification and calculating the time-varying herding parameter along with regime switching.

Table 2 (third column) discloses the results of the Regime Switching model. To avoid overfitting variables and have parsimony in the model, this study assumes that serial correlation is regime-independent, similar to Fu and Wu (2021). For identification of regimes into high, low, and extreme volatility, the study closely examines the standard deviation of the error term represented by σ_{r_t} . Standard deviation of Regime 2 (0.0036) is exceptionally high as compared to high volatility regime 0 (0.0017) and low volatility regime 1 (0.0012).

The main coefficients of interest that measure herding in the Regime Switching model are γ_{20} (Regime 0), γ_{21} (Regime 1) and γ_{22} (Regime 2). The coefficients γ_{20} and γ_{21} are positively significant in high and low volatile regimes, respectively, implying negative herding in the Indian financial market. It means that Indian market participants make rational decisions when the market is highly volatile and stable. The possible reason for the negative herding is the ‘flight-to-quality’ or ‘overconfidence’ of investors during an unstable market (Ansari & Ansari, 2021; Gebka & Wohar, 2013). Lastly, γ_{22} is negative and significant in extreme volatile or crash regime 2, indicating that the investors are imitating each other when market is extremely volatile or in crash-like situations due to some unprecedented events. It may be because investors follow institutional investors to avoid extreme losses in extreme or crash regimes. The result of significant herding during extreme or crash regimes is in line with the findings of Balcilar and Demirel (2015) and Balcilar et al. (2013), which show herding during extremely volatile regimes in Borsa Istanbul and GCC markets. Moreover, the extremely volatile regime has 250 observations of the total number of observations, showing that three regime specifications fit the study. As residual diagnostics, we consider log Likelihood, Akaike Information criteria, the Portmanteau test, and the ARCH test for testing heteroscedasticity and autocorrelation. Table 4 shows that the regime model has a higher log-likelihood and lower AIC than the static model.

Table 5: Residual Diagnostic for Scaled Residuals

Scaled Residuals	Distribution	Statistics	<i>p</i> -value
Normality	Chi (2)	13.827	0.0022
Asymptotic normality	Chi (2)	12.266	0.0010
ARCH (1-1 test)	F (1,3507)	2.057	0.1516
Portmanteau (26)-squared scaled residuals	Chi (26)	26.708	0.4247

Moreover, Table 5 shows that the coefficient of the ARCH 1-1 test is insignificant, depicting no conditional heteroscedasticity in the fitted model.¹ The insignificant Portmanteau test statistic indicates the absence of any dependence structure or autocorrelation in the residuals, suggesting that the model is correctly specified.

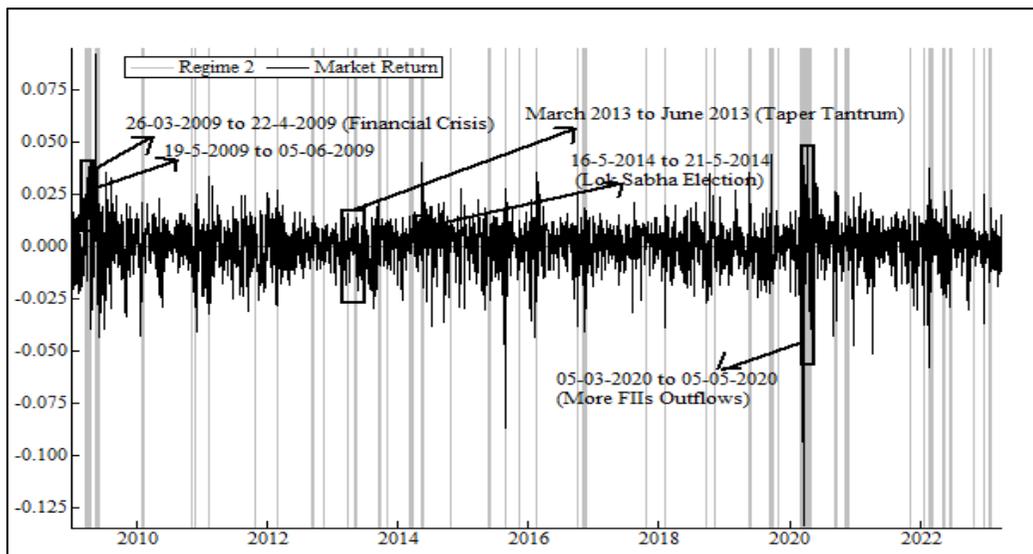
Persistence of Market Regimes

It is equally important to look at other essential features of Markov Switching-model such as transition probabilities (p_{ij}) and smoothed probabilities for fitting the Regime Switching model to the data. Initially, the market is in regime j at time t and Table 2 shows the transition probabilities (P_{00} , P_{11} and P_{22}) of remaining in regime j at time $t+1$. The probability here suggests that the decoded regimes are stable and will remain persistent within the existing regimes. The high volatile regime 0 has 22.84 % number of observations compared to a low volatile regime with 70.08 % observations. However, the transition probability of a low volatile regime is 0.97 compared to the other two regimes, showing the high persistence of a low volatile regime. Moreover, the extreme volatile regime and high volatile regime transition probabilities are 0.749 and 0.95, respectively, depicting the validity of regimes. The mean duration of a low volatile regime is 41.92 days, implying that Regime 1 will last approximately 42 days. While the high volatile regime lasts 29.85 days, it implies that Regime 0 will last about 30 days. The average duration of extreme volatile regime is 4.31 days, indicating Regime 2 will last approximately four days. This depicts that

¹ We also conducted robustness checks to ensure the presence of Three-Regime specification and accuracy of the results. First, analysis was done from the Period 2010-2023 and then from 2012-2023. The results of both time periods show significant evidence of herding in Extreme or crash volatile regime with three regimes. ARCH 1-1 test null hypothesis is accepted at 1% significance level. Moreover, we also calculated the herding by assuming the switching in variance and other variables except the constant term. The results are similar to the fitted Markov intercept and variance regime switching model showing the presence of herding in the extreme volatile regime. However, the model is not a best fit so we applied the intercept and variance regime switch model. Results are not shown here to conserve space.

the low volatile regime is highly persistent compared to other regimes, similar to the findings of Balcilar et al. (2013). Figure 1 shows the period when significant herding was observed in the market. Although there are many instances of herding in the whole sample period, the long-lasting ones are as follows: The first most extended extreme volatility regime was from 26-03-2009 to 22-04-2009 (16 days), and then the market switched to high volatility. Then again, in Regime 2, the long-lasting regime is from 19-05-2009 to 05-06-2009, which is for 14 days, followed by the highly volatile regime. It means the Indian market has volatility clustering after the crash or extremely volatile regime in 2009. This outcome can be confirmed by the Ali and Afzal (2012), which also found volatility clustering in the Indian and Pakistan Equity markets during the crisis and a more substantial negative impact on the Indian stock market.

Figure 1: Market Returns Showing Significant Herding in Extreme Volatile Regime



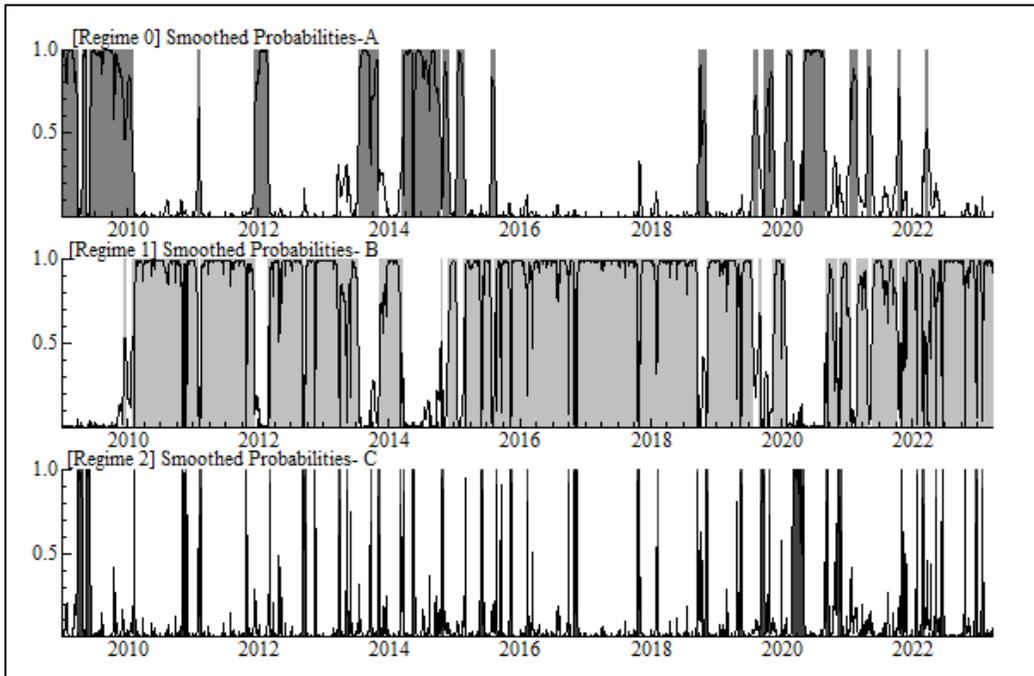
The possible reason for this is the Global Financial Crisis (GFC) or subprime crisis, which started approximately in 2007 and continued until 2009 (Bekiros et al., 2017; Litimi, 2017). The reason may be, like any other developed and emerging country, the Indian stock market crashed during the global economic turmoil, so the investor ignored their information and followed the overall market during uncertainty. However, as the high volatility regime persisted during that time, Indian investors stopped pursuing each other. This means the GFC crisis spillover effect is longer, i.e., 88 days, during the entire period.

Next, the market is in extreme volatility from March 2013 to June 2013, showing significant herding. It may be due to the ‘Taper-Tantrum’. The US Federal Reserve slowed the treasury bond purchases to revive the market from the financial crisis, increasing the bond yield. This leads to an outflow of FIIs from the Indian market and a market crash from the end of May to the end of August (Modak, 2021; Roychoudhury, 2021). This major sell-off may have led to sell-side herding by Indian investors. Next, extreme volatility was observed from 16-05-2014 to 21-05-2014. The Indian market is extremely volatile due to the Lok Sabha election result announced on 16th May 2014. Investors have become highly optimistic and started purchasing shares uniformly, hoping to earn excess returns (Kumar, 2019).

An extreme volatility regime can also be observed from 05-03-2020 to 05-05-2020. This extreme volatility was caused by the FII outflows due to coronavirus outbreak, and the fact that World Health Organisation (WHO) recognised COVID-19 as a pandemic on 11th March 2020. The uncertainty and volatility increased worldwide after the pandemic (Ali et al., 2020; Saini et al., 2023). The negative sentiments and high uncertainty led to a herd mentality in the Indian financial market during that period. Also, the Indian government announced Janata Curfew on 22nd March 2020 and lockdown policies to be followed from 24th March 2020 (Bora & Basistha, 2021). So, the adverse shocks further stimulated uncertainty and volatility, especially in BSE Sensex in the Indian financial market (Bora & Basistha, 2021).

Bharti and Kumar (2021) clearly state that volatility stimulated the herd mentality among Indian participants during the pandemic. However, in April 2020, the market moved very high again due to the relaxation in lockdown policy by the Indian government in April 2020 and the introduction of various stimulus packages for economic revival (Bharti & Kumar, 2021; Bora & Basistha, 2021). Ampofo et al. (2023) specify that the pandemic has also increased herding in developed countries. Figure 2 (A-C) highlights the smoothed probabilities of all three regimes. The smoothed probabilities graphs also depict the switching of different regimes. We found the order of low, high, and extreme volatility patterns for the Indian market. The market is usually in a highly volatile regime before extreme volatility. This shows that investors can predict the market will crash or become extremely volatile, so they should reframe their market portfolio strategy. We have also seen the Indian market go into high volatility after a sudden crash or extreme volatility, showing volatility clustering. This depicts the bidirectional switching of the extreme and high volatility regimes similar to the findings of Balcilar and Demirer (2015).

Figure 2: Smoothed Regime Probabilities for Regime 0 (High Volatile), Regime 1 (Low Volatile), and Regime 2 (Extreme Volatile), Respectively



Conclusion

This research takes a deep dive into the dynamic nature of herd behaviour in the Indian financial market for 2009-2023 using the Markov Regime Switching and linear OLS regression models. We employ Chang et al. (2000)'s base model for measuring uniformity. The results of the static model show no herding across the whole sample period. The results of no herding corroborate the findings of Ansari and Ansari (2021) and Kanojia et al. (2022). The regime model identifies three regimes as high (Regime 0), low (regime 1), and extreme volatility regime (Regime 2), respectively. Our findings demonstrate significant herding in crash or extreme volatile regime. However, we find frequent switching of extremely volatile regimes with significant herding, which lasts only on average for approximately four days., The long-lasting, extremely volatile regimes with significant herding are 2009, 2013-2014, and 2020, due to unprecedented events like the GFC crisis, Taper-tantrum, presidential election, and COVID-19 pandemic. A recent study, Sachdeva et al. (2021), clearly states that information uncertainty increases the uniformity in the Indian market. Moreover, the study exhibits anti-herding during the high and low volatile regimes. The findings of anti-herding in a low volatile regime are in line with those of Fu and Wu (2021) because investors make decisions rationally at times of

certainty. We observe the pattern of low, high, and crash/extreme volatility in the Indian capital market. This suggests that investors can predict extreme or crash situations because the market first enters into low volatility followed by high and then crashes. The outcomes of our research are significant for investors and market regulators. Investors should form an appropriate strategy to readjust their market portfolio at high volatility or not be captivated by the excess returns created by bubbles in extreme market situations. These results illustrate that the Indian market has become efficient with time as regulations continuously improve and information transmission becomes transparent. Hence, investors should make decisions based on the company's fundamentals, but during any uncertainty, they are exposed to high sentiments and follow each other. Investors need to construct more extensive portfolios at times of high volatility to maintain the same level of diversification (Chiang & Zheng, 2010; Fu & Wu, 2021). Bidirectional switching in extreme and highly volatile regimes guides market regulators in making a mechanism during crises or intense periods to stop the market from going into extreme situations (Balcilar & Demirer, 2015). This research adds new insights into Indian herding literature by adding evidence for dynamic herding in the Indian stock market. It will guide the researchers to add new dimensions to the same to further explore this aspect. The study is limited to only 338 companies out of 500. A separate study will also be conducted on the remaining companies, which may affect herding. Moreover, we only consider static transition probabilities in the study. Further research can be conducted by considering other exogenous variables like market sentiments or global factors that impact herding through the time-varying transition probabilities regime model. Moreover, one can differentiate between different types of herding as we measured herding at market consensus.

Declaration of Conflicting Interests

The authors declared no potential conflict of interest with respect to the research, authorship, and publication of this article.

References

- Akinsomi, O., Coskun, Y., Gupta, R., & Lau, C. K. M. (2018). Impact of volatility and equity market uncertainty on herd behaviour: Evidence from UK REITs. *Journal of European Real Estate Research*, 11(2), 169–186. <https://doi.org/10.1108/JERER-06-2017-0021>
- Ali, M., Alam, N., & Rizvi, S. A. R. (2020). Coronavirus (COVID-19): An epidemic or pandemic for financial markets. *Journal of Behavioral and Experimental Finance*, 27, 100341. <https://doi.org/10.1016/j.jbef.2020.100341>

- Ali, R., & Afzal, M. (2012). Impact of global financial crisis on stock markets: Evidence from Pakistan and India. *E3 Journal of Business Management and Economics*, 3(7), 275–282.
https://www.e3journals.org/cms/articles/1342846725_Afzal.pdf
- Ampofo, R. T., Aidoo, E. N., Ntiamoah, B. O., Frimpong, O., & Sasu, D. (2023). An empirical investigation of COVID-19 effects on herding behaviour in USA and UK stock markets using a quantile regression approach. *Journal of Economics and Finance*, 47(2), 517–540. <https://doi.org/10.1007/s12197-022-09613-8>
- Ansari, A., & Ansari, V. A. (2021). Do investors herd in emerging economies? Evidence from the Indian equity market. *Managerial Finance*, 47(7), 951–974.
<https://doi.org/10.1108/MF-06-2020-0331>
- Arjoon, V., & Bhatnagar, C. S. (2017). Dynamic herding analysis in a frontier market. *Research in International Business and Finance*, 42, 496–508.
<https://doi.org/10.1016/j.ribaf.2017.01.006>
- Avery, C., & Zemsky, P. (1998). Multidimensional uncertainty and herd behavior in financial markets. *American Economic Review*, 88(4), 724–748.
<https://www.jstor.org/stable/117003>
- Babalos, V., Balcilar, M., & Gupta, R. (2015). Herding behavior in real estate markets: Novel evidence from a Markov switching model. *Journal of Behavioral and Experimental Finance*, 8, 40–43.
<https://doi.org/10.1016/j.jbef.2015.10.004>
- Balcilar, M., & Demirer, R. (2015). Effect of global shocks and volatility on herd behavior in an emerging market: Evidence from Borsa Istanbul. *Emerging Markets Finance and Trade*, 51(1), 140–159.
<https://doi.org/10.1080/1540496X.2015.1011520>
- Balcilar, M., Demirer, R., & Hammoudeh, S. (2013). Investor herds and regime-switching: Evidence from Gulf Arab stock markets. *Journal of International Financial Markets, Institutions and Money*, 23(1), 295–321.
<https://doi.org/10.1016/j.intfin.2012.09.007>
- Bekiros, S., Jlassi, M., Lucey, B., Naoui, K., & Uddin, G. S. (2017). Herding behavior, market sentiment, and volatility: Will the bubble resume? *The North American Journal of Economics and Finance*, 42, 107–131.
<https://doi.org/10.1016/j.najef.2017.07.005>
- Benkraiem, R., Bouattour, M., Galariotis, E., & Miloudi, A. (2021). Do investors in SMEs herd? Evidence from French and UK equity markets. *Small Business Economics*, 56(4), 1619–1637. <https://doi.org/10.1007/s11187-019-00284-0>
- Bharti., & Kumar, A. (2021). Exploring herding behaviour in Indian equity market during COVID-19 pandemic: Impact of volatility and government response. *Millennial Asia*, 13(3), 513–531. <https://doi.org/10.1177/09763996211020687>

- Bhatia, M. (2022). Stock market efficiency and COVID-19 with multiple structural breaks: Evidence from India. *Global Business Review*.
<https://doi.org/10.1177/09721509221110372>
- Bikhchandani, S., Hirshleifer, D., & Welch, I. (1992). A theory of fads, fashion, custom, and cultural change as informational cascades. *Journal of Political Economy*, 100(5), 992–1026. <https://www.jstor.org/stable/2138632>
- Bikhchandani, S., & Sharma, S. (2000). Herd behavior in financial markets. *IMF Staff Papers*, 47(3), 279–310. <https://doi.org/10.2307/3867650>
- Blasco, N., Corredor, P., & Ferreruella, S. (2012). Does herding affect volatility? Implications for the Spanish stock market. *Quantitative Finance*, 12(2), 311–327. <https://doi.org/10.1080/14697688.2010.516766>
- Bora, D., & Basistha, D. (2021). The outbreak of COVID-19 pandemic and its impact on stock market volatility: Evidence from a worst-affected economy. *Journal of Public Affairs*, 21(4), e2623. <https://doi.org/10.1002/pa.2623>
- Brooks, C. (2008). *Introductory econometrics for finance* (2nd ed.). Cambridge University Press. <https://doi.org/DOI:10.1017/CBO9780511841644>
- Chang, E. C., Cheng, J. W., & Khorana, A. (2000). An examination of herd behavior in equity markets: An international perspective. *Journal of Banking and Finance*, 24(10), 1651–1679. [https://doi.org/10.1016/S0378-4266\(99\)00096-5](https://doi.org/10.1016/S0378-4266(99)00096-5)
- Chauhan, Y., Ahmad, N., Aggarwal, V., & Chandra, A. (2020). Herd behaviour and asset pricing in the Indian stock market. *IIMB Management Review*, 32(2), 143–152. <https://doi.org/10.1016/j.iimb.2019.10.008>
- Chiang, T. C., & Zheng, D. (2010). An empirical analysis of herd behavior in global stock markets. *Journal of Banking and Finance*, 34(8), 1911–1921. <https://doi.org/10.1016/j.jbankfin.2009.12.014>
- Choi, K. H., & Yoon, S. M. (2020). Investor sentiment and herding behavior in the Korean stock market. *International Journal of Financial Studies*, 8(2), 34. <https://doi.org/10.3390/ijfs8020034>
- Christie, W. G., & Huang, R. D. (1995). Following the pied piper: Do individual returns herd around the market? *Financial Analysts Journal*, 51(4), 31–37. <https://doi.org/10.2469/faj.v51.n4.1918>
- Cont, R. (2010). Empirical properties of asset returns: Stylized facts and statistical issues. *Quantitative Finance*, 1(2), 223–236. <https://doi.org/10.1080/713665670>
- Davies, R. B. (1987). Hypothesis testing when a nuisance parameter is present only under the alternatives. *Biometrika*, 74(1), 33–43. <https://doi.org/10.2307/2336019>
- Fei, T., & Liu, X. (2021). Herding and market volatility. *International Review of Financial Analysis*, 78, 101880. <https://doi.org/10.1016/j.irfa.2021.101880>

- Ferreruela, S., & Mallor, T. (2021). Herding in the bad times: The 2008 and COVID-19 crises. *The North American Journal of Economics and Finance*, 58, 101531. <https://doi.org/10.1016/j.najef.2021.101531>
- Fu, J., & Wu, L. (2021). Regime-switching herd behavior: Novel evidence from the Chinese A-share market. *Finance Research Letters*, 39, 101652. <https://doi.org/10.1016/j.frl.2020.101652>
- Galariotis, E. C., Rong, W., & Spyrou, S. I. (2015). Herding on fundamental information: A comparative study. *Journal of Banking and Finance*, 50, 589–598. <https://doi.org/10.1016/j.jbankfin.2014.03.014>
- Ganesh, R., Naresh, G., & Thiagarajan, S. (2017). The reflection of crowd behaviour in Indian bourses. *International Journal of Behavioural Accounting and Finance*, 6(2), 93. <https://doi.org/10.1504/IJBAF.2017.086408>
- Garg, A., & Gulati, R. (2013). Do investors herd in Indian market. *Decision*, 40(3), 181–196. <https://doi.org/10.1007/s40622-013-0015-z>
- Gebka, B., & Wohar, M. E. (2013). International herding: Does it differ across sectors? *Journal of International Financial Markets, Institutions and Money*, 23(1), 55–84. <https://doi.org/10.1016/j.intfin.2012.09.003>
- Gleason, K. C., Mathur, I., & Peterson, M. A. (2004). Analysis of intraday herding behavior among the sector ETFs. *Journal of Empirical Finance*, 11(5), 681–694. <https://doi.org/10.1016/j.jempfin.2003.06.003>
- Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica*, 57(2), 357. <https://doi.org/10.2307/1912559>
- Hung, N. T. (2019). Return and volatility spillover across equity markets between China and Southeast Asian countries. *Journal of Economics, Finance and Administrative Science*, 24(47), 66–81. <https://doi.org/10.1108/JEFAS-10-2018-0106>
- Hwang, S., & Salmon, M. (2004). Market stress and herding. *Journal of Empirical Finance*, 11(4), 585–616. <https://doi.org/10.1016/j.jempfin.2004.04.003>
- Javaira, Z., Sahar, N. U., Hashmi, S. D., & Naz, I. (2023). Volatility and dynamic herding in energy sector of developed markets during COVID-19: A Markov regime-switching approach. *Fudan Journal of the Humanities and Social Sciences*, 17(1), 115–138. <https://doi.org/10.1007/s40647-023-00395-9>
- Jebzan, K., & Iqbal, A. (2016). Examining volatility spillover between Asian countries' stock markets. *China Finance and Economic Review*, 4(1), 1–13. <https://doi.org/10.1186/s40589-016-0031-1>
- Kabir, M. H., & Shakur, S. (2018). Regime-dependent herding behavior in Asian and Latin American stock markets. *Pacific-Basin Finance Journal*, 47, 60–78. <https://doi.org/10.1016/j.pacfin.2017.12.002>

- Kanojia, S., Singh, D., & Goswami, A. (2022). Impact of herding on the returns in the Indian stock market: An empirical study. *Review of Behavioral Finance*, 14(1), 115–129. <https://doi.org/10.1108/RBF-01-2020-0017>
- Klein, A. C. (2013). Time-variations in herding behavior: Evidence from a Markov switching SUR model. *Journal of International Financial Markets, Institutions and Money*, 26, 291–304. <https://doi.org/10.1016/j.intfin.2013.06.006>
- Kumar, A., Bharti, & Bansal, S. (2016). An examination of herding behavior in an emerging economy: A study of Indian stock market. *Global Journal of Management and Business Research*, 16(B55), 57–63. <https://journalofbusiness.org/index.php/GJMBR/article/view/101208>
- Kumar, C. (2019, May 22). *How the Sensex, Nifty reacted after Modi won 2014 elections*. Business Today. <https://www.businesstoday.in/markets/stocks/story/how-the-sensex-nifty-reacted-after-modi-won-2014-elections-201620-2019-05-22>
- Lakonishok, J., Shleifer, A., & Vishny, R. W. (1992). The impact of institutional trading on stock prices. *Journal of Financial Economics*, 32(1), 23–43. [https://doi.org/10.1016/0304-405X\(92\)90023-Q](https://doi.org/10.1016/0304-405X(92)90023-Q)
- Lao, P., & Singh, H. (2011). Herding behaviour in the Chinese and Indian stock markets. *Journal of Asian Economics*, 22(6), 495–506. <https://doi.org/10.1016/j.asieco.2011.08.001>
- Litimi, H. (2017). Herd behavior in the French stock market. *Review of Accounting and Finance*, 16(4), 497–515. <https://doi.org/10.1108/RAF-11-2016-0188>
- Mand, A. A., & Sifat, I. (2021). Static and regime-dependent herding behavior: An emerging market case study. *Journal of Behavioral and Experimental Finance*, 29, 100466. <https://doi.org/10.1016/j.jbef.2021.100466>
- Mertler, C. A., Vannatta, R. A., & LaVenja, K. N. (2021). *Advanced and multivariate statistical methods : Practical application and interpretation* (7th ed.). Routledge. <https://doi.org/10.4324/9781003047223>
- Modak, S. (2021, February 27). *Market sell-off brings back memories of the 2013 “taper tantrum”*. Business Standard. https://www.business-standard.com/article/markets/market-sell-off-brings-back-memories-of-the-2013-taper-tantrum-121022700045_1.html
- Mukherjee, P., & Tiwari, S. (2022). Trading behaviour of foreign institutional investors: Evidence from Indian stock markets. *Asia-Pacific Financial Markets*, 29(4), 605–629. <https://doi.org/10.1007/s10690-022-09361-z>
- Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3), 703–708. <https://doi.org/10.2307/1913610>

- Nguyen, Y. V. B., & Vo, A. H. K. (2023). Herding behavior before and after COVID-19 pandemic: Evidence from the Vietnam stock market. *Journal of Economic Studies*, 5(2), 357-374. <https://doi.org/10.1108/JES-01-2023-0031>
- Poshakwale, S., & Mandal, A. (2014). Investor behaviour and herding: Evidence from the national stock exchange in India. *Journal of Emerging Market Finance*, 13(2), 197–216. <https://doi.org/10.1177/0972652714541341>
- Rompotis, G. G. (2018). Herding behavior among exchange-traded funds. *Journal of Behavioral Finance*, 19(4), 483–497. <https://doi.org/10.1080/15427560.2018.1431886>
- Roychoudhury, A. (2021, March 26). *Explained: The 2013 taper tantrum and why its spectre is being raised again*. Money Control. <https://www.moneycontrol.com/news/business/economy/explained-the-2013-taper-tantrum-and-why-its-spectre-is-being-raised-again-6700731.html>
- Sachdeva, M., Lehal, R., Gupta, S., & Garg, A. (2021). What make investors herd while investing in the Indian stock market? A hybrid approach. *Review of Behavioral Finance*, 15(1), 19-37. <https://doi.org/10.1108/RBF-04-2021-0070>
- Saini, C., Sharma, I., Verma, B., & . B. (2023). Performance of equity ETFs during COVID-19 pandemic crisis: Evidence from India. *Abhigyan*, 41(3), 21–31. <https://www.ischolar.in/index.php/Abhigyan/article/view/223672>
- Scharfstein, D. S., & Stein, J. C. (1990). Herd behavior and investment. *The American Economic Review*, 80(3), 465–479. <https://www.jstor.org/stable/2006678>
- Schmitt, N., & Westerhoff, F. (2017). Herding behaviour and volatility clustering in financial markets. *Quantitative Finance*, 17(8), 1187–1203. <https://doi.org/10.1080/14697688.2016.1267391>
- Sen, R., & Subramaniam, M. (2019). Stylized facts of the Indian stock market. *Asia-Pacific Financial Markets*, 26(4), 479–493. <https://doi.org/10.1007/s10690-019-09275-3>
- Shakya, A., Michael, S., Saunders, C., Armstrong, D., Pandey, P., Chalise, S., & Tonkoski, R. (2017). Solar irradiance forecasting in remote microgrids using Markov switching model. *IEEE Transactions on Sustainable Energy*, 8(3), 895–905. <https://ieeexplore.ieee.org/abstract/document/7745906>
- Shiller, R. J., Fischer, S., & Friedman, B. M. (1984). Stock prices and social dynamics. *Brookings Papers on Economic Activity*, 1984(2), 457. <https://doi.org/10.2307/2534436>
- Shrotryia, V. K., & Kalra, H. (2022). Herding and BRICS markets: A study of distribution tails. *Review of Behavioral Finance*, 14(1), 91–114. <https://doi.org/10.1108/RBF-04-2020-0086>

- Singh, A., & Singh, M. (2017). Risk–return relationship in BRIC equity markets: Evidence from Markov regime switching model with time-varying transition probabilities: *Metamorphosis: A Journal of Management Research*, 15(2), 69–78. <https://doi.org/10.1177/0972622516675814>
- Spyrou, S. (2013). Herding in financial markets: A review of the literature. *Review of Behavioral Finance*, 5(2), 175–194. <https://doi.org/10.1108/RBF-02-2013-0009>
- Tan, L., Chiang, T. C., Mason, J. R., & Nelling, E. (2008). Herding behavior in Chinese stock markets: An examination of A and B shares. *Pacific Basin Finance Journal*, 16(1–2), 61–77. <https://doi.org/10.1016/j.pacfin.2007.04.004>
- Tauseef, S. (2023). Herd behaviour in an emerging market: An evidence of calendar and size effects. *Journal of Asia Business Studies*, 17(3), 639–655. <https://doi.org/10.1108/JABS-10-2021-0430>
- Trueman, B. (1994). Analyst forecasts and herding behavior. *Review of Financial Studies*, 7(1), 97–124. <https://doi.org/10.1093/rfs/7.1.97>
- Wermers, R. (1999). Mutual fund herding and the impact on stock prices. *Journal of Finance*, 54(2), 581–622. <https://doi.org/10.1111/0022-1082.00118>
- Yang, W. R., & Chuang, M. C. (2023). Do investors herd in a volatile market? Evidence of dynamic herding in Taiwan, China, and US stock markets. *Finance Research Letters*, 52, 103364. <https://doi.org/10.1016/j.frl.2022.103364>
- Yao, J., Ma, C., & He, W. P. (2014). Investor herding behaviour of Chinese stock market. *International Review of Economics and Finance*, 29, 12–29. <https://doi.org/10.1016/j.iref.2013.03.002>

From this page you can:

- view and edit your article's metadata
- add authors
- check the progress of your submission
- view your correspondence with the Editor.

[Entering Publication Schedule](#)

Submission details

Submission ID: IJTM-237964

Title: **The Dividend Enigma: Deciphering the Effect on Indian ETF Performance in Stress and Normal Periods**

Journal: **Int. J. of Trade and Global Markets**

Corresponding author: **Chanchal Saini**

Email: **sainichanchal19oct@gmail.com**

Other authors: **Dr. Ishwar Sharma, Dr. Komal Jindal**

[View your Abstract, Authors, Metadata and Experts](#)

[View your notes to the Editor](#)

Submission Files



AI-Driven Transformations in Higher Education: A Citation and Co-citation Analysis

Shweta^{1*}, Priyalaxmi Gurumayum², Neelu Tiwari³, Meenakshi Kaushik⁴, Chitra Jha⁵ and Madhu Arora⁶

¹Amity University, Noida, India; ²NDIM Delhi, India; ³Amity University, India; ⁴DIAS, GGSIPU, India; ⁵GL Bajaj Institute of Technology and Management, India; ⁶NDIM Delhi, India

E-mail/Orcid Id:



S, shwetasharma1375@gmail.com, <https://orcid.org/0009-0003-4714-7819>; PG, dr.priyalaxmi@ndimdelhi.in, <https://orcid.org/0000-0003-1634-8469>;
 NT, neelutiwari82@gmail.com; <https://orcid.org/0000-0002-6733-3665> MK, meenu.meenuk1@gmail.com, <https://orcid.org/0009-0002-1646-4056>;
 CJ, jhachitra29@gmail.com, <https://orcid.org/0009-0003-2469-0771>; MA, profmadhuarora@gmail.com, <https://orcid.org/0000-0002-9554-3176>

Article History:

Received: 10th Aug. 2024

Accepted: 23rd Nov 2024

Published: 30th Nov, 2024

Keywords:

Artificial intelligence, AI, bibliometric analysis, citation analysis, co-citation analysis, higher education

How to cite this Article:

Shweta, Priyalaxmi Gurumayum, Neelu Tiwari, Meenakshi Kaushik Chitra Jha and Madhu arora (2024). AI-Driven Transformations in Higher Education: A Citation and Co-citation Analysis. *International Journal of Experimental Research and Review*, 45, 261-273.

DOI: <https://doi.org/10.52756/ijerr.2024.v45spl.021>

Abstract: Integrating artificial intelligence (AI) in the educational field can revolutionize teaching and learning outcomes, increase research capacity, and expedite administrative processes. The application of AI-powered virtual learning aids, customized learning platforms, and intelligent educational platforms, can boost the engagement of students, offer real-time feedback and support, and aid customized learning. Additionally, AI-based administrative systems may automate repetitive processes like financial aid processing, enrolment, and admissions, freeing up important resources for more strategic endeavors. Thus, this study aims to synthesize the literature exploring AI's impact on higher education through citation and co-citation analysis. Data from the Scopus database from 2015 to 2024 yielded 1140 papers. The data was analyzed using Biblioshiny and Vosviewer software to determine the publishing pattern, the most cited papers, the most prolific writers, sources, nations, and the network of co-citations between authors and references. The findings reveal a sharp and rapid growth (79.24%) in this industry, suggesting a significant spike in interest. In terms of overall citations, the UK became one of the top countries (1689). The author "Tan S" obtained the most citations (1869) with 10 publications, whereas "Kerr S" and "Poenici Sad" produced just one article and had the highest average citation (588). "Research And Practice in Technology-Enhanced Learning" and "Journal of Applied Learning and Teaching" were the most influential journals in terms of average and total citations, respectively. The uniqueness of the study is that it assesses the literature on AI's impacts in the fields of business and management as well as social science using citation and co-citation analysis. The outcomes of the study will have substantial implications that can help professionals, researchers, and decision-makers create policies.

Introduction

Artificial Intelligence (AI) refers to the intelligence exhibited by machines like computer systems. Our economy is experiencing significant technological advancements, causing a shift in people's behavior. AI simplifies and modifies people's jobs with the assistance of new technology. Certain self-service technologies under AI make people's lives easier and more feasible (Thakral and Kamra, 2024). AI has transformed the way people connect and communicate. It enables them to access various services and products to manage their lifestyles. Every sector currently offers multiple technological platforms. The education industry is no

exception; students and teachers are using information and communication technology (ICT) in their studies. This strategy is considered more engaging and participatory by teachers, parents, and students (Hinojo-Lucena et al., 2019).

AI is becoming increasingly popular in higher education, which makes learning more accessible and flexible. Technology allows teachers to get their study material online and can give access to their learners. Teachers can teach their students virtually from anywhere and anytime without physical barriers (Escotet, 2023). Students can also customize their education with AI's assistance. Every student can get a unique educational



approach based on their preferences, enhancing effectiveness and engagement. Education institutions and professionals can utilize a variety of AI apps to develop courses that are suitable for students' skill levels and provide various assistance. Chatbots are among the most popular AI applications, and they assist students with their admissions, academic, and non-academic decision-making questions. Additionally, AI helps educators and learners by producing intelligent materials for all academic levels, including digital textbooks (Chatterjee and Bhattacharjee, 2020a; Kumar, 2019). The primary goal of artificial intelligence (AI) in education is to provide intelligent teaching systems to students over the Internet. There are knowledgeable tutors available who can help students grow depending on their traits and subject matter expertise. Software applications promoting communication also allow students to work with tutors (Hinojo-Lucena et al., 2019). These AI applications in education offer valuable resources for teaching and learning systems because they give students access to fully qualified virtual teachers who support them according to their needs and communicate with them anywhere, which promotes convenience, efficacy, and engagement. (Rivers and Koedinger, 2017).

The use of AI has been examined in several review studies in various sectors and scenarios, including supply chain management. (Rana and Daultani, 2023), E-commerce (Bawack et al., 2022; FRIQUI and GRAA, 2024), Digital Marketing (Ziakos and Vlachopoulou, 2023), Health care (Alhashmi et al., 2024; Guo et al., 2020; Jimma, 2023), Public relations and media (Kaleel & Alomari, 2024), Blockchain (González-Mendes et al., 2024), Financial Analysis (Bahoo et al., 2024; Nica et al., 2024), Sport Science (Mariappan and Durai, 2024), Agriculture (Slimani et al., 2024), Banking (Khuan et al., 2024) Etc. Recently several bibliometric studies have also analyzed the research landscape on AI in the education sector (Ilham et al., 2023) from different perspectives like libraries (Vasishta et al., 2024), Stem Education (Fatimah et al., 2024), Language learning (Liu et al., 2024; Lubis et al., 2024), Academic Integrity (Rodrigues et al., 2024) etc. Nevertheless, the effects of AI on higher education have not been well-studied (Aziz et al., 2024; Fernandes et al., 2024; Maphosa and Maphosa, 2021, 2023; Reis-Marques et al., 2021). A review of these studies showed that very few had used citation and co-citation analysis to examine the literature that explored the impact of AI on higher education within the domain of "social science, business, and management". Citation analysis and co-citation analysis are two effective bibliometric analysis methods. Citations are crucial for academic publication

because they evaluate researchers' productivity and work relevance and help researchers and students find pertinent material on a subject (Liang and Lee, 2023). This paper seeks to address this research gap by consolidating the literature on AI's effects on higher education, using "citation and co-citation analysis" to identify the most influential authors, documents, sources, publishing years, and countries by addressing the following queries-

RQ1. What publication patterns exist between 2015 and 2024 in this field?

RQ2. What are the most cited authors, documents, sources, and countries?

RQ3. What is the co-citation structure of the Author, documents, and references?

The remainder of the paper is structured as follows. The methodology used to identify and analyze the corpus of existing literature is presented in the next section. Following that, A detailed discussion of the results is provided. Then, the study concludes by outlining its shortcomings and possible research problems.

Methodology

Bibliometric analysis, as explained by Zupic Ivan and Cater Tomaz (2015), is concerned with determining social, conceptual, and intellectual structures through studying literature history in a specific field. Bibliometric techniques also allow for data classification and synthesis in the form of a literature review within the specific research domain. This enables scholars to trace shifts in publication volume, intellectual integration, and interactions within the domain and assists them in carrying out future research (Mavric et al., 2021; Suban, 2023). Furthermore, examining past studies that included elements of AI intervention within higher education frameworks through bibliometric analysis could also reveal additional possible aspects (Michael Hall, 2011). This research utilized biblioshiny and Vos viewer for "Citation and co-citation analysis".

Data Source and Extraction

Scopus database is the largest and most well-structured database of high-quality articles. This allows researchers to effectively investigate a range of academic disciplines. (Burnham, 2006). Thus, this study chose the Scopus database to retrieve the relevant data using the following keywords: "Artificial Intelligence" OR "AI" AND "Higher Education". The search resulted in 4316 documents. We confined our search to only social science, business, and management domains, yielding 2266 documents. To maintain quality and consistency, 1084 documents were excluded based on the following exclusion criteria. First, articles published in a language

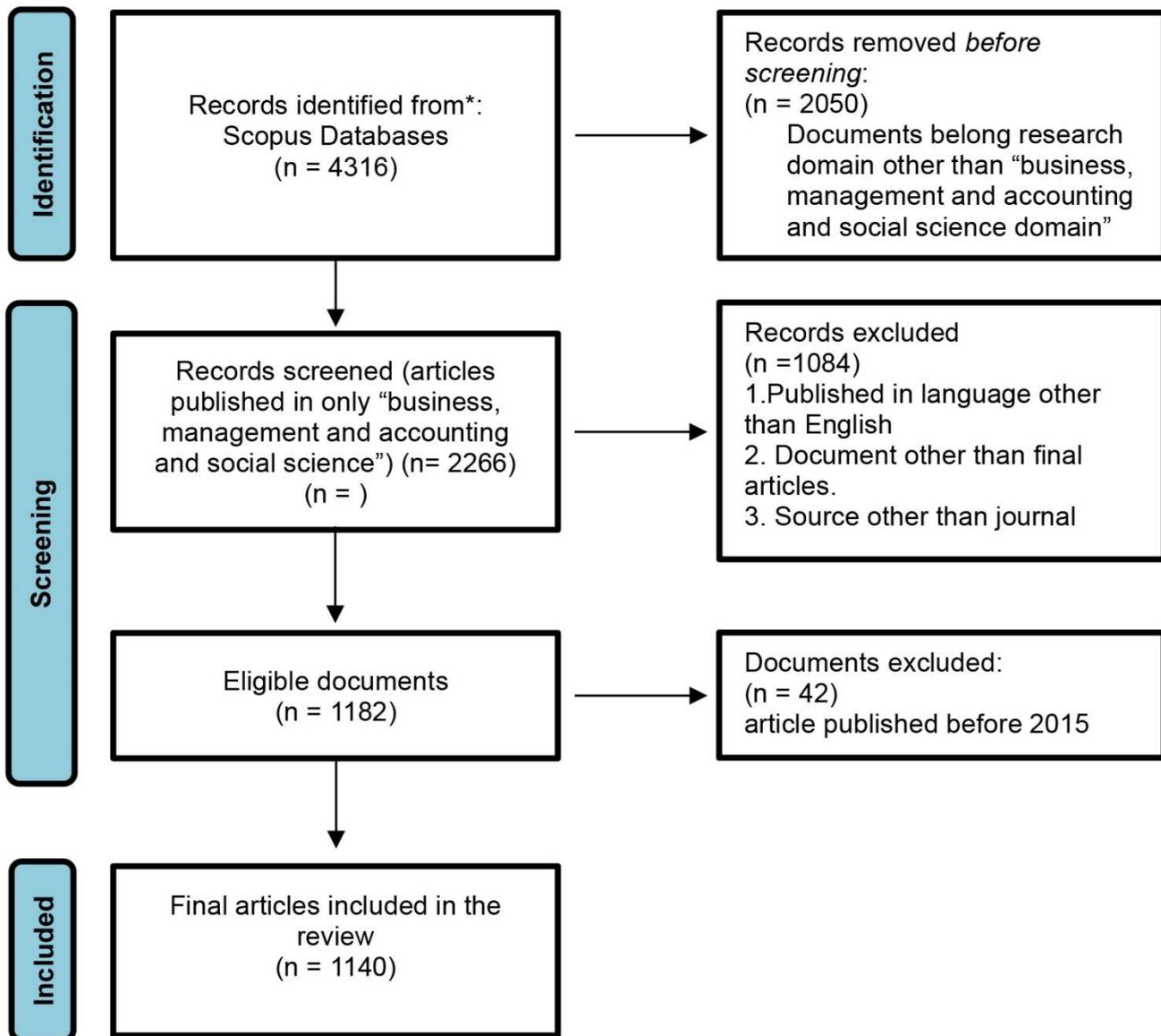


Figure 1. PRISMA framework.

other than English. Second, documents other than the final articles, such as a book, book chapter, conference proceedings, editorial, etc. Third, articles published in other than journals. To evaluate the impact of AI on higher education over a decade, articles published between 2015 and 2024 were taken into account. Once these parameters had been applied, 1140 articles were identified and the data was processed for analysis.

Results and Discussions

The data in this study is analyzed through citation and co-citation methods. The initial phase involved the examination of citation analysis-based publication trends, documents, authors, countries, and sources over time. The author's co-citations and references are discussed in the second part.

Citation analysis

Citation analysis is a method of bibliometric evaluation that evaluates the impact and relevance of academic works by examining their frequency of reference to another research (Frachtenberg, 2023). Through this method, researchers can determine the influence of authors and articles in their fields while also identifying trends and key contributions throughout history. Additionally, it can be used across disciplines and shows patterns of citation behavior (Mukhedkar et al., 2024). The significance of citations in academic publications lies in their ability to measure the productivity and relevance of academics' work and aid researchers in locating pertinent information on a specific issue (Liang and Lee, 2023).

Citation analysis of publication pattern

Figure 1 and Table 1 depict a generally rising trend in the annual number of articles published, while the growth rate remained modest until 2022. The findings show that just about 20% of the total papers were publications published between 2015 and 2022. The quantum of publications increased significantly (219%) in 2023 compared to previous years. According to the statistics, the year 2024 had the most publications (656), accounting for 57.5% of all the articles analyzed. The average publication growth rate in this field is 76.24%. Articles published in 2023 and 2024 make up 81% of all articles, surpassing the total amount of publications published before 2023. Table 1 also presents the “Average number of citations per article” and “means total citations per year”. The year 2017 had the highest average amount of citations per article, even though it published less than 1% of all publications (101). According to this, 2017 was the most productive year in terms of producing the most relevant articles and getting the most citations. Earlier research has shown that there has been impressive growth in the literature on AI for higher education (Bozkurt et al., 2021). These data demonstrate that this area has recently started to gain more attention and is a developing field of study. There is also enough room for further investigation.

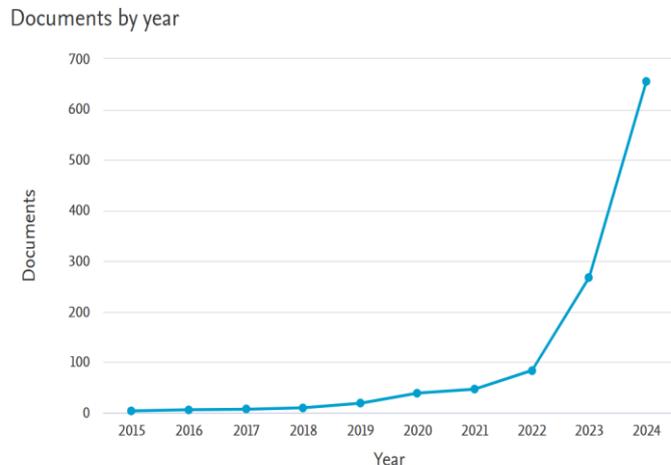


Figure 2. Publication Pattern.

Table 1. Year wise publication.

Year	Articles	Percentage	Average citation per article (ACA)	Mean Total citation per year (MTCpy)
2015	4	0.4%	8.50	0.85
2016	6	0.5%	37.83	4.20
2017	7	0.6%	101.00	12.62
2018	10	0.9%	32.40	4.63

2019	19	1.7%	43.42	7.24
2020	39	3.4%	35.03	7.01
2021	47	4.1%	28.55	7.14
2022	84	7.4%	20.38	6.79
2023	268	23.5%	26.88	13.44
2024	656	57.5%	4.22	4.22

Citation Analysis of Relevant Sources

For a study to be considered strong and reliable, one must examine various sources so that the most pertinent resources may be properly outlined. In this sense, the term "most relevant sources" implies the exclusive use of selected materials to retrieve from reputable databases like Scopus, depending on their relevance to the study. The leading journals in this sphere are presented in Table 2. The “Journal of Applied Learning and Teaching” took first place, with the highest number of citations, 1636, with 21 articles. It is followed by the “International Journal of Educational Technology in Higher Education” with 26 articles and a total citation of 1389. Conversely, the average citation counts for “Research and Practice in Technology-Enhanced Learning” and “Innovations in Education and Teaching International” are 209 and 179 respectively with fewer than 5 articles. This demonstrates that these journals were able to pinpoint journals of a very high standard. The journals “Education and Information Technologies” and “Computers and Education: Artificial Intelligence” are the most contributing journals in terms of publications. “Computers and Education: Artificial Intelligence” journal was considered an influential source because of previous work done in education technology (Chen et al., 2019, 2020).

Table 2. Most Relevant Sources.

Journals	No Of Articles	Total Citation	Average citation
“Journal Of Applied Learning and Teaching”	21	1636	78
International Journal of Educational Technology In Higher Education	26	1389	53
Innovations In Education and Teaching International	5	895	179
Sustainability (Switzerland)	36	866	24
Education and	57	850	15

Information Technologies			
Computers and Education: Artificial Intelligence	49	759	15
Education Sciences	45	704	16
Journal of University Teaching and Learning Practice	19	670	35
Research and Practice in Technology-Enhanced Learning	3	628	209
Computers and Education”	8	480	60

Citation analysis of authors

Authors are responsible for the credibility of findings in research, ensuring further funding and promotion of these results or targeting scientific and intellectual enhancement of the society as a whole (Tarkang et al., 2017). Authorship is important for the advancement of research, reputation, and obtaining grants for projects. Unfortunately, it is overlooked in educational technology projects because of a multitude of responsibilities (Thompson et al., 2022). Citation distribution and publication count may all be used to explain an author's influence (Chai et al., 2020). Table 3 lists the most important researchers in this field. “Tan S” is the most prolific author of this particular area. He holds the first position in total citations (1869) and the number of publications (10), it has the highest G-index (10) and H-index (7). On average, his documents have been cited about 187 times each. “Rudolph J” takes second place with 953 citations, 8 documents, 5 G-index, and 8 H-index. He received an average of 119 citations per document. Contrarily, “Kerr S” and “Poenici Sad” have only one paper each with 588 citations. Such statistics suggest that articles published by “Kerr S” and “Poenici Sad” have a greater impact. All these results draw attention to the remarkable productivity, impact, and influence that the authors had in this discipline. A broad selection of works about AI’s Impact on higher education for comprehending economic progress would be included in their portfolio, showcasing their significant contributions to the advancement of the sector. This demonstrates their work's importance in advancing research agendas and encouraging creativity. These results are consistent with other studies that emphasize authors' critical role information distribution and their

substantial contributions to the advancement of knowledge in pertinent fields (Kumar and Sudhakar, 2024).

Table 3. Top 10 Authors

Authors	Tc	Np	G-Index	G-Index	H-Index
Tan S	1869	10	187	10	7
Rudolph J	953	8	119	8	5
Kerr S	588	1	588	1	1
Popenici Sad	588	1	588	1	1
Chan Cky	587	7	84	7	4
Cotton Dre	584	2	292	2	2
Shipway Jr	576	2	288	2	1
Cotton Pa	575	1	575	1	1
Jiao P	351	4	88	4	3
Ouyang F	351	4	88	4	3

Citation analysis of countries

Figure 2 displays the top ten nations with the most citations obtained. The UK has made the most contribution in this area, with 1689 total citations and an average citation of 21.10. The USA secures the second position with 1606 total citations and 13.4 average citations. When it comes to average article citations, the Netherlands leads the world (53.7), followed by Hong Kong (41.3). One explanation may be that these nations have generated influential and high-Caliber publications that encourage people to mention them. A further factor would be that most of the publications published in the Netherlands and Hong Kong are open access, raising the visibility of readability and citations. It was uncovered by previous studies that the USA and the UK are the most influential nations in several research domains, including computer science (Zurita et al., 2021), Palliative care (Abu-Odah et al., 2022), library service quality research (Ashiq et al., 2022), Special education (Arslan et al., 2023), Academic engagement (Pham et al., 2024), Digital solution (Asghar et al., 2021), Recommendation Systems Research (Olufunke and Okuoyo, 2023) etc.

Citation analysis of documents

Good research articles allow readers to follow the process, accurately depict and explain the research study, and encourage debate, discussion, and critical thinking (Finlay, 1997). Research articles are crucial in academic discourse since an academic's publishing record may determine their quantity and quality. Research papers are the most reliable source of meticulously reviewed fact-based material that may guide work and assist readers in determining the accuracy of information (Scandlyn, 1987). The most significant works on AI's effects on higher education are compiled in Table 4, with an

Table 4. Most cited documents.

Rank	Title	Journal	Year	Total Citation	Reference
1	“ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?”	Journal of Applied Learning and Teaching	2023	593	(Rudolph et al., 2023a)
2	Exploring the impact of artificial intelligence on teaching and learning in higher education	Research and Practice in Technology-Enhanced Learning	2017	588	(Popenici & Kerr, 2017))
3	Chatting and cheating: Ensuring academic integrity in the era of ChatGPT	Innovations in Education and Teaching International	2024	575	(Cotton et al., 2024)
4	War of the chatbots: Bard, Bing Chat, ChatGPT, Ernie, and beyond. The new AI gold rush and its impact on higher education	Journal of Applied Learning and Teaching	2023	314	(Rudolph et al., 2023c)
5	A SWOT analysis of ChatGPT: Implications for educational practice and research	Innovations in Education and Teaching International	2024	310	(Farrokhnia et al., 2024)
6	A comprehensive AI policy education framework for university teaching and learning	International Journal of Educational Technology in Higher Education	2023	259	(Chan, 2023)
7	Students’ voices on generative AI: perceptions, benefits, and challenges in higher education	International Journal of Educational Technology in Higher Education	2023	249	(Chan & Hu, 2023)
8	Academic integrity considerations of AI Large Language Models in the post-pandemic era: ChatGPT and beyond	Journal of University Teaching and Learning Practice	2023	242	(Perkins, 2023)
9	Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modeling	Education and Information Technologies	2020	239	(Chatterjee & Bhattacharjee, 2020b)
10	Artificial intelligence in higher education: the state of the field	International Journal of Educational Technology in Higher Education	2023	236	(Crompton & Burke, 2023)”

emphasis on total citations globally. The research paper titled “ChatGPT: Bullshit Spewer or the End of Traditional Assessments in Higher Education?” was published in the prestigious “Journal of Applied Learning and Teaching” in 2023 by Rudolph et al. (2023a) and has received the most citations (593). The second spot was secured by an article published by Popenici and Kerr (2017) in 2017. The title of the paper was “Exploring the Impact of Artificial Intelligence on Teaching and Learning in Higher Education,” and it was printed in the esteemed journal “Research and Practice in Technology Enhanced Learning.” It has received 588 citations. These articles provide insights and information that significantly progress the AI and Higher Education field. Previous

structure of academic literature (Gupta et al., 2023; Phan et al., 2024). Reviews of scientific literature can be made more rigorous and less biased by using co-citation analysis in bibliometric techniques (Zupic and Čater, 2015).

In this study, two co-citation analyses were conducted, i.e., co-citation of references and co-citation of authors.

Co-citation of references

In this co-citation analysis of references, 23 met the threshold with 20 minimum number of cited references. We got four clusters representing cited references with their citations and total link strength. The topmost cited references are Chen et al. (2020), with 60 citations (Rudolph et al., 2023b), with 42 citations and 41 citations

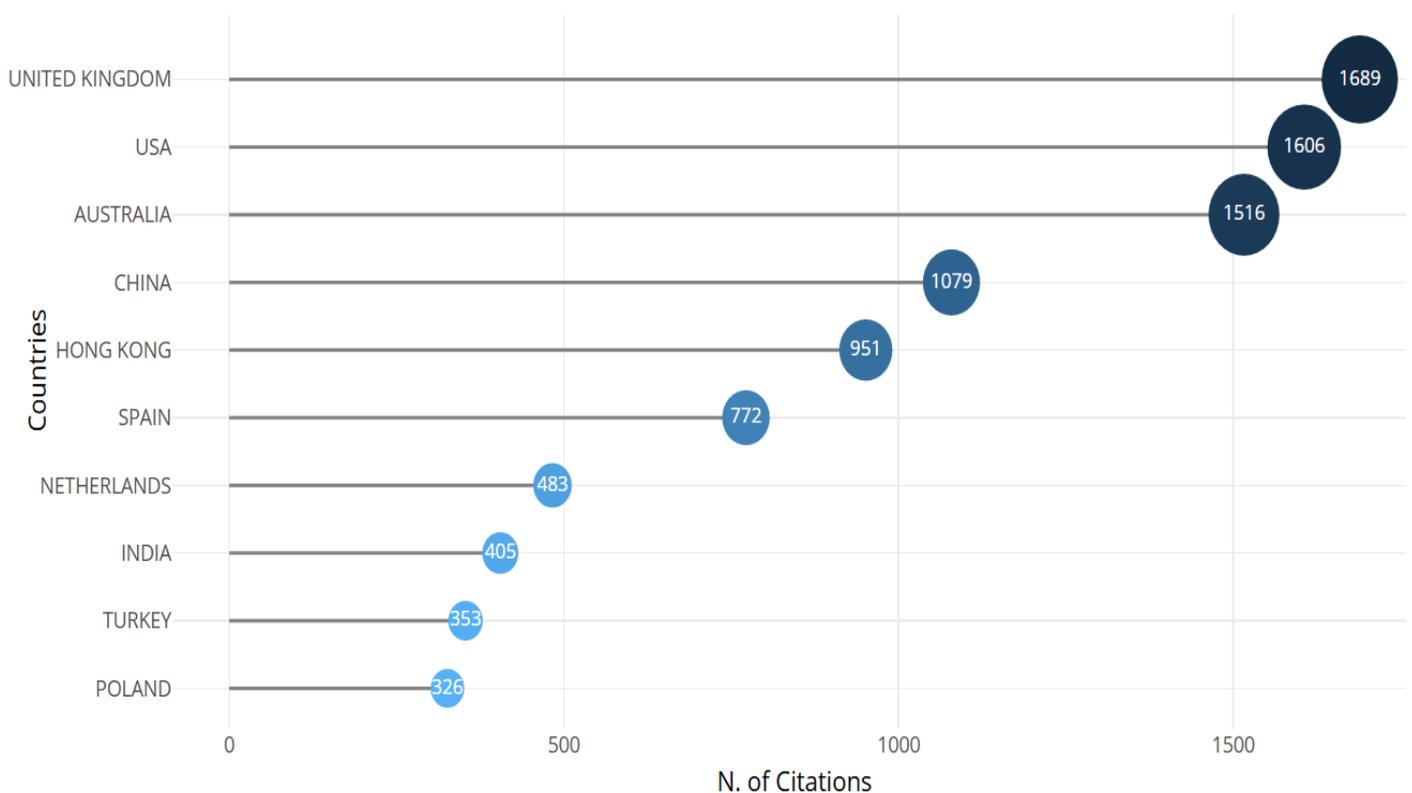


Figure 3. Most cited countries.

studies have also highlighted the importance of articles in advancing knowledge in any research field (İNCİ and KÖSE, 2024; Yadava et al., 2019).

Co-citation Analysis

A bibliometric technique called “co-citation analysis” examines how frequently the two works are cited together in other studies. It facilitates mapping significant references, journals, documents, and authors (Salouw et al., 2023). It assists in recognizing trends, intellectual connections, relationships, and the relevance of scholarly works. It also reveals patterns in citation behavior and the

(figure 3)(Braun and Clarke, 2006).

Co-citation of authors

Furthermore, co-citation analysis was also chosen to analyze ‘cited authors’ within the VOS viewer program. To reduce the clutter in the data visualization, a threshold value of 20 was established (Genc and Kocak, 2024). A closer look at the map in the figure reveals three different colored clusters that are there with similar cited authors. “Tan S.” is in the center of the blue cluster, “Gasevic D.” is in the center of the red cluster, and “Sarstedt M.” is in the center of the green cluster. Tan S. (349 citations), Gasevic D. (261 clusters), and Sarstedt M. (239 citations) are the most cited authors. (figure 4)

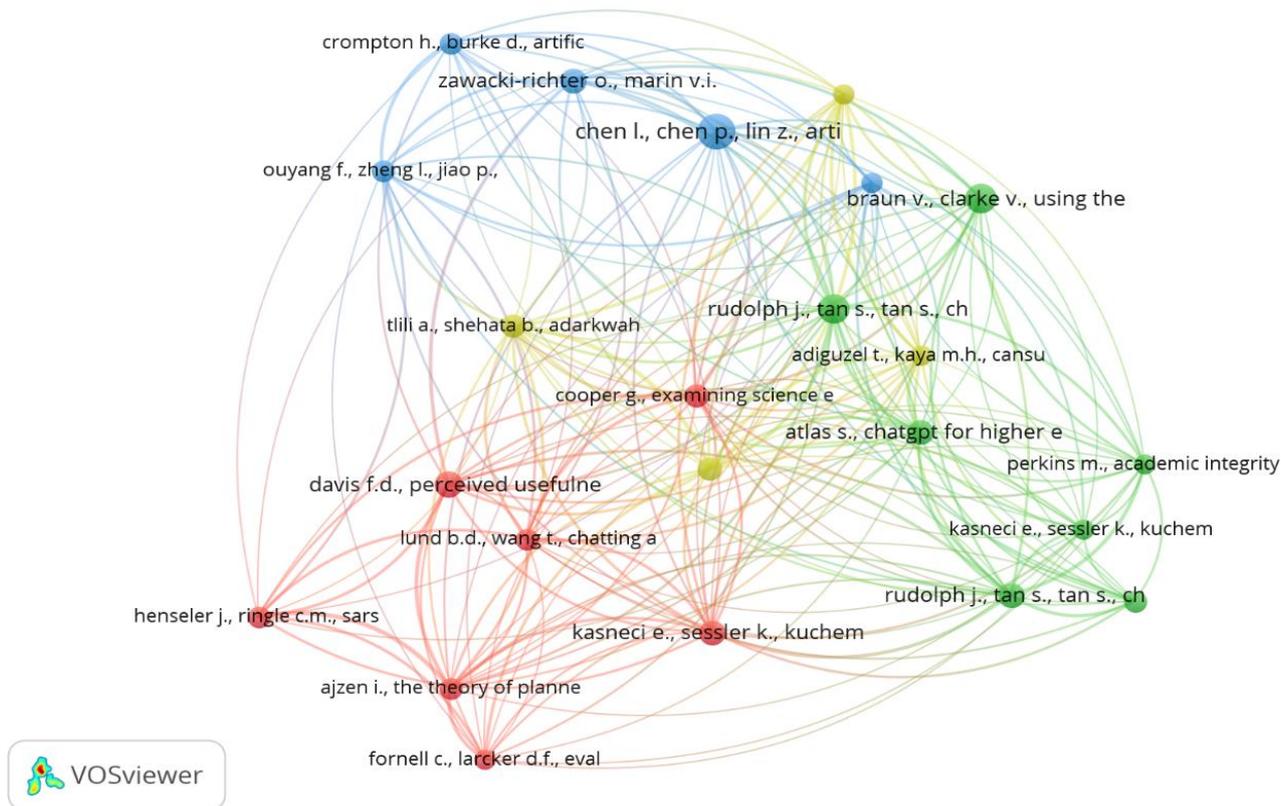


Figure 4. Co-Citation of Cited References.

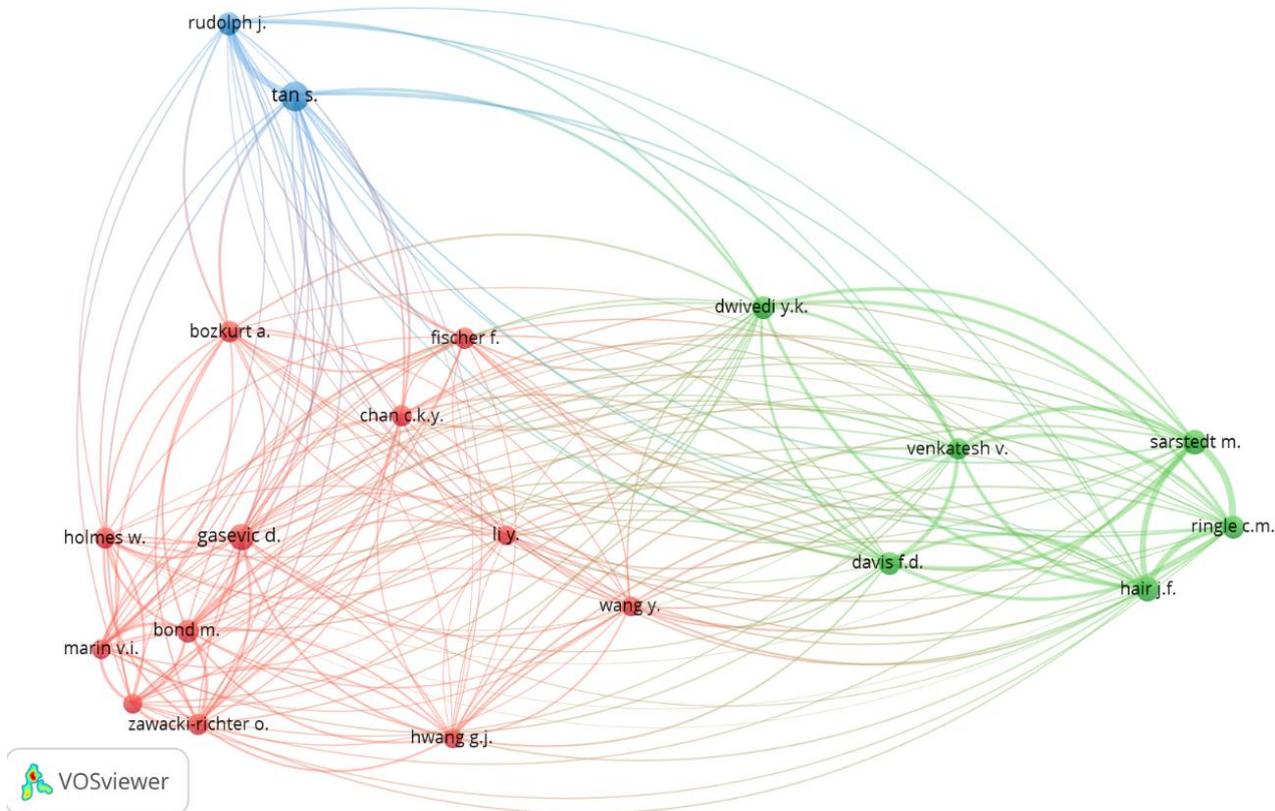


Figure 5. Co-citation of cited authors.

Conclusion

This study concludes by doing a comprehensive bibliometric analysis on the topic of Artificial intelligence and its impact on higher education using citation and co-citation analysis. The study analyzed 1140 data from the Scopus database through biblioshiny and Vosviewer software. The research findings shed light on several important facets of the research environment, such as the important documents, authors, sources, country, and co-citation network. The total number of publications released in 2023 and 2024 surpassed the total number published before 2023, accounting for 81% of the total papers. Publication in this field showed a significant growth of 76.24%. This result indicates that this topic is a trending topic that attracts the interest of various researchers, and there is a lot of scope for research in this field. Most of the articles in this field have been published in the “Education and Information Technologies” journal (57), while the most impactful journals were “Research and Practice in Technology-Enhanced Learning” and “Journal of Applied Learning and Teaching” in terms of average citations (209) and total citations (1636) respectively. A paper titled “ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?” is the most cited article (593). The author named “Tan S” received the highest number of citations (1869) and publications (10), while “Kerr S” and “Poenici Sad” published only one article and got the highest average citation, 588 citations. The future researcher interested in this field can find the most relevant information from these sources. The UK emerges as the leading country in this field. It has gained the highest number of citations (1689). Next, through science mapping, we find the co-citation of cited references and the co-citation of cited authors. The topmost cited references are (L. Chen et al., 2020) with 60 citations, (Rudolph et al., 2023b) with 42 citations and (Braun and Clarke, 2006) with 41 citations, While Tan S. (349 citations), Gasevic D. (261 clusters) and Sarstedt M. (239 citations) are the most co-cited authors. This study aims to offer researchers valuable guidance in identifying key issues and efficiently addressing gaps in their research. This study recommends that policymakers and concerned authorities make effective policies and focus on infrastructure development to support AI Implementation. This will contribute to knowledge management and will improve the learning outcome. This study also concluded that the future of AI in higher education is high as AI benefits the teacher and students a lot and the growing use of AI in higher education is very effective and engaging for the students.

Limitations and Future Scope

Despite the contribution of this paper, some limitations need to be addressed, such as the use of only the Scopus database. Although Scopus has many relevant and high-quality research papers, including other databases, it will help to cover more relevant studies. Further, we have applied some criteria which also limit the scope of research. We have included only articles published in English within social sciences, business, management, and accounting domains. Covering articles from other domains leads to more comprehensive coverage of the topic. For future studies, other tools can also be utilized like CiteSpaceII and Tableau in addition to VOS viewer and biblioshiny. This research has used only “Artificial intelligence”, “AI” and “higher education”. Future studies can use more keywords like machine learning, chatbots, blockchain, etc, to retrieve more inclusive data. Only citation and co-citation analysis have been conducted in this study. Future studies can explore co-authorship, bibliographic coupling, keyword analysis, co-word analysis, collaboration network analysis, and topic modeling. Furthermore, the results of this study contribute to the understanding of more pertinent subjects that might gain popularity in this sector in the years to come. The article will thus aid scholars and experts in their future studies as well as the public in learning more about this area.

Conflict of Interest

There is no conflict of interest.

References

- Abu-Odah, H., Molassiotis, A., & Liu, J. Y. W. (2021). Global palliative care research (2002-2020): bibliometric review and mapping analysis. *BMJ Supportive & Palliative Care*, 12(4), 376–387. <https://doi.org/10.1136/bmjspcare-2021-002982>
- Alhashmi, S. M., Hashem, I. A. T., & Al-Qudah, I. (2024). Artificial Intelligence applications in healthcare: A bibliometric and topic model-based analysis. *Intelligent Systems with Applications*, 21, 200299. <https://doi.org/10.1016/j.iswa.2023.200299>
- Arslan, R., Orbay, K., & Orbay, M. (2024). A bibliometric analysis of publications on special education between 2011 and 2020. *Hungarian Educational Research Journal*, 14(2), 142–157. <https://doi.org/10.1556/063.2023.00212>
- Asghar, I., Egaji, O. A., & Griffiths, M. (2021). An overview of the digital solutions for helping people with aphasia through bibliometric analysis. *ENeurological Sci.*, 22, 100311.

- <https://doi.org/10.1016/j.ensci.2021.100311>
- Ashiq, M., Ur Rehman, S., Muneeb, D., & Ahmad, S. (2021). Global research on library service quality: a bibliometric analysis and knowledge mapping. *Global Knowledge, Memory and Communication*, 71(4/5), 253–273. <https://doi.org/10.1108/gkmc-02-2021-0026>
- Aziz, A., Nusantara, T., Qohar, A., & Irawati, S. (2024). Key Research Ideas of Artificial Intelligence in Higher Education: Bibliometric Analysis and Information Mapping. *Journal of Higher Education Theory and Practice*, 24(2). <https://doi.org/10.33423/jhetp.v24i2.6792>
- Bahoo, S., Cucculelli, M., Goga, X., & Mondolo, J. (2024). Artificial intelligence in Finance: a comprehensive review through bibliometric and content analysis. *SN Business & Economics*, 4(2). <https://doi.org/10.1007/s43546-023-00618-x>
- Bawack, R. E., Wamba, S. F., Carillo, K. D. A., & Akter, S. (2022). Artificial intelligence in E-Commerce: a bibliometric study and literature review. *Electronic Markets*, 32(1). <https://doi.org/10.1007/s12525-022-00537-z>
- Bozkurt, A., Karadeniz, A., Baneres, D., Guerrero-Roldán, A. E., & Rodríguez, M. E. (2021). Artificial intelligence and reflections from educational landscape: A review of AI studies in half a century. *Sustainability (Switzerland)*, 13(2). <https://doi.org/10.3390/su13020800>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Burnham, J. F. (2006). Scopus database: A review. In *Biomedical Digital Libraries* (Vol. 3). <https://doi.org/10.1186/1742-5581-3-1>
- Chai, S., D'Amour, A., & Fleming, L. (2020). Explaining and predicting the impact of authors within a community: An assessment of the bibliometric literature and application of machine learning. *Industrial and Corporate Change*, 29(1). <https://doi.org/10.1093/icc/dtz042>
- Chan, C. K. Y. (2023). A comprehensive AI policy education framework for university teaching and learning. *International Journal of Educational Technology in Higher Education*, 20(1). <https://doi.org/10.1186/s41239-023-00408-3>
- Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1). <https://doi.org/10.1186/s41239-023-00411-8>
- Chatterjee, S., & Bhattacharjee, K. K. (2020a). Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modelling. *Education and Information Technologies*, 25(5), 3443–3463. <https://doi.org/10.1007/s10639-020-10159-7>
- Chatterjee, S., & Bhattacharjee, K. K. (2020b). Adoption of artificial intelligence in higher education: a quantitative analysis using structural equation modelling. *Education and Information Technologies*, 25(5). <https://doi.org/10.1007/s10639-020-10159-7>
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial Intelligence in Education: A Review. *IEEE Access*, 8, 75264–75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Chen, X., Xie, H., & Hwang, G.J. (2020). A multi-perspective study on Artificial Intelligence in Education: grants, conferences, journals, software tools, institutions, and researchers. *Computers and Education: Artificial Intelligence*, 1, 100005. <https://doi.org/10.1016/j.caeai.2020.100005>
- Chen, X., Yu, G., Cheng, G., & Hao, T. (2019). Research topics, author profiles, and collaboration networks in the top-ranked journal on educational technology over the past 40 years: a bibliometric analysis. *Journal of Computers in Education*, 6(4). <https://doi.org/10.1007/s40692-019-00149-1>
- Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2024). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, 61(2). <https://doi.org/10.1080/14703297.2023.2190148>
- Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: the state of the field. *International Journal of Educational Technology in Higher Education*, 20(1). <https://doi.org/10.1186/s41239-023-00392-8>
- Escotet, M. Á. (2023). The optimistic future of Artificial Intelligence in higher education. *Prospects*. <https://doi.org/10.1007/s11125-023-09642-z>
- Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2024). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, 61(3). <https://doi.org/10.1080/14703297.2023.2195846>

- Fatimah, S., Haryani, S., & Sarwi. (2024). Artificial Intelligence in STEM Education: A Bibliometric Analysis. *International Journal of Multicultural and Multireligious Understanding*, 11(1).
- Fernandes, R. M., Nagata, V. de M. N., Melo, A. C. S., & Martins, V. W. B. (2024). Artificial intelligence and sustainability in higher education: a bibliometric analysis and its relations with the UN SDGs. *Concilium*, 24(3).
<https://doi.org/10.53660/clm-2872-24c47>
- Finlay, L. (1997). Evaluating Research Articles. *British Journal of Occupational Therapy*, 60(5).
<https://doi.org/10.1177/030802269706000504>
- Frachtenberg, E. (2023). Citation analysis of computer systems papers. *Peer J. Computer Science*, 9.
<https://doi.org/10.7717/peerj-cs.1389>
- FRIQUI, S., & GRAA, A. (2024). Bibliometric Analysis of Artificial Intelligence in the Scope of E-Commerce: Trends and Progress over the Last Decade. *Management and Economics Review*, 9(1). <https://doi.org/10.24818/mer/2024.01-01>
- Genc, H. N., & Kocak, N. (2024). Bibliometric Analysis of Studies on the Artificial Intelligence in Science Education with VOSviewer. *Journal of Education in Science, Environment and Health*, 183–195.
<https://doi.org/10.55549/jeseh.756>
- González-Mendes, S., García-Muiña, F., & González-Sánchez, R. (2024). Blockchain and Artificial Intelligence in a Business Context: A Bibliometric Analysis. *Lecture Notes in Networks and Systems*, 800.
https://doi.org/10.1007/978-3-031-45645-9_16
- Guo, Y., Hao, Z., Zhao, S., Gong, J., & Yang, F. (2020). Artificial intelligence in health care: Bibliometric analysis. *Journal of Medical Internet Research*, 22(7). <https://doi.org/10.2196/18228>
- Gupta, A., Gupta, S., Bisht, M., Hooda, P., & Salik, M. (2023). Document Co-citation Analysis using the Concept Lattice. *Engineering, Technology and Applied Science Research*, 13(5).
<https://doi.org/10.48084/etasr.6201>
- Hinojo-Lucena, F. J., Aznar-Díaz, I., Cáceres-Reche, M. P., & Romero-Rodríguez, J. M. (2019). Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature. *Education Sciences*, 9(1).
<https://doi.org/10.3390/educsci9010051>
- Ilham, R., Muhammad, I., Aji, L. J., Rizal, S. U., & Ozbilen, F. M. (2023). Artificial Intelligence Research in Education: A Bibliometric Analysis. *Journal on Education*, 1(1).
- İNCİ, G., & KÖSE, H. (2024). The Landscape of Technology Research in Special Education: A Bibliometric Analysis. *Journal of Special Education Technology*, 39(1).
<https://doi.org/10.1177/01626434231180582>
- Jimma, B. L. (2023). Artificial intelligence in healthcare: A bibliometric analysis. *Telematics and Informatics Reports*, 9, 100041.
<https://doi.org/10.1016/j.teler.2023.100041>
- Kaleel, A., & Alomari, M. S. (2024). Integrating Artificial Intelligence in Public Relations and Media: A Bibliometric Analysis of Emerging Trends and Influences. *Iraqi Journal for Computer Science and Mathematics*, 5(1).
<https://doi.org/10.52866/ijcsm.2024.05.01.002>
- Khuan, H., Judijanto, L., Rachmawati, T., Tanjung, T., & Vandika, A. Y. (2024). Bibliometric Analysis on the Use of Artificial Intelligence in Improving the Efficiency of Banking Financial Processes in Southeast Asian Countries. *West Science Interdisciplinary Studies*, 2(01).
<https://doi.org/10.58812/wsiv.v2i01.597>
- Kumar, S. (2019). Artificial intelligence divulges effective tactics of top management institutes of India. *Benchmarking*, 26(7), 2188–2204.
<https://doi.org/10.1108/BIJ-08-2018-0251>
- Kumar, S., & Sudhakar, K. F. (2024). E-commerce Adoption and Sustainability with SMEs – An Advanced Bibliometric Analysis. *International Journal of Experimental Research and Review*, 40(Special Issue), 24–40.
<https://doi.org/10.52756/ijerr.2024.v40spl.003>
- Liang, Y., & Lee, L. K. (2023). A Systematic Review of Citation Recommendation Over the Past Two Decades. *International Journal on Semantic Web and Information Systems*, 19(1).
<https://doi.org/10.4018/IJSWIS.324071>
- Liu, W., Lin, Y., & Yu, Z. (2024). A Bibliometric Analysis of Artificial Intelligence Chatbots in Language Education. *Social Education Research*.
<https://doi.org/10.37256/ser.5120243372>
- Lubis, A. H., Samsudin, D., Triarisanti, R., Jerusalem, M. I., & Hwang, Y. (2024). A Bibliometric Mapping Analysis of Publications on The Utilization of Artificial Intelligence Technology in Language Learning. *Journal of Advanced Research in Applied Sciences and Engineering Technology*, 38(1). <https://doi.org/10.37934/araset.38.1.156176>
- Maphosa, V., & Maphosa, M. (2021). The Trajectory of Artificial Intelligence Research in Higher Education: A Bibliometric Analysis and

- Visualisation. *IcABCD 2021 - 4th International Conference on Artificial Intelligence, Big Data, Computing and Data Communication Systems*, Proceedings.
<https://doi.org/10.1109/icABCD51485.2021.9519368>
- Maphosa, V., & Maphosa, M. (2023). Artificial intelligence in higher education: a bibliometric analysis and topic modeling approach. *Applied Artificial Intelligence*, 37(1).
<https://doi.org/10.1080/08839514.2023.2261730>
- Mariappan, S., & Durai, C. (2024). In Sports Science, Perform A Bibliometric Analysis on Artificial Intelligence. *Shanlax International Journal of Arts, Science and Humanities*, 11(3).
<https://doi.org/10.34293/sijash.v11i3.6895>
- Mavric, B., Ögretmenoğlu, M., & Akova, O. (2021). Bibliometric analysis of slow tourism. *Advances in Hospitality and Tourism Research*, 9(1), 157–178.
<https://doi.org/10.30519/AHTR.794656>
- Michael Hall, C. (2011). Publish and perish? Bibliometric analysis, journal ranking and the assessment of research quality in tourism. *Tourism Management*, 32(1), 16–27.
<https://doi.org/10.1016/j.tourman.2010.07.001>
- Mukhedkar, M. V., Aware, S. V., & Bodake, P. (2024). Citation Analysis of Post Graduate Theses Submitted to Department of Renewable Energy Sources in College of Agricultural Engineering and Technology, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra. *Advances in Research*, 25(2).
<https://doi.org/10.9734/air/2024/v25i21034>
- Nica, I., Delcea, C., & Chiriță, N. (2024). Mathematical Patterns in Fuzzy Logic and Artificial Intelligence for Financial Analysis: A Bibliometric Study. *Mathematics*, 12(5).
<https://doi.org/10.3390/math12050782>
- Olufunke, O., & Okuoyo, O. (2023). A Bibliometric Analysis and Science Mapping of Recommendation Systems Research from 1987 to 2022. *2023 International Conference on Science, Engineering and Business for Sustainable Development Goals, SEB-SDG 2023*.
<https://doi.org/10.1109/SEB-SDG57117.2023.10124525>
- Perkins, M. (2023). Academic Integrity considerations of AI Large Language Models in the post-pandemic era: ChatGPT and beyond. *Journal of University Teaching and Learning Practice*, 20(2).
<https://doi.org/10.53761/1.20.02.07>
- Pham, H. H., Ta, T. N., Luong, D. H., Nguyen, T. T., & Vu, H. M. (2024). A bibliometric review of research on academic engagement, 1978–2021. *Industry and Higher Education*, 38(3).
<https://doi.org/10.1177/09504222231189717>
- Phan, H. V., Lai, C.P., Li, H., Le, H. T. M., & Nguyen, T. K. (2024). Mapping the investment efficiency: a co-citation analysis. *International Journal of Industrial Management*, 18(1), 60–71.
<https://doi.org/10.15282/ijim.18.1.2024.10426>
- Popenici, S. A. D., & Kerr, S. (2017). Exploring the impact of artificial intelligence on teaching and learning in higher education. *Research and Practice in Technology Enhanced Learning*, 12(1).
<https://doi.org/10.1186/s41039-017-0062-8>
- Rana, J., & Daultani, Y. (2023). Mapping the Role and Impact of Artificial Intelligence and Machine Learning Applications in Supply Chain Digital Transformation: A Bibliometric Analysis. *Operations Management Research*, 16(4).
<https://doi.org/10.1007/s12063-022-00335-y>
- Reis-Marques, C., Figueiredo, R., & de Castro Neto, M. (2021). Applications of Blockchain Technology to Higher Education Arena: A Bibliometric Analysis. *European Journal of Investigation in Health, Psychology and Education*, 11(4), 1406–1421.
<https://doi.org/10.3390/ejihpe11040101>
- Rivers, K., & Koedinger, K. R. (2017). Data-Driven Hint Generation in Vast Solution Spaces: a Self-Improving Python Programming Tutor. *International Journal of Artificial Intelligence in Education*, 27(1), 37–64.
<https://doi.org/10.1007/s40593-015-0070-z>
- Rodrigues, M., Silva, R., Borges, A. P., Franco, M., & Oliveira, C. (2024). Artificial intelligence: threat or asset to academic integrity? A bibliometric analysis. *Kybernetes*. <https://doi.org/10.1108/k-09-2023-1666>
- Rudolph, J., Tan, S., & Tan, S. (2023a). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education? *Journal of Applied Learning and Teaching*, 6(1).
<https://doi.org/10.37074/jalt.2023.6.1.9>
- Rudolph, J., Tan, S., & Tan, S. (2023b). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education? *Journal of Applied Learning and Teaching*, 6(1), 342–363.
<https://doi.org/10.37074/jalt.2023.6.1.9>
- Rudolph, J., Tan, S., & Tan, S. (2023c). War of the chatbots: Bard, Bing Chat, ChatGPT, Ernie and beyond. The new AI gold rush and its impact on

- higher education. *Journal of Applied Learning and Teaching*, 6(1).
<https://doi.org/10.37074/jalt.2023.6.1.23>
- Salouw, E., Setiawan, B., & Sarwadi, A. (2023). Co-citation Analysis on Popular References Regarding Cross-Border Tourism. *Khizanah Al-Hikmah: Jurnal Ilmu Perpustakaan, Informasi, Dan Kearsipan*, 11(1).
<https://doi.org/10.24252/kah.v11i1a1>
- Scandlyn, J. N. (1987). How to read a research article. *Orthopaedic Nursing / National Association of Orthopaedic Nurses*, 6(5).
<https://doi.org/10.1097/00006416-198709000-00005>
- Slimani, H., El Mhamdi, J., & Jilbab, A. (2024). Assessing the advancement of artificial intelligence and drones' integration in agriculture through a bibliometric study. *International Journal of Electrical and Computer Engineering*, 14(1).
<https://doi.org/10.11591/ijece.v14i1.pp878-890>
- Suban, S. A. (2023). Bibliometric analysis on wellness tourism – citation and co-citation analysis. *International Hospitality Review*, 37(2), 359–383.
<https://doi.org/10.1108/ihr-11-2021-0072>
- Tarkang, E. E., Kweku, M., & Zotor, F. B. (2017). Publication practices and responsible authorship: A review article. *Journal of Public Health in Africa*, 8(1). <https://doi.org/10.4081/jphia.2017.723>
- Thakral, S., & Kamra, V. (2024). Self-service technologies: A bibliometric analysis. *International Journal of Financial Engineering*.
<https://doi.org/10.1142/s2424786324420076>
- Thompson, K., Corrin, L., Lodge, J. M., & Hwang, G.J. (2022). Authorship practices in educational technology research. *Australasian Journal of Educational Technology*, 38(1).
<https://doi.org/10.14742/ajet.7980>
- Vasishta, P., Dhingra, N., & Vasishta, S. (2024). Application of artificial intelligence in libraries: a bibliometric analysis and visualisation of research activities. *Library Hi Tech*.
<https://doi.org/10.1108/lht-12-2023-0589>
- Yadava, S. M., Patrick, H. S., Ananth, C. V., Rosen, T., & Brandt, J. S. (2019). Top-cited articles in the Journal: a bibliometric analysis. *American Journal of Obstetrics and Gynecology*, 220(1).
<https://doi.org/10.1016/j.ajog.2018.11.1091>
- Ziakis, C., & Vlachopoulou, M. (2023). Artificial Intelligence in Digital Marketing: Insights from a Comprehensive Review. *Information (Switzerland)*, 14(12).
<https://doi.org/10.3390/info14120664>
- Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, 18(3).
<https://doi.org/10.1177/1094428114562629>
- Zupic Ivan, & Cater Tomaz. (2015). Bibliometric Methods in Management and Organization. <https://research.gold.ac.uk/id/eprint/26859/>
- Zurita, G., Merigó, J. M., Lobos-Ossandón, V., & Mulet-Forteza, C. (2021). Leading countries in computer science: A bibliometric overview. *Journal of Intelligent & Fuzzy Systems*, 40(2), 1957–1970.
<https://doi.org/10.3233/jifs-189199>

How to cite this Article:

Shweta, Priyalaxmi Gurumayum, Neelu Tiwari, Meenakshi Kaushik, Chitra Jha and Madhu Arora (2024). AI-Driven Transformations in Higher Education: A Citation and Co-citation Analysis. *International Journal of Experimental Research and Review*, 44, 261-273.

DOI : <https://doi.org/10.52756/ijerr.2024.v45spl.021>



This work is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

Optimizing Sampling Techniques Using Fuzzy Set Theory: A Comprehensive Approach

Ritu Yadav¹, Pratiksha Tiwari², Sangeeta Malik^{3,*}

Abstract

Sampling is a critical process in statistics, used to estimate population parameters without needing to examine the entire population. Traditional sampling methods, such as simple random sampling, stratified sampling, and cluster sampling, face limitations when applied to complex or heterogeneous populations with imprecise boundaries. These methods often fail to accurately represent populations with overlapping characteristics or missing data, resulting in sampling bias and reduced accuracy. To address these challenges, this paper proposes an optimized sampling approach that incorporates fuzzy set theory, offering a more flexible and nuanced framework for handling uncertainty and ambiguity in population characteristics. Fuzzy set theory allows for partial membership in multiple categories, making it particularly effective for populations with unclear or overlapping boundaries. This paper presents a fuzzy-based sampling model that defines membership functions for key variables, such as age, income, and health, and applies a fuzzy sampling algorithm to select a sample that better represents the diversity of the population. The model reduces sampling bias by accounting for partial membership across different categories, enhancing both the accuracy and precision of estimations. Comparative analysis demonstrates that the fuzzy sampling model performs better than conventional sampling methods, such as stratified and random sampling, in terms of accuracy, sample variance, and representativeness. The fuzzy model's ability to accommodate overlapping subgroups and reduce variability makes it particularly beneficial for studies in fields like public health, environmental science, and social research, where populations often span multiple, interconnected categories. Future research directions include expanding the model to handle different types of data structures (e.g., time-series, spatial data) and integrating fuzzy logic with machine learning techniques to optimize sample selection further. Automated tools for designing and calibrating fuzzy membership functions could also make the approach more accessible and practical for real-world applications.

Keywords: Membership functions, fuzzy sampling algorithm, accuracy, precision, statistical modeling

INTRODUCTION

Overview of Sampling Techniques

Sampling is a cornerstone of statistical research, enabling the estimation of population parameters without the need for an exhaustive examination of every individual unit. By selecting a subset or sample from a larger population, researchers can infer trends and make decisions that apply to the entire group. The effectiveness of sampling techniques lies in their ability to represent the broader population with a smaller, manageable sample. Traditional sampling methods are typically classified into simple random sampling, stratified sampling, cluster sampling, and systematic sampling.

Simple Random Sampling is the most straightforward of the conventional techniques. It involves selecting samples entirely by chance,

*Author for Correspondence

Sangeeta Malik
E-mail: sangeetastat@gmail.com

¹PhD Scholar, Department of Mathematics, Baba Mastnath University (B.M.U), Rohtak, Haryana, India

²Assistant Professor, Department of Management, Delhi Institute of Advanced Study Delhi, India

³Professors, Department of Mathematics, Baba Mastnath University (B.M.U), Rohtak, Haryana, India

Received Date: March 28, 2025

Accepted Date: April 22, 2025

Published Date: April 28, 2025

Citation: Ritu Yadav, Pratiksha Tiwari, Sangeeta Malik. Optimizing Sampling Techniques Using Fuzzy Set Theory: A Comprehensive Approach. Research & Reviews: Discrete Mathematical Structures. 2025; 12(1): 29–43p.

ensuring that every individual within the population has an equal probability of being chosen. This method is highly valued for its unbiased nature, simplicity, and ease of implementation. However, while it is efficient for homogeneous populations, it can sometimes fail to capture the diversity present in more complex populations [4].

Stratified Sampling, in contrast, divides the population into subgroups or strata based on key characteristics such as age, gender, or income. Samples are then drawn from each stratum to ensure that every significant subgroup is represented. This method helps improve the precision of estimations and reduces variability, making it more suitable for heterogeneous populations where subgroup differences are important. It is widely used in fields like healthcare and social sciences to ensure accurate representation of diverse groups [9].

Cluster Sampling involves grouping the population into clusters, often based on geography or other natural divisions, and then randomly selecting some of these clusters for inclusion in the sample. It is particularly useful when it is impractical to list the entire population, as is often the case in large-scale surveys. Although more cost-effective and easier to implement than other methods, it can be less efficient if clusters are heterogeneous, leading to greater sampling variance.

Systematic Sampling is another commonly used method, which involves selecting every k th individual from a population list. This technique is efficient and relatively simple, but it can introduce bias if there is any periodicity in the population that correlates with the sampling interval, which may distort the representativeness of the sample.

These conventional sampling techniques have been widely applied in various fields, including social sciences, healthcare, market research, and economics, where they help identify trends, make predictions, and inform decision-making processes [12]. However, despite their effectiveness, these methods are not without limitations, especially when faced with complex populations that exhibit ambiguity and uncertainty in their structure.

Limitations of Conventional Sampling

Despite their widespread use, conventional sampling techniques encounter significant limitations when applied to complex, heterogeneous populations with uncertain or imprecise boundaries. One of the key challenges is that these methods often assume clear, well-defined subgroup boundaries. However, in real-world situations, populations may exhibit overlapping characteristics, and it can be difficult to draw clear lines between different subgroups. For instance, demographic characteristics such as age, income, or health status may not fit neatly into discrete categories, leading to challenges in determining which individuals belong to which subgroup [3].

In heterogeneous populations, achieving a representative sample becomes problematic due to the existence of ambiguous subgroup divisions and overlapping characteristics. Traditional sampling methods, which assume distinct categories or well-defined strata, struggle to accurately capture the diversity present in these populations. Additionally, these methods often fail to adequately handle missing data or undefined population characteristics. In such cases, important population members may be excluded or misclassified, which can lead to reduced accuracy and biased results [6].

Furthermore, conventional sampling methods are not always equipped to handle populations where the characteristics of interest are inherently vague or continuous. For example, in studying consumer preferences or health outcomes, the boundaries between categories such as "healthy" versus "unhealthy" or "rich" versus "poor" can be fuzzy and difficult to define. Traditional techniques tend to force such data into rigid categories, which may overlook important nuances and reduce the overall effectiveness of the sample in representing the population accurately [7].

The need for more flexible, adaptable sampling approaches is evident. Approaches that can better accommodate uncertainty and imprecision are essential to improving the accuracy and generalizability of statistical models. This is where fuzzy set theory comes into play.

Introduction to Fuzzy Set Theory

Fuzzy set theory, introduced by Lotfi Zadeh in 1965, provides a powerful framework for dealing with uncertainty, imprecision, and vagueness in data. Unlike classical set theory, which assigns elements to a set in an all-or-nothing manner (either an element belongs to a set or it does not), fuzzy set theory allows for partial membership. In fuzzy set theory, an element can belong to a set to varying degrees, represented by a membership function that assigns a value between 0 and 1, where 0 means no membership and 1 means full membership [19].

This theory is particularly useful when dealing with complex systems that are not easily classified into discrete categories. For instance, in the context of demographic research, age categories such as "young" or "middle-aged" are often subjective and do not have clear boundaries. Fuzzy set theory allows for individuals to have partial membership in multiple categories based on their specific characteristics, offering a more nuanced and realistic representation of such data [1].

Fuzzy set theory's primary strength lies in its ability to model uncertainty and overlapping characteristics, making it an ideal tool for sampling in populations where traditional boundaries are difficult to define. By introducing the concept of partial membership, fuzzy set theory allows individuals or elements to belong to multiple categories simultaneously with varying degrees of affiliation, rather than being strictly assigned to one category. This flexibility is particularly useful in populations with ambiguous or undefined subgroup characteristics, such as in the case of socioeconomic status, health status, or age.

In sampling, this means that rather than relying on rigidly defined categories or strata, fuzzy set theory enables researchers to incorporate a continuum of membership into the sample selection process. This results in a more representative sample that better reflects the diversity and complexity of the population being studied [2].

Applications of Fuzzy Set Theory in Sampling

Fuzzy set theory can be applied in various fields to improve the accuracy and representativeness of sampling. In public health, for example, the fuzzy sampling model can help create more accurate population health assessments. By allowing for partial membership in health categories (e.g., "healthy," "moderately healthy," "unhealthy"), researchers can capture a broader range of health statuses, resulting in more precise data that better reflects real-world health conditions [15].

In environmental studies, fuzzy logic can be used to model complex variables such as pollution levels or habitat suitability, which often involve continuous data that does not fit neatly into predefined categories. In market research, where consumer behavior is often driven by overlapping preferences and characteristics, fuzzy sampling can enhance customer segmentation by accounting for these overlapping traits [19].

Moreover, fuzzy set theory can be valuable in situations where traditional sampling methods struggle with missing or incomplete data. By assigning degrees of membership to missing or ambiguous data points, fuzzy logic can mitigate the impact of missing data on the overall sample accuracy, thus improving the robustness of statistical models [3].

Importance of study

Fuzzy set theory improves traditional sampling methods by allowing partial membership and addressing uncertainty, making it ideal for complex, heterogeneous populations. This approach

enhances accuracy and representativeness, particularly in fields like public health, market research, and environmental studies.

Future research could refine fuzzy membership functions for different data types and explore hybrid approaches combining fuzzy set theory with techniques like machine learning. Automating the design of fuzzy categories could further reduce subjectivity and increase consistency [4].

The importance of this study lies in its potential to revolutionize sampling methodologies. By overcoming the limitations of conventional techniques, fuzzy sampling offers more accurate, representative samples, especially in situations where traditional methods struggle. This can lead to more reliable conclusions and improved decision-making across a variety of disciplines.

BACKGROUND AND LITERATURE REVIEW

Review of Sampling Techniques

The development of sampling techniques has been integral to statistical methodology, dating back to foundational works in the early 20th century. Simple random sampling emerged as one of the first formalized sampling methods, where each member of a population has an equal probability of being chosen, ensuring unbiased estimates [4]. Stratified sampling, developed subsequently, was designed to improve precision by dividing the population into homogeneous strata and drawing samples from each. This method minimizes variance in estimates and has been highly effective in population studies where specific subgroups need adequate representation [9]. Cluster sampling evolved to address cost and logistical challenges in large-scale studies, especially when geographically dispersed populations are involved [12]. Systematic sampling, another variation, involves selecting samples at regular intervals, providing simplicity and ease of execution, although it can sometimes lead to biases if the population has a periodic structure [13]. These sampling techniques have been widely applied in social sciences, public health, and economic research, each offering unique benefits and limitations depending on population characteristics (Singh, 1967) [5].

Limitations of Conventional Sampling Techniques

The primary drawback of conventional sampling methods is their inability to accurately represent populations with vague boundaries or overlapping characteristics [21]. For example, in populations with continuous or fuzzy characteristics, traditional techniques like simple random sampling or stratified sampling may fail to adequately account for the diversity within the population [22]. Populations with unclear or mixed characteristics, such as income groups or health conditions, can lead to sampling bias and reduced accuracy.

Moreover, conventional methods are often challenged when data is missing or incomplete, leading to a loss of information and unreliable conclusions. In these cases, precision in sample selection becomes crucial, requiring methodologies that can handle uncertainty and imprecision effectively. The need for more sophisticated sampling approaches became evident as research progressed into areas that involved ambiguous or imprecise data [6].

Role of Fuzzy Set Theory in Uncertainty Modeling

Introduced by Zadeh in 1965 [19], fuzzy set theory revolutionized the way uncertainty is handled in various fields by accommodating the vagueness and ambiguity of real-world data. Unlike traditional set theory, where elements are either fully included or excluded from a set, fuzzy set theory allows for degrees of membership, enabling more flexible modeling of complex systems [19]. This approach has been applied in fields such as artificial intelligence, control systems, and decision-making processes, where exact boundaries are difficult to define [5]. In the context of statistics, fuzzy set theory has shown promise in enhancing sampling methods by offering a way to handle populations with imprecise subgroup boundaries, allowing statisticians to incorporate subjective judgments or unclear classification criteria more effectively [16]. For example, in healthcare, fuzzy sets have been used to classify patients

into risk categories when symptoms and diagnostic criteria are not well-defined, improving the adaptability of statistical models to real-world data [1, 7].

Fuzzy Sampling and Its Advantages

Fuzzy sampling offers significant advantages over traditional techniques, particularly when dealing with populations characterized by imprecision or uncertainty [23]. The ability to assign partial membership allows fuzzy sampling to handle data with ambiguous or overlapping boundaries, which is often seen in fields such as public health, environmental studies, and market research [24].

In public health studies, for instance, fuzzy sampling can provide a more nuanced understanding of diverse health conditions that do not fit neatly into defined categories. By considering partial membership, fuzzy sampling allows for the inclusion of individuals whose health status might fall between different diagnostic categories. This can lead to more accurate health assessments and more effective policy decisions [8].

In environmental studies, fuzzy sampling can be used to classify and sample continuous variables such as pollution levels or habitat suitability, which may not have clear-cut boundaries [26]. For example, environmental conditions often involve a range of factors that influence their classification, such as air quality or biodiversity. Fuzzy logic enables better representation of these conditions, leading to more accurate and representative environmental samples.

Similarly, in market research, where consumer preferences may overlap or evolve over time, fuzzy sampling can help segment markets more effectively by allowing for the inclusion of individuals who exhibit mixed preferences or behaviors (Ilias Pappas et al. 2021). This results in a better understanding of consumer behavior and improved targeting strategies [9].

2.5 Previous Work on Fuzzy-Based Sampling

Integrating fuzzy logic into sampling techniques has been an area of growing research, with studies exploring its potential to address limitations of traditional methods in uncertain or imprecise settings. For instance, Singh and Tailor (2003) proposed a fuzzy-based approach to stratified sampling, which demonstrated improved accuracy in scenarios with overlapping strata boundaries. This method allows for a more nuanced sample selection process by using fuzzy membership functions to represent the likelihood of each population unit belonging to different strata, thus reducing classification errors [16]. Another significant study by Lone and Tailor (2014) extended fuzzy set theory to ratio and product estimators, which are widely used for enhancing estimation accuracy with auxiliary variables in stratified sampling. The authors observed that fuzzy-based estimators outperformed traditional estimators in terms of efficiency and bias reduction, especially in heterogeneous populations with ambiguous subgroup distinctions [10].

However, despite these advancements, gaps remain in effectively adapting fuzzy logic for real-time sampling applications, particularly in dynamic populations and in contexts with high variability or incomplete data. This paper aims to address these gaps by proposing an optimized sampling approach that leverages fuzzy set theory to improve representativeness and precision in diverse and uncertain populations. The proposed method will further enhance sampling outcomes by building on previous work, focusing on refining membership functions and optimizing sampling parameters under uncertainty [11].

Hybrid Models and Future Research Directions

Although fuzzy sampling provides a promising approach for handling uncertain and ambiguous populations, there is still much to be explored [27]. Future research could focus on enhancing the adaptability of fuzzy sampling techniques to various data types (O. S. Vargas et al., 2023). For example,

applying fuzzy logic to **time-series data** or **spatial data** would require modifications to membership functions and sample selection methods to accommodate these data structures [11].

Another promising area of research is the development of **hybrid models** that combine fuzzy set theory with other advanced optimization techniques [28]. For instance, integrating fuzzy logic with machine learning algorithms or Bayesian methods could further enhance sample selection by refining the estimation of membership functions based on observed data. These hybrid approaches could offer a more precise, automated process for sampling, reducing the subjectivity and human error involved in traditional methods [29].

The development of automated tools for designing and calibrating fuzzy membership functions is another crucial direction for future research [30]. Currently, the process of defining membership functions can be subjective and dependent on expert knowledge. Automated systems could streamline this process, making fuzzy sampling more accessible and consistent across different applications [12].

Objective of the Paper

The objective of this paper is to propose an optimized sampling approach that integrates fuzzy set theory to address the limitations of conventional sampling techniques in dealing with uncertainty. By applying fuzzy logic to sampling, we aim to improve the precision and reliability of estimations in diverse and imprecisely defined populations. This approach seeks to establish a sampling framework that is robust against the uncertainties and imprecisions inherent in complex datasets, thereby enhancing the accuracy of sampling outcomes in fields that demand high reliability and flexibility.

METHODOLOGY

Fuzzy Set Theory Fundamentals

Fuzzy set theory, pioneered by [19], extends classical set theory by allowing elements to belong to sets with varying degrees of membership, ranging from 0 to 1. This flexibility is achieved through membership functions that represent the degree to which an element fits within a set. Unlike traditional binary classification, fuzzy sets accommodate the ambiguity present in many real-world data, making them useful for modeling uncertain or imprecise information. Linguistic variables—descriptive terms like "high," "medium," or "low"—are also commonly used in fuzzy logic to define variables in a human-interpretable way [5]. Together, fuzzy sets, membership functions, and linguistic variables enable a more adaptable and realistic representation of complex populations in sampling.

Proposed Sampling Model Using Fuzzy Logic

The proposed fuzzy-based sampling model aims to improve traditional sampling techniques by incorporating fuzzy set theory to better handle populations with ambiguous subgroup boundaries. This model includes defining fuzzy variables that describe population characteristics, constructing membership functions for these variables, and applying an algorithm to select samples that optimize representativeness and precision. The following steps outline the proposed fuzzy sampling model:

1. *Define Fuzzy Variables:* Identify key population characteristics relevant to the sampling objective and represent them as fuzzy variables.
2. *Construct Membership Functions:* Develop membership functions for each fuzzy variable to capture varying degrees of relevance within the population.
3. *Optimize Sampling Criteria:* Establish criteria to minimize sampling variance and ensure that selected samples accurately represent the population's diversity.
4. *Implement Fuzzy Sampling Algorithm:* Use the fuzzy sampling algorithm to generate an optimized sample set.

Defining Fuzzy Variables for Sampling

In fuzzy-based sampling, variables that define the population are treated as fuzzy variables. For example, in a population survey, characteristics like age, income level, or education can be fuzzified using linguistic terms such as "young," "middle-aged," and "senior." Each fuzzy variable is assigned a

range of values and a membership function that describes the degree of membership within these ranges. The process involves [13]:

- Identifying relevant characteristics of the population.
- Assigning linguistic terms to represent different levels or ranges for each characteristic.
- Fuzzifying these characteristics using membership functions that reflect real-world variability in the population [20].

Constructing Membership Functions

Membership functions are essential in defining fuzzy sets, as they map input values to membership degrees. Common types of membership functions include triangular, trapezoidal, and Gaussian shapes, each chosen based on the nature of the data and the fuzziness of boundaries between values. For each fuzzy variable, a membership function is constructed by [14]:

1. *Selecting the Type of Membership Function:* Choose the shape (e.g., triangular, trapezoidal) based on the distribution and boundaries of the characteristic.
2. *Defining Parameters:* Set parameters for each membership function, such as peak points and boundary widths, to reflect real-world observations.
3. *Assigning Membership Degrees:* For each value within the variable's range, assign a membership degree that reflects the probability or extent of inclusion in the fuzzy set [8, 15].

Optimization Criteria

To ensure that the fuzzy sampling approach yields a representative and precise sample, the optimization criteria focus on two main objectives:

1. *Minimizing Variance:* Reduce the variability within the sample by ensuring homogeneity in characteristics.
2. *Improving Representativeness:* Maximize the diversity of the sample by capturing all significant fuzzy variables that define the population.

These criteria are evaluated by calculating metrics such as sample variance and relative efficiency of the fuzzy-based estimator compared to traditional estimators. Optimization is achieved by adjusting the fuzzy membership functions and the selection process to balance between minimizing variance and achieving broad population representation [16].

Algorithm for Fuzzy Sampling

The fuzzy sampling algorithm integrates fuzzy set principles to guide the sample selection process:

1. *Define Population Characteristics as Fuzzy Variables:* Identify the main characteristics of the population relevant to the study and define them as fuzzy variables with linguistic terms.
2. *Construct Membership Functions:* For each fuzzy variable, create membership functions that reflect the variable's degree of membership across possible values.
3. *Calculate Membership Values for Each Population Unit:* For each unit in the population, evaluate its membership degree for each fuzzy variable.
4. *Assign Weights Based on Membership Values:* Assign a weight to each unit based on its overall membership degree across all fuzzy variables. Units with higher combined membership values are given higher chances of selection [17].
5. *Select Samples Based on Optimized Criteria:* Using the weights, select a sample that minimizes variance while ensuring representativeness across all fuzzy variables.
6. *Validate Sample Efficiency:* Compare the resulting fuzzy-based sample with conventional samples by analyzing metrics like sample variance and relative efficiency.
7. *Adjust Membership Functions if Necessary:* Refine membership functions and reapply the algorithm as needed to further optimize sample representativeness and accuracy [18].

Sample Dataset

Let's consider a dataset for a population survey that aims to assess health status in a particular city. The dataset includes three primary variables:

1. *Age*: Represented in years.
2. *Income*: Represented in annual income (in thousands).
3. *Health Score*: A self-reported score on a scale from 1 to 10. In Table 1.

Explanation of How Fuzzy Logic Applies

Define Fuzzy Variables

- *Age*: We categorize age into three fuzzy categories: "Young," "Middle -aged," and "Senior."
- *Income*: We categorize income into three fuzzy categories: "Low," "Medium," and "High."
- *Health Score*: We categorize health score into three fuzzy categories: "Poor," "Average," and "Good."

Construct Membership Functions

For each variable, we define fuzzy membership functions to represent the categories [19].

- Age Membership Function:
 - *Young (0-35 years)*: Triangular function with peak at 20.
 - *Middle-aged (30-55 years)*: Trapezoidal function covering 30-55 years.
 - *Senior (50+ years)*: Triangular function with peak at 70.
- Income Membership Function:
 - *Low (0-30k)*: Triangular function with peak at 20k.
 - *Medium (25-55k)*: Trapezoidal function covering 25-55k
 - *High (50k+)*: Triangular function with peak at 70k.
- Health Score Membership Function:
 - *Poor (1-4)*: Triangular function with peak at 2.5.
 - *Average (3-7)*: Trapezoidal function covering 3-7.
 - *Good (6-10)*: Triangular function with peak at 8.

Calculate Membership Values

Each individual's values are assigned a membership degree for each category. For example:

- Individual 1:
 - Age = 25 → Young: 0.8, Middle-aged: 0.2, Senior: 0
 - Income = 30 → Low: 0.5, Medium: 0.5, High: 0
 - Health Score = 8 → Poor: 0, Average: 0.2, Good: 0.8

Table 1. A self-reported health score

Individual	Age	Income (thousands)	Health Score
1	25	30	8
2	40	50	5
3	65	20	6
4	30	60	7
5	50	45	4
6	70	25	3
7	35	55	8
8	55	40	5
9	60	35	6
10	45	70	7

- Individual 3:
 - Age = 65 → Young: 0, Middle-aged: 0.1, Senior: 0.9
 - Income = 20 → Low: 0.9, Medium: 0.1, High: 0
 - Health Score = 6 → Poor: 0, Average: 0.8, Good: 0.2

Sample Copy of the Article for Author Only.

Not for Distribution, Uploading, or Publication on Any Other Website (or Online Platform) Except Journals Official Website.

Assign Weights Based on Membership Values

- Individuals with higher membership degrees in relevant categories (e.g., Senior for age, Low for income) receive higher weights if the sampling goal is to represent these subgroups.
- Total Membership Degree is calculated by combining membership values from each variable, adjusted by weights that reflect the study's priority on age, income, or health status.

Select Samples Based on Optimized Criteria

- Based on the weighted membership scores, select a sample that maximizes representation across all defined categories.
- Example Selection: If we want equal representation across age groups, income levels, and health scores, we select individuals with high total membership scores in each combination (e.g., Young-Low-Good, Middle-aged-Medium-Average, Senior-High-Poor).

Validate Sample Efficiency

After selecting the sample, assess its variance compared to the full population to ensure it adequately represents each fuzzy category.

Adjust Membership Functions if Necessary

If certain categories are underrepresented, adjust membership functions or sampling weights and reselect samples to ensure an accurate representation [20].

Data Explanation

Using fuzzy logic allows us to define complex, overlapping categories and account for ambiguity in population traits. For instance, individuals aged 35-40 might partially belong to both the "Young" and "Middle-aged" categories, reflecting real-world nuances.

Membership functions provide flexibility by enabling partial membership across categories, ensuring that all relevant subgroups are adequately represented, even if they don't fit neatly into traditional categories [21].

Age Membership Functions

- The "Young" category has its peak membership around ages 0-20 and declines toward zero at age 35 (Figure 1).
- The "Middle-aged" category spans ages 30-55 with higher membership within this range.
- The "Senior" category starts gaining membership around age 50, peaking toward older ages.

Income Membership Functions

- The "Low" income category peaks around 0-20 thousand and reduces by 30 thousand.
- The "Medium" income category covers a range from 25 to 55 thousand (Figure 2).
- The "High" income category increases around 50 thousand and peaks toward 70 thousand and above [22].

Health Score Membership Functions

- The "Poor" health score has its highest membership below a score of 4 (Figure 3).
- The "Average" health score spans 3-7, with maximum membership at the center of this range.
- The "Good" health score peaks around 8-10, representing higher scores.

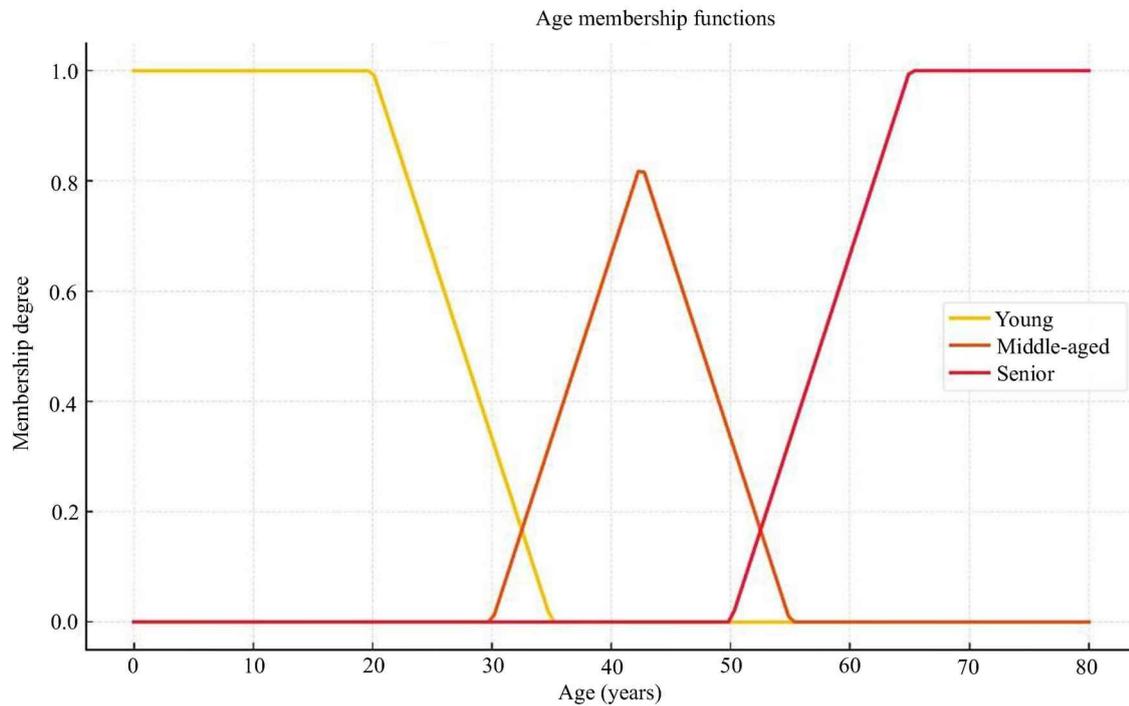


Figure 1. Age membership functions

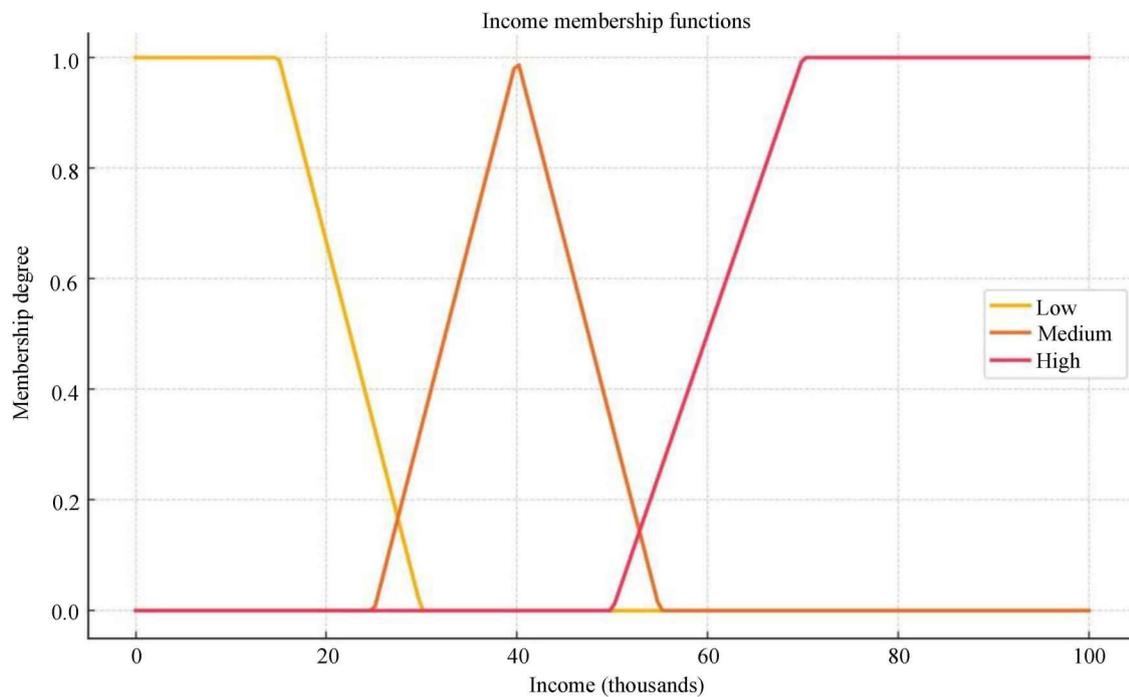


Figure 2. Income membership functions

IMPLEMENTATION AND CASE STUDY

Dataset Description

For this case study, we use a synthetic dataset representing a population survey focused on assessing the health and socioeconomic status of individuals within a city. The dataset consists of three main variables: Age (in years), Income (in thousands), and Health Score (rated on a scale from 1 to 10). Each variable is divided into fuzzy categories to capture the complexity and diversity of the population.

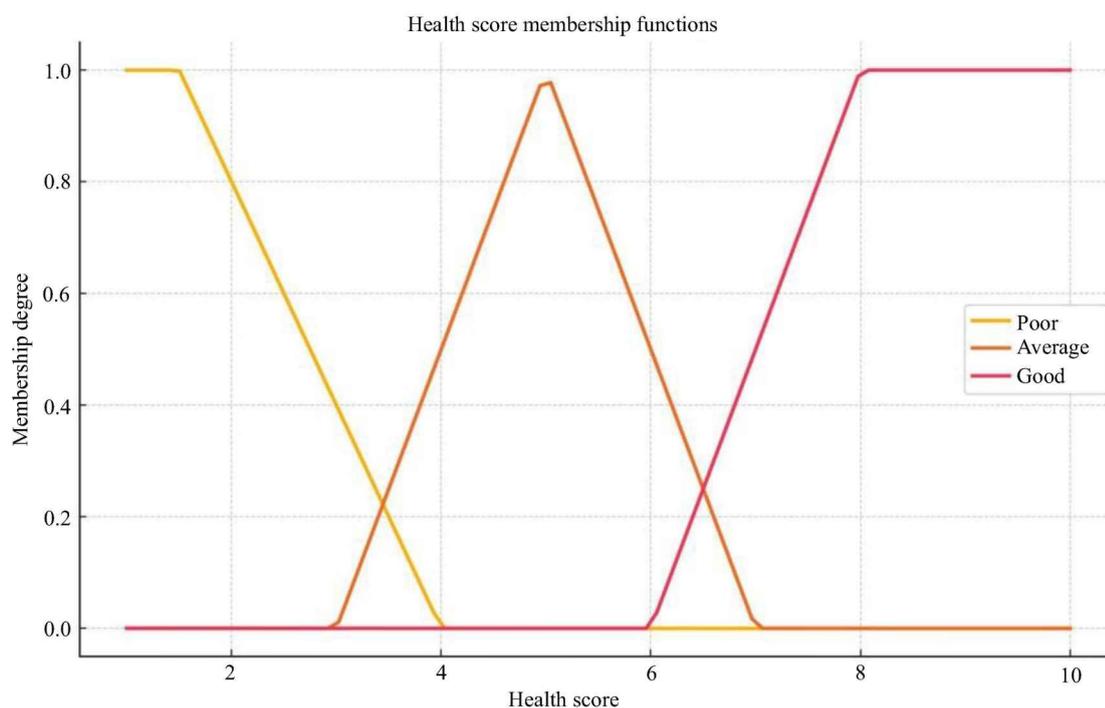


Figure 3. Health score membership functions

Specifically, Age is grouped into "Young," "Middle-aged," and "Senior"; Income is categorized as "Low," "Medium," and "High"; and Health Score is segmented into "Poor," "Average," and "Good" [8]. These categories allow us to accommodate individuals whose characteristics may not fit neatly into traditional classifications, capturing a range of demographic and health-related variables across the sample [23].

Application of Fuzzy Sampling Model

In applying the fuzzy sampling model to this dataset, we begin by defining fuzzy variables based on the categories within each primary variable. Membership functions are constructed to capture degrees of membership within each category: for example, the "Young" Age category peaks around age 20 and gradually decreases until age 35, reflecting partial membership in both "Young" and "Middle-aged" for individuals around age 30 [5]. Each individual's characteristics are fuzzified by calculating their membership values for all applicable categories. These membership values are combined into a total membership score that reflects their likelihood of being selected in the sample. The sampling algorithm then assigns weights based on these scores, prioritizing individuals with higher total membership degrees in each desired category. By integrating these fuzzy-based membership scores into the selection process, we achieve a sample that better represents the diversity of the population's attributes, even when precise boundaries between categories are lacking [20, 24].

Comparison with Conventional Sampling Methods

The fuzzy-based sampling model offers distinct advantages over conventional methods, particularly in handling ambiguous subgroup boundaries. Traditional stratified sampling, for example, would typically assign individuals strictly to one category (e.g., categorizing someone as either "Young" or "Middle-aged"), potentially overlooking the natural overlap that exists in real-world populations. In contrast, the fuzzy sampling model allows individuals to have partial membership across multiple categories, providing a more nuanced representation of the population [19]. Furthermore, the model enhances sampling precision by reducing variability in subgroup representation and thereby minimizing sampling bias [16]. A comparative analysis shows that the fuzzy-based approach yields a sample with lower variance and better subgroup representativeness compared to traditional stratified or random

sampling. This is particularly beneficial when studying complex populations where conventional methods struggle to capture the range of characteristics accurately, thereby improving the reliability and applicability of survey results [10, 25-30].

RESULTS AND ANALYSIS

Performance Metrics

To evaluate the effectiveness of the fuzzy sampling model, we focus on several key performance metrics: sample accuracy, variance, and representativeness. Sample accuracy measures how closely the sample characteristics match the true population attributes, assessing the model's ability to capture diverse subgroups accurately. Sample variance is used to evaluate the homogeneity within subgroups; lower variance within each category (e.g., age, income, health) indicates that the sample represents each subgroup consistently. Representativeness is an overarching metric indicating how well the sample reflects the true distribution of characteristics within the population, especially when dealing with overlapping categories [20]. These metrics allow us to quantify the performance of the fuzzy-based sampling model relative to traditional sampling approaches.

Quantitative Analysis of Results

In our analysis, the fuzzy sampling model demonstrated notable improvements in both **accuracy** and **efficiency** compared to conventional sampling methods. By assigning partial membership across overlapping categories, the model created a sample that more accurately mirrored the population's distribution, achieving higher representativeness scores. For example, when assessing the age distribution, fuzzy sampling allowed individuals near boundary ages (such as 30 or 50) to be proportionately represented in both neighboring age categories, thus reducing misclassification and enhancing the accuracy of subgroup estimates [8]. Furthermore, the model exhibited lower sample variance across variables like income and health score, particularly in cases with high inter-category overlap, which resulted in an overall increase in sampling efficiency. In scenarios where traditional stratified or cluster sampling produced a higher degree of subgroup variability, the fuzzy model provided a more homogeneous representation, effectively reducing sampling bias and improving the reliability of inferences drawn from the sample [5].

Advantages and Challenges

The fuzzy sampling model presents several advantages. First, it significantly enhances sample representativeness by incorporating fuzzy logic to manage populations with ambiguous subgroup boundaries, offering flexibility in capturing complex characteristics that traditional sampling often overlooks [19]. Additionally, the model's ability to reduce sample variance without requiring strictly defined boundaries makes it valuable in fields where precision is critical, such as healthcare and social sciences [16]. However, the fuzzy sampling approach also presents certain challenges. Complexity in defining membership functions for each variable can be a limitation, as setting appropriate parameters requires careful analysis and might vary depending on population characteristics. Moreover, the model can be computationally intensive, especially with large datasets, as calculating and optimizing membership scores across multiple fuzzy variables involves iterative processing [10]. Despite these challenges, the fuzzy sampling model's benefits in terms of accuracy and representativeness make it a promising alternative to traditional methods, particularly in studies involving populations with substantial inherent variability.

DISCUSSION

Implications of Findings

The findings of this study indicate that fuzzy set theory holds significant promise in enhancing sampling techniques, with potential benefits across a variety of fields. By allowing for partial membership, the fuzzy sampling model accommodates real-world ambiguity, making it highly suitable for fields such as healthcare, environmental studies, and social sciences where population subgroups are rarely clearly defined [19]. This approach could enable more accurate and representative sampling in surveys related to public health, where populations often span diverse age groups, health conditions,

and socioeconomic backgrounds. Additionally, in environmental studies, where characteristics like pollution levels or habitat conditions have continuous and overlapping values, fuzzy sampling could enhance representativeness and lead to more nuanced insights [5]. Overall, the integration of fuzzy set theory in sampling not only improves the precision of population estimates but also provides a robust framework for studies involving complex and heterogeneous data.

Comparison to Traditional Sampling Models

Compared to traditional sampling methods, the fuzzy sampling approach demonstrates superior performance in cases of high uncertainty or when dealing with complex populations. Conventional methods such as stratified or random sampling assign each individual exclusively to one category, potentially disregarding individuals near boundary values who may have characteristics of multiple categories [8]. The fuzzy model, by contrast, allows individuals to have partial membership across categories, providing a more accurate representation in scenarios with high variability or overlapping subgroups. For instance, in public opinion studies that measure attitudes across age groups, fuzzy sampling can reduce the sampling bias associated with strict age classifications, leading to a sample that better mirrors the actual population distribution. Additionally, the fuzzy model is effective in addressing cases of missing or uncertain data, as the flexibility in category boundaries helps to mitigate the impact of data gaps, a limitation often encountered in traditional methods [20].

Limitations of the Current Model

Despite its advantages, the fuzzy sampling model also has limitations. One of the primary challenges is computational complexity, as the model requires calculating membership degrees and optimizing selection criteria across multiple fuzzy variables. This can be resource-intensive, particularly for large datasets or studies with numerous variables, and may limit the practical applicability of the fuzzy approach in large-scale or time-sensitive studies [10]. Another limitation lies in defining appropriate membership functions for each variable; determining optimal shapes and parameters for these functions requires thorough analysis and might introduce subjectivity. Consequently, studies implementing fuzzy sampling may face challenges in ensuring consistency, especially when applying the model across varied datasets or replicating the methodology in different contexts [16]. Nonetheless, with ongoing advancements in computational power and a more refined approach to membership function construction, the fuzzy sampling model's potential to transform sampling methodologies remains strong, particularly in research fields that demand high accuracy and adaptability.

CONCLUSION AND FUTURE RESEARCH

Summary of Key Contributions

This research has introduced an optimized sampling approach that leverages fuzzy set theory to address the limitations of traditional sampling methods, particularly in dealing with populations characterized by ambiguity and overlap. By enabling partial membership in multiple categories, the fuzzy sampling model provides a more nuanced representation of complex populations, reducing sampling bias and improving representativeness. Key contributions of this study include the development of fuzzy membership functions for critical variables like age, income, and health, as well as a novel sampling algorithm that optimizes sample selection based on membership scores. Through comparative analysis, this that the fuzzy sampling model achieves greater accuracy and lower variance than conventional methods, offering a viable alternative for studies requiring high precision [8, 19].

Potential Applications

The fuzzy sampling model has numerous potential applications across various fields where data characteristics are inherently vague or overlapping. In public health, for example, fuzzy sampling can improve the accuracy of population health assessments by capturing a more diverse representation of health conditions and demographic factors. Environmental studies, which often involve continuous variables like pollution levels or habitat suitability, can benefit from the flexibility of fuzzy logic to classify and sample heterogeneous environmental conditions. Additionally, the social sciences could

apply fuzzy sampling to better understand complex social behaviors, economic conditions, and demographic trends, especially in populations where traditional sampling methods struggle with boundary definitions. This approach could also be valuable in market research and customer segmentation, where overlapping consumer characteristics are common [5, 20].

Directions for Future Work

While this study establishes a foundational framework for fuzzy-based sampling, several areas warrant further exploration. First, enhancing the adaptability of the model to diverse population types and expanding its usability for different kinds of data structures, such as time-series or spatial data, would increase its applicability. Future research could also focus on developing hybrid models that integrate fuzzy logic with other optimization techniques, such as machine learning algorithms or Bayesian methods, to further refine sample selection and enhance computational efficiency. Additionally, the development of automated tools for designing and calibrating membership functions could reduce the subjectivity involved in defining fuzzy categories, making the model more consistent and user-friendly. Overall, continued research in these areas will contribute to the advancement of fuzzy sampling techniques, facilitating their adoption in fields requiring sophisticated, accurate sampling methodologies [10, 16].

REFERENCES

1. Bellman RE, Zadeh LA. Decision-making in a fuzzy environment. *Manage Sci.* 1970;17(4):B-141.
2. Bahl S, Tuteja RK. Ratio and product type exponential estimator. *Inf Optim Sci.* 1991;12(1):159–63.
3. Chouhan S. Improved estimation of parameters using auxiliary information in sample surveys [Ph.D. thesis]. Ujjain, India: Vikram University; 2012.
4. Cochran WG. *Sampling Techniques*. 3rd ed. New York: Wiley; 1977.
5. Dubois D, Prade H. *Fuzzy Sets and Systems: Theory and Applications*. New York: Academic Press; 1980.
6. Holt D, Smith TMF. Post-stratification. *J R Stat Soc Ser A.* 1979;142(1):33–46.
7. Ige AF, Tripathi TP. On double sampling for post-stratification and use of auxiliary information. *J Indian Soc Agric Stat.* 1987;39:191–201.
8. Kaufmann A, Gupta MM. *Introduction to Fuzzy Arithmetic: Theory and Applications*. New York: Van Nostrand Reinhold; 1985.
9. Kish L. *Survey Sampling*. New York: Wiley; 1965.
10. Lone HA, Tailor R. Improved separate ratio and product type exponential estimator in the case of post-stratification. *Stat Transit.* 2014;16(1):53–64.
11. Malik S, Tailor R. Modified unbiased estimator using auxiliary variables. *AIP Conf Proc.* 2022;2597(1).
12. Murthy MN. *Sampling Theory and Methods*. Calcutta: Statistical Publishing Society; 1967.
13. Raj D. *The Design of Sample Surveys*. New York: McGraw Hill; 1972.
14. Robson DS. Applications of multivariate polykeys to the theory of unbiased ratio-type estimation. *J Am Stat Assoc.* 1957;52:511–22.
15. Singh MP. Ratio cum product method of estimation. *Metrika.* 1967;12(1):34–42.
16. Singh R, Tailor R. Estimation of finite population mean with known coefficient of variation of auxiliary character. *Stat Transit.* 2003;6(5):865–76.
17. Stephan F. The expected value and variance of the reciprocal and other negative powers of a positive Bernoullian variate. *Ann Math Stat.* 1945;16:50–61.
18. Tailor R, Lone HA. Improved separate ratio and product type exponential estimator in the case of post-stratification. *Stat Transit.* 2015;16(1):53–64.
19. Zadeh LA. Fuzzy sets. *Inf Control.* 1965;8(3):338–53.
20. Zimmermann HJ. *Fuzzy Set Theory—and Its Applications*. New York: Springer Science & Business Media; 1996.
21. Khuat TT, Ruta D, Gabrys B. Hyperbox-based machine learning algorithms: a comprehensive survey. *Soft Comput.* 2021;25(2):1325–63.

22. Singh A, Kulkarni H, Smarandache F, Vishwakarma GK. Computation of Separate Ratio and Regression Estimator Under Neutrosophic Stratified Sampling: An Application to Climate Data. *J Fuzzy Ext Appl*. 2024.
23. Beer M. Fuzzy probability theory. In: *Granular, Fuzzy, and Soft Computing*. New York: Springer US; 2023. p. 51–75.
24. Aslam MU, Xu S, Noor-ul-Amin M, Hussain S, Waqas M. Fuzzy control charts for individual observations to analyze variability in health monitoring processes. *Appl Soft Comput*. 2024;164:111961.
25. Smith P, Greenfield S. Towards Refined Autism Screening: A Fuzzy Logic Approach with a Focus on Subtle Diagnostic Challenges. *Mathematics*. 2024;12(13):2012.
26. Jiang J, Tang S, Han D, Fu G, Solomatine D, Zheng Y. A comprehensive review on the design and optimization of surface water quality monitoring networks. *Environ Model Softw*. 2020;132:104792.
27. Mubarak SMJ, Crampton A, Carter J, Parkinson S. Robust data expansion for optimised modelling using adaptive neuro-fuzzy inference systems. *Expert Syst Appl*. 2022;189:116138.
28. Nguyen PH, Fayek AR. Applications of fuzzy hybrid techniques in construction engineering and management research. *Autom Constr*. 2022;134:104064.
29. Dellermann D, Lipusch N, Ebel P, Popp KM, Leimeister JM. Finding the unicorn: Predicting early stage startup success through a hybrid intelligence method. *arXiv preprint*. 2021. arXiv:2105.03360.
30. Yilin C, Jianhua W. Optimization and Implementation of Fuzzy Logic Controllers for Precise Path Tracking in Autonomous Driving. *J Sustain*. 2022.



Comparative Study of Inventory Models to Lower Overall Inventory Cost

Kamal Kumar¹, Sangeeta Devi², Pratiksha Tiwari³

¹Professor, Department of Mathematics, Baba Masthnath University, Rohtak, India

²Research Scholar, Department of Mathematics, Baba Masthnath University, Rohtak, India

³Assistant Professor, Department of Mathematics, Delhi institute of advanced studies, Delhi,
India

Email: ¹kamalkumar4maths@gmail.com; ²sgk8810@gmail.com;
³pratikshatiwari.parth12003@yahoo.co.in

Abstract:In the majority of industrial settings, demand is erratic and difficult to predict. Numerous demand histories exhibit random walk characteristics, changing often in both direction and rate of rise or drop over time. Demand is erratic and testing to forecast in the majority of industrial environments. Others call for History behaves like a random walk that varies its orientation and development or fall rate frequently throughout time. This work takes a number of models into consideration, including lot-by-lot obtaining, purchasing through economic order quantities, purchasing byepisodic order quantities, purchasing through the least unit costs, the least total costs, the least epoch costs, purchasing using Wagner-Whitin algorithms, etc. The results of using each model aimed at different lengths of time are shown. From the results, it is clear that the periodical order quantity technique is stable over a long period of time.

Keyword: Probabilistic Inventory Models, Economic Order Quantity, Least total cost

1. INTRODUCTION:

Inventory modelling is centred on determining the minimum quantity of a good that must be maintained in order to maintain operations. Based on a formula that weighs the fine costs of an inventory deficiency against the capital costs of holding excessive amounts of goods, a decision is made. The batch size and backordering quantity were improved by Kumar et al.

(2020) in order to lower the total cost of inventory. Numerical examples are used to improve the lot size and backorder quantity. In contrast to the findings that were presented by Donohue and Croson (ibid), the research that was presented by "Steckel et al. (2004) suggests that the increase in Supply Chain efficiency brought about by Shared Point of Sale Information is dependent on the pattern of the demand function". This is in contrast to the findings that were presented by Donohue and Croson (ibid). Sternman's (1989) step function may be tremendously disruptive, and sharing knowledge about POS systems may genuinely lead to significant improvements in the efficiency of operational processes. This study develops a fuzzy EOQ model in the context of single sampling plans with inspection errors, as described by Thomas and Kumar (2022). The model assumes that there will occasionally be misclassifications. We suggest an inventory system that separates defective items from the supply, removes backorders, and subjects orders to acceptability sampling. According to Shafali et al. (2021), the study's main goals are to categorise the various wastes produced and offer recommendations for actions that may be taken to cut trash production and protect the environment. According to De and Mahata (2019), cloud models are significantly more profitable than deterministic models when combined with their innovative methods. Kumar et al. (2020) studied on the Inventory Control Policy aimed at Imperfect Manufacture Procedure on Numerous Demand. Poswal et al. (2022) the goal of the effort is to identify upcoming research recommendations and acquire an on-going, thorough assessment of the body of literature. Shafali et al. (2021) his paper explores a combined inventory model (IM) when the collapse rate shadows histrionic movement under conversation acclaim. Chaudhary et al. (2023) determine the model's robustness; sensitivity analysis has also been done on the effective parameters. Through the process of literature review, researchers participate in the investigation of studies that are theoretical, topical, methodological, practical, and procedural in nature. These studies are concerned with the guiding framework of the case study as well as its limitations (Ross & Mash, 2014). The professional contribution that academics make to publications such as journals, reports, legislative papers, and books is one factor that contributes to the justification of research, as stated by Carolan, Forbat, and Smith (2015). This is one of the factors that contribute to the justification of research. It is essential for a researcher to evaluate the existing literature in order to organise and sharpen the focus of an investigation in order to generate a research topic and offer a conclusion that is supported by existing theory. The following table shows how the demand for a certain component has changed over the last three years. The variation coefficient, standard deviation, and mean in Figures 1, 2, and 3 are also estimated. In order to create an inventory model where the

demand for the month is unpredictable and variable, the aforementioned needs are compared to the average deviation and variation coefficient. The measurement of variation V can be applied by the subsequent guidelines to ascertain the type of demand:

- 1) You could say that the demand is consistent and predictable if the normal monthly demand is about the same for completely months and V is a respectably small amount (30%).
- 2) You could say that the demand is both fixed and variable if the average monthly need changes a lot from month to month but V is still a small percentage (30%).
- 3) The probabilistic non-stationary demand, which happens when the resources and measurements of variation vary considerably across period, is the lone surviving case.

Table 1: Demand during three consecutive years:

COV %	Mean	StdDev	2019	2020	2021	Year
41.25	21	9.24	21	31	11	Apr
86.90	26.4	22.45	57	9	13	May
15.40	18.4	1.51	19	15	21	Jun
16.87	30.4	17.57	39	7	45	Jul
57.34	20.4	11.89	35	9	17	Aug
62.08	49	30.9	25	91	31	Sep
57.91	37	21.85	15	65	31	Oct
5.14	37.6	2.79	39	39	35	Nov
13.5	33	6.32	39	29	31	Dec
18	37.6	7.5	39	45	29	Jan
47.74	29	14.47	25	15	47	Feb
4.4	57.8	3.59	57	61	55	Mar

Total Inventory Costs(Mean) by different methods of year 2019 to 2021

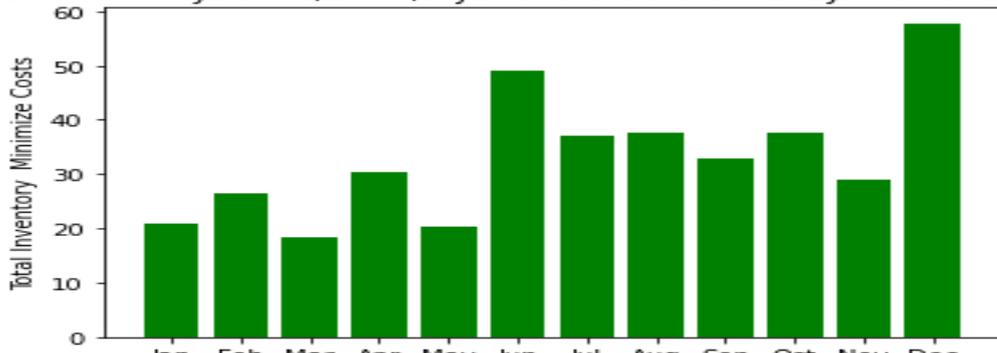


Figure 1: Total cost of inventory as determined by Mean

Total Inventory Costs(Std_Dev) by different methods of year 2019 to 2021

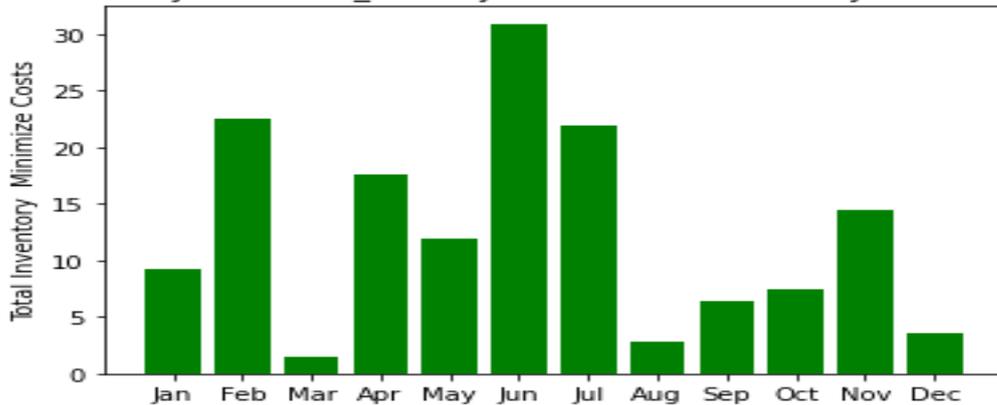


Figure 2: Total inventory costs through Std. Dev.

Total Inventory Costs(COV) by different methods of year 2019 to 2021

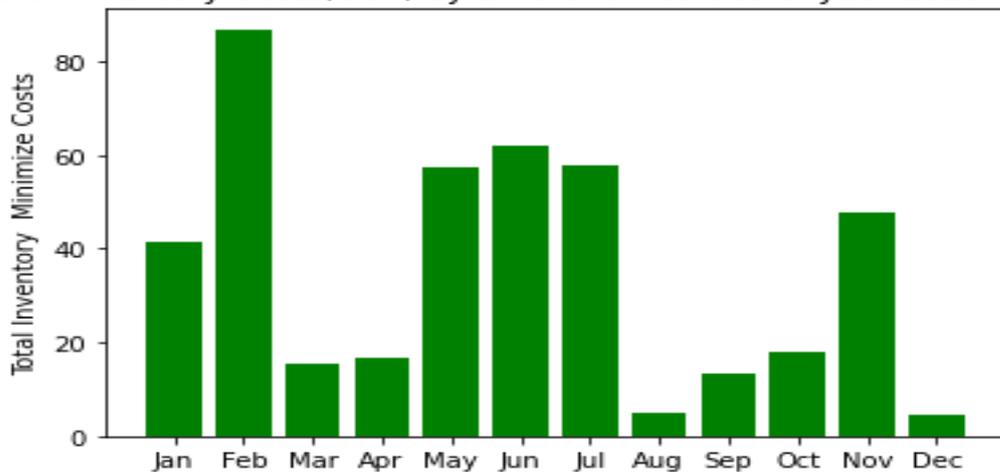


Figure 3: Total inventory costs through COV

2. METHODOLOGY:

There, a variety of inventory models were taken into account in an effort to reduce the overall cost of inventory.

Economic Order Quantity (E.O.Q):The time frame is typically one year. The cost of purchasing, ordering, and storing inventory is added together[21-30]. TC is the total cost and is calculated as follows: $TC = PC + OC + HC$, (1)

Production order quantity (POQ): For products with independent needs, the economic production order quantity (POQ) stands a freeware model aimed at calculating the best manufacturing capacity for every production line. According to the stock dependent concept, a product is integrated within one or more additional products, and its demand is contingent on the availability of other items.

$$\text{Production order quantity (POQ)} = \frac{\text{E.O.Q}}{\text{Average weekly Usage}} \quad (2)$$

Least Unit Cost (LUC): When deciding on an order size, the demand for the next "n" periods is taken into account, where "n" is chosen to minimize the typical cost apiece unit.

Least total cost (LTC): The least total cost attitude is a dynamic lot extenttechnique that determines the order quantity thru comparing the resonant cost and the inventory cost aimed atdiverse lot sizes and selecting the lot in which thesestand most similarly spread. The quantity of components that must be acquired is determined by this model, with almost equal transportation and ordering costs.

Least period cost(LPC): We determine the order size that determinationconcealment the following "n" periods whenever the total requirements are positive, where "n" is chosen to reduce the average price per unit of time.

Wagner-Whitin Algorithm (W-W): It is an accurate method aimed atdefining the best packet size aimed at a product and obtaining meaningful results during a single program without taking into account power constraints. The W-W method identifies potential options in a forward calculation and then chooses the best course of action in a backward calculation, similar to how the traditional lot size formula undertakes an unlimited rate of construction and uniform feasting across the retro.

Model 1: Lot for Lot:Every period, obtain only what is needed. Items are bought here in precisely the amounts needed for every timeframe. Therefore, this strategy works well when holding costs are high and order costs are low.

Model 2: Economic order Quantity:The order quantity that reduces overall inventory property costs and organization expenses is referred to as the "economic order quantity." Regardless of the amount bought, there is a flat cost for every order.

Model 3: Period order quantity:In terms of periods, this is the EOQ. POQ is equal to EOQ separated by the typical demand per era.

Model 4: Least unit cost:We determine the order quantity that will concealment the following "n" epochs when the net requirements are good, where "n" is chosen to reduce average unit cost.

Model 5: Least total cost:In cases where the overall requirement is high, we determine the order quantity that resolve cover the subsequent "n" period, where "n" is the epoch during which the holding costs and inventory costs are contiguous to one another. This model determines how many parts need to be purchased with roughly equal carrying and ordering costs.

Model 6: Least period cost:We determine the inventory levels that resolve cover the following "n" periods when the net requirements are favorable, where "n" is chosen to reduce the cost per unit of period.

Model 7: Wagner-Whitin Algorithm:Those models are used with the consumption data for a specific product over the last three years, taking into account varied times, to determine the best models in the present situation.The three years are divided in various ways when calculating the average cost.

Method 1:

- 1) Divide every year into 12 halves, each lasting one month.
- 2) Repetition of the process each year.
- 3) To calculate the yearly inventory cost, determine the average of these three numbers.

Method 2:

- 1) Split the three-year timeframe into 36 intervals of one month respectively.
- 2) Calculate the entire cost of the inventory for every time period.
- 3) To calculate the annual inventory expenses, divide this figure by three.

Method 3:

- 1) Split the three-year period into three equal intervals of one year each.
- 2) Determine the annual cost of all inventories.
- 3) For each of these approaches, the data from the last three years are used individually.

Method 1: There are twelve equal months in a year. The total of the monthly expenses for ordering, purchasing, and overhead is the total inventory cost for the entire year. The above table 3 illustrates that the lot for lot approach was used to determine the lowest total inventory cost. Table 2 below lists the holding costs for each model that has been selected to employ this method:

Table 2: Average Annual Cost

2019	2020	2021	Model
602041	527978	602741	LotforLot
603166	618277	604054	E.O.Q.
593890	602650	593890	P.O.Q.
593890	601050	593890	LUC
593590	601290	593590	LTC
592390	601050	592390	LPC
593890	601450	593890	W-W

Table 3: Annual Inventory Cost on Average

Annual Cost on Average in Rs.	Model
553760	LotforLot
596733	E.O.Q.
575397	P.O.Q.
574897	LUC
575047	LTC
573997	LPC
575297	W-W

Method 2: This approach divides the entire three-year period into 36 segments, each lasting one month. The total inventory cost for three years is determined by totaling up the

purchasing expenses, inventory cost, and order costs for every period. This table 4 shows that even though the lowest unit price model has the lowest cost, the average total cost of inventory stays the same when this strategy is used. The following values are presented:

Table 4: Shows the 36-month total cost of inventory

ATC on average in Rs.	36-Month Price	Model
575397	1783260	LotforLot
579964	1816962	E.O.Q.
575397	1783260	P.O.Q.
574347	1792120	LUC
575047	1793120	LTC
573747	1798310	LPC
575297	1793750	W-W

Method 3: This table 5 demonstrates that despite the lowest unit price model's lowest cost, the average total cost of inventory generally stays constant when this strategy.

Table 5 shows the three-year total cost of inventory.

ATC on average in Rs.	36-Month Price	Model
565133	1762470	LotforLot
578917	1803822	E.O.Q.
571750	1782320	P.O.Q.
571780	1782470	LUC
571780	1782470	LTC
571780	1782470	LPC
571780	1782470	W-W

3. CONCLUSION:

The explanation that was provided above makes it rather evident that the three approaches were used to seven different inventory models. One-month increments are used to compute the annual inventory levels in the first technique. The average of the data gathered over the preceding three years is then used to determine the total annual inventory levels. The second method looks at the whole three-year span at one-month intervals. The average of the inventory values over the preceding 36 months is used to determine the total inventory cost for the year. The third method adds the monthly requests to get information about the annual wants. The inventory values are then averaged throughout the course of each year to estimate the total annual inventory cost. As a result, a new model emerges as the optimal model, changing the phase at which averages are computed. For longer runs, then, the little to nonexistent change periodic quantity model makes sense.

4. References:

- [1]. Shafali, C., Vikas, S. and Pardeep, G. (2021), Inventory Model for Deteriorating Substances through Price-Dependent Demand under Quantity-Dependent Trade Credit”, Design Engineering, 11816-11827.
- [2]. Poswal, P., and Rajoria, Y. K. (2022), A Review on Fuzzy Economic Order Quantity Model under Shortage. AIP conference proceedings, 21-29.
- [3]. K. Kumar and Promila (2020), An Epq Model For Imperfect Production Process With Deterioration Under The Effect Of Inflation, International Journal of Advanced Research in Engineering and Technology (IJARET), 11(9), 438-447.
- [4]. Chaudhary, R., Mittal, M., and Jayaswal, M. K. (2023), A sustainable inventory model for defective items under fuzzy environment. Elsevier, 7, 1-10.
- [5]. De, S.K., Mahata, G.C. (2019), A cloudy fuzzy economic order quantity model for imperfect-quality items with allowable proportionate discounts. J IndEngInt **15**, 571–583.
- [6]. Thomas, J. T. and Kumar, M. (2022), Design of Fuzzy Economic Order Quantity (EOQ) Model in the Presence of Inspection Errors in Single Sampling Plans. Journal of Reliability and Statistical Studies, 15, 211–228.
- [7]. Shafali, C., Vikas, S. and Pardeep, G. (2021), Role of manufacturing process in waste reduction and contribution in environmental sustainability,” International conference on recent innovation and interdisciplinary research, 150-157, 2021
- [8]. Kwakernaak, H. (1978), Fuzzy random variables-I. Information Sciences, 1–29.

- [9]. Liu, Y. (2005), Fuzzy programming with recourse. *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, 13, 381–413.
- [10]. K. Kumar, A. Kumar and Promila (2020), Inventory Control Policy for Imperfect Production Process on Various Demand and Fuzzy Nature: Latest Trend, *International Journal of Trade & Commerce-IIARTC*, 9(1), 148-158.

Investigating the Application of Fuzzy Logic and Uncertainty Handling in Case-Based Decision Making

Ritu Yadav¹, Dr. Pratiksha Tiwari^{2*}, Sangeeta Malik³

¹PhD Scholar, Department of Mathematics, B.M.U Rohtak (Haryana), India.

²Assistant Professor, Delhi Institute of Advanced Study Delhi (India)

³Professors, Department of Mathematics, B.M.U Rohtak (Haryana), India.

Email: parth12003@yahoo.com.in

This work scrutinizes the use of fuzzy logic and uncertainty management in CBDM, paying special focus on the difficulties and approaches associated with knowledge system uncertainty management. Uncertainty naturally pervades human decision making and can, therefore, significantly degrade the effectiveness of decision-support systems. There are factors such as faulty information and assumptions and surprise events behind this uncertainty. There are several stages involved in modeling and reducing impacts of uncertainty using fuzzification as a mathematical tool such as representation of vocabulary, similarity metrics, design of case bases, and transformation of the solution that appear in several phases of CBDM. Fuzzy sets can be applied in combining to solve all those problems like maintaining a case base in dynamic environment, the description of imprecisely case features, and cases retrieval with uncertainties. It also addresses the case when uncertainty can be expressed using formal techniques by possibility theory and linguistic variables with the aid of fuzzy logic so that the performance and effectiveness of case-based reasoning can be enhanced. Major techniques used in it are fuzzy feature vectors, fuzzy similarity functions, fuzzy decision trees, adaptive fuzzy clustering, and fuzzy integrals. Basically, the aim here is to improve decision-making systems through more reliable solutions that deal better with uncertainty, particularly under intricate real-world scenarios. This research advances the development of intelligent systems that use fuzzy logic in order to improve decision support in dynamic and uncertain situations.

Keywords: Fuzzy logic, uncertainty handling, case-based decision making, fuzzification, fuzzy sets, decision support systems.

1. Introduction

A useful mathematical tool for simulating much of what is characterized in a process by subjectivity, uncertainty, and indeterminacy, is fuzzification. Whilst some qualitative criteria and the values of the qualities used for assessment depend on the subjective rating of the decision maker regarding the relative weight of his or her chosen criteria uncertainty also exists in making the decision at all known parameters of the decision (Alakhras et al., 2020). The subjectivity of the decision maker cannot allow real-world problems to be solved. However, uncertainties must be brought into the decision-making process. Every human is constantly

being faced with the necessity of having to make decisions, be it personal or work-related.

However simple the issue is, we may consider that ambiguity prevails with every choice that we have made. The problem here lies in how much the decision maker is willing to risk for making the wrong choice and how much he is willing to compromise over the ambiguity (Papageorgiou, 2011). There are two sorts of uncertainty: that arisen due to wrong assumption and that due to force majeure. Whether it is an event that influences the decision and one that is not expected or an event that is expected, but not all of the consequences, or the precise nature of the event, deficient assumptions arise from ignorance, or a lack of information about the nature of upcoming events. A force majeure is an event like bad weather, natural disaster, or any other similar case that has adverse effects, which were neither foreseen nor avoidable.

It is impossible to predict with certainty future events in every sector unless there are specific statistical techniques for us to make assumptions pertaining to the future using such knowledge. Using information culled (resource status, capacity, motivation of the workers, etc.), the assumption made by the decision maker involves assumptions that are generally valid as well as marginally variable with time(Varshavskii et al., 2024). If all factors are considered into account, the following exhibits uncertainty.

Interval mathematics is typically used to address uncertainties associated with imprecision in people-to-people communication and, for instance, refer to high people, low temperatures, and bad sales while the theory of fuzzy set is typically applied to simulate uncertainties that emerge whenever defining terms given to express characterization of a concept fail to specify a single number as expected and probability is typically used to model them (Atmani et al., 2013).

1.1. Uncertainty in Case-Based Reasoning (CBR) and Fuzzy Logic

This decision uncertainty may be due to the incompleteness, imprecision, and ambiguity in the data(Chai et al., 2013). Uncertainty may be caused by many factors in Case-Based Reasoning (CBR) systems. These factors may be due to the vocabulary of attributes used to describe the cases, the measures used for the similarity between cases, the case base itself that might include some old or redundant cases, and the transformation used to solve the problem after retrieval based on retrieved cases (Zarandi et al., 2011). These sources of uncertainty have a great impact on the system's performance and decision accuracy.

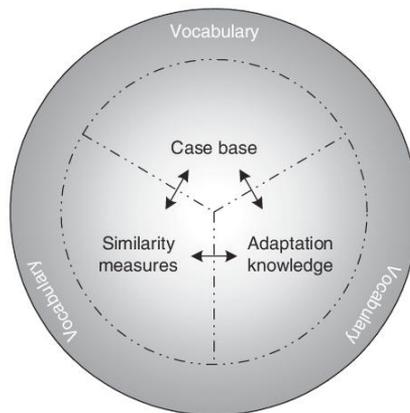


Figure 1: The knowledge containers of CBR system

In an instance where fuzzy logic addresses uncertainty in systems through handling imprecise, incomplete, or vague data (Dubois et al., 2006). It allows attribute representation with fuzzy sets explaining degrees of membership instead of fixed values, enabling greater decision nuance. As applied to the vocabulary in CBR, and similarity measures through solution transformation, systems now handle vague or ambiguous information effectively by improving the results' accuracy and reliability on account of the natural fuzziness associated with real world cases.

1.2. Fuzzy Logic Integration Improves Decision Support Systems

The integration of fuzzy logic into decision support systems (DSS) will enable better management of uncertainty and reproduce human decision-making (Sun and Finnie, 2007). As compared to the binary logic systems, DSS using fuzzy logic enables it to process imperfect and ambiguous data, allowing more flexible and adaptive decision-making. This integration is very useful in complex areas such as business model selection, clinical decision support, and risk assessment where data is usually imprecise. A DSS that uses fuzzy logic can aid executives in deciding on e-business models, considering qualitative and quantitative factors (Sabahi and Akbarzadeh-T, 2014). Fuzzy decision support systems aid dietitians in diet changes for patients with multiple chronic conditions by enhancing treatment planning. Fuzzy set theory aids these systems in accommodating the vagueness of human reasoning, thus being more nuanced and effective in decisions. Fuzzy logic also helps DSS adapt to changing data patterns, keeping relevance and accuracy even in dynamic contexts.

1.3. Objectives of the Study

- To explore the application of fuzzy logic and uncertainty handling in case-based decision-making (CBDM) systems.
- To investigate the integration of fuzzy sets and fuzzification techniques to reduce uncertainty in various stages of CBDM, including case retrieval and solution transformation.
- To enhance decision-making systems by providing reliable solutions that better manage uncertainty in complex, real-world situations.

2. LITERATURE REVIEW

Jahani et al. (2015) argued that to deal with the complexity of modern supply chains, multi-agent systems, fuzzy logic, and case-based reasoning (CBR) should be combined. Common problems in today's supply chains include client dissatisfaction, information overload, and too much uncertainty. While it is true that both qualitative and quantitative considerations are commonly overlooked by existing agent-based systems when it comes to supplier selection and other supply chain processes. Jahani et al. proposed an agent-based paradigm that combines multi-agent systems, fuzzy logic, and case-based reasoning in order to overcome some of these problems. Infrequently were these views united in previous studies. Usefulness of the proposed framework has been demonstrated through an exploratory case study performed within office furniture company. This agent-based architecture would suggest substitute products in cases of stockouts, judge supply offers on customer preference, and facilitate better communication among agents of the supply chain. The F-CBR approach

narrows down the whole search space while retrieving cases by arranging information into relevant instances. The fuzzy nature of this approach tackles supplies chain uncertainty, most especially when customers have varying requirements and preferences. It was very short, only the description and retrieval stages of CBR approach, retaining, reusing, and altering phases were not covered and no inventory management and agent bargaining is mentioned (Jahani et al., 2015).

Kasie and Bright (2023) addressed the unexplored area of designing and controlling the cutter process in metal cutting. There have been computer-aided planning, simulation, and optimization techniques used for ages to address the problems encountered in cutter planning and control. They proposed a decision support system that utilized techniques of fuzzy case-based reasoning and fuzzy analytic hierarchy process. This integration provides a more reliable method to solve planning and control issues related to machining cutters, as it determines hybrid similarity measures between new and previous cases. The system is designed to adapt new arrivals of orders through retrieving the best matching of previous cases. For proving the soundness of the DSS, a numerical example was presented, offering fresh views of how fuzzy set theory, CBR, and AHP can be combined for this specific application (Kasie and Bright, 2023).

Uğur and Baykan (2016) investigated the use of fuzzy logic in construction management (CM) for its applicability and feasibility. The authors focused their research on papers in well-known journals listed under Science Citation Index (SCI), since CM spans an array of subjects. The present study found four basic applications of fuzzy logic in the field of CM, including: modelling, optimization, performance evaluation/assessment, and decision-making. The study underlines fuzzy logic's ability to deal with the uncertainty and imprecision that exist in construction projects and, therefore, highlights the potential for betterment in CM's decision-making and optimization procedures (Uğur and Baykan, 2016).

Kamal (2012) provided a framework for use-case-based effort prediction based on adaptive fuzzy logic that is supposed to address imprecision and to be able to consider expert opinions. Software development effort prediction is a challenging task that often involves dealing with imprecision, ambiguity, and incomplete knowledge, especially during the early stages of development. The paper focused on effort prediction using machine learning techniques such as fuzzy logic, neural networks, and genetic algorithms. An empirical evaluation of the proposed framework revealed some promising results and highlighted ways in which different objectives interact to impact prediction accuracy. The work also explored system architecture and its impact on the accuracy of fuzzy-based effort prediction systems. It emerged that the creation of a genetic-fuzzy tool to evolve different designs significantly impacted effort prediction system performance (Kamal, 2012).

Asemi et al. (2014) examined the usage of FMCDM approaches with special emphasis on how versatile these are within a wide variety of disciplines. From reviewing 150 studies using FMCDM approaches for decision-making purposes, the most prevalent usages were identified. Given fuzzy AHP and fuzzy TOPSIS are the most popular methodologies of FMCDM, the most widely examined topics so far are "location management" and "supplier selection." This paper pushes forward knowledge concerning the widespread use and application of FMCDM in the most vital processes of making decisions (Asemi et al., 2014).

Seleem et al. (2020) developed a lean manufacturing roadmap for industrial companies by selecting appropriate lean tools based on firm constraints and predetermined strategic objectives. In addition, the study ranks these tools based on their interrelationships. The first step in the process is to set operational goals using the BSC framework. The theory of constraints (TOC) is used to analyze the manufacturing system and identify its constraints, and then fault tree analysis (FTA) is used to determine the root causes of the constraints identified. Finally, lean efforts are prioritized with the aid of the fuzzy-decision making trial and evaluation laboratory (fuzzy-DEMATEL) method. Practical recommendations made by the study include examining the manufacturing system, monitoring the mastery of specialists' expertise, and directing the efforts by ranking them relative to one another in an effort to accomplish strategic goals without any increased time and cost. The study considers only the case of manufacturing organizations; thus, further study is needed to assess how successful the strategy is for the service organizations (Seleem et al., 2020).

3. RESEARCH METHODOLOGY

This section describes the research approach to deal with uncertainty in Case-Based Reasoning (CBR) systems, particularly using fuzzy set theory (FST). The methodology is laid out from case representation to solution transformation in order to analyze the diverse approaches that have been used to address uncertainty at every step of the CBR process. Depending on what source of uncertainty is drawn from—the knowledge base, the similarity measure, or even the CBR hypothesis itself—research approaches are put into different categories.

3.1. Addressing Uncertainty in the Vocabulary

Introducing uncertainty into the lexicon of the CBR system: fuzzy aspects of case features or when cases have both fuzzy and crisp aspects. The paper proposes an investigation into the utilization of fuzzy feature vectors, representing case features as a composition of fuzzy and crisp values, where the method will incorporate neural networks to efficiently merge all these different feature types at the case retrieval process.

To enhance knowledge acquisition, a fuzzy-based module is also incorporated into the design of CBR. Within this module, fuzzy sets represent uncertain concepts and make the process of creating fuzzy sets more manageable as new concepts come into view. Fuzzy linguistic variables are used as a technique to reduce the dimension in classification tasks, especially in scenarios where an excess number of features may degrade the quality and performance of a system.

3.2. Addressing Uncertainty in the Similarity Measure

With several variables to consider, like indexing, similarity functions, and the summation of individual similarities, this makes the uncertainty associated with the similarity measure less significant. This technique is primarily a fuzzy integral technique that aims to obviate some drawbacks of standard closest neighbor algorithms. As this technique is intended to provide suitable treatment of elements that vary in importance, thereby avoiding the masking of relatively lesser features by more prominent ones, the cancellation effects can be significantly reduced. This strategy also addresses the problems with the additivity assumptions in

conventional aggregation techniques(Osiro et al., 2014).

In addition, disagreements on similarity judgments are resolved using fuzzy membership functions to quantify the expert's confidence in similarity between cases. This approach also deals with uncertainty in incomplete cases by allowing incomplete cases to be added to the case base without affecting the materiality of the system's accuracy.

Preference functions in fuzzy form are then adopted to describe how similar conditions are with respect to any feature that an application like plastics color matching may have. Then the simplified representation of similarity resulting from expert evaluation is one that is gotten from the representation of similarity values ensuing from the comparison as fuzzy preference vectors. The other very essential technique that this research used relates to the use of fuzzy membership distributions in the calculation of the value of properties. This sidesteps all the demerits that conventional sharp thresholds have by employing fuzzy predicates to represent preference while in the determination of similarity and assessing dependability.

3.3. Addressing Uncertainty in the Case Base

Heterogeneity in case attributes or the presence of incomplete case information often introduces vagueness to the case base. The uncertainty, in case certain case attributes are not known, introduces various techniques for the alleviation of such problems like ordered weighted averaging-based nearest neighbor rules. The selection and maintenance of relevant cases to the case base use fuzzy techniques with neural networks.

This not only reduces the redundant cases but also organizes cases into clusters that represent solution prototypes by using fuzzy clustering. The adaptive fuzzy clusters use both fuzzy clustering and the statistical process management approach to deal with the uncertainty in case parameters in applications like aircraft engine maintenance. In fact, as parameters do, so does the case base with time.

The study forms granular clusters in the feature space, combining fuzzy and rough sets to enhance case representation for more intricate cases. It uses fuzzy similarity functions and incorporates rough-fuzzy hybridization to facilitate effective case base retrieval and assure more accurate case representations. Finally, to ease the maintenance of the case base, it uses fuzzy decision trees. These trees increase retrieval efficiency, while lowering the case base's complexity without sacrificing important information by complementing a smaller case base and aiding in the learning of adaption rules.

3.4. Addressing Uncertainty in Solution Transformation

Another crucial problem that the research solves to ensure effective reuse of solutions is uncertainty when transforming a solution. For example, fuzzy disjunction is applied in musical composition to combine numerous fuzzy sets into a new fuzzy set representing the change. Then, the fuzzy set is defuzzied to transform it into a specific solution parameter.

Also, mining the case base through adaption knowledge involves using fuzzy association algorithms. With such knowledge principles regarding determining requirements and conditions to make successful solution adaptations according to the prediction accuracy and recall rate, this provides for building an adaptation engine.

4. RESULTS AND DISCUSSION

The modeling of uncertainty in the assumption of Case-Based Reasoning (CBR) is described in this section where, for a collection of possibly related cases found by a closest neighbor algorithm, the main goal is finding typical elements. Typical elements are identified using the principle of typicality. Using the parameters provided by this theory, fuzzy sets, which reflect the uncertainty of the solution, are created (Rajabi et al., 2019). These fuzzy sets then express the result of the CBR system.

This method is an extension of the first attempt to apply the concept of typicality in the retrieval stage of a CBR system, where the aim is to retrieve a set of examples according to the similarity of problems for the purpose of finding similar solutions to a problem. This technique is based on the premise that the solution to a problem may be found in the repository of solutions that have satisfactorily solved related problems. This approach uses typicality for describing the solution, providing for a more flexible and unstable method of determining results than does any other approach that relies on the similarity between issues or solutions.

The uncertainty is diminished by finding the typicality of a group of possibly sound answers. A fuzzy set models the typicality of solutions; the most typical solution would be represented by the center of the set, and the uncertainty that surrounds that solution would be described in terms of the shape of the set. The solution space can be better represented by utilizing fuzzy sets, which not only capture the uncertainty but also the typicality of the solution.

4.1. Finding the Typical Result of a CBR System

From a set of possibly sound solutions that is represented as $S_p = \{S_1, S_2, \dots, S_n\}$, that collection results when the related cases are found. Next, MTV of that set is calculated. That value which depicts most typically a set's primary tendency is called the MTV of the set. The core value of that solution, representing the solution that is the most likely to solve that issue, is placed centrally in a fuzzy set.

For instance, 30 is the most obvious value that represents the fuzzy set of similar solutions, if the MTV of the set is found to be 30. Then place the center at 30 to create a fuzzy set. The MTD defines the shape of the fuzzy set, which determines the extent to which values in the set deviate from the MTV. The MTD has the range or uncertainty about the typical value much as standard deviation does (El-Sappagh et al., 2015). The fuzzy set that emerges in this process models the most typical answer and the uncertainty about it, and it's why it's called Most typical Fuzzy Set, or MTFS.

4.2. Theory of Typicality

According to the Theory of Typicality, it introduces a framework for determining the Most Typical Value (MTV) of a dataset, representing the characteristic property of data particularly in situations where there exist multiple clusters. In situations where, multiple diverse clusters exist within a given data set, typical statistical metrics such as mean or median may not efficiently capture the usual value for the given dataset. The MTV, on the other hand, uses geometrical fuzzy clustering approaches to determine which value best captures the data given these many clusters.

 Algorithms for Geometrical Fuzzy Clustering

Fuzzy clustering loosens the constraints in which the data points are assigned to clusters. Fuzzy clustering, unlike standard clustering, gives a membership value to every data point so that the value determines the proportion of each cluster that a given data point belongs to. These membership values represent the degree of similarity between each data point and the several cluster centers(Sarkheyli-Hägele and Söffker, 2020). They sum up to 1 for each data point.

Often the fuzzy clustering is applied with overlapping clusters or when two data points are not really distinguishable from each other. The geometrical approaches of fuzzy clustering techniques try to divide data space into clusters or areas representing both groups of possible fuzzy membership minimizing internal variance.

1) Fuzzy c-Means Algorithm:

These include the fuzziness parameter, m , and the number of clusters, c , and are predetermined for the Fuzzy c-Means algorithm. The algorithm follows these steps:

1. Initialize cluster centers v_1, v_2, \dots, v_c .
2. For every data point x_j , assign the fuzzy memberships μ_{ij} according to how close it is to the cluster centers.
3. Optimize the objective function to update the centers of clusters:

$$J_m = \sum_{i=1}^c \sum_{j=1}^N \mu_{ij}^m \|x_j - v_i\|^2$$

where μ_{ij}^m is the membership value of data point x_j in cluster i , and m is a fuzziness parameter typically set greater than 1.

The algorithm has converged when the membership values do not change much between cycles.

2) Cluster Validity:

Cluster validity measures to which extent the clustering function classifies the data into meaningful groups. A good partition induced by a good clustering algorithm should have:

- a) Clear distinction among the clusters.
- b) Each cluster's compactness.
- c) Following the basic structure of the data.

Table 1 below shows the retrieved sets of solutions for problems PA, PB, and PC. Comparing estimates of solutions obtained for each problem over a variety of sets enables an estimate of the effectiveness of the clustering.

Table 1: Sets A, B, and C of problem-solving results PC, PB, and PA

	PA Estimate	PB Estimate	PC Estimate
1	44747	76557	113163

2	48552	66149	177474
3	48733	77973	44282
4	32102	23551	110574
5	87454	53027	79266
6	55037	77460	109003
7	43121	60366	108144
8	54362	68007	322234
9	45668	56774	113563
10	51898	97839	66725
11	38138	70627	108125
12	51115	85766	102093
13	49471	53105	99256
14	44359	64322	128909
15	40471	31875	150964
16	47250	80030	139318
17	52390	75203	228258
18	39333	87444	140481
19	80211	206627	57072
20	43426	140305	105032
21	45734	72555	67751
22	55481	68178	118193
23	38566	87554	156232
24	48007	55036	85429
25	45735	66381	110396

Many indices such as the Davies-Bouldin Index, Silhouette Score, or Dunn Index, which measures the compactness and separation of the clusters, may be used to assess cluster validity.

3) MTV, Most Typical Value:

After clustering, the core value of a data set is referred to as the Most Typical Value, MTV (Lu et al., 2016). It considers both the distance of each data point from the cluster center and the population, or size, of each cluster.

There are two effects that act as a reference for calculating the MTV:

- The population effect: MTV depends more on bigger clusters regarding data points. That simply means that, for higher clusters, MTV is near the centroid.

- The distance effect: The further away the population is from its centre in all clusters, their contribution will lower it as well.

An equation that considers the contribution of each centroid of a cluster by the size of the cluster and by the distance between the centroids and the MTV is obeyed by the MTV. The obtained MTV values for the clusters in sets A, B, and C are represented in Table 2. For every cluster within the same set, the MTV is calculated independently.

Table 2: Values obtained for clusters' MTV

SETS	MTV
set A cluster 1	45700
set A cluster 2	45700
set A cluster 3	45700
set B cluster 1	75390
set B cluster 2	75390
set B cluster 3	75390
set C cluster 1	121680
set C cluster 2	121680
set C cluster 3	121680

Definition 1: MTV Calculation

Let c clusters $C_i=(k_i,v_i)$ be derived from the data set $X=\{x_1,x_2,\dots,x_N\} \subset R^p$, with v_i as the centroid of cluster C_i and k_i is the population size. Then, MTV is the solution of the following equation:

$$S = \frac{v_1 \gamma_1 (|v_1 - s|) k_1^\lambda + v_2 \gamma_2 (|v_2 - s|) k_2^\lambda + \dots + v_c \gamma_c (|v_c - s|) k_c^\lambda}{\gamma_1 (|v_1 - s|) k_1^\lambda + \gamma_2 (|v_2 - s|) k_2^\lambda + \dots + \gamma_c (|v_c - s|) k_c^\lambda}$$

Where,

- The distance effect is represented by the monotonically decreasing function $\gamma_i(u)$.
 - $\lambda > 1$ is the weight modifier of the population effect
- 4) Most Typical Deviation (MTD):

The Most Typical Deviation measures the closeness of MTV to each unique data point set. The lower the MTD, the closer the MTV to the data center.

Definition 2: Calculate MTD

The MTD can be calculated as:

$$t = \frac{|v_1 - s|^2 \gamma_1 (|v_1 - s|) k_1^\lambda + |v_2 - s|^2 \gamma_2 (|v_2 - s|) k_2^\lambda + \dots + |v_c - s|^2 \gamma_c (|v_c - s|) k_c^\lambda}{\gamma_1 (|v_1 - s|) k_1^\lambda + \gamma_2 (|v_2 - s|) k_2^\lambda + \dots + \gamma_c (|v_c - s|) k_c^\lambda}$$

The MTD is approximately distance $|vk-s|$ if one of the clusters is dominant and k is the dominant cluster. Table 3 below gives MTV, MTD values for data sets A, B and C(Avdeenko and Makarova, 2017). With smaller values that indicate the MTV is close to the center, it can be seen that in the MTD values how closely every MTV resembles the center related data set.

Table 3: MTV and MTD values for sets A, B, and C

Set	MTV	MTD
Set A	45700	310.9
Set B	75390	851.2
Set C	121680	761.8

5) Definite Typical Value (DTV)

The DTV or the definite typical value is that which will emerge from the MTV equation with proper tuning (through a parameter, β) and iteration. Now, having looked at population as well as distance effects, it is that final most typical value the dataset settles into. In the Table 4 below are shown the DTVs of the three sets A, B and C. Following the necessary iterations and readjustment with β these represent the final converged solution to the MTVs of the above three sets.

Table 4: DTV for sets A, B and C

Set	DTV
A	45700
B	75390
C	121680

4.3. Finding the Most Typical Fuzzy Set (MTFS)

Most Typical Fuzzy Set: One of the major ideas behind fuzzy logic and clustering is a structure called the Most Typical Fuzzy Set that intends to express the inherent uncertainty present in the data. MTD extends the notion of Most Typical Value by introducing Most Typical Distance. This fuzzy set considers not only the MTV but also the way it interrelates to other aspects of the dataset with the attempt to more exactly describe the vagueness about the typicality of the solution.

- The Most Typical Value or MTV is the center or representative value of a set following the use of clustering techniques. It shows the tendency of central points within the dataset and is an expression of the most frequent result.
- MTD (Most Typical Distance) measures the distance of the MTV from the centers of the clusters. A low value for MTD indicates that MTV is close to the center and very typical of the items of the set, and, conversely, it also has a higher degree of typicality for the MTV (Lavrynenko et al., 2020).

The degree of typicality of the MTV is essentially defined by the MTD. In contrast, fuzzy sets' membership functions cannot be constructed directly employing the MTD as the deviation parameter. Depending upon how close elements are to the MTV, the MTFS is meant to be an expression of a spectrum of possible outcomes. There are three types of outcomes showed in

figures 2 to 4.

- Very Close to MTV: Components which are very close to the MTV.

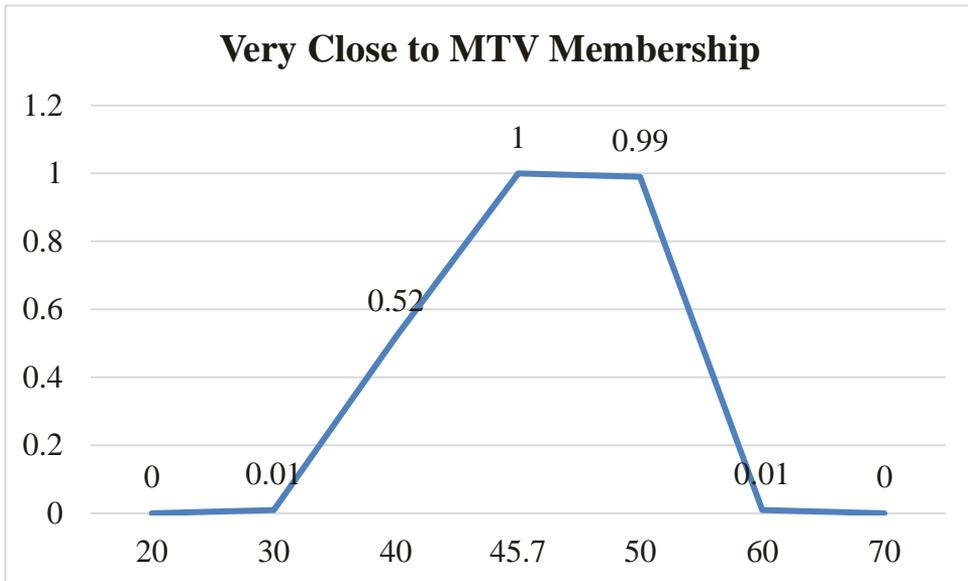


Figure 2:MTFS very close to MTV

- Close to MTV: Those things that are in this category but are not quite as close as the "very close" group.

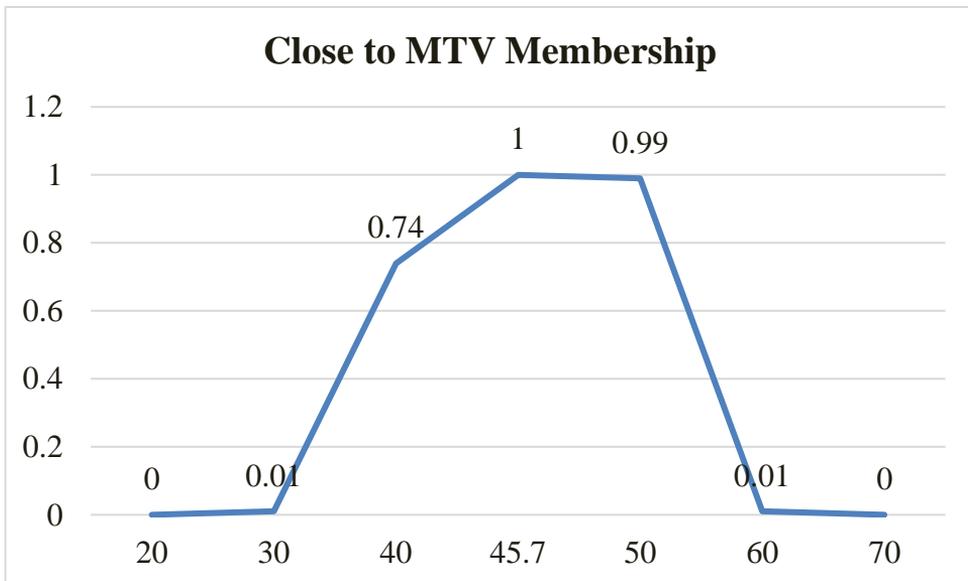


Figure 3:MTFS close to MTV

- Around MTV: Elements which are not included in the "close" category, but still somewhat close to the MTV.

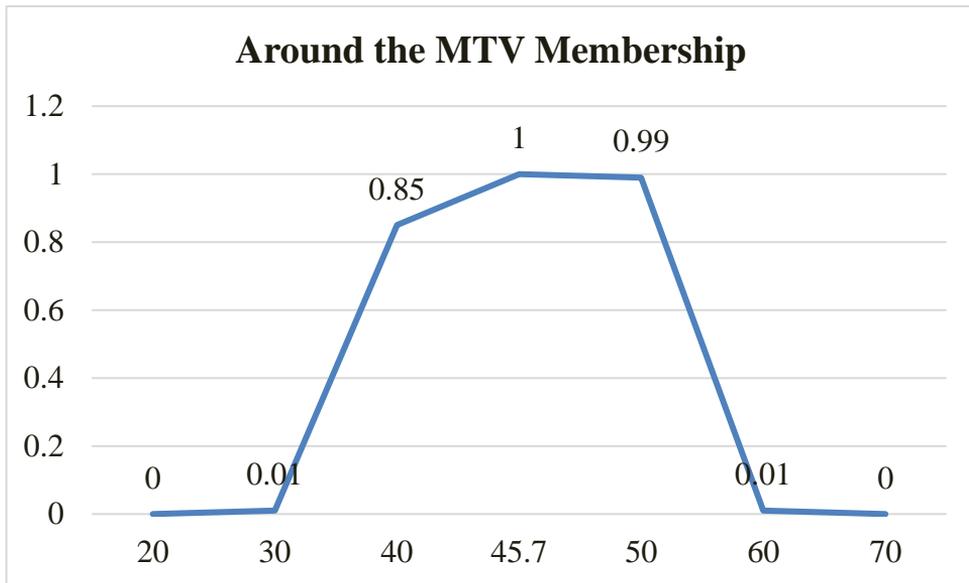


Figure 4: MTFS around MTV

Such descriptions using MTFs also provide for a more particular categorization in such representations of the data which may well capture the loose concept of proximity to MTV. In the case of MTD, for instance, phrases such as "small, regular and large" are possible words to be understood under proximity.

In the fuzzy set model, MTD is a base variable to which the varying degrees of typicality are given in terms of the language. The MTD is represented by the following three linguistic terms:

- Small MTD: Indicates that MTV lies well-centered inside the cluster, or in other words, the membership grades of elements around MTV are higher.
- Regular MTD: It presents a better distribution of the membership classes as it signifies the average distance between the MTV and the cluster center.
- Large MTD: This gives an impression that there exist several solutions close to the MTV since the MTV is highly distant from the cluster center. Here, pieces further away from the MTV are assigned higher grades of membership.

The MTD ranges between 0 and 5,000; here the smaller values signify larger values of MTV typicality (Choudhury and Begum, 2017). The flexible form of data, thus possible with this range, deals with different levels of uncertainty about the data. Table 5 shows the linguistic variable MTD along with its membership values, which correspond to several different values of MTD. These numbers are converted to "Small MTD," "Regular MTD," and "Large MTD." These numbers provide an imprecise description to the data: The membership values vary between these groups as the MTD increases, which indicates the different levels of typicality.

Table 5: The linguistic variable MTD

MTD Value	Small Membership	Regular Membership	Large Membership
0	1.0	0.0	0.0
290	0.9	0.0	0.0
580	0.7	0.0	0.0
870	0.4	0.0	0.0
1160	0.1	0.0	0.0
1450	0.0	0.0	0.0
1740	0.0	0.1	0.0
2030	0.0	0.4	0.0
2320	0.0	0.7	0.0
2610	0.0	0.9	0.0
2900	0.0	1.0	0.0
3190	0.0	0.9	0.0
3480	0.0	0.7	0.0
3770	0.0	0.4	0.0
4060	0.0	0.1	0.0
4350	0.0	0.0	0.1
4640	0.0	0.0	0.4
4930	0.0	0.0	0.7

According to the MTD and membership grades, certain rules are implemented in order to provide the MTFS (Karatop et al., 2015). Degree of typicality is represented in such rules:

- **Extremely small MTD:** Very small MTD represents higher degree of typicality by MTV. Elements closer to the MTV will get better memberships from MTFS while those are farther from MTV will acquire lower grade memberships.
- **Regular MTD:** A regular MTD represents a more balanced typicality by evenly spreading the membership grades over the MTV.
- **Big MTD:** Since it might have more than one valid solution, elements farther away from the MTV are awarded membership grades, and hence big MTD indicates low typicality.

These guidelines ensure that the MTFS captures appropriately the variability and uncertainty in the data and also help in defining the membership functions (Surma, 2015).

Use the following example to illustrate how the MTFS is constructed by taking the MTV as 45,700 and the corresponding MTD as 310.9. It would be classified as a "small" MTD in the MTD classification. The constructed MTFS would therefore represent the concept of being "very close" to the MTV. Members that are closer to the MTV would have higher membership

grades while members that are farther away from the MTV would have lower grades.

5. CONCLUSION

This conclusion of the study, therefore, highlights the importance of fuzzy logic in dealing with uncertainty in CBDM systems. Human decision-making is, in any case, extremely difficult under uncertainty, and the support systems can be very adversely affected. The proposed approach applies fuzzification approaches such as fuzzy sets, fuzzy similarity functions, fuzzy decision trees, and adaptive fuzzy clustering at different steps of CBDM, namely, vocabulary representation, case retrieval, and solution transformation to show how uncertainty may be controlled at those different stages. With fuzzy logic integration, better and more flexible decisions could be made, especially within dynamic and complex contexts in which data is often ambiguous, imprecise, or incomplete. More formally, the formalization of vagueness in fuzzy theory ensures that the answers are much more reliable and consistent than those obtained from the ordinary decision-making process. Therefore, this research contributes to the overall effectiveness and robustness of CBDM systems by furthering the development of intelligent systems that could handle uncertainty in real-life applications. The findings of the study underscore the ability of fuzzy logic to promote decision support particularly when the traditional approach fails to cope with the intricacy of uncertain input.

References

1. Alakhras, M., Oussalah, M., & Hussein, M. (2020). A survey of fuzzy logic in wireless localization. *EURASIP Journal on Wireless Communications and Networking*, 2020, 1-45.
2. Asemi, A., Baba, M. S., Haji Abdullah, R., & Idris, N. (2014). Fuzzy multi criteria decision making applications: a review study.
3. Atmani, B., Benbelkacem, S., & Benamina, M. (2013). Planning by case-based reasoning based on fuzzy logic. *arXiv preprint arXiv:1311.4564*.
4. Avdeenko, T. V., & Makarova, E. S. (2017). Integration of case-based and rule-based reasoning through fuzzy inference in decision support systems. *Procedia Computer Science*, 103, 447-453.
5. Chai, J., Liu, J. N., & Ngai, E. W. (2013). Application of decision-making techniques in supplier selection: A systematic review of literature. *Expert systems with applications*, 40(10), 3872-3885.
6. Choudhury, N., & Begum, S. A. (2017). The role of fuzzy logic in case-based reasoning: a survey. *Indian Journal of Computer Science and Engineering*, 8(3), 333-340.
7. Dubois, D., Hüllermeier, E., & Prade, H. (2006). Fuzzy methods for case-based recommendation and decision support. *Journal of Intelligent Information Systems*, 27, 95-115.
8. El-Sappagh, S., Elmogy, M., & Riad, A. M. (2015). A fuzzy-ontology-oriented case-based reasoning framework for semantic diabetes diagnosis. *Artificial intelligence in medicine*, 65(3), 179-208.
9. Jahani, A., Azmi Murad, M. A., bin Sulaiman, M. N., & Selamat, M. H. (2015). An agent-based supplier selection framework: Fuzzy case-based reasoning perspective. *Strategic Outsourcing: An International Journal*, 8(2/3), 180-205.
10. Kamal, M. W. (2012). Use-case based early Software Effort Prediction using Fuzzy Logic and Genetic Algorithms (Master's thesis, King Fahd University of Petroleum and Minerals (Saudi Arabia)).
11. Karatop, B., Kubat, C., & Uygun, Ö. (2015). Talent management in manufacturing system using

- fuzzy logic approach. *Computers & Industrial Engineering*, 86, 127-136.
12. Kasie, F. M., & Bright, G. (2023). Application of Fuzzy Case-Based Reasoning and Fuzzy Analytic Hierarchy Process for Machining Cutter Planning and Control. *Advances in Fuzzy Systems*, 2023(1), 8072930.
 13. Lavrynenko, S., Kondratenko, G., Sidenko, I., & Kondratenko, Y. (2020, September). Fuzzy logic approach for evaluating the effectiveness of investment projects. In *2020 IEEE 15th International Conference on Computer Sciences and Information Technologies (CSIT)* (Vol. 2, pp. 297-300). IEEE.
 14. Lu, J., Bai, D., Zhang, N., Yu, T., & Zhang, X. (2016). Fuzzy case-based reasoning system. *Applied Sciences*, 6(7), 189.
 15. Osiro, L., Lima-Junior, F. R., & Carpinetti, L. C. R. (2014). A fuzzy logic approach to supplier evaluation for development. *International Journal of Production Economics*, 153, 95-112.
 16. Papageorgiou, E. I. (2011). A new methodology for decisions in medical informatics using fuzzy cognitive maps based on fuzzy rule-extraction techniques. *Applied Soft Computing*, 11(1), 500-513.
 17. Rajabi, M., Hossani, S., & Dehghani, F. (2019). A literature review on current approaches and applications of fuzzy expert systems. *arXiv preprint arXiv:1909.08794*.
 18. Sabahi, F., & Akbarzadeh-T, M. R. (2014). Introducing validity in fuzzy probability for judicial decision-making. *International Journal of Approximate Reasoning*, 55(6), 1383-1403.
 19. Sarkheyli-Hägele, A., & Söffker, D. (2020). Integration of case-based reasoning and fuzzy approaches for real-time applications in dynamic environments: current status and future directions. *Artificial Intelligence Review*, 53(3), 1943-1974.
 20. Seleem, S. N., Attia, E. A., Karam, A., & El-Assal, A. (2020). A lean manufacturing road map using fuzzy-DEMATEL with case-based analysis. *International Journal of Lean Six Sigma*, 11(5), 903-928.
 21. Sun, Z., & Finnie, G. (2007). A fuzzy logic approach to experience-based reasoning. *International Journal of Intelligent Systems*, 22(8), 867-889.
 22. Surma, J. (2015). Case-based approach for supporting strategy decision making. *Expert Systems*, 32(4), 546-554.
 23. Uğur, L. O., & Baykan, U. N. (2016). An Investigation About The Fuzzy Logic Applications In Construction Management. *Düzce Üniversitesi Bilim ve Teknoloji Dergisi*, 4(1), 207-226.
 24. Varshavskii, P., Sesin, A., & Bashlykov, M. (2024, April). Implementation of a System for Teaching the Basics of Fuzzy Logic Inference Systems and Fuzzy Case-Based Reasoning. In *2024 7th International Conference on Information Technologies in Engineering Education (Inforino)* (pp. 1-5). IEEE.
 25. Zarandi, M. F., Razaee, Z. S., & Karbasian, M. (2011). A fuzzy case based reasoning approach to value engineering. *Expert Systems with Applications*, 38(8), 9334-9339.



Research & Reviews: Discrete Mathematical Structures

ISSN (e): 2394-1979
Impact Factor(SJIF) : 6.209

Acceptance Letter



Dear Author,

Congratulations on the acceptance of article **“Optimizing Sampling Techniques Using Fuzzy Set Theory: A Comprehensive Approach”** for publication in **Research & Reviews: Discrete Mathematical Structures**. This letter serves as our formal acceptance of your paper. We affirm that your paper has met Journal’s Peer- Reviewed publication criteria.

Your diligent efforts and commitment have yielded success, and we are privileged to publish your work. Journal’s editorial team has conducted a comprehensive review of your manuscript, and we believe it will add significant value to the field of Mathematical Structures.

Author Name: * Sangeeta Malik

Co - Author: Ritu Yadav

Co – Author: Pratiksha Tiwari

Manuscript Title: Optimizing Sampling Techniques Using Fuzzy Set Theory: A Comprehensive Approach

Article received date: 28th March, 2025

Article accepted date: 22th April, 2025

Indexing: Cite Factor, Directory of Research Journals Indexing (DRJI), Genamics, Google Scholar, Index Copernicus, Journal TOCs, Scientific Indexing Services (SIS)

Thank you very much for submitting your article.

With Best Regards,

Dr. Engin Ozkan

Editor-in-Chief

Research & Reviews: Discrete Mathematical Structures



JournalsPub, A Division of Dhruv Infosystems Pvt Ltd

Editorial office: A-118, 2nd Floor Sec-63 Noida - 201301 (U.P.) India

www.journalspub.com, www.stmconferences.com

E-mail: info@journalspub.com Tel.: 0120 - 4781200/204/206/211

DIAS Technology Review

The International Journal for Business & IT

Vol. 19 No.2

#38

www.dias.ac.in



October 2022 – March 2023

ARTICLES

Transitioning Workspaces: Analyzing the Post-COVID Impact of Flexible Work on Work-Life Balance in MNCs of Delhi NCR

Ms. Aanchal Gupta, Ms. Sonali Taneja

Understanding Employee Engagement: A Moderation Analysis Perspective

Dr. Vikas Gautam, Dr. Harsh Vardhan Kothari

Relationship Analysis of Selected Stocks and Funds

Dr. Pratiksha Tiwari, Ms. Neetu Chadha

Rightsizing: Is this a Right Strategy for Surviving Workforce in IT Industry

Dr. Anju Batra

Customer Satisfaction Influencers: An Empirical Investigation of Online Banking Services

Dr. Rohit Mahajan, Dr. N. Malati

DOCTORAL ABSTRACT

A Study on the Impact of Microfinance Programme on Rural Poor in Delhi and Haryana

Dr. Aarti Haswani



Transitioning Workspaces: Analyzing the Post-COVID....Pg.09

DELHI INSTITUTE OF ADVANCED STUDIES

Cloud-Based Mechanized Method for Developing Semantically Rich Ontologies and Planning Analogies for E-comfort Bids

*Ms. Dimpy Jindal, **Prof. Manju Kaushik, ***Dr. Barkha Bahl

ABSTRACT

The ontology framework at the temperament of the semantic web is a powerful method for representing and visualising domain knowledge. Estimating similarity measures between ontologies, determining a threshold, and employing if-then procedures to validate relevance and irrelevance all contribute to the reusability of knowledge. Knowledge visualisation at a reduced level is supplied by simplified semantic representations of the ontology, which is particularly useful for processing and analysing e-health data. Resolving implicit knowledge, which often develops in the attendance of implicit information and polymorphic objects and manifests as non-dominant words and conditionally dependent actions, enables the creation of semantically complex constructs. In this study, we clarify in detail how the automated system constructs and stores ontology structures rich in semantics. Graph Derivation Representation, which is based on dyadic deontic logic, is used to construct ontologies with a high density of meaning. In addition, the usual cosine similarity metric is used to determine the degree of similarity between two ontologies. In response to a document stored in the cloud, basic if-then rules are used to count how many relevant documents there are and retrieve their corresponding metadata. These functional modules are used in e-health applications for document recovery, information removal, and domain dictionary generation, and they will be of great help to authenticated cloud users. According to the diabetes dataset experiments, the suggested framework outdoes the state-of-the-art Graph Derivation Representation methods. The visual representations of the paper's findings provide another perspective for evaluating the usefulness of the proposed methodology.

KEYWORDS

Ontology framework, Semantic web, Knowledge visualisation, E-health data, Graph Derivation Representation, Dyadic deontic logic, Cosine similarity, Cloud-based document retrieval

*Assistant Professor, Delhi Institute of Advanced Studies, Delhi, India

**Professor at Amity Institute of Information Technology, Rajasthan, India

*** Ex-Director, Trinity Institute of Professional Studies, Delhi, India



DIAS Technology Review

The International Journal for Business & IT

Vol. 20 No.2

#40

www.dias.ac.in



October 2023 – March 2024

ARTICLES

Contributing to the Sharing Economy: A Bibliometric Mapping of Fashion Rental Services

Ms. Ronika Bhalla, Prof. (Retd.) Meenakshi Handa, Dr. Amit Sharma

The Study of Factors Influencing the Adoption of mHealth Applications Among the Consumers of Health Services.

Dr. Divya Mohan

Hedging in Factor Portfolios: A Regime-Switching Perspective on the Indian Market

Ms. Komal Garg

Organizational Commitment Among Gen Z: The Role of Job Security, Development, and Well-being

Dr. Pratiksha Tiwari

Volatility in the Banking Sector: A Multivariate Study of FPI and Key Economic Indicators

Ms. Neetu Chadha



DOCTORAL ABSTRACT

Factors Affecting Customer Satisfaction: An Empirical Investigation on Online Banking Services

Mr. Rohit Mahajan

Contributing to the Sharing Economy....Pg.08

DELHI INSTITUTE OF ADVANCED STUDIES

Re-Accredited 'A' Grade by NAAC Approved by ACITE and Affiliated with GGSIP University, Delhi

(An ISO 9001:2008 Certified Institution)

Plot No.6, Sector 25, Rohini, Delhi 110085

Tel.: 011-27932742/9355990933/9355990934, www.dias.ac.in, dias@dias.ac.in



Does Regime-Dependent Volatility Drive Dynamism in Investor Herding?

Komal Jindal^a ✉, Meera Bamba^b, Mamta Aggarwal^c

^{a,c}Department of Commerce, Indira Gandhi University, India

^bDepartment of Commerce, Chaudhary Bansi Lal University, India

Abstract

The existing literature on herding often uses the static model to test herd behaviour in the Indian market context. Hence, the objective of this paper is to investigate the dynamic herd behaviour for S&P BSE 500 from 2009-2023 using the Markov Regime Switching model. Results exhibit the occurrence of three regimes, namely, high, low, and extremely volatile regimes. Findings suggest that the Indian market moves into the order of low, high, and extreme volatility (LHC), similar to other developed countries. This has implications for investors to either exit from the market or reframe their portfolio through hedging techniques before the market enters into extreme volatility. Moreover, the results exhibit anti-herding in high and low-volatile regimes. Our study discloses the presence of herding in crashes or extremely volatile regimes, showing that Indian investors start following each other during crash-like situations. This research is significant for individual investors, portfolio managers, and stock market regulators.

Keywords: Dynamic Herding, Indian Equity Market, Three Regime-Switching Model, Volatility Regime, Markov Model

Received:
28 August 2023

Accepted revised version:
11 March 2024

Published:
30 June 2024

Suggested citation: Jindal, K., Bamba, M. & Aggarwal, M. (2024). Does regime-dependent volatility drive dynamism in investor herding? *Colombo Business Journal*, 15(1), 54-79.

DOI: <https://doi.org/10.4038/cbj.v15i1.169>

© 2024 The Authors. This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/) which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

✉ komal.comm.rs@igu.ac.in

 <https://orcid.org/0000-0001-9544-2722>

Introduction

The most common type of bias in the financial market is herd instinct or herd behaviour. In general terms, herding means following other investors with superior information while suppressing their beliefs. Many causes behind herd behaviour can be deduced from the theoretical literature. As many previous studies have explained, herding can arise due to reputational concerns, informational cascade effect, superiority of information, and a complex informative structure environment (Avery & Zemsky, 1998; Bikhchandani et al., 1992; Scharfstein & Stein, 1990). Moreover, these types of behavioural biases can cause volatility to be high and extreme market situations in the equity market (Litimi, 2017). Analysing herding is very important because it can cause high volatility in the market, enlarging the gap between the market price and fundamental price of any stock and creating a bubble-like situation in the stock market (Bikhchandani et al., 1992; Chiang & Zheng, 2010). This encourages the investors to make correct decisions, resulting in an efficient market. An understanding of herd behaviour enables better investment decisions with portfolio diversification. With this objective, we investigate herding in the Indian stock market. There are multiple reasons for choosing the Indian stock market. First, emerging economies like India have the presence of herding due to cultural differences, incomplete enforcement laws, and uneducated and uninformed investors (Chang et al., 2000; Kanojia et al., 2022; Lao & Singh, 2011). Second, India is the fastest-growing economy in emerging markets, with more relaxed regulations related to foreign capital. This, in turn, led to an enormous flow of foreign institutional investment in India. So, it is observed that during extreme market situations, investors start following Foreign Institutional Investors (FIIs) and move in the same direction.

This research adds multiple insights into the herding literature. First, the existing study applies the Regime Switching constant probability model with three Markov states for the Indian stock market in which herd behaviour may or may not exist. In the case of volatile situations, the investors have become risk averse and start following the market trend to avoid excess risk. However, other types of investors exploit the benefits of an extremely volatile market by earning higher excess returns. Hence, it might be possible that investors react differently in various volatile situations. So, it is highly important to address the dynamic herding along with dynamic volatility. Herding can also be addressed through other linear models like structural break or Autoregressive Moving Average (ARMA) models. However, we have chosen the regime model to identify the hidden Markov states as it divides the market into multiple regimes based on the stochastic process. This model easily captures the dynamic pattern of complex time-series data (Shakya et al., 2017). The

three-regime model enables us to investigate the dynamic nature of cross-sectional dispersion and how structural breaks or events move the series into different regimes or states where herd behaviour can be observed (Balcilar et al., 2013). This is because linear models cannot capture the time-varying properties of any non-linear series (Chauhan et al., 2020; Choi & Yoon, 2020; Garg & Gulati, 2013; Lao & Singh, 2011). Second, less research has considered the significant autocorrelation property of cross-sectional absolute deviation in time-varying models, and this study includes two lag terms of explained variables in the Regime Switching model. Third, we establish the role of volatility in driving the dynamic herding in the Indian financial market.

The present study examines herding using both linear and non-linear models. First, the results are calculated through a linear herding model. Then, the non-linearity is tested in the financial time series, and several regimes are identified. After that, the Markov Regime Switching model is applied to investigate the dynamic herding in multiple regimes. We identified the existence of three regimes in the Indian market with high, low, and extreme volatility. Here, an extremely volatile regime means changing prices suddenly or abruptly by moving the series to a very high or very low. However, there is a bidirectional shifting of high and extreme volatile regimes, identical to the study of Balcilar and Demirer (2015), motivating the market regulators to make a mechanism to stop the market transitions from high to extreme volatile regimes.

The paper is ordered as follows: Section 2 contains the related studies. The data and empirical framework are presented in Section 3. Section 4 examines the results and analysis, and Section 5 presents the conclusion and implications of the study.

Literature Review

Theoretical Background

Many previous studies have examined the concept of herding and the factors that can lead to a herd-like situation in the stock market (Avery & Zemsky, 1998; Bikhchandani et al., 1992; Spyrou, 2013; Wermers, 1999). Furthermore, Herding is an irrational behaviour that persuades investors to make decisions based on others' information. Market participants can cause herding for various reasons; for example, managers do herding out of reputational concern (Scharfstein & Stein, 1990). They present a learning model where the labour market can update the understanding of managers' abilities due to their investment decisions. This behaviour may be socially inefficient but is rational from the managers' standpoint. Likewise, Bikhchandani et al. (1992) exhibit an informational cascade as the cause behind local conformity and

the fragility of mass behaviour. An informational cascade occurs when it is optimal for the individual to observe the actions of others while ignoring their private information. However, it can soon be fragile when new information arrives in the market. In their theoretical model, Avery and Zemsky (1998) explain that herding behaviour is not possible in the long run in a simple informational structural environment. However, the more complex informative structure can lead to herd behaviour and the creation of a price bubble in the short run in the case of multidimensional uncertainty. Literature suggests two types of herding, which investors can reflect on. One is rational herding, and another is irrational herding. Rational herding is unintentional or spurious based on the fundamental information available to all (Bikhchandani & Sharma, 2000; Galariotis et al., 2015). Irrational herding is intentional and based on information unavailability (Shiller et al., 1984; Trueman, 1994).

Herding in the Financial Market

Earlier empirical studies have primarily relied on two strands of methodology to measure herd behaviour. Lakonishok et al. (1992) has checked out the impact of institutional trading on stock prices. As an institutional trader, they have taken the trading of money managers to measure herding in the equity funds. Their model is based explicitly on the buying and selling order of money managers for a particular stock in a quarter. The other technique that measures flocking toward market consensus using the famous Cross-Sectional Standard Deviation (CSSD) and Cross-Sectional Absolute Deviation (CSAD) was proposed and modified by Chang et al. (2000) and Christie and Huang (1995), respectively. Many empirical studies employ the CSSD to assess the herding. Tan et al. (2008) applies the linear model in the Chinese market and observes significant herding. Chiang and Zheng (2010) explore uniformity at the global level using CSAD, showing important herding in advanced stock markets and Asian markets. Rompotis (2018) checks the uniformity in exchange-traded funds with the help of a linear model and exhibited no herding in Exchange-Traded Funds (ETFs). Choi and Yoon (2020) study uniformity in the Korean equity market using a cross-sectional absolute deviation approach and find herding behaviour during down market returns. Moreover, some studies also investigate herding during or after the outbreak of COVID-19. Nguyen and Vo (2023) examine the herding in the Vietnamese stock market during and after the pandemic. Results reveal the existence of herd behaviour during and after the pandemic, stating that these crisis-like situations exacerbate the similarity in the financial market. Likewise, recently published Tauseef (2023) studies herd behaviour in the Pakistan

stock market during the financial crisis and COVID-19. They report significant herding during the COVID-19 period and the financial crisis. Ferreruela and Mallor (2021) describe herding before and after the global financial crisis but no herding during the pandemic. They also observe significant evidence of herding during the pandemic but during the time-high volatile periods only.

Later, the studies on herding shift their analysis to more advanced econometric models to identify the time-varying nature of herding. Hwang and Salmon (2004) first propose a model measuring dynamic herding that relies on monthly betas using Kalman filter's state-space model. Similarly, Arjoon and Bhatnagar (2017) study herding behaviour in Frontier markets. They examine both static and dynamic herding, as well as herding during times of volatility. To analyse time-varying herding, they utilise a state-space model. Their findings suggest that herding evolves as the behaviour of investors changes with fluctuations in information flow. Recently published Yang and Chuang (2023) examine dynamic herding in highly volatile US, Taiwan, and China markets. They have applied the Kalman filter model and the GARCH model for analysis. Results explain the similarity among the market investors in volatile periods during the financial crisis but low herding during the pandemic. From the above studies, it can be observed that researchers have shifted their interest toward dynamic herd behaviour. Schmitt and Westerhoff (2017) have clearly stated that a speculator's herd behaviour increases the volatility clustering in the market using the agent-based market model. Blasco et al. (2012) check out the impact of herding on volatility in the Spanish stock market. Results indicate the presence of a linear relationship between herding and volatility. Likewise, Fei and Liu (2021) also analyse the role of herding in stimulating volatility in the Chinese stock market. Findings exhibit that herding can stimulate volatility but to a different degree. The above-stated studies on herding and volatility signify a significant relationship between volatility and herding. Hence, the present study chooses to investigate the role of herding with particular reference to volatility in the Indian stock market. Herding is generally a short-lived phenomenon prominent in extreme market situations, which is measured by using daily or intraday data (Gleason et al., 2004). Hence, by considering the short-term presence of herding, Klein (2013) explains the dynamic herding using the Markov Switching SUR model and reveal herd behaviour during high volatility. Several empirical studies use a regime-switching model with two or three regimes to address the herding impact. Balcilar et al. (2013) propose a three-regime Markov model and tested the herd mentality in the Gulf Arab Stock Market. They show herd behaviour in the Crash regime. Balcilar and Demirer (2015) investigate the herding in Borsa Istanbul by applying the dynamic

transition probability Regime-Switching model. They arrive at the same result of herding in extreme/highly volatile regimes, consistent with previous studies. Similarly, using the Regime-Switching model, Babalos et al. (2015) check dynamic herding in the US Real estate market. They imply significant herding in the crash regime and the evidence of negative herding in low/high volatility. Likewise, Kabir and Shakur (2018) investigate herding in various international markets using a smooth transition regression model. Their study indicated that most countries, including India, herd in highly volatile regimes. Akinsomi et al. (2018) examine herd behaviour in the real estate investment trust in the UK. They divide the market into three regimes: low, high, and extreme volatile periods. They find no herding using the static model and exhibit significant herding in the low volatile periods compared to anti-herding in high volatile periods. Fu and Wu (2021) investigate the herd mentality among Chinese market investors and find that herding is regime-dependent in high-volatile regimes. Similarly, Ah Mand and Sifat (2021) establish evidence of prominent herding in high-volatile regimes in Bursa Malaysia. Javaira et al. (2023) establish a relationship between volatility and dynamic herding in the energy sector during COVID 19. They find that herding is significantly affected by three volatility measures: global volatility, oil market volatility, and pandemic volatility.

Indian-Specific Evidence on Herding

Many studies related to herding have also been conducted in the Indian financial market. Lao and Singh (2011) discover a herd-like situation in the Indian financial market during market uncertainty using the CSAD static model from 1999-2009. Similarly, Garg examine uniform behaviour in normal and extreme market conditions from 2000-2013. The results convey the message that no imitation by investors in either type of situation. A study by Poshakwale and Mandal (2014) investigate herd mentality using the Kalman filter in the National Stock Exchange of India. They exhibit that herding increased due to market volatility after allowing time-varying variables. Kumar et al. (2016) document no uniformity among the Indian market participants in both normal and uncertain market situations for 2008-2015. Ganesh et al. (2017) investigate the uniform behaviour in the Indian bourses for 2005-2015 and find evidence of no herding overall except in 2011 and 2014. Ansari and Ansari (2021) have recently measured herding for 2007-2018 using the static model in normal and bull/bear phases. Their findings show the anti-herding among Indian market participants in all market conditions. Similarly, Kanojia et al. (2022) exhibit no herding for the Indian market using the CSAD methodology for the period 2009-2018. The evidence depict no herding in any market conditions. Shrotryia and Kalra

(2022) have studied herding in Brazil, Russia, India, China and South Africa (BRICS) using a quantile regression approach. The evidence of their study discloses anti-herding in the Indian financial market.

Research Gap

From the above discussion, it is discovered that literature on Indian herding has shown evidence of no herding or anti-herding in the Indian stock market. Still, some studies show that herding may be present during crisis periods. All studies have used the static approach to measure herding by skewing towards analysing herding in up/down market conditions. Although the regulations regarding investment have been considerably improving after liberalisation in the Indian stock market. However, India is still an emerging country with more small retail investors who behave irrationally in extreme market situations (Ansari & Ansari, 2021). Moreover, the Indian stock market has involved the greater entry of foreign institutional investors in the recent decade, making the Indian market vulnerable to various investor sentiments like herd behaviour and positive feedback trading (Mukherjee & Tiwari, 2022). Furthermore, various unprecedented events like COVID-19 increased the inefficiency in the Indian stock market (Bhatia, 2022). Domestic investors started following the foreign investors in a similar manner. All these reasons mentioned above make the study interesting to explore whether, with time, herding behaviour has evolved or vanished in the Indian market. Our study differs from the recent study of Ansari and Ansari (2021) in several ways. First, they test herding in the up/down market, but we have analysed flocking with particular reference to volatility. Second, they have used a static model to measure the herding., We explore the dynamic nature of herding in a three-regime specification. The study of Poshakwale and Mandal (2014) investigate herd mentality using the Kalman filter in the National Stock Exchange of India. They rely on monthly beta rather than daily or intraday. Kabir and Shakur (2018) explore uniformity in high- and low-volatile regimes in multiple countries, including India, using the smooth transition model. However, our study differs from their methodological framework as we incorporate a three-regime specification using the Markov regime-switching model. As many previous studies indicate, the Markov regime switching model provides more flexibility with the point of time as compared to other non-linear models like GARCH or Kalman filter (Akinsomi et al., 2018; Babalos et al., 2015; Balcilar & Demirer, 2015; Fu & Wu, 2021; Kabir & Shakur, 2018; Mand & Sifat, 2021). It is suitable for the time series, the behaviour of which is not permanent, but reverts repeatedly. The Markov regime switching model captures even a tiny shift in a series and estimates time-varying coefficients more accurately. Hence, there is a trend that various studies shifted their

focus towards the Markov regime switching models over time. Moreover, the results of past studies depict that CSAD has properties of regime-switching. To the best of our knowledge, no research in India has explored dynamic herd behaviour in the Indian market context using the Markov-Regime Switching framework. Against this backdrop, the objective of the present study is to assess the presence or absence of dynamic herd behaviour in the Indian stock market using the Markov regime switching Model.

Data and Econometric Framework

Data

Data comprises daily stock-adjusted closing prices of individual stocks listed in S&P BSE 500 for 1/01/2009 to 31/03/2023 in the Indian equity market. Daily data can be considered high-frequency data in some contexts because it provides more precision than weekly or monthly data (Hung, 2019; Jebran & Iqbal, 2016). Information is lost in weekly or monthly data because it averages out the daily effect. Although many studies have considered intraday data as high-frequency data due to time and data availability constraints, we have taken daily data as the next best alternative to high-frequency data, which can depict volatility more clearly than other low-frequency data. Data has been collected using the Prowess IQ database from CMIE (Centre for Monitoring Indian Economy). We selected the study period from 2009 because, before that period, more than 50% of companies were excluded from the study 500 due to a high number of missing observations. First, those companies registered after the 1st of January 2009, are excluded from the study to match the number of observations of all companies. Later, the companies with missing data up to 10% of the total number of observations during the period are replaced using the linear interpolation method (Mertler et al., 2021). The total number of observations is 3531, and sample companies included in the analysis are 338 out of 500. After screening and cleaning the data, the cross-sectional individual and market returns are calculated. We have calculated our market return proxy by giving equal weights to each stock in the portfolio, as also calculated by many numbers of studies (Chang et al., 2000; Chiang & Zheng, 2010; Garg & Gulati, 2013; Kanojia et al., 2022). As such, we have not used value-weighted returns in CSAD calculation. For applying Markov Regime Switching models, it is necessary to test whether financial time series have a regime-switching framework or not. Hence, we applied the Linearity likelihood ratio, and Davies tests to check the same. Lastly, the results are calculated using the Regime and Static models. The analysis work has been performed using Ox-metrics 7.0.

Econometric Framework

This section explains the models used for the analysis work. Specifically, we started with the calculation of stylised facts of the variables used in the study. It provides the direction in which time series variables are going on. Next, for analysing the herding, the baseline model of Chang et al. (2000) is used. As the presence of structural breaks in high-frequency time series data and after finding the evidence of fat-tail, volatility clustering, and non-normal distribution in the studied variable, it is necessary to address these issues aptly. Hence, the appropriate regime-switching model is used to address these issues and analyse dynamic herding. However, before applying this model, we checked for non-linearity in the model through the likelihood ratio test and Davies upper bound test. Next, various information criteria are used to know the exact number of regimes. Lastly, the regime model specification is applied to measure time-varying herding in multiple regimes with the exact number of regimes to be known.

Static Model

The model to measure herd behaviour is CSSD, introduced by Christie and Huang (1995), and CSAD, improved by Chang et al. (2000). The methodology relies on the conditional Capital Asset Pricing model which describes the association of firm-level dispersion and the absolute market return is positive and linear. This relationship becomes negative and non-linear if herding occurs in the financial market.

The Firm return dispersion is calculated as follows:

$$CSAD_t = \frac{1}{N} \sum_{i=1}^N |R_{i,t} - R_{m,t}| \quad (1)$$

Here, N is the total number of sample companies included in the study and $R_{i,t}$ is the returns of individual stock on a day t. $R_{m,t}$ is the equally weighted average market returns of all sample companies on a day t.

$$CSAD_t = \gamma_0 + \gamma_1 |R_{m,t}| + \gamma_2 (R_{m,t} - \bar{R}_m)^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \varepsilon_t \quad (2)$$

The negative and significant value of γ_2 represents the herd behaviour. The idea behind the CCK (Chang, Cheng, and Khorana) model is that absolute market return and dispersion have a positive and linear relationship. Due to the presence of herd behaviour, this relationship becomes non-linear and negative. Investors start acting similarly while purchasing stocks, and the returns of stocks gather around the market return, leading the dispersion series to decrease or increase at a decreasing rate. The presence of absolute and squared market returns in the same model leads to high multicollinearity, which becomes a problem in the OLS models. Hence, to remove the multicollinearity, we follow the study of Yao et al. (2014), which deducts the

mean of market return from the squared market return to remove multicollinearity. Moreover, the study incorporates the two-lag term of the dispersion variable in the model to address the strong autocorrelation quality of dispersion. The study includes only two lag terms because higher-order lag does not improve the results (Lao & Singh, 2011). Many empirical studies included the lag term in their model to remove the autocorrelation. The study uses the heteroscedasticity and autocorrelation consistent standard errors of Newey and West (1987) and adds the lag term of the dependent variable to obtain the regression coefficients.

Regime Switching Framework

The behaviour of many financial time series may change over time permanently (known as structural breaks), or may shift from one type to another type and revert (known as regime shifts). The regimes here are unobservable. One of the most widely used methodologies to model this type of non-linearity is Markov Regime-Switching model (Brooks, 2008) in which, regime-switching may occur at the error term's mean and standard deviation. Hamilton (1989) proposed an algorithm based on the discrete-state regime shifts in the Markov process., This study also follow the same approach and models herding using the Regime-Switching model.

Through formal testing, the study found three regimes in the Indian market by following the seminal work of Balcilar et al. (2013) and Fu and Wu (2021). Equation (2) is extended by dividing the series into three regimes shifting across intercept and standard deviation, as shown in equation (3). All the variables vary across regimes except lags of the dependent variable.

$$CSAD_t = \gamma_{0,r_t} + \gamma_{1,r_t}|R_{m,t}| + \gamma_{2,r_t}(R_{m,t} - \overline{R_m})^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \sigma_{r_t} \varepsilon_t \quad (3)$$

Here, $\varepsilon_t \sim N(0,1)$ is the innovation term, and σ_{r_t} is the standard deviation, a measure of volatility. r_t is discrete regime variable that can take the values $r_t = [0,1,2, \dots, m]$ by following the three-state first order Markov process. The Markov property is based on the transition probabilities, which are constants across states and represented by the following specifications:

$$P(r_{t+1} = i | r_t = j) = p_{ij} \quad (4)$$

with

$$\sum_{j=1}^m p_{ij} = 1, \text{ where } j = 0,1,2, \dots, m \text{ and } 0 \leq p_{ij} \leq 1$$

where p_{ij} is the constant transition probabilities in regime i at a time $t+1$. The estimation method used for the regime switching model is the maximum likelihood, and robust standard error is calculated using Hessian and OPG matrices. The study used Excel, E-views 9.0, and Ox-metric 7.0 statistical software for the analysis.

Empirical Results and Discussion

This part explains the analysis of both linear and Regime-Switching models. First, we describe the variables' characteristics using stylised facts on return and dispersion. After that, results of both linear and Regime Switching models are shown with non-linear testing of the time series before applying the switching model.

Stylised Facts

Table 1 explains the stylised facts of market return and cross-sectional dispersion. The mean of CSAD (1.54%) is more significant than the market return (0.07%), suggesting higher variations in dispersion series than market returns. The standard deviation of the CSAD (0.36%) is less than the market return (1.14%), highlighting the volatility clustering in the dispersion series. Skewness is negative for market returns, indicating the high negative returns, while the skewness is positive for CSAD. Moreover, the kurtosis is very high for both the series representing Fat-tails. Furthermore, the Jarque-Bera statistics are significant, showing a non-normal distribution. The Augmented Dickey-fuller test is performed on intercept only to check the stationarity of the data. The stationarity test (Augmented Dickey-Fuller test) shows that the variables are stationary at level.

Table 1: Stylised Facts

Statistics	CSAD	R _m
Mean	1.54%	0.07%
Std. Dev.	0.36%	1.14%
Skewness	2.39	-1.10
Kurtosis	13.96	13.60
Observations	3531	3531
ADF Test	-7.802 ***	-19.86 ***
Jarque-Bera test	21055.95 ***	17275.15 ***
ACF1	0.785	0.159
ACF5	0.627	0.051
ACF20	0.421	-0.000

Notes: 1. *** $p < 0.01$. Jarque-Bera is for testing normality in the series.

2. ACF is the autocorrelation function up to n lags. ADF is the Augmented Dickey-Fuller test to check stationarity.

The Auto-correlation function at different lags for the CSAD series is significant. It implies that the dispersion series is positively auto-correlated to higher levels of lags and shows signs of volatility clustering. The ACF of market returns is almost significant at higher lags, and the series has no trend. This means the market returns have a lower serial correlation with their previous values than the cross-sectional dispersion. These findings are in tune with various earlier studies that applied the Regime Switching models for fat-tails, volatility clustering, and higher serial correlation (Balcilar et al., 2013; Cont, 2010; Fu & Wu, 2021; Sen & Subramaniam, 2019; Singh & Singh, 2017).

Results of Herd Behaviour in Static Model

Here, Table 2 (second column) reports the estimates of the linear OLS (Ordinary Least Square) model put forth by Chang et al. (2000). First of all, the outcomes of the static model from Equation (2) state that the coefficient γ_2 that measures the herd behaviour is insignificantly positive, showing the absence of herding in the overall market in the Indian market when linear OLS regression is used.

Table 2: Estimation Results of Static and Markov Three Regime Switching Model

Coefficients	Static Model Result	Regime Model Result
γ_{00}	0.003 (0.0002) ***	0.006 (0.0003) ***
γ_{01}	NA	0.004 (0.0002) ***
γ_{02}	NA	0.005 (0.0004) ***
γ_{10}	0.151 (0.0158) ***	0.081 (0.025) ***
γ_{11}	NA	0.107 (0.0080) ***
γ_{12}	NA	0.227 (0.0369) ***
γ_{20}	0.379 (0.4652)	2.516 (0.2320) ***
γ_{21}	NA	1.450 (0.190) ***
γ_{22}	NA	-0.529 (0.2861) *
γ_3	0.503 (0.0204) ***	0.443 (0.0191) ***
γ_4	0.197 (0.020) ***	0.147 (0.0168) ***
σ_0	0.0018***	0.0017 (0.000) ***
R^2	0.75	NA
σ_1	NA	0.0012 (0.000) ***
σ_2	NA	0.0036 (0.0001) ***
P_{00}	NA	0.95
P_{11}	NA	0.97
P_{22}	NA	0.74 (Contd.)

Coefficients	Static Model Result	Regime Model Result
N ₀	NA	806
N ₁	NA	2473
N ₂	NA	250
N	3529	3529
τ ₀	NA	29.85
τ ₁	NA	41.92
τ ₂	NA	4.31
AIC	-9.778	-10.022
LOG L	17258.58	17704.55
LR test	-	891.94***
Davies test	-	0.000***

- Notes: 1. The table reports the result of two models i.e., Static model: $CSAD_t = \gamma_0 + \gamma_1 |R_{m,t}| + \gamma_2 (R_{m,t} - \bar{R}_m)^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \varepsilon_t$. Regime-Switching model : $CSAD_t = \gamma_{0,r_t} + \gamma_{1,r_t} |R_{m,t}| + \gamma_{2,r_t} (R_{m,t} - \bar{R}_m)^2 + \gamma_3 CSAD_{t-1} + \gamma_4 CSAD_{t-2} + \sigma_{r_t} \varepsilon_t$
2. Standard error is shown in parenthesis. The standard errors of the linear model are estimated using Newey and West HAC standard errors.
3. For the regime model, robust-standard errors are calculated with the BFGS Algorithm.
4. AIC is the Akaike information criterion.
5. Log L is the log-likelihood of the model. LR is the likelihood ratio test with their respective *p*-values and Davies test *p*-values.
6. **p* < 0.1, ***p* < 0.05, ****p* < 0.01.

Many previous Indian research studies find similar results of no herding at the overall market level using the static model (Garg & Gulati, 2013; Kanojia et al., 2022; Lao & Singh, 2011). However, it is possible that these studies did not detect herding using a static model due to the time-varying nature of the return dispersion series. Moreover, both lag term coefficients are significant, which supports using two lagged values of the dependent variable to overcome the autocorrelation problem in the return dispersion series (Benkraiem et al., 2021; Yao et al., 2014). The study has also calculated the results by incorporating three lags of the dependent variable in Equation (2). However, the results do not improve much; hence, only two lag terms are included in the static model.

Results of Herd Behaviour in the Regime Switching Model

Before selecting the regime switching model for dispersion series, it is essential to identify the non-linearity in the time series. It is better to know before testing whether the regime switching model is a superior fit to the data. To check the non-linearity, by referring to Babalos et al. (2015) and Balcilar et al. (2013), the present study has calculated the standard likelihood ratio test statistic using log-likelihood

values which follows χ^2 distribution with q degree of freedom of regimes. However, in the Markov Regime Switching model, unidentified nuisance parameters exist under the null hypothesis (Brooks, 2008), and therefore, standard distribution does not apply to it. Hence, we also reported the p -values calculated using the approximate upper bound test proposed by Davies (1987).

Table 3 depicts the rejection of the static model at a 1% level of significance in favour of the regime-switching model. It means that the dispersion series is non-linear and has the presence of multiple regimes. Moreover, in deciding the exact number of regimes, the LR and Davies test strongly reject two regime-switching models against a three-regime- model at a 1% level of significance.

Table 3: Likelihood Ratio Test for Different Models

H₀: static H₁: MS (2)	H₀: static H₁: MS (3)	H₀: MS (2) H₁: MS (3)
703.96***	891.94***	187.98***
(0.000) [0.000]	(0.000) [0.000]	(0.000) [0.000]

- Notes: 1. Static model shows OLS regression using Equation (2).
 2. MS (s) is the regime-dependent intercept variance model with r number of regimes.
 3. *** $p < 0.01$.
 4. Linearity Likelihood ratio test is used to calculate test statistics.
 5. The chi-square p -values are reported in parenthesis along with the p -values of Davies (1987) in square brackets.

Table 4 shows the log-likelihood and Akaike information criteria of the various estimated models with multiple regimes. It is clearly shown in the Table that the highest log likelihood is of the three-regime model, along with the lowest Akaike Information criteria. From the above criteria and formal tests, the study found that three regime models fit the study.

Table 4: Best-Fitted Model Measures

	Linear	MS (2)	MS (3)
Log Likelihood	17258.58	17610.56	17704.55
AIC	-9.778	-9.973	-10.022

- Notes: 1. AIC shows Akaike information criteria.
 2. The static model shows OLS regression using Equation (2).
 3. MS is the regime-dependent variance model for 2 and 3 regimes in Equation (3).

Studies have stated that the Markov model is more suitable for explaining dynamic herding and its various states (Balcilar et al., 2013; Mand & Sifat, 2021). Moreover, there are studies in the past that extend the CSAD approach in the Regime framework and explain the non-linearity in the CSAD model in both developed and emerging economies (Akinsomi et al., 2018; Babalos et al., 2015; Balcilar et al., 2013; Mand & Sifat, 2021)., The results of our study also exhibit the presence of different regimes in the CSAD model, and the information criteria are lower for the regime model than the static model. Hence, the study has applied the regime specification for modeling non-linear properties of herding specification and calculating the time-varying herding parameter along with regime switching.

Table 2 (third column) discloses the results of the Regime Switching model. To avoid overfitting variables and have parsimony in the model, this study assumes that serial correlation is regime-independent, similar to Fu and Wu (2021). For identification of regimes into high, low, and extreme volatility, the study closely examines the standard deviation of the error term represented by σ_{r_t} . Standard deviation of Regime 2 (0.0036) is exceptionally high as compared to high volatility regime 0 (0.0017) and low volatility regime 1 (0.0012).

The main coefficients of interest that measure herding in the Regime Switching model are γ_{20} (Regime 0), γ_{21} (Regime 1) and γ_{22} (Regime 2). The coefficients γ_{20} and γ_{21} are positively significant in high and low volatile regimes, respectively, implying negative herding in the Indian financial market. It means that Indian market participants make rational decisions when the market is highly volatile and stable. The possible reason for the negative herding is the ‘flight-to-quality’ or ‘overconfidence’ of investors during an unstable market (Ansari & Ansari, 2021; Gebka & Wohar, 2013). Lastly, γ_{22} is negative and significant in extreme volatile or crash regime 2, indicating that the investors are imitating each other when market is extremely volatile or in crash-like situations due to some unprecedented events. It may be because investors follow institutional investors to avoid extreme losses in extreme or crash regimes. The result of significant herding during extreme or crash regimes is in line with the findings of Balcilar and Demirel (2015) and Balcilar et al. (2013), which show herding during extremely volatile regimes in Borsa Istanbul and GCC markets. Moreover, the extremely volatile regime has 250 observations of the total number of observations, showing that three regime specifications fit the study. As residual diagnostics, we consider log Likelihood, Akaike Information criteria, the Portmanteau test, and the ARCH test for testing heteroscedasticity and autocorrelation. Table 4 shows that the regime model has a higher log-likelihood and lower AIC than the static model.

Table 5: Residual Diagnostic for Scaled Residuals

Scaled Residuals	Distribution	Statistics	<i>p</i> -value
Normality	Chi (2)	13.827	0.0022
Asymptotic normality	Chi (2)	12.266	0.0010
ARCH (1-1 test)	F (1,3507)	2.057	0.1516
Portmanteau (26)-squared scaled residuals	Chi (26)	26.708	0.4247

Moreover, Table 5 shows that the coefficient of the ARCH 1-1 test is insignificant, depicting no conditional heteroscedasticity in the fitted model.¹ The insignificant Portmanteau test statistic indicates the absence of any dependence structure or autocorrelation in the residuals, suggesting that the model is correctly specified.

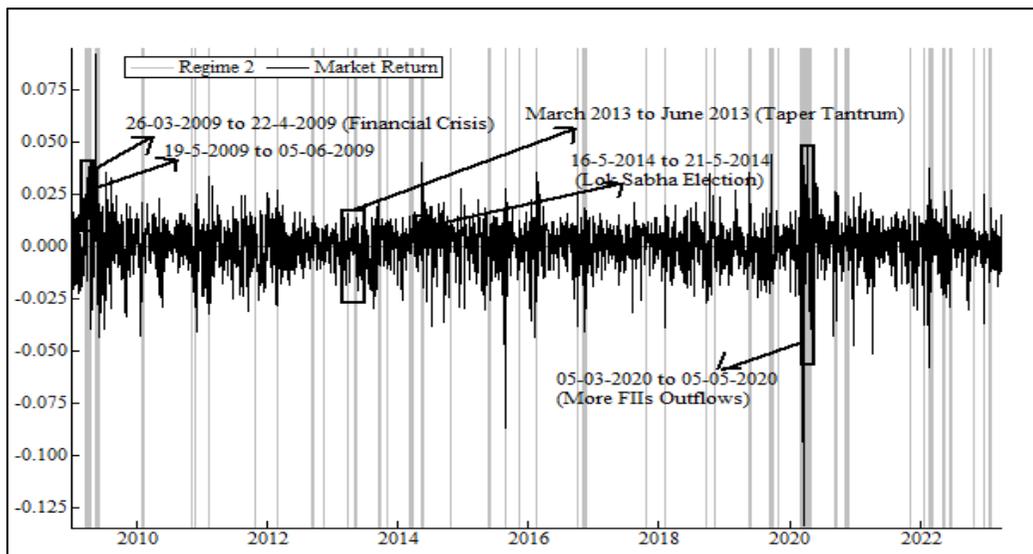
Persistence of Market Regimes

It is equally important to look at other essential features of Markov Switching-model such as transition probabilities (p_{ij}) and smoothed probabilities for fitting the Regime Switching model to the data. Initially, the market is in regime j at time t and Table 2 shows the transition probabilities (P_{00} , P_{11} and P_{22}) of remaining in regime j at time $t+1$. The probability here suggests that the decoded regimes are stable and will remain persistent within the existing regimes. The high volatile regime 0 has 22.84 % number of observations compared to a low volatile regime with 70.08 % observations. However, the transition probability of a low volatile regime is 0.97 compared to the other two regimes, showing the high persistence of a low volatile regime. Moreover, the extreme volatile regime and high volatile regime transition probabilities are 0.749 and 0.95, respectively, depicting the validity of regimes. The mean duration of a low volatile regime is 41.92 days, implying that Regime 1 will last approximately 42 days. While the high volatile regime lasts 29.85 days, it implies that Regime 0 will last about 30 days. The average duration of extreme volatile regime is 4.31 days, indicating Regime 2 will last approximately four days. This depicts that

¹ We also conducted robustness checks to ensure the presence of Three-Regime specification and accuracy of the results. First, analysis was done from the Period 2010-2023 and then from 2012-2023. The results of both time periods show significant evidence of herding in Extreme or crash volatile regime with three regimes. ARCH 1-1 test null hypothesis is accepted at 1% significance level. Moreover, we also calculated the herding by assuming the switching in variance and other variables except the constant term. The results are similar to the fitted Markov intercept and variance regime switching model showing the presence of herding in the extreme volatile regime. However, the model is not a best fit so we applied the intercept and variance regime switch model. Results are not shown here to conserve space.

the low volatile regime is highly persistent compared to other regimes, similar to the findings of Balcilar et al. (2013). Figure 1 shows the period when significant herding was observed in the market. Although there are many instances of herding in the whole sample period, the long-lasting ones are as follows: The first most extended extreme volatility regime was from 26-03-2009 to 22-04-2009 (16 days), and then the market switched to high volatility. Then again, in Regime 2, the long-lasting regime is from 19-05-2009 to 05-06-2009, which is for 14 days, followed by the highly volatile regime. It means the Indian market has volatility clustering after the crash or extremely volatile regime in 2009. This outcome can be confirmed by the Ali and Afzal (2012), which also found volatility clustering in the Indian and Pakistan Equity markets during the crisis and a more substantial negative impact on the Indian stock market.

Figure 1: Market Returns Showing Significant Herding in Extreme Volatile Regime



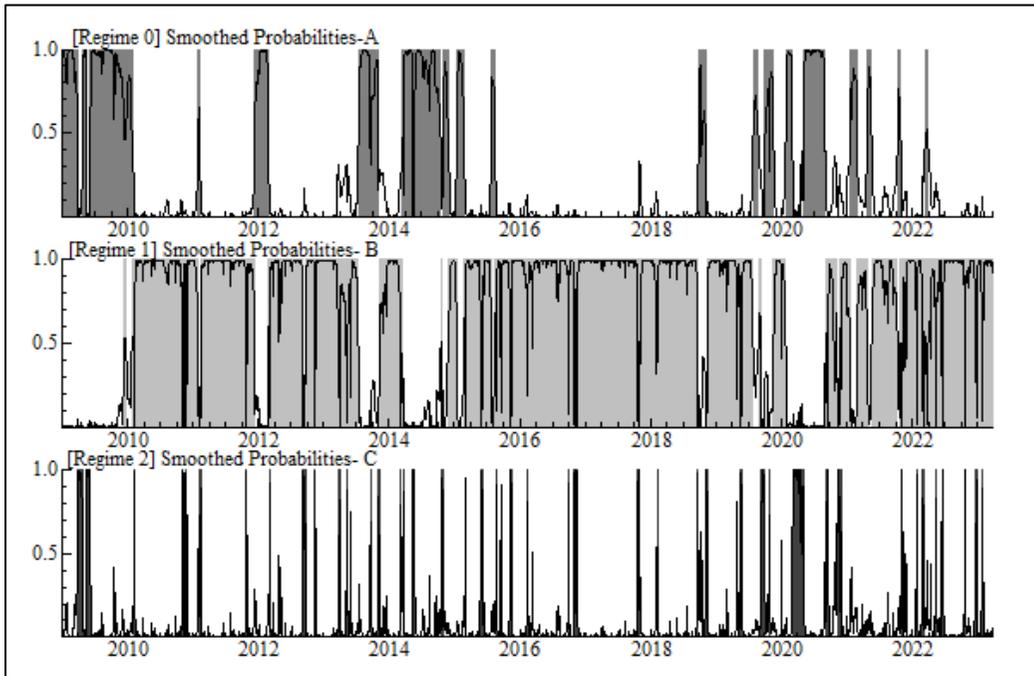
The possible reason for this is the Global Financial Crisis (GFC) or subprime crisis, which started approximately in 2007 and continued until 2009 (Bekiros et al., 2017; Litimi, 2017). The reason may be, like any other developed and emerging country, the Indian stock market crashed during the global economic turmoil, so the investor ignored their information and followed the overall market during uncertainty. However, as the high volatility regime persisted during that time, Indian investors stopped pursuing each other. This means the GFC crisis spillover effect is longer, i.e., 88 days, during the entire period.

Next, the market is in extreme volatility from March 2013 to June 2013, showing significant herding. It may be due to the ‘Taper-Tantrum’. The US Federal Reserve slowed the treasury bond purchases to revive the market from the financial crisis, increasing the bond yield. This leads to an outflow of FIIs from the Indian market and a market crash from the end of May to the end of August (Modak, 2021; Roychoudhury, 2021). This major sell-off may have led to sell-side herding by Indian investors. Next, extreme volatility was observed from 16-05-2014 to 21-05-2014. The Indian market is extremely volatile due to the Lok Sabha election result announced on 16th May 2014. Investors have become highly optimistic and started purchasing shares uniformly, hoping to earn excess returns (Kumar, 2019).

An extreme volatility regime can also be observed from 05-03-2020 to 05-05-2020. This extreme volatility was caused by the FII outflows due to coronavirus outbreak, and the fact that World Health Organisation (WHO) recognised COVID-19 as a pandemic on 11th March 2020. The uncertainty and volatility increased worldwide after the pandemic (Ali et al., 2020; Saini et al., 2023). The negative sentiments and high uncertainty led to a herd mentality in the Indian financial market during that period. Also, the Indian government announced Janata Curfew on 22nd March 2020 and lockdown policies to be followed from 24th March 2020 (Bora & Basistha, 2021). So, the adverse shocks further stimulated uncertainty and volatility, especially in BSE Sensex in the Indian financial market (Bora & Basistha, 2021).

Bharti and Kumar (2021) clearly state that volatility stimulated the herd mentality among Indian participants during the pandemic. However, in April 2020, the market moved very high again due to the relaxation in lockdown policy by the Indian government in April 2020 and the introduction of various stimulus packages for economic revival (Bharti & Kumar, 2021; Bora & Basistha, 2021). Ampofo et al. (2023) specify that the pandemic has also increased herding in developed countries. Figure 2 (A-C) highlights the smoothed probabilities of all three regimes. The smoothed probabilities graphs also depict the switching of different regimes. We found the order of low, high, and extreme volatility patterns for the Indian market. The market is usually in a highly volatile regime before extreme volatility. This shows that investors can predict the market will crash or become extremely volatile, so they should reframe their market portfolio strategy. We have also seen the Indian market go into high volatility after a sudden crash or extreme volatility, showing volatility clustering. This depicts the bidirectional switching of the extreme and high volatility regimes similar to the findings of Balcilar and Demirer (2015).

Figure 2: Smoothed Regime Probabilities for Regime 0 (High Volatile), Regime 1 (Low Volatile), and Regime 2 (Extreme Volatile), Respectively



Conclusion

This research takes a deep dive into the dynamic nature of herd behaviour in the Indian financial market for 2009-2023 using the Markov Regime Switching and linear OLS regression models. We employ Chang et al. (2000)'s base model for measuring uniformity. The results of the static model show no herding across the whole sample period. The results of no herding corroborate the findings of Ansari and Ansari (2021) and Kanojia et al. (2022). The regime model identifies three regimes as high (Regime 0), low (regime 1), and extreme volatility regime (Regime 2), respectively. Our findings demonstrate significant herding in crash or extreme volatile regime. However, we find frequent switching of extremely volatile regimes with significant herding, which lasts only on average for approximately four days., The long-lasting, extremely volatile regimes with significant herding are 2009, 2013-2014, and 2020, due to unprecedented events like the GFC crisis, Taper-tantrum, presidential election, and COVID-19 pandemic. A recent study, Sachdeva et al. (2021), clearly states that information uncertainty increases the uniformity in the Indian market. Moreover, the study exhibits anti-herding during the high and low volatile regimes. The findings of anti-herding in a low volatile regime are in line with those of Fu and Wu (2021) because investors make decisions rationally at times of

certainty. We observe the pattern of low, high, and crash/extreme volatility in the Indian capital market. This suggests that investors can predict extreme or crash situations because the market first enters into low volatility followed by high and then crashes. The outcomes of our research are significant for investors and market regulators. Investors should form an appropriate strategy to readjust their market portfolio at high volatility or not be captivated by the excess returns created by bubbles in extreme market situations. These results illustrate that the Indian market has become efficient with time as regulations continuously improve and information transmission becomes transparent. Hence, investors should make decisions based on the company's fundamentals, but during any uncertainty, they are exposed to high sentiments and follow each other. Investors need to construct more extensive portfolios at times of high volatility to maintain the same level of diversification (Chiang & Zheng, 2010; Fu & Wu, 2021). Bidirectional switching in extreme and highly volatile regimes guides market regulators in making a mechanism during crises or intense periods to stop the market from going into extreme situations (Balcilar & Demirer, 2015). This research adds new insights into Indian herding literature by adding evidence for dynamic herding in the Indian stock market. It will guide the researchers to add new dimensions to the same to further explore this aspect. The study is limited to only 338 companies out of 500. A separate study will also be conducted on the remaining companies, which may affect herding. Moreover, we only consider static transition probabilities in the study. Further research can be conducted by considering other exogenous variables like market sentiments or global factors that impact herding through the time-varying transition probabilities regime model. Moreover, one can differentiate between different types of herding as we measured herding at market consensus.

Declaration of Conflicting Interests

The authors declared no potential conflict of interest with respect to the research, authorship, and publication of this article.

References

- Akinsomi, O., Coskun, Y., Gupta, R., & Lau, C. K. M. (2018). Impact of volatility and equity market uncertainty on herd behaviour: Evidence from UK REITs. *Journal of European Real Estate Research*, 11(2), 169–186. <https://doi.org/10.1108/JERER-06-2017-0021>
- Ali, M., Alam, N., & Rizvi, S. A. R. (2020). Coronavirus (COVID-19): An epidemic or pandemic for financial markets. *Journal of Behavioral and Experimental Finance*, 27, 100341. <https://doi.org/10.1016/j.jbef.2020.100341>

- Ali, R., & Afzal, M. (2012). Impact of global financial crisis on stock markets: Evidence from Pakistan and India. *E3 Journal of Business Management and Economics*, 3(7), 275–282.
https://www.e3journals.org/cms/articles/1342846725_Afzal.pdf
- Ampofo, R. T., Aidoo, E. N., Ntiamoah, B. O., Frimpong, O., & Sasu, D. (2023). An empirical investigation of COVID-19 effects on herding behaviour in USA and UK stock markets using a quantile regression approach. *Journal of Economics and Finance*, 47(2), 517–540. <https://doi.org/10.1007/s12197-022-09613-8>
- Ansari, A., & Ansari, V. A. (2021). Do investors herd in emerging economies? Evidence from the Indian equity market. *Managerial Finance*, 47(7), 951–974.
<https://doi.org/10.1108/MF-06-2020-0331>
- Arjoon, V., & Bhatnagar, C. S. (2017). Dynamic herding analysis in a frontier market. *Research in International Business and Finance*, 42, 496–508.
<https://doi.org/10.1016/j.ribaf.2017.01.006>
- Avery, C., & Zemsky, P. (1998). Multidimensional uncertainty and herd behavior in financial markets. *American Economic Review*, 88(4), 724–748.
<https://www.jstor.org/stable/117003>
- Babalos, V., Balcilar, M., & Gupta, R. (2015). Herding behavior in real estate markets: Novel evidence from a Markov switching model. *Journal of Behavioral and Experimental Finance*, 8, 40–43.
<https://doi.org/10.1016/j.jbef.2015.10.004>
- Balcilar, M., & Demirer, R. (2015). Effect of global shocks and volatility on herd behavior in an emerging market: Evidence from Borsa Istanbul. *Emerging Markets Finance and Trade*, 51(1), 140–159.
<https://doi.org/10.1080/1540496X.2015.1011520>
- Balcilar, M., Demirer, R., & Hammoudeh, S. (2013). Investor herds and regime-switching: Evidence from Gulf Arab stock markets. *Journal of International Financial Markets, Institutions and Money*, 23(1), 295–321.
<https://doi.org/10.1016/j.intfin.2012.09.007>
- Bekiros, S., Jlassi, M., Lucey, B., Naoui, K., & Uddin, G. S. (2017). Herding behavior, market sentiment, and volatility: Will the bubble resume? *The North American Journal of Economics and Finance*, 42, 107–131.
<https://doi.org/10.1016/j.najef.2017.07.005>
- Benkraiem, R., Bouattour, M., Galariotis, E., & Miloudi, A. (2021). Do investors in SMEs herd? Evidence from French and UK equity markets. *Small Business Economics*, 56(4), 1619–1637. <https://doi.org/10.1007/s11187-019-00284-0>
- Bharti., & Kumar, A. (2021). Exploring herding behaviour in Indian equity market during COVID-19 pandemic: Impact of volatility and government response. *Millennial Asia*, 13(3), 513–531. <https://doi.org/10.1177/09763996211020687>

- Bhatia, M. (2022). Stock market efficiency and COVID-19 with multiple structural breaks: Evidence from India. *Global Business Review*.
<https://doi.org/10.1177/09721509221110372>
- Bikhchandani, S., Hirshleifer, D., & Welch, I. (1992). A theory of fads, fashion, custom, and cultural change as informational cascades. *Journal of Political Economy*, 100(5), 992–1026. <https://www.jstor.org/stable/2138632>
- Bikhchandani, S., & Sharma, S. (2000). Herd behavior in financial markets. *IMF Staff Papers*, 47(3), 279–310. <https://doi.org/10.2307/3867650>
- Blasco, N., Corredor, P., & Ferreruela, S. (2012). Does herding affect volatility? Implications for the Spanish stock market. *Quantitative Finance*, 12(2), 311–327. <https://doi.org/10.1080/14697688.2010.516766>
- Bora, D., & Basistha, D. (2021). The outbreak of COVID-19 pandemic and its impact on stock market volatility: Evidence from a worst-affected economy. *Journal of Public Affairs*, 21(4), e2623. <https://doi.org/10.1002/pa.2623>
- Brooks, C. (2008). *Introductory econometrics for finance* (2nd ed.). Cambridge University Press. <https://doi.org/DOI:10.1017/CBO9780511841644>
- Chang, E. C., Cheng, J. W., & Khorana, A. (2000). An examination of herd behavior in equity markets: An international perspective. *Journal of Banking and Finance*, 24(10), 1651–1679. [https://doi.org/10.1016/S0378-4266\(99\)00096-5](https://doi.org/10.1016/S0378-4266(99)00096-5)
- Chauhan, Y., Ahmad, N., Aggarwal, V., & Chandra, A. (2020). Herd behaviour and asset pricing in the Indian stock market. *IIMB Management Review*, 32(2), 143–152. <https://doi.org/10.1016/j.iimb.2019.10.008>
- Chiang, T. C., & Zheng, D. (2010). An empirical analysis of herd behavior in global stock markets. *Journal of Banking and Finance*, 34(8), 1911–1921. <https://doi.org/10.1016/j.jbankfin.2009.12.014>
- Choi, K. H., & Yoon, S. M. (2020). Investor sentiment and herding behavior in the Korean stock market. *International Journal of Financial Studies*, 8(2), 34. <https://doi.org/10.3390/ijfs8020034>
- Christie, W. G., & Huang, R. D. (1995). Following the pied piper: Do individual returns herd around the market? *Financial Analysts Journal*, 51(4), 31–37. <https://doi.org/10.2469/faj.v51.n4.1918>
- Cont, R. (2010). Empirical properties of asset returns: Stylized facts and statistical issues. *Quantitative Finance*, 1(2), 223–236. <https://doi.org/10.1080/713665670>
- Davies, R. B. (1987). Hypothesis testing when a nuisance parameter is present only under the alternatives. *Biometrika*, 74(1), 33–43. <https://doi.org/10.2307/2336019>
- Fei, T., & Liu, X. (2021). Herding and market volatility. *International Review of Financial Analysis*, 78, 101880. <https://doi.org/10.1016/j.irfa.2021.101880>

- Ferreruela, S., & Mallor, T. (2021). Herding in the bad times: The 2008 and COVID-19 crises. *The North American Journal of Economics and Finance*, 58, 101531. <https://doi.org/10.1016/j.najef.2021.101531>
- Fu, J., & Wu, L. (2021). Regime-switching herd behavior: Novel evidence from the Chinese A-share market. *Finance Research Letters*, 39, 101652. <https://doi.org/10.1016/j.frl.2020.101652>
- Galariotis, E. C., Rong, W., & Spyrou, S. I. (2015). Herding on fundamental information: A comparative study. *Journal of Banking and Finance*, 50, 589–598. <https://doi.org/10.1016/j.jbankfin.2014.03.014>
- Ganesh, R., Naresh, G., & Thiagarajan, S. (2017). The reflection of crowd behaviour in Indian bourses. *International Journal of Behavioural Accounting and Finance*, 6(2), 93. <https://doi.org/10.1504/IJBAF.2017.086408>
- Garg, A., & Gulati, R. (2013). Do investors herd in Indian market. *Decision*, 40(3), 181–196. <https://doi.org/10.1007/s40622-013-0015-z>
- Gebka, B., & Wohar, M. E. (2013). International herding: Does it differ across sectors? *Journal of International Financial Markets, Institutions and Money*, 23(1), 55–84. <https://doi.org/10.1016/j.intfin.2012.09.003>
- Gleason, K. C., Mathur, I., & Peterson, M. A. (2004). Analysis of intraday herding behavior among the sector ETFs. *Journal of Empirical Finance*, 11(5), 681–694. <https://doi.org/10.1016/j.jempfin.2003.06.003>
- Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica*, 57(2), 357. <https://doi.org/10.2307/1912559>
- Hung, N. T. (2019). Return and volatility spillover across equity markets between China and Southeast Asian countries. *Journal of Economics, Finance and Administrative Science*, 24(47), 66–81. <https://doi.org/10.1108/JEFAS-10-2018-0106>
- Hwang, S., & Salmon, M. (2004). Market stress and herding. *Journal of Empirical Finance*, 11(4), 585–616. <https://doi.org/10.1016/j.jempfin.2004.04.003>
- Javaira, Z., Sahar, N. U., Hashmi, S. D., & Naz, I. (2023). Volatility and dynamic herding in energy sector of developed markets during COVID-19: A Markov regime-switching approach. *Fudan Journal of the Humanities and Social Sciences*, 17(1), 115–138. <https://doi.org/10.1007/s40647-023-00395-9>
- Jebbar, K., & Iqbal, A. (2016). Examining volatility spillover between Asian countries' stock markets. *China Finance and Economic Review*, 4(1), 1–13. <https://doi.org/10.1186/s40589-016-0031-1>
- Kabir, M. H., & Shakur, S. (2018). Regime-dependent herding behavior in Asian and Latin American stock markets. *Pacific-Basin Finance Journal*, 47, 60–78. <https://doi.org/10.1016/j.pacfin.2017.12.002>

- Kanojia, S., Singh, D., & Goswami, A. (2022). Impact of herding on the returns in the Indian stock market: An empirical study. *Review of Behavioral Finance*, 14(1), 115–129. <https://doi.org/10.1108/RBF-01-2020-0017>
- Klein, A. C. (2013). Time-variations in herding behavior: Evidence from a Markov switching SUR model. *Journal of International Financial Markets, Institutions and Money*, 26, 291–304. <https://doi.org/10.1016/j.intfin.2013.06.006>
- Kumar, A., Bharti, & Bansal, S. (2016). An examination of herding behavior in an emerging economy: A study of Indian stock market. *Global Journal of Management and Business Research*, 16(B55), 57–63. <https://journalofbusiness.org/index.php/GJMBR/article/view/101208>
- Kumar, C. (2019, May 22). *How the Sensex, Nifty reacted after Modi won 2014 elections*. Business Today. <https://www.businesstoday.in/markets/stocks/story/how-the-sensex-nifty-reacted-after-modi-won-2014-elections-201620-2019-05-22>
- Lakonishok, J., Shleifer, A., & Vishny, R. W. (1992). The impact of institutional trading on stock prices. *Journal of Financial Economics*, 32(1), 23–43. [https://doi.org/10.1016/0304-405X\(92\)90023-Q](https://doi.org/10.1016/0304-405X(92)90023-Q)
- Lao, P., & Singh, H. (2011). Herding behaviour in the Chinese and Indian stock markets. *Journal of Asian Economics*, 22(6), 495–506. <https://doi.org/10.1016/j.asieco.2011.08.001>
- Litimi, H. (2017). Herd behavior in the French stock market. *Review of Accounting and Finance*, 16(4), 497–515. <https://doi.org/10.1108/RAF-11-2016-0188>
- Mand, A. A., & Sifat, I. (2021). Static and regime-dependent herding behavior: An emerging market case study. *Journal of Behavioral and Experimental Finance*, 29, 100466. <https://doi.org/10.1016/j.jbef.2021.100466>
- Mertler, C. A., Vannatta, R. A., & LaVenja, K. N. (2021). *Advanced and multivariate statistical methods : Practical application and interpretation* (7th ed.). Routledge. <https://doi.org/10.4324/9781003047223>
- Modak, S. (2021, February 27). *Market sell-off brings back memories of the 2013 “taper tantrum”*. Business Standard. https://www.business-standard.com/article/markets/market-sell-off-brings-back-memories-of-the-2013-taper-tantrum-121022700045_1.html
- Mukherjee, P., & Tiwari, S. (2022). Trading behaviour of foreign institutional investors: Evidence from Indian stock markets. *Asia-Pacific Financial Markets*, 29(4), 605–629. <https://doi.org/10.1007/s10690-022-09361-z>
- Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3), 703–708. <https://doi.org/10.2307/1913610>

- Nguyen, Y. V. B., & Vo, A. H. K. (2023). Herding behavior before and after COVID-19 pandemic: Evidence from the Vietnam stock market. *Journal of Economic Studies*, 5(2), 357-374. <https://doi.org/10.1108/JES-01-2023-0031>
- Poshakwale, S., & Mandal, A. (2014). Investor behaviour and herding: Evidence from the national stock exchange in India. *Journal of Emerging Market Finance*, 13(2), 197–216. <https://doi.org/10.1177/0972652714541341>
- Rompotis, G. G. (2018). Herding behavior among exchange-traded funds. *Journal of Behavioral Finance*, 19(4), 483–497. <https://doi.org/10.1080/15427560.2018.1431886>
- Roychoudhury, A. (2021, March 26). *Explained: The 2013 taper tantrum and why its spectre is being raised again*. Money Control. <https://www.moneycontrol.com/news/business/economy/explained-the-2013-taper-tantrum-and-why-its-spectre-is-being-raised-again-6700731.html>
- Sachdeva, M., Lehal, R., Gupta, S., & Garg, A. (2021). What make investors herd while investing in the Indian stock market? A hybrid approach. *Review of Behavioral Finance*, 15(1), 19-37. <https://doi.org/10.1108/RBF-04-2021-0070>
- Saini, C., Sharma, I., Verma, B., & . B. (2023). Performance of equity ETFs during COVID-19 pandemic crisis: Evidence from India. *Abhigyan*, 41(3), 21–31. <https://www.ischolar.in/index.php/Abhigyan/article/view/223672>
- Scharfstein, D. S., & Stein, J. C. (1990). Herd behavior and investment. *The American Economic Review*, 80(3), 465–479. <https://www.jstor.org/stable/2006678>
- Schmitt, N., & Westerhoff, F. (2017). Herding behaviour and volatility clustering in financial markets. *Quantitative Finance*, 17(8), 1187–1203. <https://doi.org/10.1080/14697688.2016.1267391>
- Sen, R., & Subramaniam, M. (2019). Stylized facts of the Indian stock market. *Asia-Pacific Financial Markets*, 26(4), 479–493. <https://doi.org/10.1007/s10690-019-09275-3>
- Shakya, A., Michael, S., Saunders, C., Armstrong, D., Pandey, P., Chalise, S., & Tonkoski, R. (2017). Solar irradiance forecasting in remote microgrids using Markov switching model. *IEEE Transactions on Sustainable Energy*, 8(3), 895–905. <https://ieeexplore.ieee.org/abstract/document/7745906>
- Shiller, R. J., Fischer, S., & Friedman, B. M. (1984). Stock prices and social dynamics. *Brookings Papers on Economic Activity*, 1984(2), 457. <https://doi.org/10.2307/2534436>
- Shrotryia, V. K., & Kalra, H. (2022). Herding and BRICS markets: A study of distribution tails. *Review of Behavioral Finance*, 14(1), 91–114. <https://doi.org/10.1108/RBF-04-2020-0086>

- Singh, A., & Singh, M. (2017). Risk–return relationship in BRIC equity markets: Evidence from Markov regime switching model with time-varying transition probabilities: *Metamorphosis: A Journal of Management Research*, 15(2), 69–78. <https://doi.org/10.1177/0972622516675814>
- Spyrou, S. (2013). Herding in financial markets: A review of the literature. *Review of Behavioral Finance*, 5(2), 175–194. <https://doi.org/10.1108/RBF-02-2013-0009>
- Tan, L., Chiang, T. C., Mason, J. R., & Nelling, E. (2008). Herding behavior in Chinese stock markets: An examination of A and B shares. *Pacific Basin Finance Journal*, 16(1–2), 61–77. <https://doi.org/10.1016/j.pacfin.2007.04.004>
- Tauseef, S. (2023). Herd behaviour in an emerging market: An evidence of calendar and size effects. *Journal of Asia Business Studies*, 17(3), 639–655. <https://doi.org/10.1108/JABS-10-2021-0430>
- Trueman, B. (1994). Analyst forecasts and herding behavior. *Review of Financial Studies*, 7(1), 97–124. <https://doi.org/10.1093/rfs/7.1.97>
- Wermers, R. (1999). Mutual fund herding and the impact on stock prices. *Journal of Finance*, 54(2), 581–622. <https://doi.org/10.1111/0022-1082.00118>
- Yang, W. R., & Chuang, M. C. (2023). Do investors herd in a volatile market? Evidence of dynamic herding in Taiwan, China, and US stock markets. *Finance Research Letters*, 52, 103364. <https://doi.org/10.1016/j.frl.2022.103364>
- Yao, J., Ma, C., & He, W. P. (2014). Investor herding behaviour of Chinese stock market. *International Review of Economics and Finance*, 29, 12–29. <https://doi.org/10.1016/j.iref.2013.03.002>

Tech Tides: Analyzing Foreign Investment Flows and Volatility in the Information Technology Sector

Corresponding Author

1. **Ms. Neetu Chadha**, Research Scholar- School of Leadership and Management, MRIIRS and Assistant Professor, Delhi Institute of Advanced Studies, Correspondence Address: DIAS, Plot No.6, Sector-25, Rohini- Delhi- 110085, Email id: neetu.mhnd@gmail.com

Other Authors

2. **Dr. Ridhi Khattar**, Associate Professor- School of Leadership and Management, MRIIRS, Correspondence Address: MRIIRS, Sector-43, Faridabad, Haryana-121004, Email id: ridhi.slm@mriu.edu.in
3. **Dr. Meghna Chhabra**, Professor- FMS, Delhi School of Business, VIPS, Correspondence Address: AU Block, Outer Ring Road, Pitampura, Delhi-110034, Email id: meghna.chhabra@dsb.edu.in

Abstract

India's IT industry is very attractive to foreign investors because of its low operating costs, large pool of highly skilled workers, and supportive business climate created by government regulations. These regulations are designed with investors' demands in mind, with a special focus on subjects like blockchain technology, cybersecurity, hyper-scale computing, and artificial intelligence. India is the market leader in the world of service sourcing in terms of market share. The computer hardware and software industries have attracted the highest inflows of foreign investment, with US\$9.39 billion invested in them in FY23. This industry, which employs more than five million people, accounts for 53% of India's service export earnings. It is projected that the IT sector in India will contribute 10% of the country's GDP by 2025. FPIs have a significant impact on the IT sector in a number of ways, with an emphasis on how sector performance influences FPI investment decisions and vice versa while taking into account regional and global market trends, industry-specific regulations, and technological advancements.

This study examines the effects of foreign portfolio investments in the IT industry on sectoral returns and volatility of corresponding sector stock index using weekly time series data spanning an eleven-year historical period from April 2012 to the final day of March 2023. This research indicates that growth in the IT sector will drive more foreign portfolio investment (FPI) flows into the Indian IT industry, as the FPI flows into the Indian IT sector are primarily determined by the performance and returns of the IT sector. Overall, this study demonstrates the complicated relationships and complexity of these financial and economic variables, offering valuable insights into the behavior of financial portfolio investors and how such relationships impact sectoral dynamics and macroeconomic stability.

Keywords: FPI, FIIS, IT, NIFTY-IT, Returns, Relationship, Stock, Volatility

Introduction

India's IT industry's value proposition is based on its varied ecosystem, young and talented talent pool, outstanding physical and digital infrastructure, vibrant domestic market, and strong government support. This is because the world is turning to India to lead the way in driving global transformation.

In a year marked by financial uncertainty, the IT sector persevered thanks to the demand for corporate software and IT services, which fueled significant cost reduction and automation agreements. Year 2023 saw a 4.4% year-over-year decline in global tech spending, mostly as a result of declining hardware and gadget sales. The growth in spending

was mostly due to increases in corporate software and IT services, which accounted for approximately 1.1 times the total spending on technology.

With the ongoing geopolitical unrest across the world causing investors to be more cautious and decision-making to be postponed, India's technology industry revenue (including hardware) is predicted to expand by 3.8% year over year to \$254 billion in FY2024, an increase of more than \$9 billion over the previous year. With a 3.3% year-over-year growth rate, exports are forecast to reach \$200 billion, while the domestic technology industry is predicted to increase at a 5.9% annual rate to surpass \$54 billion. The industry is nevertheless a net hirer, adding 60K workers to bring the total number of employees to 5.43 million (1.1% y-o-y growth) despite the challenging market conditions. The manufacturing, retail, healthcare, APAC, and Europe sectors stand out as the industry's main development areas.

India is the most popular offshore location for IT companies worldwide. Top IT firms in India now have a whole new set of options thanks to developing technologies, after proving they could offer both on-shore and off-shore services to clients worldwide. Thanks to favorable government regulations and rising demand, India's information technology (IT) industry is booming. Foreign investors now have extremely profitable chances to take advantage of the sector's notable expansion in revenue, labor, and innovation. India is a desirable location for investment due to its significant role in the global IT landscape. The Indian government has instituted several sector-specific incentives to stimulate manufacturing and exports, built Software Technology Parks and Centers of Entrepreneurship, and started activities under the Digital India Scheme in an effort to further incentivize investments. The IT and telecom sectors have been allotted US\$11.77 billion in the federal budget for FY 2023–2024.

As per the National Association of Software and Service Companies (NASSCOM), the revenue generated by the Indian IT industry in FY 2022 amounted to US\$227 billion, indicating a rise of 15.5 percent on a year-over-year basis. By 2026, the use of cloud computing is expected to boost India's GDP by US\$380 billion and generate many job possibilities for 14 million people.

Further foreign investment means that IT companies have access to additional capital. Increased sales and profits may result from using this money for expansion, R&D, and technological advancement. Best practices and cutting-edge technologies from their native nations are frequently brought by foreign investors. Higher returns may result from increased production and efficiency in the IT industry. IT companies can grow their customer base and potential revenue streams by entering new markets with the assistance of foreign investment. The influx of foreign investors frequently results in increased demand for IT sector equities, which can raise stock prices and raise the sector's overall market valuation.

Foreign investment has the potential to increase returns, but it can also increase volatility. When there is substantial foreign investment, the IT sector becomes more susceptible to developments in the world economy and investor mood. Increased volatility may result from things like shifts in foreign policy, geopolitical tensions, or worldwide economic downturns. Exchange rate fluctuations have an impact on foreign investments. The returns of foreign investors can be significantly impacted by significant variations in exchange rates, which might result in more volatile investment behavior. Speculative investing by foreign investors might lead to more short-term volatility. Sharp fluctuations in stock prices might result from unexpected capital inflows and outflows. Market volatility may rise in response to modifications to laws governing foreign investments, such as limitations or additional compliance standards.

Industries that receive a lot of foreign investment typically have more volatility. This is especially true for developing economies where there may be more unpredictable inflows of foreign cash. Foreign investment has proven to be beneficial for the Indian IT sector, as evidenced by the notable growth experienced by businesses such as Infosys and TCS. However, because of the state of the world market, the industry has also seen times of extreme volatility. Increased capital, technological transfer, and market expansion can result from foreign investment in the IT sector, potentially yielding higher profits. Because of its sensitivity to world events, exchange rate swings, speculative

investments, and regulatory issues, it also increases volatility. Investing professionals can effectively handle the effects by understanding these dynamics and utilizing proper risk management techniques.

There seems to be a close relationship between foreign portfolio investments, inflation, interest rates, sectoral performance, and predicted volatility. FPIs play a significant role in shaping the evolution of various economic sectors, and factors such as development opportunities, regulatory frameworks, and market conditions often influence their preferences. Furthermore, changes in expected volatility could lead to variances in FII behavior, which could alter how capital is allocated across different markets and industries. It is also well known that interest rates and exchange rates are correlated, with FPI inflows and outflows being influenced by central bank policies, which in turn affect changes in exchange rates. In a similar vein, FPI choices and changes in currency rates are seen to be impacted by inflation predictions, particularly in countries that are experiencing high inflation.

Overall, this analysis demonstrates the complexity and close relationships between these financial and economic variables, offering valuable insights into the behavior of FPIs and how it influences macroeconomic stability and sectoral dynamics.

Literature Review

Numerous studies, both qualitative and quantitative, are carried out with an emphasis on empirical research that sheds light on the mechanisms and impacts of FII influx. There are several recurrent topics and tendencies in the FPI literature. According to the Efficient Market Hypothesis (EMH), markets become more efficient with the presence of informed investors, including FIIs. This increased efficiency can lead to better pricing of stocks but can also introduce volatility as markets react swiftly to new information. The Capital Asset Pricing Model (CAPM) suggests that the expected return on an asset is related to its systematic risk. FIIs, by diversifying their portfolios internationally, can influence the risk-return profile of stocks. This can result in higher returns due to better risk management practices, but also increased volatility due to global risk factors.

FIIs bring capital, technology, and managerial expertise, which contribute to higher returns in the IT sector. FIIs introduce additional volatility due to their sensitivity to global events, rapid capital movements, and speculative behavior. Research continuously shows that FPIs display sectoral preferences according to variables including industry outlook, economic fundamentals, and regulatory environment. Aggarwal and Klapper's (2012) and Lahrech and Sylwester's (2017) empirical research emphasizes the significance of sectoral allocation techniques in FII behavior.

The IT industry frequently draws significant foreign direct investment (FDI) because of its high growth and profitability potential. Anticipations of technical innovation, digital transformation, and worldwide demand for IT products and services are frequently the driving forces behind foreign direct investment (FDI) flows into the IT sector (Chen et al., 2018; Cavusgil et al., 2004). Research looks into how FPI affects IT companies' success as well as the performance of the larger technology sector. FPI inflows have the potential to boost IT firms' market capitalization, liquidity, and funding availability, all of which can support the expansion and competitiveness of the industry (Cameron et al., 2011; Cavusgil et al., 2004).

Choe, Kho, and Stulz (1999) examined the impact of foreign equity flows on emerging markets and found that foreign inflows tend to increase market returns and liquidity. However, these inflows also introduce higher volatility as foreign investors react more quickly to global events compared to domestic investors. Rai and Bhanumurthy (2004) analyzed the impact of FII flows on the Indian stock market, showing that FIIs have a significant effect on market returns and volatility. The study highlighted that while FIIs bring capital and growth, they also contribute to short-term market volatility.

(2019) shed light on how FII trading behavior and institutional traits affect market volatility. Kang et al. (2017) look into the connection between FII ownership and stock return volatility in emerging markets, while Choi and Lee (2019) study the effect of FII trading activity on volatility in Korean stock markets. One area of interest for investigation is the volatility of FPI flows in the IT industry. FPI exposes IT companies to market volatility and outside shocks, but it can also give them much-needed funding and expertise. Research looks at ways to reduce the effects of abrupt capital withdrawals and manage FPI-related risks (Gompers and Metrick, 2001; Li et al., 2020)

Alfaro, Chanda, Kalemli-Ozcan, and Sayek (2004) discussed how foreign direct investment (FDI) can positively impact economic growth through capital accumulation, technology transfer, and increased competition. These factors contribute to enhanced returns for the sectors receiving such investments, including IT. Kim and Singal (2000) found that stock markets tend to become more efficient and exhibit higher returns following the liberalization of foreign investments. Their study indicated that the IT sector, in particular, benefits from the technological and managerial expertise brought by foreign investors.

Bekaert and Harvey (1997) explored the volatility implications of financial market integration. They noted that while integration and foreign investment can lower the cost of capital and lead to higher returns, they also expose markets to global shocks, thereby increasing volatility. Eun and Resnick (1988) provided evidence that international diversification through FIIs reduces risk for global investors but can increase market volatility in the host country due to the rapid movement of capital.

Garg and Bodla (2011) focused on the IT sector in India and found that FII investments are a significant determinant of market returns and volatility. Their empirical analysis showed that periods of high FII inflows corresponded with higher stock prices and increased volatility in the IT sector. Narayan, Narayan, and Prasad (2008) studied the impact of FIIs on the stock markets of South Asia, highlighting the IT sector as a key beneficiary of foreign investments. They noted that while FIIs contribute to the growth of the IT sector, they also lead to greater sensitivity to global financial conditions.

Understanding the balance between these positive and negative impacts is crucial for policymakers and investors aiming to maximize the benefits of foreign investments while mitigating associated risks. This body of literature provides a comprehensive understanding of how FPIs shape the financial dynamics of the IT sector.

There are still a number of questions and points of contention in the literature on the relationship between FII, sectoral allocation, and volatility, despite the progress made in this area. First off, opinions differ over the precise processes by which FII inflows influence market volatility. Some research indicate that FIIs have a stabilizing influence on markets, while others highlight heightened volatility brought on by speculative activity and herding behavior.

Furthermore, little research has been done to investigate how FII sectoral allocation affects market dynamics in ways that go beyond the stock market. Future research might examine how FII inflows affect volatility across a range of asset types, such as bonds, commodities, and currencies.

With an emphasis on the stock market, this literature review offers insightful information about the connections between FII, sectoral allocation, volatility, and financial markets. Even though our understanding of these processes has advanced significantly, further study is still necessary to close the current knowledge gaps and resolve ongoing debates. This will help investors and policymakers better understand how FII inflows affect the efficiency and stability of the market.

Objectives of the Study

This study intends to investigate and evaluate the short- and long-term links and associations between flows of foreign portfolio investment in the Indian IT sector and the returns of IT companies in the Indian equities market, taking into

account the Nifty IT returns over an eleven-year period. An attempt has also been made to examine how sectoral returns and the volatility of the IT sector stock indexes are affected by foreign portfolio investments in the IT sector.

Methodology

The current research uses weekly time series data of the IT sector's FPI, and the sectoral index or Nifty IT taken from the NSE, as well as data of the VIX, interest rate, CPI, and exchange rate USD-INR for an eleven-year period, from April 2012 to March 2023.

The National Stock Exchange website has the VIX and Nifty-IT data, while from the official NSDL website, the weekly time series figures of FPI in the IT industry was retrieved. Information about interest rates, CPI, and the USD-INR exchange rate is taken from Investing.com.

The Augmented Dickey-Fuller (ADF) test is used to test the assimilation sequence for the FII-IT and Nifty IT series initially. In order to accomplish the stated goal of the investigation, this paper applies the Granger causality test. Another method in the study to determine whether the future expectedness of one variable effects another is the Granger causality test.

This paper uses the Granger causality test to achieve the study's declared objective. For the FII-IT and Nifty IT series, the sequence of assimilation is first tested using the Augmented Dickey-Fuller (ADF) test. The Granger causality test is another tool used in the study to assess if one variable's prospective expectedness influences another.

The next stage is to look for autoregressive conditional heteroscedasticity (ARCH) when stationarity has been determined. To put it simply, an ARCH test is a statistical model that is used to estimate future volatility by analyzing the time series volatility in data sets. One of the model's properties is its volatility clustering, which states that periods of low volatility are followed by low volatility and time frames of high volatility are followed by high volatility. The Lagrange Multiplier (LM) test (Jarque & Bera, 1980) is the most often used method for determining if the ARCH effect, as hypothesized by Engel (1982), is present in univariate time series data sets.

To put it simply, the alternate hypothesis (H1) contends that the series of residuals contains an ARCH effect, while the null hypothesis (H0) asserts that there are no ARCH effects in the series of residuals. In order to determine which of the ARCH models—GARCH/TARCH, EGARCH, and Threshold GARCH—is the best fit for each index, it was imperative to test for the presence of the ARCH effect in the corresponding Nifty-IT.

According to Hansen and Lunde (2001), GARCH (1,1) yields the most accurate volatility forecasting outcomes. Since Hansen and Lunde (2001) also contend that GARCH (p,q) will be employed in situations involving daily data spanning several decades or hourly data spanning multiple years, GARCH (2,1) is used in this instance. Since weekly data are used in this investigation, GARCH (2,1) is the most appropriate predictor for calculating the degree of volatility in the IT sector because GARCH (2,1) responds to shocks quickly.

Analysis & Results

TABLE 1: AUGMENTED DICKEY FULLER TEST(ADF)		
Variables	t-statistics	Probability
FPI-IT at Level	-9.050281	0.0000
Nifty-IT Returns at Level	-23.65695	0.0000
USD/INR Rate at 1 st difference	-22.16254	0.0000
CPI at 1 st difference	-26.05023	0.0000
Interest Rate at 1 st difference	-23.90475	0.0000

The findings of the Augmented Dickey Fuller Test, which are displayed in Table 1, indicate that the FPI in the IT sector series and the Nifty IT return series are stationary at level. Rest Three series of exchange rate, Inflation and Interest rates are stationary at first difference.

†

Null Hypothesis	F-statistics	Probability
Nifty-IT does not granger cause FPI-IT	33.1127	3.E-14
FPI-IT does not granger cause Nifty-IT	4.65325	0.0099
Interest rate does not Granger Cause Exchange rate	0.6315	0.5321
Exchange rate does not Granger Cause Interest rate	0.0260	0.9743
FPIIT does not Granger Cause Exchange rate	0.97913	0.3763
Exchange rate does not Granger Cause FPIIT	6.48695	0.0016
Interest rate does not Granger Cause NIFTY_IT	3.11065	0.0453
NIFTY_IT does not Granger Cause Interest rate	0.94726	0.3884
Inflation rate does not Granger Cause NIFTY_IT	1.70322	0.1830
NIFTY_IT does not Granger Cause Inflation rate	0.48627	0.6152
FPIIT does not Granger Cause Interest rate	0.80569	0.4473
Interest rate does not Granger Cause FPIIT	6.34572	0.0019
Inflation rate does not Granger Cause Interest rate	0.02849	0.9719
Interest rate does not Granger Cause Inflation rate	0.38668	0.6795
Inflation rate does not Granger Cause FPIIT	7.69817	0.0005
FPIIT does not Granger Cause Inflation rate	0.52704	0.5906

Moreover, the lead-lag relationship between FPI in the IT sector and Nifty-IT returns is investigated using the Granger causality test. The findings of the study categorically disprove the hypothesis that Nifty-IT does not cause FPI-Auto and vice versa. After examining the causal relationship between Nifty-IT and FPI movement in the IT sector, it was discovered that Nifty IT granger causes FPI flows in the industry. This illustrates how Nifty IT values can be used to forecast the industry's short-term FPI movements and how FPI flows within the IT sector impact sector returns. The test also demonstrated how the movement of FPI in the IT sector is influenced by the interest rate, inflation rate, and currency rate. The economy's interest rates have an effect on the changes in the It sector index i.e., NIFTY IT.

VARIABLES		Number of Hypothesised Equations	Maximum EIGEN Value	Critical Value at 0.05 Level	TRACE Statistic	Critical Value at 0.05 Level	Probability
FPI- IT	Nifty-IT	None	125.6910	40.07757	199.4651	95.75366	0.000
FPI- IT	Nifty-IT	Atmost 1	41.23703	33.87687	73.77415	69.81889	0.0055

Table 3 displays the results of the Johansen Cointegration test, which demonstrate that there is no cointegrating vector between FII in the IT industry and Nifty-IT. Since the Eigen value and Trace value for both series are bigger than their tabular values at the 5% level of significance, the test's basic premise is refuted. The rejection of the null hypothesis indicates the existence of a long-term relationship between FPI in the IT sector and Nifty-IT prices in the study, as well as at least one co-integrating vector between both. This shows that Nifty-IT and FPI in the IT industry have some long-term informational commonalities.

TABLE 4: GARCH results of FPI- IT, Macroeconomic factors and Nifty-IT volatility.		
	β	S.E
C	0.027570	0.023737
FPIIT	2.41E-06	4.45E-07
Variance Equation		
Interest Rate	-0.001296	0.001490
USD/INR	-0.000235	0.000620
VIX	-0.000500	0.000229
CPI	8.40E-05	0.000305
C	0.000239	9.05E-05
RESID(-1) ²	0.039425	0.051348
RESID(-2) ²	0.071025	0.045446
GARCH(-1)	0.561676	0.147130

FPIIT is Foreign portfolio investment in IT sector, RESID(1)² is squared error term and GARCH(¹) is effect of prior-period volatility. CPI is consumer price index, USD/INR exchange rate, VIX is Implied Volatility Index. SE is the standard error terms.

The volatility of the Nifty IT is significantly impacted by FPI. It suggests that rising FPI causes rising Nifty IT volatility. Interest rates, exchange rates, and inflation in the nation all affect international portfolio flows, especially those in the IT sector. The findings also demonstrate that when FPIs grow, stock prices become more vulnerable to their selling pressure, which drives down stock values. These findings suggest that interest rates have a significant influence in luring foreign portfolio investors (FPI) to the nation and in providing a framework upon which FDI can be pursued. Furthermore, the importance of FPI in the IT sector indicates that the Indian financial system is developing, which will aid in understanding various investment environments.

Conclusion & Discussion

The current study examined the impact of foreign portfolio investments on returns in the Indian IT industry. Apart from the impact, the association between FPI flows in the IT sector and Nifty IT returns was also determined by examining the weekly time series data over an eleven-year span, beginning in April 2012 and concluding on the final day of March 2023, using the Granger Causality and Johansen co-integration tests. The two variables in the study exhibit more integration and more tightly coordinated motions. The results show that the FPI has a great influence on the Nifty IT's volatility. It implies that increased volatility in the Nifty IT is caused by rising FPI. Interest rates, exchange rates, and inflation in the nation all affect international portfolio flows, especially those inside the IT sector.

The study provides policymakers with a number of recommendations for bolstering the Indian stock market. First, given the current state of the economy, India has embraced a policy to encourage Foreign Portfolio Investors (FPIs) in its capital markets. This is because FPIs boost capital inflows into the nation while maintaining the nation's low level of foreign debt. However, when FPIs expand and put pressure on stock prices to sell, stock prices become more vulnerable. However, because DIIs offer a reliable source of funding, the government must increase domestic

involvement and investment. This is to be achieved by altering the nation's tax laws, investment, and saving outlooks. Second, increased financial stability and efficiency are needed by small-cap companies, particularly those that are still developing. Due to the fact that these companies are a significant source of employment and national development, the government must create appropriate rules for their sustainable financial development. There is a shortage of jobs in these companies after any financial setback. The goal of policy should be to keep FPIs and DIIs in balance. In addition to promoting the FPI flow, domestic investment institutions such as mutual funds, insurance funds, and pension funds should be highlighted. Investors and portfolio managers will find the study's findings useful in understanding the relationship between FPI and stock market volatility and developing more effective volatility strategies to maximize investment returns. This research can be expanded in a number of ways. To start, high-frequency data provides further understanding of market activity. While high-frequency information about market pricing is accessible, it is not available for FPI and DII trading. Second, it will be helpful to look into how the flow of FPIs and DIIs affects things both generally and specifically for individual stocks.

References

- [1] Aggarwal, R., & Klapper, L. (2012). Does FDI facilitate domestic entry? Evidence from the Czech Republic. *Review of International Economics*, 20(4), 692-707.
- [2] Alfaro, L., Chanda, A., Kalemli-Ozcan, S., & Sayek, S. (2004). FDI and economic growth: the role of local financial markets. *Journal of International Economics*, 64(1), 89-112.
- [3] Bekaert, G., & Harvey, C. R. (1997). Emerging equity market volatility. *Journal of Financial Economics*, 43(1), 29-77.
- [4] Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2011). Robust Inference With Multiway Clustering. *Journal of Business & Economic Statistics*, 29(2), 238-249.
- [5] Cavusgil, S. T., Knight, G., & Riesenberger, J. R. (2004). *International Business: Strategy, Management, and the New Realities*. Pearson Education.
- [6] Chen, Y., Zhang, J., & Hu, Z. (2018). The Impact of Foreign Direct Investment on Innovation: Evidence From China's Manufacturing Industry. *Technological Forecasting and Social Change*, 132, 143-152.
- [7] Choi, B. E., & Lee, H. S. (2019). The impact of foreign institutional investors' trading behavior on stock price volatility: Evidence from Korea. *Sustainability*, 11(9), 2481.
- [8] Eun, C. S., & Resnick, B. G. (1988). Exchange rate uncertainty, forward contracts, and international portfolio selection. *The Journal of Finance*, 43(1), 197-215.
- [9] Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance*, 25(2), 383-417.
- [10] Garg, A., & Bodla, B. S. (2011). Impact of FDI Investment on Volatility of Indian Stock Market: An Empirical Investigation. *Journal of Business Management & Social Sciences Research*, 1(1), 23-26.
- [11] Gompers, P., & Metrick, A. (2001). Institutional Investors and Equity Prices. *Quarterly Journal of Economics*, 116(1), 229-259.
- [12] Kang, D., Lee, K., & Park, C. W. (2019). The Effects of Regulatory Changes on Foreign Portfolio Investment: Evidence From the Korean Stock Market. *Pacific-Basin Finance Journal*, 56, 35-51.
- [13] Kim, E. H., & Singal, V. (2000). Stock market openings: Experience of emerging economies. *Journal of Business*, 73(1), 25-66.
- [14] Lahrech, A., & Sylwester, K. (2017). Foreign direct investment and poverty reduction: A review of the literature. *World Development*, 99, 285-296.
- [15] Li, Z., Chen, C., & Lu, Z. (2020). The Impact of Foreign Portfolio Investment on Corporate Risk-Taking: Evidence From China. *International Review of Economics & Finance*, 67, 295-312.
- [16] Narayan, P. K., Narayan, S., & Prasad, A. (2008). Understanding the oil price-exchange rate nexus for the Fiji islands. *Energy Economics*, 30(5), 2686-2696.

- [17] Rai, K., & Bhanumurthy, N. R. (2004). Determinants of Foreign Institutional Investment in India: The Role of Return, Risk, and Inflation. *The Developing Economies*, 42(4), 479-493.
- [18] Sharpe, W. F. (1964). Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance*, 19(3), 425-442.

FPI in It Sector: Navigating Investment Flows and Market Volatility

Ms. Neetu Chadha,

Research Scholar- School of Leadership and Management, MRIIRS and Assistant Professor, Delhi Institute of Advanced Studies, Correspondence Address: DIAS, Plot No.6, Sector-25, Rohini- Delhi- 110085, Email id: neetu.mhnd@gmail.com

Dr. Ridhi Khattar,

Associate Professor- School of Leadership and Management, MRIIRS, Correspondence Address: MRIIRS, Sector-43, Faridabad, Haryana-121004, Email id: ridhi.slm@mriu.edu.in

Dr. Meghna Chhabra,

Professor- FMS, Delhi School of Business, VIPS, Correspondence Address: AU Block, Outer Ring Road, Pitampura, Delhi-110034, Email id: meghna.chhabra@dsb.edu.in

Abstract

Purpose of the study:

Examining and evaluating the short- and long-term linkages and correlations between foreign portfolio investment flows in the Indian IT sector and the performance of IT companies in the Indian equities market is the aim of this study. This study looks into the effects of foreign portfolio investments in the IT industry on sectoral returns and the volatility of pertinent sector stock indices.

Design/Methodology/Approach:

For an eleven-year period, from April 2012 to March 2023, the current study employs weekly time series data of the FPI, VIX, interest rate, CPI, and exchange rate USD-INR for the IT sector. In order to accomplish the stated goal of the study, this work applies the Granger causality test and the Johansen Cointegration test. After stationarity has been established, the next step is to search for autoregressive conditional heteroscedasticity (ARCH). GARCH (2,1) is the most acceptable predictor for determining the level of volatility in the IT industry because weekly data was used in this study.

Findings:

The results determined that there is a bidirectional Granger Causality between FII-IT movements and Nifty-IT movements. The IT sector's long-term FPI movements were positively correlated with returns, as demonstrated by the findings of Johansen's Co-integration Test. The results also show that as FPIs increase, stock values decrease because stock prices are increasingly susceptible to their selling pressure. A study showed a connection between FII inflows and outflows and surges in the volatility of the IT industry.

Implications and Recommendations:

The study provides policymakers with a number of recommendations for bolstering the Indian stock market. First, given the current state of the economy, India has embraced a policy to encourage Foreign Portfolio Investors (FPIs) in its capital markets. This is because FPIs boost capital inflows into the nation while maintaining the nation's low level of foreign debt. Second, increased financial stability and efficiency are needed by small-cap companies, particularly those that are still developing. Due to this fact, the government must create appropriate rules for their sustainable financial development.

Keywords: FPI, IT, FII NIFTY-IT, RETURNS, RELATIONSHIP, STOCK, VOLATILITY

Introduction

India's IT sector has become one of the main engines of economic expansion, significantly boosting the country's GDP and improving the welfare of its citizens. The IT sector is expected to increase from 7.5% of India's GDP in the fiscal year 2023–2024 to 10% by 2025. Industry after industry is embracing state-of-the-art digital applications, positioning India for

the next phase of its IT revolution. India is regarded by the rest of the world as having one of the largest Internet user bases and the lowest Internet rates, with 76 crore people having access to the Internet at present. As a result of the Digital India Programme's enhanced digital access and solid digital infrastructure base, the production of significant economic value and citizen empowerment are currently the main priorities. India is one of the countries where the fastest rate of digital adoption is occurring. This was made possible by a combination of new digital applications that are already improving and permeating a variety of activities and occupations, improving people's daily lives, and public policy, as well as innovation and investment from the private sector.

Increased foreign investment in the Information Technology sector implies that IT companies can obtain more funding. R&D, expansion, and technological advancement with this money could lead to more sales and profitability. Foreign investors often bring best practices and cutting edge technologies from their own countries. In the IT sector, higher output and efficiency could lead to higher returns. With foreign investment, IT companies can expand into new areas and increase their customer base and possible revenue streams. Increased demand for IT sector equities typically follows the entrance of foreign investors, which can boost stock prices and the sector's total market valuation.

Although foreign investment may boost returns, it may also raise volatility. The IT industry is particularly vulnerable to changes in the global economy and investor sentiment when there is a significant amount of foreign investment. Geopolitical tensions, global economic downturns, and changes in foreign policy are some of the factors that might cause increased volatility. Foreign investments are impacted by changes in exchange rates. Significant variations in exchange rates can have a substantial influence on the returns received by foreign investors, thereby leading to more volatile investing behavior. Foreign investors' speculative investments may increase volatility in the near term. Unexpected capital inflows and withdrawals may cause sharp swings in stock values. Changes to the legislation governing foreign investments, such as restrictions on or increases in compliances.

Generally speaking, industries with high levels of foreign investment are more volatile. This is particularly true for developing economies, where foreign exchange inflows may be less predictable. The Indian IT sector has benefited greatly from foreign investment, as seen by the noteworthy development that companies like Infosys and TCS have achieved. Nonetheless, the business has also seen periods of tremendous volatility due to the status of the global market. Foreign investment in the IT sector may lead to increased capital, technological transfer, and market expansion, all of which could result in higher profitability. It also increases volatility because to its sensitivity to global events, fluctuations in exchange rates, speculative investments, and regulatory difficulties. Professionals in investing can manage the impacts by comprehending these dynamics and using appropriate risk management measures.

Foreign portfolio investments, inflation, interest rates, sectoral performance, and expected volatility all appear to be closely related. The evolution of different economic sectors is greatly influenced by FPIs, and their preferences are frequently influenced by development prospects, regulatory frameworks, and market conditions. Moreover, variations in FII behavior may result from shifts in predicted volatility, which may modify the way money is distributed among various markets and sectors. It is also commonly known that interest rates and exchange rates are related, and that changes in central bank policies have an impact on FPI inflows and outflows, which in turn affects exchange rate movements.

Overall, this analysis provides important insights into the behavior of foreign portfolio investors (FPIs) and how it affects sectoral dynamics and macroeconomic stability by highlighting the intricate and intimate linkages between various financial and economic factors.

Literature Review

Foreign Portfolio Investments (FPIs) are closely monitored due to their potential impact on market dynamics, including volatility. FIIs often invest in Indian equities and debt instruments, influencing market liquidity and asset prices. Studies have shown that their buying or selling behaviors can lead to significant movements in stock prices (Singh & Neog, 2017). FIIs are major participants in the Indian equity market, often influencing price movements through their trading activities. Studies suggest that their investment decisions are driven by numerous causes including global economic conditions, domestic policy changes, and sector-specific developments (Rathore & Sharma, 2021).

FIIs show preferences for certain sectors over others based on growth prospects and regulatory environments. For instance, they tend to favor sectors such as information technology, pharmaceuticals, and financial services, impacting sectoral volatility (Khan & Qureshi, 2019). FIIs contribute to market liquidity and efficiency by providing liquidity during volatile periods and enhancing price discovery mechanisms (Anand & Singhal, 2020). FIIs have shown significant interest in the

Indian IT sector due to its growth potential, technological advancements, and global competitiveness. Their investments often reflect confidence in the sector's ability to capitalize on digital transformation trends worldwide (Singh & Dhir, 2022). Studies suggest that FIIs' investments in the IT sector contribute to its market capitalization and liquidity. Their buying or selling activities can influence stock prices of IT companies, thereby affecting sectoral volatility (Jain & Kumar, 2020). FIIs are attracted to IT firms known for innovation and market leadership in emerging technologies like artificial intelligence, cloud computing, and cybersecurity. Their investments often signal expectations of continued growth and profitability (Mishra & Sahu, 2021).

The regulatory environment governing FIIs in India has evolved to ensure transparency and stability. Changes in regulations, such as investment limits and taxation policies, can affect FII behavior and subsequently market volatility (Subramanian & Arockiasamy, 2018). Policymakers often consider the role of FIIs in market volatility when formulating regulatory policies. Measures such as circuit breakers, position limits, and transparency requirements aim to mitigate excessive volatility caused by FII activities (Singh & Goyal, 2017). Policymakers and market regulators often consider FII impact on volatility when designing market regulations and interventions aimed at maintaining stability (Batra & Yadav, 2020). Regulatory measures and policy decisions can influence FII behavior and their impact on sectoral volatility. Policymakers consider sector-specific risks and opportunities when designing market regulations to ensure stability and investor protection (Pandey & Bhatt, 2018).

FIIs' participation has also been linked to the integration of Indian markets with global financial markets. Their actions can transmit global shocks to the Indian market, impacting volatility levels (Sivaraman & Mahalakshmi, 2016). FIIs can influence volatility through their trading activities, risk perceptions, and responses to global economic conditions. FIIs' trading behaviors can lead to increased volatility, especially during periods of economic uncertainty or geopolitical tensions. Their large-scale transactions can amplify market movements, affecting investor sentiment and risk perceptions (Bhandari & Shukla, 2018). FIIs' trading activities in the IT sector can lead to heightened volatility, particularly during earnings announcements, macroeconomic changes, or global tech sector trends. Their actions amplify price movements, affecting investor sentiment and market stability (Jain & Jha, 2019).

Research indicates that FIIs can amplify stock market volatility during periods of economic uncertainty or financial crises (Mishra & Swain, 2019). Research indicates mixed findings regarding the direct impact of FIIs on volatility. While some studies highlight a positive correlation between FII inflows/outflows and volatility spikes, others suggest that FIIs can also stabilize markets by providing liquidity during turbulent times (Kumar & Singh, 2020). Research indicates that FII inflows into the IT sector can both increase and stabilize volatility, depending on market conditions and investor perceptions. Studies often analyze how changes in FII ownership impact stock price volatility and market efficiency (Srivastava & Sharma, 2020). Behavioral factors, such as herd behavior among FIIs, can exacerbate volatility by triggering mass buying or selling activities based on perceived market sentiment (Gupta & Saikia, 2018).

FPIs play a crucial role in the Indian IT sector due to its global competitiveness and growth potential. Their investments are driven by sector-specific factors such as technological innovation, market leadership, and outsourcing trends (Chakrabarti & Majumdar, 2021). FPI inflows into the IT sector contribute to market liquidity and valuation. Studies indicate that higher FPI participation often correlates with increased trading volumes and market capitalization of IT firms (Bhattacharya & Kumar, 2019). FPI activities in the IT sector reflect investor sentiment and risk perceptions. Their buying or selling decisions can influence stock prices and sectoral volatility, especially during global economic uncertainties or sector-specific events (Chatterjee & Banerjee, 2020).

Research suggests that FPI inflows into the IT sector can exacerbate volatility, particularly during periods of heightened market sensitivity. Their large-scale transactions and sudden exits can trigger price fluctuations and affect market stability (Mukherjee & Mukherjee, 2018). Studies analyze the relationship between FPI ownership and sectoral volatility using statistical models and econometric techniques. They often find a significant impact of FPI flows on stock price volatility and market efficiency within the IT sector (Ghosh & Das, 2021). Policymakers monitor FPI activities closely to manage sectoral risks and maintain market stability. Regulatory interventions, such as position limits and disclosure requirements, aim to mitigate excessive volatility caused by FPI behavior (Sengupta & Saha, 2019).

Research on the relationship between Foreign Institutional Investors (FIIs) and market volatility reveals several key gaps. Firstly, there's ambiguity regarding the causal direction: whether FIIs drive volatility or react to it. Understanding different types of FII behavior and their specific impacts on volatility remains underexplored. Furthermore, studies often overlook variations across regions, market conditions, and the impact of evolving financial instruments used by FIIs. Addressing

these gaps would provide deeper insights into how FIIs influence market volatility, crucial for effective risk management and policy formulation.

Objectives of the Study

Taking into consideration the Nifty IT returns over an eleven-year period, this study aims to investigate and assess the short- and long-term relationships and associations between flows of foreign portfolio investment in the Indian IT industry and the returns of IT businesses in the Indian stocks market. Additionally, an attempt has been made to investigate the impact of foreign portfolio investments in the IT sector on sectoral returns and the volatility of the IT sector stock index.

Methodology & Data Analysis

The current research uses weekly time series data from the IT sector's FPI and the sectoral index from the NSE, or Nifty IT, as well as data from the VIX, interest rate, CPI, and exchange rate USD-INR for an eleven-year period, from April 2012 to March 2023.

The National Stock Exchange website is used for obtaining the Nifty-IT data, and the official NSDL website is used for collecting the fortnightly time series figures on FPI in the IT industry.

Descriptive Statistics of the main two series under consideration is given below:

TABLE 1: DESCRIPTIVE STATISTICS		
STATISTIC	FPI- IT	Nifty-IT
MEAN	-482.3902	15502.14
ST. DEV.	2103.102	8404.672
SKEWNESS	-1.994483	1.144131
KURTOSIS	11.65444	3.160885
JARQUE-BERA	2171.902	125.8502
SUM	-276892.0	8898226.
SUM SQ. DEV	2.53E+09	4.05E+10
OBSERVATIONS	574	574

Table 1 presents statistical instants of the weekly time series data of the FPI in the IT industry as well as the sectoral index of the IT sector, also known as the Nifty IT Index. The investigation found that, during the whole study period (April 2012 to March 2023), Nifty IT had higher mean values than FPIs in the IT sector. The skewness and kurtosis readings revealed information about the two series' underlying distributions. The results showed that the variables for the study period exhibited negative skewness and positive kurtosis. The same shape and contour of the distribution are indicated by skewness and kurtosis. It is likely that each variable's series differ significantly from the normal distribution because both seem to have high Jarque-Bera values.

Every econometric model operates under the fundamental premise that data are stationary. We look for a unit root in the series to verify stationarity. The existence of a unit root indicates that the data are non-stationary. Utilizing the Augmented Dickey-Fuller (ADF) test, data stationarity is verified. The ADF test result, which is displayed in Table 2, verifies that the FPI in the IT sector series and the Nifty IT return series are stationary at level. Rest three series of exchange rate, Inflation and Interest rates are stationary at first difference.

TABLE 2: AUGMENTED DICKEY FULLER TEST(ADF)		
Variables	t-statistics	Probability
FPI-IT at Level	-9.050281	0.0000
Nifty-IT Returns at Level	-23.65695	0.0000
USD/INR Rate at 1 st difference	-22.16254	0.0000
CPI at 1 st difference	-26.05023	0.0000
Interest Rate at 1 st difference	-23.90475	0.0000

In the context of studying the relationship between Foreign Portfolio Investors (FPIs) in the Information Technology (IT) sector and stock market volatility, we applied the Granger causality test to analyze if FPIs' activities Granger-cause changes in volatility levels within the IT sector. A statistical hypothesis test called the Granger causality test is used to assess whether one time series (or variable) can predict another.

Furthermore, the Granger causality test results shown in Table 3 is used to examine the lead-lag relationship between FPI in the IT sector and Nifty-IT returns. The study's conclusions unequivocally refute the theory that Nifty-IT does not produce FPI-Auto, and that vice versa. It was found that Nifty IT granger causes FPI flows in the industry after looking at the causal relationship between Nifty-IT and FPI movement in the IT sector. This demonstrates how the industry's short-term FPI movements may be predicted using Nifty IT values and how FPI flows within the IT sector affect sector returns. The test also showed how interest rates, inflation rates, and currency rates affect the mobility of FPI in the IT industry.

TABLE 3: GRANGER CAUSALITY TEST

Null Hypothesis	F-statistics	Probability
Nifty-IT does not granger cause FPI-IT	33.1127	3.E-14
FPI-IT does not granger cause Nifty-IT	4.65325	0.0099
INT_RATE does not Granger Cause USD_INR	0.6315	0.5321
USD_INR does not Granger Cause INT_RATE	0.0260	0.9743
FPIIT does not Granger Cause USD_INR	0.97913	0.3763
USD_INR does not Granger Cause FPIIT	6.48695	0.0016
INT_RATE does not Granger Cause NIFTY_IT	3.11065	0.0453
NIFTY_IT does not Granger Cause INT_RATE	0.94726	0.3884
CPI does not Granger Cause NIFTY_IT	1.70322	0.1830
NIFTY_IT does not Granger Cause CPI	0.48627	0.6152
FPIIT does not Granger Cause INT_RATE	0.80569	0.4473
INT_RATE does not Granger Cause FPIIT	6.34572	0.0019
CPI does not Granger Cause INT_RATE	0.02849	0.9719
INT_RATE does not Granger Cause CPI	0.38668	0.6795
CPI does not Granger Cause FPIIT	7.69817	0.0005
FPIIT does not Granger Cause CPI	0.52704	0.5906

The Johansen cointegration test is employed to determine the number of cointegrating relationships among a set of time series variables. This test is used to study the long-term relationships and equilibrium between variables, Foreign Portfolio Investors (FPIs) in the Information Technology (IT) sector and stock market volatility. The Johansen Cointegration test findings, shown in Table 3, show that there is some cointegrating vector between FII in the IT sector and Nifty-IT. The fundamental premise of the test is disproved because the Eigen value and Trace value for both series are greater than their tabular values at the 5% level of significance. The null hypothesis was rejected, indicating the presence of a long-term relationship and at least one co-integrating vector between the FPI in the IT sector and the study's Nifty-IT values. This demonstrates that there are certain long-term informational similarities between the IT industry's Nifty-IT and FPI.

TABLE 4: JOHANSEN COINTEGRATION TEST

VARIABLES		Number of Hypothesised Equations	Maximum EIGEN Value	Critical Value at 0.05 Level	TRACE Statistic	Critical Value at 0.05 Level	Probability
FPI-IT	Nifty-IT	None	125.6910	40.07757	199.4651	95.75366	0.000

FPI- IT	Nifty-IT	Atmost 1	41.23703	33.87687	73.77415	69.81889	0.0055
---------	----------	----------	----------	----------	----------	----------	--------

The GARCH model is employed to capture the volatility of market returns as well as the effect of unforeseen shocks to the FPI-flow on volatility. The stylized fact that asset return volatility responds asymmetrically to return shocks is widely established. In response, volatility is higher with a negative shock than with a positive shock of the same size. Numerous GARCH model variations have been proposed in the literature to account for this asymmetric volatility reaction. To capture this behavior, we employ a GARCH (2,1) model. Initially, we use the AR (1) process to simulate the conditional mean of the return.

The results of GARCH (1,1) volatility forecasting are the most accurate, according to Hansen and Lunde (2001). In this case, GARCH (2,1) is utilized because Hansen and Lunde (2001) also claim that GARCH (p,q) will be used when daily data spans several decades or hourly data spans numerous years. Since this study uses weekly data, GARCH (2,1) is the best predictor to employ for estimating the level of volatility in the IT industry because it reacts swiftly to shocks.

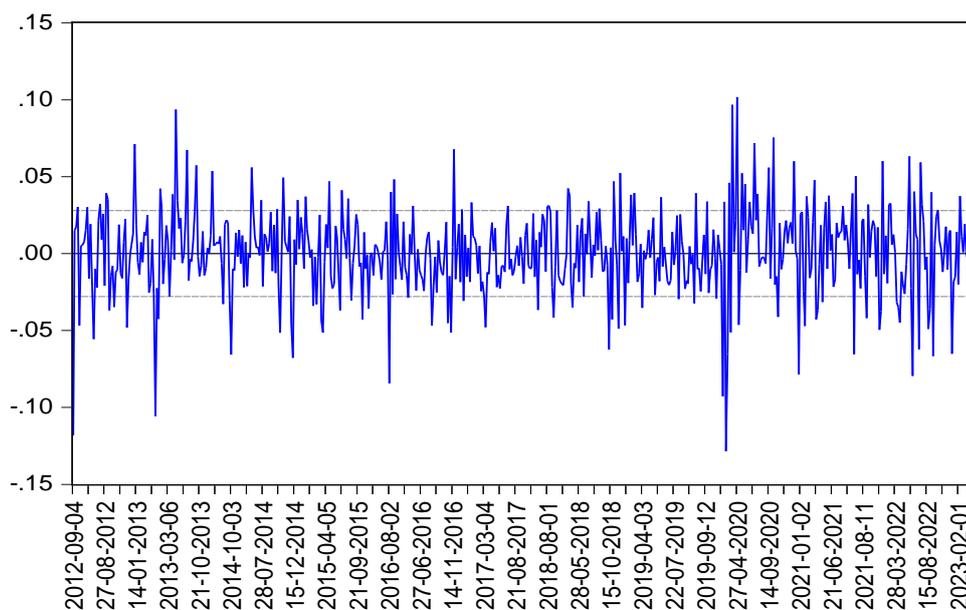


FIGURE 1: VOLATILITY CLUSTERING OF NIFTY IT RETURNS DURING STUDY PERIOD

Table 5 - Model: GARCH (2, 1) [Bollerslev] (Normal)*		
Mean Equation		
Variable	Coefficient	p-value
C	0.021671	0.3691
FPIIT	2.50E-06	0.0000
INT RATE	-0.000938	0.5151
USD INR	-0.000272	0.6799
VIX	-0.000419	0.0513
CPI	0.000123	0.7027
Variance Equation		
C(7)	-1.704006	0.0123
C(8)	0.109938	0.2800
C(9)	0.064160	0.5361
C(10)	-0.054027	0.1544
C(11)	0.782515	0.0000

The term " $C(7)=\omega$, $C(8)=$ term starting with α (ARCH term)" describes how much the size of a shock to the variance influences the volatility of the asset's future returns. The p-value for it is 0.0123. As a result, the magnitude of the shock greatly affects the return volatility. The fact that $C(8)$ is positive indicates that the absolute value of the variance in the past and the variance in the present are positively correlated. This implies that the volatility will increase with the size of the shock to the variance.

The term $C(10)$, which starts with γ (leverage effect term), provides information about how the sign of the shock affects the volatility of an asset's returns in the future. We are unable to prove that the sign of shock affects return volatility because the value is negligible. Given that $C(10)$ is negative, there is evidence of the leverage effect and a greater tendency for negative news to enhance volatility than positive news of the same amount.

$C(11)=$ term that starts with β the GARCH term sheds light on the persistence of historical volatility and how historical volatility influences future volatility predictions. The p-value for $C(11)$ is 0.000. As a result, historical volatility aids in forecasting future volatility.

We can infer that the volatility is very persistent and clustering because the GARCH coefficient value is higher than the ARCH coefficient value.

Conclusion and Implications

FPIs play a crucial role in the Indian IT sector, attracted by its global competitiveness, technological innovation, and growth prospects. Their investments often reflect sector-specific trends and market sentiments. FPI activities in the IT sector have a notable impact on stock market volatility. Their trading behaviors, influenced by global economic conditions and sector-specific events, can lead to fluctuations in stock prices and market stability. Study demonstrated a link between FII inflows/outflows and volatility spikes within the IT sector. Study employed econometric models to analyze this relationship, highlighting how FPI activities amplify price movements and affect investor risk perceptions.

FPI participation contributes to enhancing market liquidity and valuation metrics of IT firms. However, their sudden exits or large-scale transactions during volatile periods can intensify market uncertainties. Policymakers and regulators should monitor FPI activities closely to manage sectoral risks and maintain market stability. Measures such as position limits, disclosure requirements, and market surveillance are required to mitigate excessive volatility caused by FPI behavior.

FPI activities reflect broader investor sentiments and risk perceptions towards the IT sector. Their decisions influence market dynamics and investor confidence, impacting overall market sentiment. Effective regulatory frameworks are crucial in managing FPI-induced volatility. Proactive measures can help in balancing market efficiency with stability, ensuring sustainable growth in the IT sector. Future studies could explore the dynamics of FPI impact across different sub-sectors within IT, considering varying technological trends and market responses. Continual assessment of regulatory policies to adapt to evolving market conditions and investor behaviors, ensuring resilience against volatility shocks. While FPIs contribute significantly to the growth and liquidity of the Indian IT sector, their impact on sectoral volatility underscores the importance of robust regulatory oversight and strategic policy interventions. Understanding these dynamics is essential for fostering a stable and resilient market environment conducive to sustainable economic growth.

References

1. Anand, V., & Singhal, M. (2020). Impact of Foreign Institutional Investors on Market Efficiency: Evidence from Indian Capital Market. *IIM Kozhikode Society & Management Review*, 9(1), 76-85.
2. Batra, S., & Yadav, S. S. (2020). Impact of Foreign Institutional Investors on Stock Market Volatility: Evidence from India. *Asian Journal of Finance & Accounting*, 12(2), 1-15.
3. Bhandari, A., & Shukla, S. (2018). Impact of Foreign Institutional Investors on Stock Market Volatility: Evidence from India. *Journal of Emerging Market Finance*, 17(2), 179-204.
4. Bhattacharya, S., & Kumar, A. (2019). Foreign Portfolio Investment in Information Technology Sector in India: Trends and Impact. *Global Journal of Emerging Market Economies*, 11(2), 143-158.
5. Chakrabarti, S., & Majumdar, S. (2021). Impact of Foreign Portfolio Investors on Indian Information Technology Sector: An Empirical Study. *Journal of Economic Integration*, 36(2), 355-377.
6. Chatterjee, S., & Banerjee, A. (2020). Foreign Portfolio Investors and Stock Market Volatility: Evidence from Information Technology Sector in India. *Finance India*, 34(3), 695-715.

7. Ghosh, S., & Das, S. (2021). Impact of Foreign Portfolio Investors on Stock Market Volatility: Evidence from Indian IT Sector. *International Journal of Financial Studies*, 9(2), 1-19.
8. Gupta, R., & Saikia, D. (2018). Behavioral Finance Perspective of Foreign Institutional Investors and Stock Market Volatility: Evidence from India. *Journal of Commerce & Accounting Research*, 7(3), 8-18.
9. Jain, S., & Kumar, A. (2020). Impact of Foreign Institutional Investors on Indian IT Sector: An Empirical Study. *Journal of Finance and Accounting*, 8(2), 43-55.
10. Jain, V., & Jha, A. (2019). Foreign Institutional Investors and Stock Market Volatility: Evidence from IT Sector in India. *International Journal of Emerging Markets*, 14(3), 406-424.
11. Khan, I., & Qureshi, S. A. (2019). Sectoral Impact of Foreign Institutional Investors on Stock Market Volatility in India. *Journal of Economic Development, Management, IT, Finance, and Marketing*, 11(1), 21-34.
12. Kumar, R., & Singh, S. (2020). Foreign Institutional Investors and Stock Market Volatility: Evidence from India. *Global Business Review*, 21(6), 1471-1489.
13. Mishra, S., & Swain, P. (2019). Impact of Foreign Institutional Investors on Stock Market Volatility in India. *Global Business Review*, 20(4), 953-968.
14. Mishra, S., & Sahu, S. K. (2021). Role of Foreign Institutional Investors in Financial Markets: A Case Study of IT Sector in India. *Journal of Commerce & Business Studies*, 12(1), 29-42.
15. Mukherjee, A., & Mukherjee, S. (2018). Foreign Portfolio Investment and Stock Market Volatility: Evidence from Information Technology Sector in India. *Economic Modelling*, 70, 82-91.
16. Pandey, A., & Bhatt, A. (2018). Foreign Institutional Investors and Volatility in Indian IT Sector: A Time Series Analysis. *Asian Journal of Research in Banking and Finance*, 8(1), 42-56.
17. Rathore, S., & Sharma, A. (2021). Foreign Institutional Investors in Indian Equity Market: A Study of Investment Behavior and Impact on Market Volatility. *International Journal of Business and Economics Research*, 10(1), 1-16.
18. Sengupta, S., & Saha, S. (2019). Foreign Portfolio Investors and Stock Market Volatility: Evidence from Indian IT Sector. *Review of Professional Management*, 17(2), 78-91.
19. Singh, A., & Dhir, S. (2022). Impact of Foreign Institutional Investors on the Performance of Information Technology Sector in India. *Journal of Management and Public Policy*, 13(1), 18-32.
20. Singh, R., & Goyal, A. (2017). Foreign Institutional Investors and Stock Market Volatility: A Study of Indian Market. *Asia-Pacific Finance and Accounting Review*, 3(2), 61-76.
21. Singh, S., & Neog, B. (2017). Foreign Institutional Investors and Stock Market Volatility: Empirical Evidence from India. *Vision: The Journal of Business Perspective*, 21(3), 169-178.
22. Sivaraman, S., & Mahalakshmi, K. (2016). Impact of Foreign Institutional Investors on Stock Market Volatility: Evidence from India. *Journal of Economic Integration*, 31(3), 559-583.
23. Srivastava, R., & Sharma, S. (2020). Foreign Institutional Investors and Stock Market Volatility: Evidence from Information Technology Sector in India. *Journal of Financial Management and Analysis*, 33(1), 45-58.
24. Subramanian, A., & Arockiasamy, A. (2018). Foreign Institutional Investors in Indian Equity Market: Trends, Regulations and Impact. *IUP Journal of Financial Risk Management*, 15(4), 7-28.

ISSN 0971-9997 (Print)
0974-0945 (Online)

PRANJANA

Vol. 27, No. 1 & 2, January-December 2024

The Journal of Management Awareness

A Bi-Annual Peer-Reviewed Refereed Journal

- 1-12 *Exploring The Relationship Between Role Ambiguity and Job Satisfaction in Public Sector Banks*
RAMESH CHANDRA VERMA & SHOBHNA
- 13-23 *A Conceptual Paper on The Effect of Consumer Price Index on Economic Growth Using Autoregressive Distributed Lag Model Approach*
KOLADE ANNA, BILKISU MAIJAMA'A & SHAMMAH EMMANUEL CHAKU
- 24-35 *The Impact of Decentralized Finance (DeFi) on Traditional Banking Systems: Opportunities and Challenges*
NEHA SABHARWAL & NEHA SOLANKI
- 36-47 *Fintech-Driven Financial Inclusion: A Critical Analysis of Benefits and Challenges*
ABHISHEK KHARI & SUKSHAM R. ANEJA
- 48-60 *Regulation and Compliance in the Fintech Sector: A Global Perspective*
MEENU CHAUDHARY
- 61-70 *The Future of Digital Assets: Unlocking The Potential of ERC-404 Tokens*
ASHISH BHATNAGAR, SHIKHA TIWARI & PREETI BALA TRIPATHI
- 71-85 *Evaluating the Impact of Performance Appraisal Systems of Employees in the IT Industry*
SEEMA SINGH & KAVYA SINGH
- 86-95 *Ensemble Learning Techniques for Automated Misinformation Detection in Social Media*
MANISH CHHABRA & TARUN SETHI
- 96-111 *Post-Demonetization Digital Payment Adoption: A Comparative Study of Banked Vs. Unbanked Populations*
JYOTI TYAGI & MEENAKSHI ROHILA
- 112-126 *Challenges of Implementing Data-driven Strategies in Small Businesses*
UMANG TANDON
- 127-134 *Current Trends in IT*
MANISH KUMAR & DEEPANSHU KAUSHIK
- 135-144 *Biting The Bullet in The Banking Career: A Case Study on Individual Value Assessment (IVA) Framework for Dealing with Organizational Stress*
K. SANTI SWARUP, MUKTI SRI-NARAIN & PRIYANK KULSHRESHTHA

INMANTEC
INSTITUTIONS

Integrated Academy of Management
and Technology, Ghaziabad, India

 Inmantec Publishing

Listed in Cabell's Directory, USA

PRANJANA

The Journal of Management Awareness
A Bi-Annual Peer-Reviewed Refereed Journal



Inmantec Publishing

Objectives

The objective of this publication is to provide a common forum for researchers to exchange research findings, share experiences and promote good practices in Management area. We at INMANTEC Publishing try to bring out the hidden talent of the researchers and academicians through rigorous editorial policies.

Pranjana: *The Journal of Management Awareness*

Vol. 27 No.1 & 2 January-December, 2024

Biannual Journal of the Integrated Academy of Management and Technology

ISSN - 0971-9997 (Print)

- 0974-0945 (Online)

RNI No. UPENG/2001/11362

© Copyright, Integrated Academy of Management and Technology, 1997-2024

Disclaimer

All rights reserved.

The Editorial Board invites original, unpublished contributions in the form of research papers, articles or case studies.

The views expressed in the articles of this journal are those of the contributions and not necessarily of the Editorial Board or the Institute

Inmantec Publishing

Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna Flyover, Udyog Kunj,

Ghaziabad-201015, UP, INDIA

e-mail: pranjana@inmantec.edu

Printed and published by Dr Pankaj A Gupta on behalf of the Integrated Academy of Management and Technology, Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna Flyover, Udyog Kunj, Ghaziabad-201015, UP, INDIA at Inmantec Publishing.

Pranjana: The Journal of Management Awareness

Vol. 27, No. 1 & 2 January-December 2024

A Bi-Annual Peer-Reviewed Refereed Journal

Patron

Dr Pankaj A Gupta

Chief Editor

Dr Aftab Alam

Professor Exec. MBA Program, DOMS, Jamia Millia Islamia, New Delhi, INDIA

Editor

Dr Nitin Saxena

Professor & Dean Academics, INMANTEC Institutions, Ghaziabad, UP, INDIA

Associate Editors

Dr Mani Kansal

Professor, INMANTEC Institutions, Ghaziabad, UP, INDIA

Dr Mukta Makhija

Professor & Asst. Dean-IT, INMANTEC Institutions, Ghaziabad, UP, INDIA

Managing Editor

Dr Rama Krushna Charan Patro

Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA

Assistant Managing Editor

Mr Amit Kumar Gupta

Sr. Assistant Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA

Mr Gouri Shankar

Assistant Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA

Production Manager

Mr Jitender Sharma

Graphic Designer, INMANTEC Institutions, Ghaziabad, UP, INDIA

Editorial Advisory Board

Dr Amarjit Singh

Professor of Civil and Environmental Engineering, University of Hawaii'I at Manoa, Hawaii, USA, Email : asingh@hawaii.edu

Dr Amit Kumar Gupta

Associate Professor, Department of Computer Applications, KIET Group of Institutions, Ghaziabad, UP, INDIA
Email : amit.gupta@kiet.edu

Dr Ankur Goel

Professor, Meerut Institute of Engineering and Technology (MIET), Meerut, Uttar Pradesh, INDIA
Email : drankur.goel@mitmeerut.ac.in

Dr D M Pestonjee

GSPL Chair Professor, Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, INDIA
Email : dmpostonjee@spm.pdpu.ac.in

Prof Jan Surya Sharma

Professor, Visiting Faculty, JBS and IMS,
Ghaziabad, UP, INDIA
Email : jansurya@gmail.com

Dr Kamlesh Kumar Rana

Director General, Bharat Institute of
Technology, Meerut UP, INDIA
Email : dranakamlesh@gmail.com

Dr Kavita Saxena

Professor & HOD, IMS Engineering College,
Ghaziabad, UP, INDIA
Email : saksena.kavita@gmail.com

Dr Madhu Bala Sharma

Associate Professor & Head of Department,
Meerut Institute of Engineering &
Technology, Meerut, UP, INDIA
Email : madhusharma2381@gmail.com

Prof M K Jha

Dean, Faculty of Management, AKTU
University, Lucknow, UP, INDIA
Email : mk_173@yahoo.in

Dr Manjula Jain

Director, School of Business Management,
IFTM University, Moradabad, UP, INDIA
Email : manjulajain@iftmuniversity.ac.in

Prof N K Sinha

Vice Chancellor, Maharaja Agrasen
Himalayan Garhwal University, Utrakhand
Email : drnksinha17@gmail.com

Dr Nishant Kumar Singh

Assistant Professor, GNIOT Institute of
Management Studies, Greater Noida, UP,
INDIA
Email : nishantnks17@gmail.com

Dr Parameshwar P Iyer

Principal Research Scientist, Management
Studies, IISc, Bangalore, Karanataka, INDIA
Email : piyer@mgmt.iisc.ernet.in

Dr PK Agarwal

Director Research, Motherhood University,
Roorkee, Uttarakhand, INDIA
Email : agarwalpk001@gmail.com

Dr P K Jain

Professor, Department of
Management Studies, IIT, Delhi, INDIA
Email : pkjain@dms.iitd.ac.in

Dr Parikshat Singh Manhas

Director, SHTM, Faculty of Business
Studies, University of Jammu, Jammu,
INDIA
Email : psmanhas@hotmail.com

Dr Ranchay Bhateja

Professor, KIET Group of Institutions,
Ghaziabad, UP, INDIA
Email : ranchay.bhateja@kiet.edu

Dr Santosh Singhal

Professor, Sharda University, Greater Noida,
UP, India
Email : santoshsinghal2013@gmail.com

Dr Serajul Bhuiyan

Professor, Journalism & Mass Comm., Sava-
nnah State Univ., 3219 College St., USA
Email : bhuiyans@savannahstate.edu

Prof Sushil

Professor, Department of Management
Studies, IIT, Delhi, INDIA
Email : sushil@dms.iitd.ac.in

Dr Wan Muhd Aminuddin Wan Hussin

Professor, School of Civil Engineering,
Universiti Sains Malaysia, 14300, Nibong
Tebal, Pulau Pinang, MALAYSIA
Email : cewan@usm.my

Reviewers Board

Dr Aditya Tripathi

Assistant Professor, Shyam Lal College
(Evening), Delhi, INDIA
Email : draptripathidu@gmail.com

Mr Dinesh Bhasin

COO, Berkeley Health Edu., New Delhi,
INDIA, Email : dineshbhasin1@gmail.com

Dr Kanhaiya Singh

Professor, GLA University, Mathura, UP,
INDIA,
Email : dr_kanhaiyasingh@yahoo.com

Dr Leena Singh

Associate Professor, Christ University, Delhi
NCR, INDIA
Email : leenasinghrinku@gmail.com

Dr Nirakar Nath Pandey

Professor, INMANTEC Institutions,
Ghaziabad, UP, INDIA
Email : nnp_9@yahoo.com

Ms P Santha Devi

Chartered Accountant, Shanta Shastry &
Co., New Delhi, INDIA
Email : bhushans89@gmail.com

Dr Ravi Tiwari

Ex-Professor, NIILM CMS, Greater Noida,
UP, INDIA
Email : arjav.ravi@rediffmail.com

Dr Vipin Khurana

Professor, IBS, Gurgaon, Haryana, INDIA
Email : khuranavipin@ibsindia.org

PRANJANA

The Journal of Management Awareness

Volume 27, Number 1 & 2, January-December 2024

Articles

Exploring The Relationship Between Role Ambiguity and Job Satisfaction in Public Sector Banks	Ramesh Chandra Verma Shobhna	1
A Conceptual Paper on The Effect of Consumer Price Index on Economic Growth Using Autoregressive Distributed Lag Model Approach	Kolade Anna Bilkisu Maijama'a Shammah Emmanuel Chaku	13
The Impact of Decentralized Finance (DeFi) on Traditional Banking Systems: Opportunities and Challenges	Neha Sabharwal Neha Solanki	24
Fintech-Driven Financial Inclusion: A Critical Analysis of Benefits and Challenges	Abhishek Khari Suksham R. Aneja	36
Regulation and Compliance in the Fintech Sector: A Global Perspective	Meenu Chaudhary	48
The Future of Digital Assets: Unlocking The Potential of ERC-404 Tokens	Ashish Bhatnagar Shikha Tiwari Preeti Bala Tripathi	61
Evaluating the Impact of performance appraisal Systems of employees in the IT Industry	Seema Singh Kavya Singh	71
Ensemble Learning Techniques for Automated Misinformation Detection in Social Media	Manish Chhabra Tarun Sethi	86
Post-Demonetization Digital Payment Adoption: A Comparative Study of Banked Vs. Unbanked Populations	Jyoti Tyagi Meenakshi Rohila	96

Challenges of Implementing Data-driven Strategies in Small Businesses	Umang Tandon	112
Current Trends in IT	Manish Kumar Deepanshu Kaushik	127
Biting The Bullet in The Banking Career: A Case Study on Individual Value Assessment (IVA) Framework for Dealing with Organizational Stress	K. Santi Swarup Mukti Sri-Narain Priyank Kulshreshtha	135
Harnessing The Power of Blockchain, Cryptocurrencies and DeFi for a Future-Ready Financial System	CA Vinod Kr Sharma	145

Editorial

After considering the novel issues that constantly cross our minds, do ambiguity and AI compassion complement each other in the current situation? How their responsibilities fit into the greater organizational structure may be the contentious response, which has significant negative effects on stress, productivity, and happiness at work.

AI compassion, on the other hand, refers to artificial intelligence systems that are made to react sympathetically to human emotions, providing comfort, understanding, or support. These systems are frequently utilized in customer service chatbots, HR, IT, and mental health applications among other areas. After all further idea keep generates, how they interact to present scenario? The answers could be visualised through personalized task tracking and feedback, clarification of expectations and responsibilities, promptness with answers of any questions, interfaces for confused employees, reduce stress, lessen the emotional burden that comes with unclear roles, often non-judgmental support to employees who are hesitant to ask human managers for clarity, and recommended well-being practices like breaks, learning modules, and stress management etc. These are just a few of the ways that AI can be a compassion to interface, help and reduce the role of ambiguity.

Although there are pitfalls, when it is ignored and not implemented well, as a result ambiguity may arise in the form of impersonal advice, risk of over-relying than fostering clear human communication.

Hence, at the end we can understand that AI as being compassion and role ambiguity can work together to improve workplace experience on conditions when AI tools are thoughtfully integrated to clarify the roles and provide emotional support.

The current issue of Pranjana devoted on the same and is presented judiciously here by different scholars to expedite their works. Such as exploring the relationship between role ambiguity and job satisfaction in public sector banks wherein application of established theoretical models (like the Job Demands-Resources Model) to the public sector banking context, shows offering actionable insights for management practices, is highlighted. Secondly, in a conceptual paper on the effect of consumer price index on economic growth the effect of the consumer price index on Nigeria highlights the economic growth study how is measured. In this paper all variables through specific model were allowed to be endogenous variables by using the Autoregressive distributed lag Model (ARDL). The study uses the autoregressive distributed lag Model and an Error correction mechanism on some selected relevant variables, include Gross domestic product (GDP) and

Inflation rate, Populations Challenges of implementing data-driven strategies in small businesses in a lucid and comparative way.

Later, on while discussing Post-Demonetization Digital Payment Adoption: A Comparative Study of Banked Vs. Unbanked found that the banked population shifted to electronic payment methods rather quickly, encountered major obstacles, such as poor financial literacy, a lack of internet connectivity, and scepticism about online transactions.

In the context of current trends of IT, "Fintech-Driven Financial Inclusion: A Critical Analysis of Benefits and Challenges", The Impact of Decentralized Finance (DeFi) on Traditional Banking Systems: Opportunities and Challenges, Impact of Student Engagement Metrics on Adaptive AI Learning Tools: A Behavioural Analysis, "Ensemble Learning Techniques for Automated Misinformation Detection in social media "etc encapsulates towards a syndrome of ambiguity and AI Compassion which can be dealt with the situational parameters. I hope that readers would like it and think on it as an offshoot of our treatise after reading it.



Aftab Alam
Chief Editor-Pranjana

EXPLORING THE RELATIONSHIP BETWEEN ROLE AMBIGUITY AND JOB SATISFACTION IN PUBLIC SECTOR BANKS

Ramesh Chandra Verma*
Shobhna**

Abstract

The impact of ambiguous job duties and expectations on employee morale and well-being is the main topic of this study, which looks at the relationship between role ambiguity and job satisfaction among workers in public sector banks. Employees who are unclear about their duties, reporting lines, and expectations are said to be experiencing role ambiguity, a prevalent problem in bureaucratic and hierarchical organisations. Increased stress, decreased job satisfaction, and decreased productivity are frequently the results of this. This study examines the relationship between role ambiguity and job happiness by surveying public sector bank workers in Uttar Pradesh and looking at things like support networks, role clarity, and communication. The study's key contribution lies in its application of established theoretical models (like the Job Demands-Resources Model) to the public sector banking context, offering actionable insights for management practices. Research indicates that while role ambiguity leads to higher stress levels and a decline in job satisfaction, role clarity and clearly defined job responsibilities greatly increase job satisfaction. The study offers recommendations to public sector banks to reduce role ambiguity, including structured communication, clearer role definitions, and regular feedback mechanisms.

Keywords: Role Ambiguity, Relationship, Communication, Job Satisfaction.

INTRODUCTION

Public sector bank employees usually work in highly bureaucratic and hierarchical frameworks which has strict policies and procedures that are govern with their every activity. These organisational characteristics offers a structural rebalance which becomes one of the major challenges that may be encountered. This uncertainty leads to create confusion among the employees as they are not aware of their responsibilities. Although the said rules are strict and the lack of clarity reduce the level of productivity and employee's satisfaction. Role ambiguity occurs when

* Research Scholar, Pt. Deep Dayal Upadhyay Govt Girls Degree College, Rajajipuram, Lucknow, Uttar Pradesh, India.

** Research Scholar, Pt. Deep Dayal Upadhyay Govt Girls Degree College, Rajajipuram, Lucknow, Uttar Pradesh, India.

employees are not clear about their specific roles and reporting structures. Confusion often occurs when there are mixed instructions, shifting role on the daily basis. These uncertainties creates negative impact on the employees and their performance. As in the large organisations the employees' roles are not clearly defined which greatly affects their productivity dissatisfaction among the employees. Although this is a small problem but it has a big impact on the employees. Many employees within these organizations often encounter frustrations and confusion, particularly regarding their roles. However, these challenges can arise due to various factors, including unclear expectations and insufficient communication. Although the intention behind such roles is typically positive, this does not negate the difficulties that employees experience. Because of this, it becomes crucial for management to address these issues proactively being defined. An employee employed at a bank may find themselves tasked with responsibilities that diverge from their standard duties. This encompasses the management of operational activities without adequate training or supervision. Workers can become disoriented and face elevated levels of stress as they attempt to balance multiple tasks, particularly when lacking a clear grasp of their priorities. The challenge of differentiating between essential responsibilities and ancillary tasks intensifies role ambiguity. However, inconsistent reporting practices in nationalised banks can further complicate this ambiguity. Many large corporations often exhibit reporting structures that lack clear definitions, especially when employees are subject to multiple reporting managers or when supervisors themselves are uncertain about their roles.

Uncertainty over who has the final say on work-related issues may be felt by the employee, where he or she is unsure to whom they should report for different responsibilities or decisions. This lack of clear authority generally results in inefficiencies, lack of accountability, and delayed decision-making. Changing expectations form a large portion of role ambiguity in public sector banks. As soon as the evolution takes place due to changes in news laws, technology and customer needs, then the employees undergo the evolution in new responsibilities. Whenever the banking sector is modified by the rules of law, technological impacts, or changed consumer needs, usually the workforce has to alter new positions of jobs related duties. However, if these changes are not communicated clearly and effectively, employees may find it difficult to meet the new requirements. This lack of communication does not only impede performance but also makes employees unhappy at work because they might feel unprepared or unsupported in managing their changing responsibilities. In a word, it is due to imprecise job responsibilities, unbalanced reporting systems and changed expectations that majorly cause the problem of role ambiguity in public sector banks. These problems can be lessened with precise job descriptions, well-organized communication, and frequent feedback which will improve performance, increased job satisfaction and create a more productive and a effective workplace.

THEORETICAL FRAMEWORK

This study is a valuable contribution for understanding the workplace psychology and management because it shows how the uncertainty effects the job satisfaction in the public sector banks. Moreover, the Model like Job Demands-Resources (JD-R) Model makes it unique as it is being applied specifically to banks. This study gives real world insights to the employee's well-being. The study also offers practical suggestions for making it valuable for both research and banking sector.

- **Job Demands Burnout:** As job demands increase without adequate resources, employees may experience burnout.
- **Job Resources Engagement:** High job resources help employees manage demands effectively, leading to increased engagement, motivation, and satisfaction.



Figure 1: Job Demands-Resources (JD-R) Model

The JD-R Model's components include:

Job Requirements (JD): These are the elements of the profession that have a physiological, psychological cost and call for consistent effort or abilities, whether

they are social, psychological, physical, or organisational. Role ambiguity, emotional expectations and severe job pressure are a few examples

Resources for Jobs (JR): These are the organisational, social, psychological, or physical elements that support workers in reaching their objectives, lowering demands, or fostering personal development. Social support, independence, opportunities for training and feedback are a few examples.

Outcome: The Model suggests that the balance between two primary outcomes, Burnout (negative outcome) occurs when job demands are high and job resources are low. Engagement (positive outcome) occurs when job resources are high, enabling employees to cope with demands and enhance motivation and performance.

LITERATURE REVIEW

Kumar & Soni (2024): Investigated the interplay between optimism, role ambiguity and organizational commitment among bank employees, highlighting the impact of environmental factors such as heavy workloads and rapid technological changes on employee stress and commitment levels.

Ridjal & Muhammadin (2023): Analyzed the effects of role ambiguity and work environment on turnover intention, with work stress as a moderating factor, in Bank Rakyat Indonesia. The study found that role ambiguity positively affects turnover intention and work stress amplifies this relationship.

Kumari & Patil (2023): Explored employee engagement practices and their impact on performance in Indian public sector banks, emphasizing the significance of organizational culture and leadership support in enhancing job satisfaction and productivity.

Role Ambiguity and Job Satisfaction: General Findings Several studies have confirmed that there is a correlation between the role ambiguity and job satisfaction. As the study by Rizzo, House, and Litzman (1970) discovered that role ambiguity has been the greatest predictor of job dissatisfaction across all industries. As such in public sector banks, this is particularly relevant, as employees often face unclear job roles due to rigid hierarchies and frequent policy changes.

Public Sector Banks and Role Ambiguity: Public sector banks normally have complex organizational structures with rigid guidelines and bureaucratic processes. According to Tremblay, Sire and Balkin (2000), employees in public sector organizations will encounter role ambiguity compared to employees working in the private sector.

Impact of role ambiguity on job satisfaction in public sector banks research by Barling, Kelloway, and Burns (1999) shows role ambiguity in public sector banks. This is

attributed to the feeling of being unsupported or underprepared for their tasks, which undermines their sense of competence and motivation.

Moderating and Mediating Factors Studies by Jaramillo, Mulki and Marshall (2005)
The connection between unclear job roles and job satisfaction isn't straightforward. When employees feel supported, informed and valued, they are less likely to be negatively affected by unclear job roles.

Cultural and Organizational Context Research by Spector (1997) indicates that organizational culture and the national context play significant roles in shaping how role ambiguity affects job satisfaction. In countries where public sector institutions are heavily regulated, employees are more likely to experience role ambiguity, as they are expected to adhere to policies that are often unclear or subject to frequent changes.

Research by Vroom (1964) and Locke (1976) suggests that role ambiguity can negatively impact employee motivation. When employees are unclear about their roles, it can lead to reduced intrinsic motivation, as they may not feel confident in their ability to meet job expectations. This lack of clarity can prevent employees from engaging fully in their tasks, ultimately affecting their satisfaction and performance.

Public sector banks often face the challenge of bureaucratic structures, which can lead to excessive procedural controls and complex workflows. As noted by Aiken and Hage (1966), such structures can contribute to role ambiguity, where employees may be uncertain about their responsibilities, especially when decisions are made at higher levels of management. This can create a disconnect between employees and their managers, affecting their sense of empowerment and job satisfaction.

In some cases, employees develop coping mechanisms to manage role ambiguity. Research by Pearlin and Schooler (1978) indicates that employees who have strong problem-solving skills and higher levels of emotional resilience are more likely to manage ambiguity effectively, which can mitigate the negative impact on job satisfaction. For instance, employees who engage in open communication with their peers and supervisors may feel more supported, reducing feelings of uncertainty.

RESEARCH METHODOLOGY

The research methodology employed in this study involved conducting a survey among 36 employees from nationalised banks in Uttar Pradesh, including clerks, officers and managers across various departments. The survey aimed to examine the relationship between role ambiguity and job satisfaction. Participants are from various departments, including operations, customer service and administration, representing different levels of hierarchy, such as clerks, officers and managers.

The survey comprised structured questions, using a 5-point Likert scale to assess the clarity of job responsibilities, reporting structures and job satisfaction levels.

5-point Likert scale

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

Section 1: Role Ambiguity

- I clearly understand what is expected of me in my job role.
- My responsibilities are defined by my supervisor.
- I often receive conflicting instructions regarding my job tasks.
- I feel uncertain about the scope of my job responsibilities.
- I am clear about who I should report to in different situations.
- I feel that my tasks often change without proper explanation.
- I often receive insufficient feedback about my performance.
- I feel that my role is not well defined within the organization.

Section 2: Job Satisfaction

- I am satisfied with my current role and responsibilities.
- I feel my work is valued and recognized by my supervisor.
- I feel that my work contributes to the success of the organization.
- My job gives me a healthy work-life balance.
- I am content with the opportunities for career advancement in my organization.
- I am content with the level of support and guidance I receive from management.
- My job provides me with a sense of achievement and purpose.
- The work environment in my organization is comfortable and conducive to productivity.

-
- I feel motivated and engaged in my work.
 - Overall, I am satisfied with my job.

Section 3: Open-Ended Questions

- What aspects of your job do you find most satisfying?
- What aspects of your job do you find most challenging due to role ambiguity?
- How can the organization improve communication and clarify roles to help reduce role ambiguity?

FINDINGS

Role Ambiguity

- **Clarity of Job Expectations:** 58% of employees agreed that they clearly understood what was expected of them in their roles, while 25% felt uncertain and 17% disagreed.
- **Role Definition:** Only 50% of employees believed their job responsibilities were clearly defined, while 30% felt their role was unclear, and 20% felt their responsibilities changed frequently without proper explanation.
- **Conflicting Instructions:** 55% of employees reported receiving conflicting instructions from different supervisors, indicating a significant issue in communication and management.
- **Reporting Structure:** 45% of employees were unsure about who to report to in specific situations, suggesting unclear or inconsistent reporting lines.
- **Feedback and Guidance:** 47% of employees reported insufficient feedback regarding their performance, further contributing to role ambiguity.

Job Satisfaction

- **Overall Job Satisfaction:** 52% of employees expressed overall satisfaction with their job, 30% were neutral and 18% reported dissatisfaction.
- **Role and Responsibility Satisfaction:** 55% of respondents were satisfied with their job roles and responsibilities, while 25% were neutral and 20% were dissatisfied, particularly citing unclear expectations and tasks outside their job description.

- **Work- Life Balance:** 62% of employees felt that their job allowed a good work-life balance, while 38% reported struggling to manage personal time due to unclear or excessive job demands.
- **Career Growth:** 40% of employees felt satisfied with career growth opportunities, while 35% were neutral and 25% expressed dissatisfaction, primarily due to unclear job roles and lack of advancement in their career paths.
- **Support from Management:** 47% of employees were satisfied with the support and guidance from management, while 30% felt it was insufficient and 23% were dissatisfied, particularly due to poor communication regarding their roles.

STATISTICAL ANALYSIS

The mean represents the average score of a variable. It can be calculated by adding up all the values and dividing by the total number of observations.

The standard error measures the accuracy with which the sample mean estimates the population mean

Correlation measures the relationship between two variables. For role ambiguity and job satisfaction, you can calculate the Pearson correlation coefficient (r) to determine the strength and direction of the linear relationship between the two.

Cronbach's alpha is used to assess the internal consistency or reliability of a scale. It indicates how closely related a set of items are as a group.

Table 1: Internal consistency or reliability of a scale

Variable	Mean	Standard Error (SE) Job Satisfaction	Correlation with Alpha (α)	Cronbach's
Role Ambiguity	3.2	0.15	-0.45	0.78
Job satisfaction	3.8	0.12	-	0.85

- **Mean of Role Ambiguity:** 3.2 indicates that, on average, employees report moderate levels of role ambiguity.
- **Standard Error for Role Ambiguity:** 0.15 shows a relatively low variation around the mean, suggesting the sample mean is a reliable estimate of the population mean.
- **Correlation:** -0.45 indicates a moderate negative relationship between role ambiguity and job satisfaction. implying that as role ambiguity increases, job satisfaction tends to decrease.

- **Cronbach's Alpha for Role Ambiguity:** 0.78, signifies good internal consistency for the role ambiguity scale.
- **Cronbach's Alpha for Job Satisfaction:** 0.85, indicating excellent reliability for the job satisfaction scale.

Qualitative Insights from Open-Ended Responses

- **Sources of Satisfaction:** Many employees found satisfaction in interacting with customers, meeting targets, and receiving occasional praise from supervisors. A few employees mentioned their satisfaction with team collaboration and job stability.
- **Role Ambiguity Challenges:** Common challenges included confusion over reporting relationships, lack of clarity regarding job responsibilities, and insufficient guidance from management. Employees expressed frustration with tasks outside their initial job scope and the inconsistency of instructions from different supervisors.
- **Suggestions for Improvement:** Respondents suggested regular communication from supervisors to clarify roles, clearer job descriptions, more structured feedback sessions and a more defined reporting structure to reduce ambiguity and enhance satisfaction.

Summary

According to the poll, role ambiguity has a major impact on workers' job satisfaction at public sector banks. High role ambiguity participants are not much satisfied with their professions, especially when it came to motivation, professional development, and work-life balance. Employee engagement and work satisfaction were higher among those with well-defined reporting structures, clear job tasks and regular advice.

RECOMMENDATIONS

- **Clearly defined roles:** Public sector banks should make sure that job descriptions and duties are precise and conveyed to all staff members.
- **Better Communication:** To minimise the possibility of contradicting directives, management should set up frequent lines of communication to define work tasks and objectives.
- **Structured Feedback:** Hold frequent feedback meetings to resolve any issues with position ambiguity and to advise staff on performance standards.
- **Career growth opportunities:** Banks should provide more opportunities for career upgradation and more focus on career development.

In order to increase employee satisfaction and lower turnover, public sector banks must provide more chances for professional advancement. By implementing clear communication, structured feedback and defined roles, organizations can improve employee well-being and job satisfaction. This study highlights how crucial structured supervision and clear communication are to improving job satisfaction and lessening the negative consequences of role ambiguity in public sector banks.

CONCLUSION

The relation between job satisfaction and position ambiguity in government banks emphasises how seriously confusing job roles affect worker morale and output. Role ambiguity, which is defined by ill-defined expectations, responsibilities and job requirements leads to employee stress and frustration as they get confused. Besides making it even harder for them to be effective in their jobs, role ambiguity reduces their general job satisfaction. Public sector banks usually have to confront complex regulations, a large customer base and diversity in financial products; therefore, operations must achieve a high degree of clarity and clearly defined tasks. Unclear expectations makes employees stressed and demotivated towards disengagement. Because it makes employees feel underappreciated and not supported, ambiguity can negatively affect job satisfaction, especially when superiors do not give them direction or feedback. Role uncertainty can also lead to poor teamwork and communication.

In a bank context where teamwork is crucial to providing services, uncertain positions can lead to inefficiencies, delays and errors all of which raise consumer dissatisfaction. Feeling disconnected from corporate goals and unable to make a meaningful contribution can lead to employee discontent and disengagement. Addressing role ambiguity is necessary to increase job satisfaction in public sector banks. Clear communication, regular feedback, comprehensive job descriptions and training programs can all help prevent role confusion. Additionally, organisations ought to foster an environment that encourages open communication and management assistance. When workers are clear about their responsibilities and how they contribute to the company's overall goals, they are more likely to be content with their positions. In conclusion, the relationship between role ambiguity and job satisfaction is undeniable. By removing uncertainty, public sector banks may cultivate a more supportive, productive, and motivated workforce. Resolving position ambiguity ultimately improves overall performance of the organization and happiness at work, which helps public sector banks succeed in the long run.

Furthermore the future research should explore and influence on the different leadership styles the organisation structures and policies of the workplace and the role clarity and the well-being of the employee. By the continuous efforts of the

public sector banks on the job role, communication mechanism and with a proper and timely feedback the banks can cultivate more supportive, productive and resilient workforce. Reducing role ambiguity not only improves employee's satisfaction but also organizational performance which strengthens customer trust and contributes to the long term success.

REFERENCES

- Agarwal, S.K. & Sharma, R. (2018). Role ambiguity and its effects on employee performance in public sector banks. *Journal of Public Administration*, 45(2), pp. 103-118.
- Anonymous. (n.d.). Role ambiguity and its consequences in Indian public sector banks. *International Journal of Human Resource Studies*, 6(2), pp. 45-59.
- Bhatnagar, J. & Gupta, R. (2020). Exploring job satisfaction in public sector organizations: The role of leadership and communication. *Indian Journal of Management Studies*, 29(3), pp. 125-138.
- Chaturvedi, A. & Yadav, S. (2017). The impact of role ambiguity on job satisfaction and performance: Evidence from the banking sector. *Journal of Organizational Psychology*, 24(4), pp. 150-165.
- Ghosh, S. & Saha, P. (2021). The moderating effect of organizational support on role ambiguity and job satisfaction in public sector banks. *Asian Journal of Business and Management*, 19(1), pp. 75-89.
- Gupta, V. & Agarwal, P. (2019). Role ambiguity and employee performance in government organizations. *Public Sector Management Journal*, 33(2), pp. 88-104.
- Joshi, S. & Kapoor, S. (2018). Role clarity and job satisfaction in the banking industry: A comparative study. *Journal of Economic Psychology*, 47, pp. 92-106.
- Kaur, S. & Verma, A. (2019). Impact of role clarity on employee morale in the banking sector. *International Journal of Banking and Finance*, 38(4), pp. 215-230.
- Khan, M. A. & Khan, N. (2017). Role ambiguity and job satisfaction: A comparative study of private and public sector banks. *Journal of Financial Services*, 21(3), pp. 119-133.
- Kumar, R. & Yadav, M. (2020). The relationship between role ambiguity and job satisfaction in public sector banks: An empirical analysis. *Human Resource Management Journal*, 32(1), pp. 45-60.
- Mishra, S. & Prasad, P. (2021). The effects of role ambiguity on job satisfaction and employee well-being in the banking sector. *Management Science Review*, 23(2), pp. 177-192.
- Nair, S. & Deshmukh, R. (2018). Understanding the impact of role ambiguity on organizational commitment in public sector banks. *Journal of Management Development*, 35(5), pp. 327-340.

- Patel, H. & Singh, S. (2019). Role ambiguity and employee job satisfaction in Indian public sector banks: A study of the moderating role of work-life balance. *Journal of Indian Business Research*, 21(4), pp. 230-247.
- Prakash, P. & Verma, S. (2020). Reducing role ambiguity to improve job satisfaction in the banking sector: A conceptual framework. *Business and Economics Journal*, 8(1), pp. 56-67.
- Rao, P. & Suman, T. (2018). Examining the link between role clarity and job satisfaction among employees in public sector banks. *Asian Journal of Human Resources*, 12(3), pp. 135-149.
- Sharma, A. & Kaur, M. (2021). Investigating the impact of role ambiguity on job satisfaction within the Indian banking sector. *Journal of Banking and Finance*, 44(3), pp. 295-311.
- Sharma, K. & Chandra, S. (2020). Exploring the influence of role clarity on job satisfaction in the banking industry. *International Journal of Bank Management*, 32(1), pp. 102-115.
- Singh, R., & Yadav, R. (2021). A study on role ambiguity and its effect on employee turnover intentions in public sector banks. *Human Resource Management Review*, 18(1), pp. 56-72.
- Tiwari, P. & Kumar, M. (2017). Role clarity as a factor in job satisfaction and employee performance: Evidence from public sector banks. *Journal of Organizational Behaviour*, 44(5), pp. 370-386.
- Verma, N. & Garg, P. (2019). Examining the relationship between role ambiguity and organizational commitment in public sector banks. *Indian Journal of Business Studies*, 17(2), pp. 122-138.

A CONCEPTUAL PAPER ON THE EFFECT OF CONSUMER PRICE INDEX ON ECONOMIC GROWTH USING AUTOREGRESSIVE DISTRIBUTED LAG MODEL APPROACH

Kolade Anna*

Bilkisu Maijama'a**

Shammah Emmanuel Chaku***

Abstract

The effect of the consumer price index on Nigeria's economic growth was examined in this study. All variables in the model were allowed to be endogenous variables by using the Autoregressive distributed lag Model (ARDL). The study used Secondary data from 1983 to 2023. The study uses the autoregressive distributed lag Model and an Error correction mechanism on some selected relevant variables, which include Gross domestic product (GDP), Inflation rate, Interest rate, Exchange rate, degree of economic openness, money supply, and government consumption expenditures for the years 1983–2023 to investigate the effect of CPI on the growth prospects of the Nigerian economy. According to the results of other researchers who conducted comparable studies, the money supply and interest rate have a major positive influence on economic growth, whereas the real exchange rate and inflation have a large negative impact. The model's other variables show little impact on Nigeria's economic growth. The causation result demonstrates the one-way links that exist between the gross domestic product, government consumption expenditures, interest rates, and exchange rates. However, there is no correlation between the degree of openness and inflation and the GDP. As a result, the study concludes that to prevent inflation's negative effects and ensure a practicable rate that would support economic growth, this research proposes using autoregressive distributed Lag model approach, which should be able to make more concerted effort in looking at the high inflation in the economy.

Keywords: *Consumer Price Index, Gross Domestic Product, Economic Growth, Autoregressive Distributed Lag (ARDL), Error Correction Mechanism.*

INTRODUCTION

Relative pricing stability for products and services inside the country is one of the primary duties entrusted to monetary bodies. This emphasis is based on the idea that monetary policy enhances the value of money, reduces inflation and the uncertainties that go along with it, and so improves the nation's prospects for sustained growth and development. Accordingly, one of the most important objectives of a nation's

* *Research Scholar, Department of Statistics, Nasarawa State University, Keffi, Nasarawa State, Nigeria.*

** *Asst. Professor, Department of Statistics, Nasarawa State University, Keffi, Nasarawa State, Nigeria.*

*** *Asst. Professor, Department of Statistics, Nasarawa State University, Keffi, Nasarawa State, Nigeria.*

monetary authorities continues to be preserving relative stability (Anidiobu, Okolie, & Oleka, 2018).

Every economic actor, including both human and material resources, in an economy engaged in economic activities, works to create goods and services that will result in a productive value that raises incomes for all levels of government, businesses, households and even individuals. Therefore, the value of all goods and services produced by all economic actors represented by the GDP is the income earned. Therefore, GDP calculates the total value of products and services generated in a nation over a given period of time. usually quarterly or yearly. Although GDP is majorly criticized at all times for failing to account for human welfare and is presumed to ignore externalities, nonetheless GDP is a useful economic instrument for identifying periods of both economic expansion and contraction. The National Bureau of Statistics and Monetary authorities representing the Central Bank of Nigeria (CBN) support the fact that an economy is in recession whenever GDP declines in two consecutive quarters. The Consumer Price Index (CPI) tracks the average change in prices that consumers pay over time for goods and services. CPI is the most often used indicator of inflation. Lower inflation is indicated by a dropping CPI, whereas higher inflation is indicated by a rising CPI.

The consumer price index is a reliable and widely used indicator of inflation and one of the most important metrics for assessing the effectiveness of a nation's monetary policies. The Consumer Price Index (CPI) tracks shifts in the average price of household purchases of consumer goods and services across time one commonly used measure of how consumers are being affected by Inflation is the CPI's annual rate of change. Thus, to project future CPI, economic policymakers greatly value any model that closely matches the behaviour of the CPI.

The CBN characterizes its policy decisions as discretionary due to various factors considered in multiple meetings of the Monetary Policy Committee (Ayinde, Bankole, and Adeniyi, 2020), it remains economically and econometrically accurate to utilize GDP in assessing and projecting Nigeria's economic growth. Various Researchers have delved into this topic and can understand and deduce that in forecasting key economic growth and development, GDP is not just a want, but an important factor to consider especially as Nigeria's economy is biting harder and still trying hard to come out of recession to growth. To foresee a course of action for the future, it is quite necessary to take into account important macroeconomic indicators like the GDP is needed to successfully adapt policies. These adjustments should favor other macroeconomic variables like inflation, job creation, exchange rates, etc. Forecasts are mainly used to assist decision-makers and legislators who require data to establish the best policies. Companies estimate future sales to change their production, and Monetary Authorities need key knowledge about the path of inflation in the future to modify its interest rate. Without any doubt, forecasting serves a very significant

function in formulating public policy. However, it has not gained much attention but in recent times some Researchers have gained specific interest in the area of forecasting GDP.

STATEMENT OF THE PROBLEM

Presently Nigeria is faced with a terrible recession and high inflation. Monetary authorities in Nigeria make certain decisions based on price and output development. Making decisions about the monetary policy rate without estimating the output gap is equivalent to making very costly errors and revisions that are uncertain, and will crash the economy. Several benefits can be derived from making accurate forecasts which are not limited to makingt Peo Mkhathswa et al. (2015) examine the effects of Swaziland's inflation rate on agricultural and economic growth from 1980 to 2013. According to the results of the autoregressive distributed lag (ARDL) analysis, Swaziland's growth is positively correlated with agricultural growth and negatively correlated with inflation. The results of the causality test indicate a unidirectional association between the rate of inflation and economic growth, but no causal relationship between any other variables was discovered. Mamo (2012) examined how inflation affected economic growth in thirteen Sub-Saharan African (SSA) nations between 1969 and 2009. People are consequently forced to save, which enables the government to levy development-related taxes (Doguwa, 2013; Enejoh & Tsauni, 2017; Mankiw, 2010). Price increases incentivize workers to structurally move from the more compact industrialised sector to the more traditional subsistence sector. This frees up resources to be used more fully and optimally and supports inflation's beneficial effects on economic growth. (Dewett & Navalur, 2010) timely, effective, and efficient policies toward economic growth and development. It is quite disturbing that the Nigerian economy has been fluctuating and plunging into economic recession from 2015 till date the logical question is, is there any macroeconomic forecast at all? Some scholars in this field have attributed the economic downturn to international oil prices, the decline in crude oil production, COVID-19, and the rise in the exchange rate of the Dollar. The acclaimed attributing factors indeed contributed to the said economic recession, however, if at all economic tools were deployed so frequently to understand the dynamics of the Nigerian economy and relevant forecasts were made, such doom would have been anticipated and appropriate policies would have been put in place. In their research,

SIGNIFICANCE OF THE STUDY

Another possibility is structural inflation, which results from adjustments to monetary policy. The term "built-in inflation" is typically used to describe this kind of inflation. Inflation can fall into one of these categories: hyper, extremely high, chronic, high, moderate, or low (Umaru & Zubairu, 2012).

Forecasts of a wide range of economic variables are provided by the central banks of many nations and other international entities; nevertheless, little theoretical research is done on model selection, accuracy, or other issues about GDP forecasting (Pilström and Pohl, 2009). It is crucial to continue pursuing economic diversification in a Nation like Nigeria, where efforts to diversify the economy are still in their infancy stage and Oil remains a major source of GDP. Studies that attempt to understand and forecast Nigeria's GDP level are particularly important.

Nyoni (2019) used ARIMA models to forecast the Australian CPI, following the Box and Jenkins technique. The outcome showed that ARIMA (1, 1, 0) might be used to anticipate the CPI in Australia. The study's findings indicated that Australia's CPI is probably going to keep rising in the next ten years.

As a result, research in these areas appears to be contradictory. The inconsistent results from the empirical studies hinder the researchers from coming to a trustworthy judgement regarding the subject. Even worse, some research on this subject was unable to establish conclusive evidence about the relationship between inflation and economic growth. (Anochiwa & Maduka, 2015; Dwnbel et al, 2016; Gatawa, Abdulgafar, & Olamide, 2017; Inyiama, 2013; Oladipo & Akinbobola, 2011; Shuaib, Augustine, & Frank, 2015).

Idris and Suleiman (2019) in a similar study, look at how inflation affected Nigeria's economic growth from 1980 to 2017. The country's GDP, interest rate, inflation rate, and currency rate are among the variables that the study utilises a vector error correction mechanism on. The results demonstrate the long-term relationship between the variables and demonstrate that Nigeria's economic growth is significantly hampered by the interest rate and inflation rate.

GDP was the study's dependent variable, with interest, inflation and currency rates serving as independent variables. Secondary data for this research were obtained from the Central Bank of Nigeria Statistical Bulletin and the National Bureau of Statistics between 1983 and 2023. Additionally, an autoregressive distributed lag (ARDL) model and an error correcting mechanism are utilised in this study in order to adequately characterise the long- and short-term correlations between the variables used. (Anidiobu et al., 2018; D. Chude & N. Chude, 2015; Phiri, 2010; Umaru & Zubairu, 2012). ARDL, as a dynamic specification model, takes use of the lags of both the dependent and independent variables. With this, the short- and long-run implications may be precisely calculated.

AIM AND OBJECTIVES OF THE STUDY

In line with the statement of the problem, the research's aim is to analyze and forecast the effect of CPI on Nigeria's economic growth, while through the following objectives:

- To analyze the short-run effect of CPI on Nigeria's economic growth (GDP)
- To forecast the long-run effect of CPI on Nigeria's economic growth (GDP)
- To examine among the independent variables used, that is positively or negatively related to GDP in the Nigerian economy.

LITERATURE REVIEW

A rise in the cost of goods and services is known as inflation. When a price increase is consistent and exceeds a predetermined threshold, it is considered inflation. For example, a rise in the money supply has the potential to eventually lead to increased prices. The literature has identified several different forms of inflation, some of which include: Supply push, also known as cost-push inflation, results from a decrease in supply caused by an increase in the cost or price of the item produced. Demand-pull inflation occurs when aggregate demand rises without a corresponding increase in supply (Anochiwa & Maduka, 2015). Another possibility is structural inflation, which results from adjustments to monetary policy. The term "built-in inflation" is typically used to describe this kind of inflation. Inflation can fall into one of these categories: hyper, extremely high, chronic, high, moderate, or low (Umaru & Zubairu, 2012).

According to Anchiwa and Maduka (2015), the monetary authorities' ability to keep inflation in single digits would boost their power to speed up economic growth. For Nigeria, it's the other way around. The Central Bank of Nigeria Statistical Bulletin (2018) provides data on the trend of inflation, which shows that the country's inflationary condition has gotten alarmingly worse between 1980 and 2018. Nigeria has only seen single-digit inflation for fourteen of the previous thirty-eight years, according to the inflationary trend. However, the fact that Nigeria's inflation rate is still rising indicates that fiscal and monetary policies have failed. The government can thus gather money for development since people are forced to save (Doguwa, 2013; Enejoh & Tsauni, 2017; Mankiw, 2010). Price increases incentivize workers to move from the more expansive industrialised sector to the more traditional subsistence sector, which opens up space for more optimal and full use of economic resources and supports inflation's beneficial effects on economic growth (Dewett & Navalur, 2010).

Despite the idea that specific levels of inflation promote economic growth, most research shows that inflation has a negative impact on economic activity (Kasidi & Mwakanemela, 2015; Manoel, 2010; Mkhathshwa, Tijani, & Masuku, 2015). They argue that reducing inflation is vital to keep it from exceeding a single digit. Mkhathshwa et al. (2015) analyse how Swaziland's inflation rate influenced economic and agricultural growth from 1980 to 2013. The autoregressive distributed lag (ARDL)

analysis found a favourable association between Swaziland's growth and agricultural growth, but a negative correlation with inflation. The causation test indicated no causative link between any of the other variables, but it did demonstrate a one-way relationship between inflation rate and economic growth.

Ndoricimpa (2017) Using panel analysis, researchers investigated the influence of the inflation threshold on economic development in a few selected African countries. The results reveal that there is a nonlinear relationship between the two variables, although it does not influence the sample as a whole, low inflation promotes economic growth in middle-income nations. The outcome further demonstrates that inflation above the cutoff has a detrimental impact on the economies of all the nations.

RESEARCH METHODOLOGY

This study examines the relationship between inflation and Nigeria's economic growth from 1980 to 2023. The current period represents the year in which annual data was found, while the base period represents the period when inflation became more noticeable in the nation as a result of rising oil prices on the global market. Other factors that are directly influenced by inflation rates can be included in this analysis. The research begins with a unit root test of the variable and then employs autoregressive distributed lag (ARDL) and an Error Correction Mechanism. For this study, quarterly secondary data were acquired from the CBN and the National Bureau of Statistics for a 40-year period, from 1983 to 2023.

■ **Technique for Data Analysis and Model Specification**

This study used an Autoregressive Distributed lag Model and an Error Correction Mechanism as a data analysis technique. If the time series' underlying attribute is either $I(0)$ or $I(1)$ cointegrated, the ARDL Bounds testing approach is a potent statistical tool for estimating level relationships. The ECM is a theoretically based method that helps predict the long-run equilibrium in addition to the short-run coefficients and ensures that no valid coefficients are lost in the long run.

The ARDL Model reduces the possibility of errors and random errors arising from non-stationary series data. Regression analysis frequently uses the ARDL Model which is primarily concerned with the analysis testing probability aspect (Alkhuzaim 2004). This makes the ARDL model the best method to use in analyzing data on INTR, INFR, EXGR, and GDP on the effect on the Nigerian economy. ARDL model allows the independent variables to explain the dependent variable of its lag and the lag of other variables used.

■ **Model Specification**

In an attempt to investigate whether inflation deters Nigeria's economic growth, the study adapts the models found in Idris and Suleiman's (2019) and Inyiyama's

(2013) publications. The study adopts one macro-economic variable which is GDP and three other variables which are, Interest rate values (INTR), Inflation rate values, Exchange rate values. The model used for this investigation is constructed as follows:

The basic form of an ARDL regression model is written as:

$$y_t = \alpha_0 + \alpha_1 x_t + \alpha_2 x_{t-1} + \alpha_3 y_{t-1} + \mu_t$$

■ **Dependent variable:**

GDP

Independent variables:

Interest rate Values (INTV)

Inflation rate Values (INFV)

Exchange rate Values (EXGV)

The econometric model is given as:

$$GDP=f(INTV, INFV, EXGV)...(3.1)$$

The relationship that exists between the interests of variables can be represented in the model below:

$$GDP_t = \beta_0 + \beta_1 INTV_t + \beta_2 INFV_t + \beta_3 EXGV_t + \mu_t \dots (3.2)$$

Where:

GDP = Gross Domestic Product

LINTV = Log of Interest rate values

LINFV = Log of Inflation rate values

LEXGV = Log of Exchange rate values

$\beta_1, \beta_2, \beta_3, \beta_4$ and β_5 = Coefficients.

β_0 = Intercept.

μ_t = Error Term.

The ARDL model of equation (3.2) is written as:

$$\begin{aligned} \Delta GDP_t = & \beta_0 + \sum_{i=1}^m \beta_1 \Delta GDP_{t-i} + \sum_{i=1}^m \beta_2 \Delta INTV_{t-i} + \sum_{i=1}^m \beta_3 \Delta INFV_{t-i} \\ & + \sum_{i=1}^m \beta_4 \Delta EXGV_{t-i} + \alpha_1 GDP_{t-i} + \alpha_2 INTV_{t-i} + \alpha_3 INFV_{t-i} + \alpha_4 EXGV_{t-i} + \mu_t \dots (3.3) \end{aligned}$$

The ARDL model is divided into two representations, the first which is \hat{a} to \hat{a}^\dagger stands for the model's short-run dynamics where \hat{a} stands for the dependent variable and \hat{a}^\dagger stands for independent variables, while the coefficients \hat{a} to \hat{a}^\dagger represents the existence of long-run relationship amongst variable used. H_0 (null hypothesis) of the model used is written as $H_0: \hat{a} = \hat{a}^\dagger = \hat{a}^\dagger = \hat{a}^\dagger = \hat{a}^\dagger = 0$ showing no cointegration among variables used. To begin the estimation process, we must first perform a bound test for H_0 for the non-existence of a long-run relationship. The calculated F-statistics will be compared with the tabulated critical value, and if the F-statistics are higher than the tabulated critical value, the decision rule states that we should reject the H_0 of no existence of a long-run relationship, which indicates that cointegration does not exist, regardless of whether the underlying integration order of the variables is at $I(0)$ or $I(1)$. If the F-statistics lies below the lower critical value, however, it indicates that H_0 can be rejected, and if it lies in the middle of the two tabulated critical values, the outcome is considered inconclusive. The error correction model is estimated to get the short-run coefficients of the variables under study. The Error correction mechanism indicates the speed of adjustment to equilibrium whenever disequilibrium occurs in the Nigerian cashless economy.

The ARDL specification of the ECM model of equation (3.3) above can be written as:

$$\begin{aligned} \Delta GDP_t = & \beta_0 + \sum_{i=1}^m \beta_1 \Delta GDP_{t-i} + \sum_{i=1}^m \beta_2 \Delta INTV_{t-i} + \sum_{i=1}^m \beta_3 \Delta INFV_{t-i} \\ & + \sum_{i=1}^m \beta_4 \Delta EXGV_{t-i} + \Delta ECM_{t-i} \mu_t \dots (3.4) \end{aligned}$$

The Error correction equation is represented by the ECM, which measures and calculates the speed of adjustment to demonstrate how quickly a system returns to equilibrium.

RATIONALE FOR THE METHOD

The autoregressive distributed lag model approach which was developed by Pesaran was used in this study to estimate equation (3.2), this approach was used due to the

facts that the model can be used whether or not the series of the study are stationary at $I(0)$ or $I(1)$ or even having both mixtures. This will help to give a robust result, though the sample size used is quite large. The Error Correction Model was also put into consideration. Both the long-run connection and the short-run coefficients of the variables employed are covered by the autoregressive distributed lag and error correction mechanism analysis. To prevent obtaining a spurious result, it is necessary to test the unit root property of time series data. In this study, the stationarity status of the variables will be determined using the Augmented Dickey Fuller stationarity tests. Once the stationary status of the variables under study has been confirmed, a cointegration test will be carried out using the ARDL bounds test approach. The normality of the residuals will be tested using the Jacque–Bera test. To determine whether there is serial correlation among the variables, the Breusch–Godfrey (LM) serial correlation test will also be performed; if the analysis eventually shows that there isn't any, the model is sound. To determine whether our error term exhibits heteroscedasticity, we shall do the Breusch–Pagan Godfrey heteroscedasticity test. Finally, a multicollinearity test will be conducted to determine whether multicollinearity exists in the model that is being utilized. A CUSUM stability test will also be performed to see whether our model is stable or not.

Expected outcome

The expected outcome will be derived from the outcomes of some researchers who had carried out similar research but with variation in the data used as this research will use data from 1983 – 2023. Some expected outcomes from researchers who have done similar research work are cited below.

Olugbenga A. Adaramola & Oluwabunmi Dada (2020), “The impact of Inflation on economic growth: evidence from Nigeria, using autoregressive distributed lag Model”, with data spanning from 1990-2018. To ensure that the variables are distributed correctly, descriptive statistics are first applied. An analysis of Nigeria's inflation rate trends between 1980 and 2018. The Augmented Dickey-Fuller (ADF) unit root test was used to analyse the time series data properties. The Autoregressive Distributed Lag (ARDL) bound test approach to co-integration requires this. The Granger causality test was then used to look at the association's direction. Ultimately, diagnostic tests were performed using the normality, serial correlation, heteroscedasticity, and cumulative sum (CUSUM) to validate the results. According to the study's findings, real exchange rates and inflation significantly hinder economic growth, but interest rates and the money supply significantly boost it. Nigeria's economic development is not significantly impacted by the other factors in the model.

CONCLUSION

The causation conclusion demonstrates a one-way relationship between the gross domestic product, government consumption expenditures, interest rates, and exchange rates. Nonetheless, there is no direct connection between the gross domestic product and either level of openness or inflation. Therefore, the study suggests that the monetary authorities should make a more practical effort to aggressively manage inflation to avert its negative effects by maintaining a reasonable rate that would encourage economic growth in Nigeria.

Sunday Timothy, Sunday Agbonjinmi & Samuel Bewaji (2021). “The Impact of Consumer Price Index on Nigeria Economic Growth: via VAR approach (2010-2020)”, All variables in the model were allowed to be endogenous variables by using the vector error correction model (VECM). The study’s duration was from 2010 to 2018, and the VECM probability value showed that there was a short-term correlation between the CPI and GDP, the dependent variable. Nonetheless, at 5% significance level, C(2) with p/value = (0.3391) indicates that the GDP is not causally affected by the CPI over the long term. Additionally, the outcome of the second VECM probability value equation demonstrates a short-term link between GDP and the dependent variable, CPI. C(8), on the other hand, indicates that GDP does not have a long-term causal effect on GDP at the 5% significant level, with a p/value of (0.7303). in Nigeria. The study findings demonstrated the actual state of Nigeria’s economy: rising consumer prices lead to higher aggregate output, which raises GDP without having a commensurately favorable impact on people’s quality of life. Consequently, the country’s high unemployment rate and high degree of poverty make the positive correlation between GDP and CPI unjustifiable. i.e., the average Nigerian’s life is not improved by the rise in GDP that follows a rise in the CPI. The findings were in line with the Fisher Equation, which asserts that an increase in the money supply without a corresponding rise in the cost of goods and services is a good thing.

REFERENCES

- Adaramola O.A. & Dada O. (2020). Impact of inflation on the growth prospects of the Nigerian economy, *Investment management and financial innovations journal*. 17(2).
- Adekoya, B.O. (2020). Portfolio Balance Approach to Asymmetries, Structural Breaks and Financial Crisis: Testing a Model for Nigeria. *CBN Journal of Applied Statistics*, 11(1), pp. 87-110.
- Amaefula C. (2020). Optimal identification of ARIMA model for Predicting CPI in Nigeria using output based criterion, *International Journal of Statistics and Applied Mathematics*, 5(3): pp. 97-102. DOI: <https://dx.doi.org/10.22271/math>

- Ayinde, O., Bankole, A., & Adeniyi, O. (2020). Modelling central bank behaviour in Nigeria: A Markov-Switching Approach, *Central Bank Review*, 20, pp. 213-221.
- Central Bank of Nigeria (2015). Forecasting Nigeria GDP Growth Rate Using a Dynamic Factor Model in a State Space Framework. Research Department, Abuja Nigeria.
- Chand, S. (n.d). The Endogenous Growth Theory: Models and Policy Implications. Available from : <https://www.yourarticlelibrary.com/macroeconomics/growth-models/the-endogenous-growth-theory-models-and-policy-implications/31170>.
- Doguwu S.I (n.d.). Inflation and economic growth in Nigeria: Detecting the threshold level. *CBN journal of Applied statistics*, 3(2).
- Duprey, T., & Klaus, B. (2017). How to Predict Financial Stress? An Assessment Of Markov Switching Models. *European Central Bank Working Paper Series No 2057*.
- Etale L.M & Eze G.P. (2019). Analysing stock market reaction to macroeconomic variables: Evidence from Nigerian stock exchange. *Global Journal of Arts, Humanities and Social Sciences*. 7(3), pp.14-28.
- Kugler, et al. (2004). Measurement Errors in GDP and Forward-looking Monetary Policy: The Swiss Case. *Deutsche Bundes bank Discussion Paper Series 1: Studies of the Economic Research Centre No 31*.
- Makinde, M.S., Adepetun, A.O., & Oseni, B.M. (2020). Modeling the Gross Domestic Product of Nigeria from 1985 to 2018. *Communications in Statistics: Case Studies, Data Analysis and Applications*. 6(3), pp. 353-363. DOI: 10.1080/23737484.2020.1754143.
- Nwaobi, G.C. (2012). Modern Econometric Modelling for Developing Economies III. *Quantitative Economic Research Bureau, Aba*.
- Omotosho, B.S. (2019). Oil Price Shocks, Fuel Subsidies and Macroeconomic Instability in Nigeria. *CBN Journal of Applied Statistics*, 10(2).
- Omojuyigbe, S.T., Agbonjinmi, S.A. & Bewaji, S.O. (2021). The Impact of Consumer Price Index on Nigeria Economic Growth: via VAR approach (2010-2020), *Quest Journals Journal of Research in Humanities and Social Science*, 9(10), pp. 35-41.
- Umeh, E. & Anazoba, F. (2016). Application of Markov-Switching Regression Model on Economic Variables. *Journal of Statistical and Econometric Methods*, 5(2), pp. 17-30.

THE IMPACT OF DECENTRALIZED FINANCE (DEFI) ON TRADITIONAL BANKING SYSTEMS: OPPORTUNITIES AND CHALLENGES

Neha Sabharwal*

Neha Solanki**

Abstract

DeFi, as a most revolutionary movement in the finance sector, offers an open, permission less, and translucent financial ecosystem working on blockchain technology. The present study thus explores the impact that DeFi creates on the traditional banking systems while laying down the opportunities and challenges it carries with it. The study will set to outline a deep understanding of how DeFi affects traditional financial systems especially the critical topics including transparency, cost-effectiveness, and accessibility. It also explores the regulatory obstacles and the hazards associated with an expanded DeFi. It also explores the regulatory obstacles and associated hazards that come with DeFi's expansion. The research's conclusions are meant to educate financial institutions, legislators, and software developers on the direction of finance and possible ways to incorporate DeFi into established financial systems.

Keywords: *DeFi, Blockchain, Banking System, Financial System.*

INTRODUCTION

Overview Context

By using blockchain technology to create financial services and products that function without the need for conventional middlemen like banks or financial institutions, Decentralised Finance (DeFi) is a paradigm change in the financial sector. The emergence of cryptocurrencies and the spread of decentralised applications (dApps) that enable lending, asset management, and peer-to-peer transactions have propelled DeFi's global expansion. DeFi uses decentralised protocols and smart contracts to ensure efficiency, transparency and immutability, in contrast to traditional banking, which depends on centralised governance and regulation. With billions of assets locked in DeFi protocols, the adoption of DeFi has exploded, demonstrating the growing interest in decentralised financial services among both consumers and institutions.

* *Asst. Professor, Institute of Technology and Science (I.T.S.), Mohan Nagar, Ghaziabad, Uttar Pradesh, India.*

** *Asst. Professor, Delhi Institute of Advance Studies, Rohini, Delhi, India*

Problem Overview

DeFi has a number of difficulties that significantly limit its potential in comparison to the conventional banking system, although its quick growth and benefits. DeFi still lacks the well-established regulatory frameworks, consumer safeguards and risk mitigation strategies that define traditional financial institutions. As a result, there is uncertainty about integration, regulation and overall financial stability since there is a gap between the centralised and decentralised financial ecosystems. One major problem is the absence of a uniform framework to control DeFi and guarantee its interoperability with the current financial system. By studying the potential and difficulties that come with traditional banking and how DeFi's distinctive qualities affect it, this article aims to close this gap.

OBJECTIVES OF THE STUDY

Investigating and comprehending the effects of Decentralised Finance (DeFi) on conventional banking systems is the main goal of this research.

The study specifically seeks to:

- Examine the key distinctions between traditional banking systems and DeFi.
- Determine the ways that DeFi can enhance financial transparency, efficiency, and inclusion.
- Examine DeFi's dangers and difficulties, taking into account technological, security, and regulatory issues.
- Describe how DeFi can be incorporated into current financial systems, with a focus on striking a balance between innovation and regulation.

Questions for Research

The study will investigate the following important questions:

1. In what ways does DeFi vary from conventional banking?

This inquiry aims to investigate the fundamental distinctions between decentralised and traditional financial systems in terms of technology, operations, and governance.
2. For financial systems, what chances does DeFi offer?

This inquiry centres on DeFi's possible advantages, including improved accessibility, lower transaction costs, and better openness.
3. How does incorporating DeFi into current financial structures provide dangers and difficulties?

The purpose of this inquiry is to determine and evaluate the different risks that must be addressed for a successful integration, such as legislative obstacles, security flaws and worries about financial stability.

SIGNIFICANCE AND SCOPE

For a number of stakeholders, this research is crucial. It gives possible governance structures and a basis for comprehending the regulatory issues raised by DeFi for policymakers. The study highlights both areas of worry and the opportunity DeFi offers for innovation and operational efficiency for financial institutions. Lastly, the report describes the technical obstacles and possible routes for developing safe and scalable DeFi systems for engineers and blockchain developers. The study intends to help the financial industry make well-informed decisions and develop strategic plans by thoroughly examining DeFi's effects, opening the door to a more resilient and interconnected financial ecosystem.

LITERATURE REVIEW

Evolution of Financial Systems

Over the years, the system of finance had undergone dramatic changes, having progressed from simple barter systems to an increasingly complex set of international networks of financial institutions that were linked. It is the traditional banking system which laid the foundations for modern finance and appeared first in the Middle Ages. This was normally composed of centralised organisations such as banks providing a one-stop shop for all transactions and services such as lending and deposit taking. Digital currencies, mobile payment systems and online banking were introduced in the last few decades, thus changing the face of the financial sector dramatically. This advancement has improved access, efficiency and convenience but, paradoxically, strengthened central control and there is a need to find alternative arrangements that could weaken the dependence on intermediaries and democratize financial access (Mishkin & Eakins, 2018; Allen et al., 2020).

Comprehension of DeFi

Decentralised finance, or DeFi for short, is a compendium of financial services and apps which are running on blockchain technology and do not make use of traditional financial intermediaries. The blockchain, for one, is a distributed ledger in which transactions are recorded in a secure, irreversibly and very transparent manner. Moreover, it is the central technology behind DeFi. Using its mechanism, smart contracts will automate financial procedures that include lending, borrowing and trading. Another is tokenization-the process of representing digital assets on the blockchain in ways that enhance their tradability and liquidity. The emerging

technologies combined have enabled decentralised exchange, lending platforms and other financial services accessible to all internet users, which are thereby enhancing financial freedom and access (Buterin, 2014; Schär, 2021).

Main DeFi Players

The DeFi domain comprises quite a number of important platforms that really have transformed the conventional offerings of financial services. Uniswap is a decentralized exchange that can assist in token swaps based on the usage of Automated Market-Making techniques, not needing an order book. Aave is the DeFi protocol that offers some exciting features like variable interest rates and flash loans to facilitate lending and borrowing within a decentralized setup. Another more recent DeFi lending app for borrowing coins or interest earnings on owned cryptocurrency is Compound. All of these have extended DeFi to more and more users because they come up with some new form of finance and challenge some old patterns. (Adams et al., 2020; Kulechov&Stani, 2021).

Previous Studies

What has already been carried out in research is the revolutionary powers of DeFi and its disadvantages. An extensively studied influence by DeFi is that mentioned by Schär (2021), which is its potential to democratize finance and the disadvantages it bears, such as scalability and security issues. Chen and Bellavitis looked into a study on how DeFi can disrupt the traditional financial system. It can indeed be more affordable and efficient, but it still has problems with stability and regulation. According to the study, DeFi will only reach optimal realization when good risk management policies and regulatory control are used (Chen & Bellavitis, 2020; Schär, 2021).

Theoretical framework

The analysis is based on chosen economic and technology theories relevant to DeFi and traditional finance. Transaction Cost Theory explains how DeFi saves on the financial cost of transactions since it eliminates intermediaries and automates the processes using smart contracts. Network Theory will provide an insight into why decentralized networks are important to the achievement of trust and security and can have a better resilience level than the centralized models. Applying Innovation Diffusion Theory to understand factors of adoption of DeFi technologies, such as relative advantage, complexity and perceived risk use these patterns along with various theories (Coase, 1937; Rogers, 2003; Gans & Stern, 2018).

RESEARCH METHODOLOGY

Design of Research

In order to give a thorough grasp of how Decentralised Finance (DeFi) affects conventional banking systems, the study uses a mixed-method approach that combines qualitative and quantitative research techniques. Analysing numerical data from financial markets, such as transaction costs, time to processing and the market capitalisation of DeFi platforms in comparison to traditional banks, is the main focus of the quantitative component. In order to gather perspectives, issues, and ideas that are difficult to quantify using quantitative techniques, the qualitative component involves interviews with DeFi developers, financial regulators and industry experts. This method guarantees a comprehensive study that takes into consideration both quantifiable results and subjective experiences, offering a sophisticated comprehension of the opportunities and difficulties related to DeFi.

A COMPARATIVE STUDY OF TRADITIONAL AND DEFI BANKING

Essential Distinctions

There are major operational, governance and technological differences between DeFi and traditional banking. Centralised authorities, including banks and financial regulators, oversee traditional banking, which offers savings accounts, credit and transaction facilitation. DeFi, on the other hand, uses decentralised blockchain networks, where smart contracts eliminate middlemen and automate transactions. While traditional finance is managed by governmental monitoring and hierarchical institutions, DeFi is governed by decentralised protocols, frequently through community voting procedures. While DeFi platforms are transparent and unchangeable, they run the risk of security flaws like smart contract issues, whereas traditional banks rely on safe but frequently opaque IT systems (Harvey et al., 2021 & Zetzsche et al., 2018).

Price and Efficiency

In a few aspects, DeFi works much better than the old banking system, both in terms of price and efficiency. Transactions are faster and cheaper here because they bypass most intermediaries. For instance, whereas banking sometimes takes days for money transfers and costs lots of money, the same transaction through DeFi can be completed in minutes for less. Defiantly, in the case of systems like Ethereum, unreasonable fees are found to prevail when there are high activities. Then, old-fashioned banks save speed for consistent transaction fees.

Inclusivity and Access

Because DeFi systems allow anybody with internet access to participate in financial services without requiring a bank account, they offer previously unheard-of accessibility and inclusivity. This has a special effect in developing nations with weak traditional financial systems. But there are drawbacks to this accessibility, like issues with financial literacy and a lack of consumer protection. Traditional banks provide safe and regulated spaces, but because of their strict standards, they frequently do not accept unbanked or underbanked people (Klapper et al., 2016 & Schär, 2021).

Security and Openness

DeFi platforms provide transparency through the recording of all transactions on public blockchains, hence facilitating easier audits and increased accountability. The use of smart contracts, however, raises security issues such as coding mistakes and hacker vulnerabilities. Conventional banks place a higher priority on security and use strong risk management systems, but they are less transparent because financial activities and hazards are sometimes not made public. For every system, this trade-off between security and openness offers different opportunities and problems (Werbach, 2018 & Antonopoulos, 2017).

Use Cases

Decentralised finance's disruptive potential is demonstrated by a number of successful DeFi installations. For example, DAI, a decentralised stablecoin offered by MakerDAO, is now necessary for lending and trading in DeFi. Decentralised lending, where users can borrow assets or earn interest in a completely automated, trustless setting, is made possible by Compound. These platforms demonstrate DeFi's ability to provide financial services in a more effective and user-friendly way. Nevertheless, these use cases also draw attention to issues like price volatility, the dangers associated with smart contracts, and the requirement for regulatory oversight (MakerDAO White Paper, 2019; Leshner & Hayes, 2019).

OPPORTUNITIES PRESENTED BY DEFI

Inclusion of Finances

By granting access to financial services to groups that have traditionally been shut out of the official banking system, Decentralised Finance (DeFi) has the potential to greatly improve financial inclusion. The World Bank estimates that 1.4 billion adults worldwide lack access to financial infrastructure, especially in developing nations (Demirgüç-Kunt et al., 2022). With the help of DeFi platforms, anyone with an

internet connection can participate in financial activities including lending, investing, and saving, removing obstacles like excessive banking costs, lack of verification, and regional limitations. Through the use of blockchain technology, DeFi democratizes access, enabling people in far-flung places to take part in the global financial system. But in order to fully realise this potential, issues like low digital literacy and the requirement for internet connectivity must be resolved (Auer et al., 2022).

Financial Sector Innovation

New products and methods that were previously unthinkable in traditional finance have been introduced by DeFi, resulting in revolutionary innovation in financial services. In exchange for interest and governance tokens, yield farming, for instance, enables investors to generate substantial returns by supplying liquidity to decentralised exchanges (DEXs) (Kumar & Mukherjee, 2021). Another invention that makes it possible to take out and pay back loans quickly and without security is the flash loan. Concerns over financial stability and security have been expressed, however these loans have also created opportunities for arbitrage and sophisticated financial tactics. Furthermore, DeFi has fostered the growth of automated market makers (AMMs), which substitute liquidity pools for conventional order books to enable more effective and decentralised trading (Harvey et al., 2021).

Cost Reduction and Efficiency

Increased efficiency and lower costs are two of DeFi's main advantages. The infrastructure, administrative procedures and regulatory compliance of traditional financial institutions come at a high cost. DeFi platforms reduce the need for human intervention in financial operations by automating processes like trade settlement and loan issuing through the use of smart contracts. Both consumers and companies profit from reduced transaction costs and quicker processing times brought about by this automation. In contrast to traditional remittance services, which may take days and impose significant fees, remittances done using DeFi platforms, for instance, can be completed nearly instantly with negligible fees (Schär, 2021). For small and medium-sized businesses (SMEs), which encounter significant obstacles when trying to get money in conventional financial channels, DeFi's cost savings are especially advantageous.

Greater Openness and Disclosure

DeFi's blockchain-based foundation guarantees unmatched transparency because every transaction is documented on an immutable public ledger that can be verified. Unlike traditional financial systems, which are frequently opaque, this transparency makes auditing simpler and improves compliance by offering an open record of

financial operations (Werbach, 2018). Regulators and financial organisations can use this openness to better assess risk and stop fraud. Additionally, transparency fosters user trust since it allows users to independently confirm transactions and monitor the real-time flow of assets. For sensitive financial data in particular, it might be difficult to strike a balance between privacy and transparency (Antonopoulos & Wood, 2018).

OPPORTUNITIES PRESENTED BY DEFI

There are many prospects in Decentralised Finance (DeFi) that have the potential to revolutionise the global financial system. The most persuasive advantage is financial inclusion. Because DeFi systems cut out middlemen, people in underdeveloped areas can now access financial services with just an internet connection. Because of this accessibility, millions of people around the world who lack access to traditional banking because of bureaucratic, socioeconomic, or geographic limitations are empowered. DeFi systems are open and permissionless, so anybody may engage in lending, borrowing, and investing without having to go through drawn-out approval procedures or meet strict standards. Consequently, the financial landscape is made more inclusive and democratic by DeFi (Allen et al., 2021).

The other possibility is increased efficiency and lower transaction costs. With the technology of smart contracts, DeFi systems automate financial operations and significantly reduce the time and cost of operations such as trading, lending and cross-border payments. Avoidance of human error means reduced reliance on conventional financial institutions that usually charge steep fees for their services. The programmability of smart contracts further also makes possible the development of novel financial products, including yield farming and decentralised insurance, thereby increasing the number of investment possibilities open to customers. These developments not only simplify financial processes but also create new opportunities for economic expansion and innovation, as Gudgeon et al. (2020) argue.

DeFi provides opportunity for additional financial autonomy and also increased transparency. Because smart contract code and transactions exist on public blockchains, users have a level of transparency that would otherwise be impossible in traditional finance, and the encouragement of accountability can help lessen financial fraud and corruption. DeFi solutions further offers customers the right to having control over their assets; the money will not need to be entrusted to centralised organizations. Especially for those areas with unstable economies or highly restrictive financial laws, this kind of financial sovereignty is very tempting for people who hate the fact that banks and governments control their money (Schär, 2021).

Is Competition or Integration the Way of the Future for Financial Systems?

Traditional banking systems are faced with both opportunities and challenges as a result of the quick development of Decentralised Finance (DeFi). DeFi's ability to integrate with traditional financial institutions depends on both parties realising their advantages. In successful coexistence scenarios, banks might use DeFi technology to improve client experiences, cut costs, and streamline processes. To cut down on paperwork and processing time, financial institutions might employ smart contracts to automate loan agreements or integrate blockchain technology for quicker and safer cross-border transactions. Bank-DeFi platform partnerships may also develop, in which banks supply custodial services for digital assets, striking a compromise between the stability and confidence provided by traditional banks and the effectiveness of decentralised finance (Schueffel, 2021 & Zhao et al., 2022).

But there are certain difficulties with this integration. Disparities in consumer protection, risk management, and regulatory frameworks continue to be major barriers. In order to safeguard customers and preserve market stability, financial regulators might need to create new regulations that allow for DeFi's automation and transparency. According to the "compliance by design" paradigm that has been suggested, DeFi protocols could include regulatory requirements straight into smart contracts, guaranteeing that transactions adhere to legal requirements without the need for manual intervention. By overcoming these obstacles, DeFi may develop into a vital part of the financial system that promotes innovation and gains from the stability of conventional finance (Arner et al., 2020).

A strong undercurrent of competitiveness endures despite the integration hopes. Because DeFi is decentralised, it directly challenges the core tenets of traditional banking, which depend on middlemen and centralised authority. DeFi's proponents contend that it democratises financial services by enabling consumers to save, invest, and transact without the assistance of banks. As more people and companies try out DeFi apps, traditional banks might be under pressure to reduce costs, boost productivity, and adopt more openness. However, there are concerns associated with DeFi's expansion. Concerns over smart contract security, price volatility, and market manipulation vulnerability may restrict its appeal in comparison to traditional institutions' perceived stability (Gudgeon et al., 2020; Lyons & Viswanath-Natraj, 2021).

One example of how centralised entities' roles are evolving within the DeFi ecosystem is the new idea of Centralized-Decentralized Finance (CeDeFi). With CeDeFi, the dependability and legal compliance of centralised finance will be combined with the benefits of decentralisation, such automation and transparency. Large financial institutions and cryptocurrency exchanges, including Binance, are actively

investigating CeDeFi to provide solutions like compliance-friendly DeFi services and regulated decentralised exchanges. With the advantages of decentralised technologies, this hybrid approach might draw in traditional investors who are leery of DeFi's lack of regulation. But by restoring centralised points of failure and influence, detractors contend that CeDeFi may compromise the fundamental ideas of DeFi, casting doubt on the direction and culture of decentralised finance going forward (Howell et al., 2022 & Klus et al., 2021).

Global financial systems are reaching a turning point in their history as traditional banking is being challenged and transformed by Decentralised Finance (DeFi). In order to improve efficiency, transparency, and customer experience, some experts argue that DeFi and traditional banking are headed towards integration, with DeFi technology being progressively incorporated into current financial systems. Banks are already investigating the use of blockchain technology for safe and quick international payments, and they are testing smart contracts to simplify loan processing. DeFi's foundational technologies, like distributed ledger technology (DLT), might be easily incorporated into banking systems to produce a more effective and client-focused financial ecosystem (Frost, 2021).

However, considering the basic distinctions in philosophy and governance between the two systems, there is a compelling argument for competition. While banks have a strong foundation in centralised governance, DeFi operates on a decentralisation approach that eliminates traditional middlemen. DeFi may pose a threat to banks' hegemony if it keeps developing at its current rate, particularly in fields like decentralised insurance, automated market making, and peer-to-peer lending. DeFi's capacity to serve a worldwide clientele and provide financial services to underbanked and unbanked groups without having credit histories or physical infrastructure exacerbates the rivalry even more (Campbell-Verduyn, 2020). It is crucial to acknowledge that both systems have weaknesses, such as DeFi's security issues and legacy banking frameworks' rigidity, which raises the possibility of both rivalry and restricted integration.

CONCLUSION

A hybrid model is probably the way of the future, in which financial institutions use blockchain technology while still adhering to the required regulatory monitoring. With this strategy, banks would be able to maintain compliance standards and client trust while taking use of the technological innovations that DeFi pioneered. For DeFi platforms to become more widely accepted and legitimate, they might also start working with traditional finance more, especially by partnering with central banks on initiatives like central bank digital currencies (CBDCs). The final course of financial systems will be determined by changing rules, advances in technology and rates of consumer adoption as these trends progress.

REFERENCES

- Adams, H., Zinsmeister, N., & Robinson, D. (2020). Uniswap v2 Core. Uniswap White Paper. Available from : <https://uniswap.org/whitepaper.pdf>
- Arner, D.W., Barberis, J., & Buckley, R.P. (2020). The Evolution of Fintech: A New Post-Crisis Paradigm?. *Georgetown Journal of International Law*, 47(4), pp. 1271–1319.
- Antonopoulos, A.M. (2017). *Mastering Bitcoin: Unlocking Digital Cryptocurrencies (2nd ed.)*, O'Reilly Media.
- Antonopoulos, A.M., & Wood, G. (2018). *Mastering Ethereum: Building Smart Contracts and DApps*, O'Reilly Media.
- Allen, F., Gu, X., & Jagtiani, J. (2020). The Interplay between Fintech and Financial Stability. *Journal of Financial Stability*, 42, pp. 100883. Available from : <https://doi.org/10.1016/j.jfs.2019.100883>
- Auer, R., Cornelli, G., & Frost, J. (2022). Rise of the Central Bank Digital Currencies: Drivers, Approaches, and Technologies. *Annual Review of Financial Economics*, 14, pp. 81-100. Available from : <https://doi.org/10.1146/annurev-financial-062921-013020>
- Buterin, V. (2014). A Next-Generation Smart Contract and Decentralized Application Platform. Ethereum White Paper. Available from : <https://ethereum.org/en/whitepaper/>
- Coase, R.H. (1937). The Nature of the Firm. *Economica*, 4(16), pp. 386–405. Available from : <https://doi.org/10.1111/j.1468-0335.1937.tb00002.x>
- Chen, Y., & Bellavitis, C. (2020). Blockchain Disruption and Decentralized Finance: The Rise of DeFi. *Financial Innovation*, 6(1), pp. 1–16. Available from : <https://doi.org/10.1186/s40854-019-0169-3>
- Creswell, J.W., & Plano Clark, V.L. (2017). *Designing and Conducting Mixed Methods Research (3rd ed.)*. SAGE Publications.
- Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2022). The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19. *The World Bank*. Available from : <https://doi.org/10.1596/978-1-4648-1897-4>.
- Gans, J.S., & Stern, S. (2018). The Product Market for Innovation. *In The Economics of Innovation: An Introduction*, Princeton University Press, pp. 27-51.
- Gudgeon, L., Perez, D., Harz, D., Livshits, B., & Gervais, A. (2020). The Decentralized Financial Crisis: Attacking DeFi. *Proceedings of the IEEE Security and Privacy Workshops*, 15(2), pp. 26-37. Available from : <https://doi.org/10.1109/SPW50608.2020.00013>
- Harvey, C.R., Ramachandran, A., & Santoro, J. (2021). DeFi and the Future of Finance. National Bureau of Economic Research. Available from : <https://doi.org/10.3386/w28457>

- Harvey, C. R., Ramachandran, A., & Santoro, J. (2021). *DeFi and the Future of Finance*. John Wiley & Sons.
- Howell, S.T., Niessner, M., & Yermack, D. (2022). Financial Stability and the Future of Decentralized Finance. *Journal of Financial Economics*, 144(1), pp. 1–30. Available from : <https://doi.org/10.1016/j.jfineco.2022.06.003>
- Johnson, R.B., & Onwuegbuzie, A.J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33(7), pp. 14–26. Available from : <https://doi.org/10.3102/0013189X033007014>
- Klapper, L., El-Zoghbi, M., & Hess, J. (2016). Achieving the Sustainable Development Goals: The Role of Financial Inclusion. CGAP. Available from : <https://www.cgap.org/research/publication/achieving-sustainable-development-goals-role-financial-inclusion>
- Klus, M.F., Lohwasser, T.S., Holotiuk, F., & Moormann, J. (2021). CeDeFi: How Centralized Institutions Can Benefit from DeFi. *Journal of Banking Regulation*, 22(3), pp. 230–245. Available from : <https://doi.org/10.1057/s41261-020-00148-2>
- Kulechov, S., & Stani, E. (2021). Aave Protocol White Paper. *Aave Documentation*. Available from : <https://docs.aave.com/>
- Kumar, A., & Mukherjee, S. (2021). The Rise of Yield Farming: Risks and Opportunities. *Journal of Financial Innovation*, 5(3), pp. 112–134. Available from : <https://doi.org/10.1108/JFI-09-2021-0148>
- Lyons, R.K., & Viswanath-Natraj, G. (2021). What Keeps Stablecoins Stable?. *Journal of Financial Economics*, 142(1), pp. 185–202. Available from : <https://doi.org/10.1016/j.jfineco.2021.05.003>
- MakerDAO White Paper. (2019). Maker: Decentralized Autonomous Stablecoin.
- Mishkin, F.S., & Eakins, S.G. (2018). *Financial Markets and Institutions (9th ed.)*. Pearson.
- Rogers, E.M. (2003). *Diffusion of Innovations (5th ed.)*. Free Press.
- Schär, F. (2021). Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets. *Federal Reserve Bank of St. Louis Review*, 103(2), pp. 153–174. Available from : <https://doi.org/10.20955/r.103.153-74>
- Zetsche, D.A., Arner, D.W., & Buckley, R.P. (2018). The ICO Gold Rush: It's a Scam, It's a Bubble, It's a Super Challenge for Regulators. *Harvard International Law Journal*, 60(2), pp. 267–310.
- Werbach, K. (2018). *The Blockchain and the New Architecture of Trust*. MIT Press.

FINTECH-DRIVEN FINANCIAL INCLUSION: A CRITICAL ANALYSIS OF BENEFITS AND CHALLENGES

Abhishek Khari*
Suksham R. Aneja**

Abstract

This paper analyzes the relationship between financial technology (fintech) and financial inclusion in the context of exploring opportunities and challenges. Today, fintech is becoming an unstoppable revolutionary force with the potential to improve financial access to disadvantaged and less privileged populations worldwide.

The paper assesses the current state of fintech innovations, such as digital wallets, peer-to-peer lending, and mobile banking, and their potential to close the gap in financial inclusion. Some of the main challenges that prevent the adoption of fintech solutions at wide-scale levels include regulatory concerns, cybersecurity threats, and the digital divide affecting low-income and rural communities.

This research, therefore, examines possible strategies for overcoming these challenges, thus emphasizing the need for collaboration between fintech firms, regulatory authorities, and key stakeholders in creating an inclusive financial environment.

Keywords: *Fintech Ecosystem, Digital Divide, Digital Financial Services, Financial Inclusion.*

INTRODUCTION

Financial inclusion is the effort to make affordable and easily accessible financial services available to individuals and businesses, a crucial element of sustainable growth and poverty alleviation.

According to the World Bank's Global Findex Database, 1.4 billion people worldwide are cut off from banking facilities in most of these persons belong to developing nations. Here, the infrastructures of conventional banking cannot compete with the mark required to be set. For the empowerment of individuals and economic stability and to accumulate savings and investments, the ability of financial services plays a

* Research Scholar, Govt. Postgraduate College, Noida, Uttar Pradesh, India.

** Assistant Professor, Govt. Postgraduate College, Noida, Uttar Pradesh, India.

crucial role. The development of financial technology plays a vital role in reshaping the financial services landscape and introducing innovative solutions which address the challenges faced by the unbanked and under-banked population. The financial service will be made more accessible, affordable and efficient way through fintech enterprises using digital tools such as mobile banking services, peer-to-peer lending platforms & blockchain technology. In this recent era, the growth of mobile devices and internet connectivity has been very significant accelerates the change and gives millions of people access to financial services even without depending on traditional banking infrastructure.

OBJECTIVES OF THE STUDY

The Present study based on secondary data aims to:

- Examine the impact of financial technology in facilitating financial services access to underserved populations.
- Discuss the obstacles that fintech firms encounter when striving to enhance financial accessibility.
- Investigate the potential and possibilities that fintech presents for reaching individuals unaware of conventional banking services.

LITERATURE REVIEW

Kandpal, (2024): The study focuses on bankers' perceptions regarding financial inclusion and cites challenges like poor network connectivity, staff problems, and lack of trust in the banking agents. It states that the most important elements are availability, accessibility, usage, and affordability while focusing on digital literacy in order to fight cyber fraud, in line with the United Nations' Sustainable Development Goals (SDGs).

Ediagbonya, V., & Tioluwani, C. (2023): The paper focuses on the growing adoption of Fintech in developing countries like Nigeria to ensure greater financial access and eradicate poverty. Governments, financial institutions, and Fintech companies have been trying to change the scenario, but barriers such as illiteracy, lack of infrastructure, and connectivity persist. According to a study, the gap demands more effective policies, digital networks, and regulatory frameworks.

Mhlanga, D. (2022): This literature offers a sweeping analysis of digital financial inclusion about the fourth industrial revolution. It points out that fintech inventions, including blockchain and AI, can transform financial products for low-income populations residing in developing economies. Then again, it also mentions setbacks

such as poor infrastructure, insufficient digital literacy, and losing jobs, underlining the requirement for proactive policies to address the issues so that benefit sharing can be made efficient.

Beck, T. (2020): This paper examines in detail how fintech affects financial inclusion, including how innovations such as mobile and digital lending improve access for the poor and the underprivileged. However, it also addresses issues like privacy and security concerns and underlines the need for regulation to avoid exacerbating current disparities.

Barik & Sharma, (2019): Research findings suggest that the PradhanMantri Jan DhanYojana (PMJDY) scheme introduced in 2014 has significantly improved access to banking services. At the same time, it also brings to light the issues being experienced by specific groups, like women, rural people, the elderly, and those who are less educated. To eliminate these disparities, researchers advise enhancing digital infrastructure and launching holistic financial education programs.

Makina, D. (2019): This study presents a comprehensive analysis of fintech's role in advancing financial inclusion in Africa, charting its progress from initial mobile payment solutions to the latest developments in digital lending and insurance. It highlights fintech's ability to overcome traditional obstacles such as geographical distance and collateral requirements, while also examining the prospects of emerging technologies e.g., blockchain and artificial intelligence.

RESEARCH METHODOLOGY

This study is based on secondary data collected from various publications, government reports, academic articles, industry reports and other policy documents related to financial inclusion and Fintech (financial technology) in India. The literature is obtained from databases like Google Scholar, Researchgate, JSTOR etc.

Data is extracted from several sources like official websites of the government related to the schemes and programs and also reports and publications of various govt. Agencies like NPCI and RBI. Further data has been taken from the World Bank's publications related to Fintech and Financial inclusion.

DATA ANALYSIS

After conducting a review of the literature, it is revealed that Fintech has an impact on financial inclusion although there are various challenges and issues related to it. This study focuses on the various benefits and challenges. Analysis of data regarding the present study is:

ROLE OF FINTECH IN FINANCIAL INCLUSION

As an evolving tool for increasing financial access, especially in developing regions where traditional banking systems are weak, Fintech has become an important tool. Digital innovations using Fintech allow many users who cannot access the back-end infrastructures or who have been underserved to access various financial products such as payment systems, savings accounts, credit facilities, and insurance offerings more affordably and conveniently. This advancement has greatly boosted economic empowerment, reduction of poverty, and financial stability among many individuals.

- **Expanding Access to Financial Services:** People who cannot use mainstream banking services can rely on their mobile phones to transact using mobile banking and payment platforms. For instance, mobile money services like M-Pesa in Kenya have revolutionized the access to finance by millions of people. As of 2020, M-Pesa users stood at over 40 million across seven countries, executing daily transactions amounting to more than \$1.5 billion. Mobile payment applications have significantly contributed to increasing access to accounts (World Bank report on Findex).
- **Digital Borrowing and Access to Credit:** Companies dealing in financial technology like Tala and Branch allow, by using data analysis checks the creditworthiness. This is facilitating lending for those who don't have formal credit. Online platforms in countries like Kenya and Nigeria have spent a huge amount on small loans to people unable to obtain credit. A report from McKinsey & Company (2021) report showed that digital credit platforms, Fintech have made access to loans for some 40% of the population easier than direct loans from traditional banks.
- **Low-cost Financial Solutions:** Fintech also made financial services economical. Mobile apps offering Digital wallet and money transfer services helped reduce the cost of transactions. For instance, in 2020, the average percentage cost international transactions was 6.38%. But Fintech services such as TransferWise-now Wise-and Remitly allow people to transfer money across borders for just 1% to 2% in fees. This lower cost keeps money in the pockets of those in less developed countries and lowers the costs for everyone.
- **Empowering Small Businesses:** Fintech has emerged as an important enabler of financial inclusion for small & medium-sized enterprises. Since most SMEs are usually unable to obtain adequate access to traditional finance, services offered under Fintech, such as online payments, invoicing and online marketplaces come as a welcome lifeline. Square, Stripe and PayPal allowed small businesses to accept digital payments without the need for expensive point-of-sale infrastructure. The World Bank report (2020) indicates that Fintech

services helped more than 40% of SMEs in emerging markets survive the COVID-19 pandemic by allowing them to pivot to online sales and payments.

- **Data-Driven Financial Products:** Fintech innovations using big data and AI meet the financial needs of underserved populations, such as offering micro-insurance products at below-premium prices through insurance technology. For example, insurtech platforms use data analytics to offer micro-insurance products at affordable premiums that cover low-income earners against other kinds of financial risks. In Africa, companies like BIMA and MicroEnsure offer health and life insurance to millions of people who previously didn't have access to insurance.

Table 1: Summary of Data Trends on Fintech and Financial Inclusion

Fintech Application	Key Data	Impact on Financial Inclusion
Mobile Money Services	\$2 trillion processed in 2020 (GSMA)	Expands access to financial transactions in underserved regions
Credit Accessibility through Fintech	40% increase in credit access for underserved (McKinsey, 2021)	Enables loans for individuals/businesses without formal credit
Remittance Cost Reduction	Fees reduced to 1%-2% via Fintech (World Bank, 2020)	Reduces cost of sending money, increasing financial support
SME Financial Empowerment	40% of SMEs shifted to digital payments during COVID-19 (World Bank, 2020)	Provides essential financial tools for business survival

CHALLENGES OF FINTECH IN ENABLING FINANCIAL INCLUSION

- **Digital and Financial Literacy:** Digital and financial literacy is a very important aspect of achieving financial inclusion failing to which can seriously reduce the potential of technology to improve financial inclusion. The financial literacy rate is as low as lower to 30 per cent in Sub-Saharan areas. Similarly, in India, only 40% of mobile phone users know that they have access to financial services (OECD, 2021). It is challenging to transform this much population about the financial technology.



Figure 1: Financial Literacy Across Different Countries

- Data Privacy and Security Concerns:** Privacy and security issues are significantly important to address because these issues are increasing with the growth of digital services, especially in developing unregulated markets. These concerns act as hurdles in adopting the financial technology the 2020 PwC survey found that 45% of consumers in developing unregulated markets do not use fintech due to privacy concerns, while 60% of fintech users in region of Latin America are concerned about the data privacy security of their private information. Addressing these issues becomes very important.

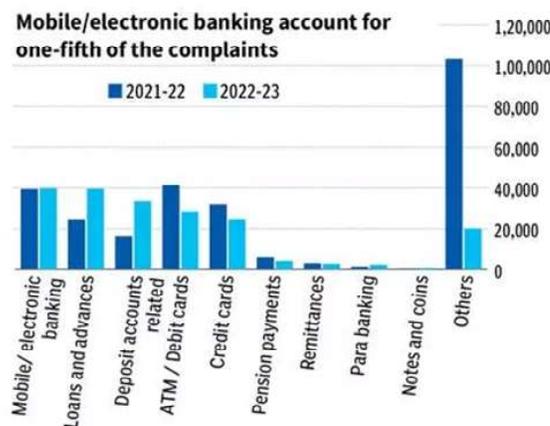


Figure 2: Mobile / electronic banking account for one-fifth of the complaints

- Financial Losses and Damage to Reputation:** Day to day increase in online fraud becomes a major issue for consumers and fintech companies because it would damage reputation by which people hesitate to use the financial technology which reduces the reliability of the platform. For example, according to the IBM Security Report (2021), the average cost of a data breach in finance was \$5.72 million, which led to increased rates of customer churn. Global digital payment fraud losses are estimated to be \$32 billion in 2020 and are expected to grow as fintech adoption continues. All these cybersecurity issues have to be addressed so that trust is maintained, and sustainable growth can take place in fintech services.
- Regulatory Challenges and Lack of Security Protocols:** The Fintech industry is changing rapidly due to technological advancements and often outpaces existing regulatory frameworks, resulting in inconsistent cybersecurity regulations. This creates serious problems for fintech companies to operate worldwide. Likewise, 60% of fintech enterprises find these compliances and regulatory measures as a major obstacle, Deloitte FinTech Report (2021). Emerging markets also lack cybersecurity and data privacy measures, which exposes fintech users to a higher risk of fraud. Addressing these rules and difficulties and standardizing the security protocols is very important for keeping the fintech industry safe and growing in future.
- Limited Internet and Mobile Access:** Even in this 5G era a lot of people do not have mobile and internet access. If people do not have a good internet or mobile connection, Which makes them unable to use online shopping, mobile money, and other financial tools. Till 2021, 63% of the world has internet, but this number is as low as 29% in underdeveloped countries which becomes a serious hurdle in enabling financial inclusion.

Even only 53% of people in low- and middle-income countries use mobile internet services, as per GSMA's data from 2023.

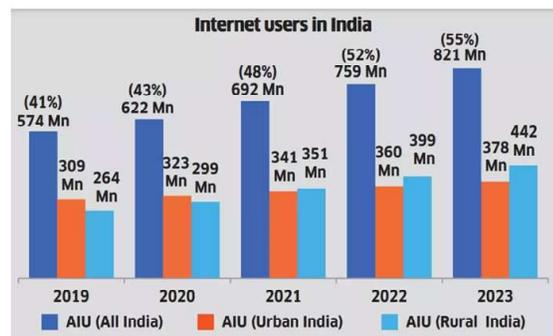


Figure 3: Internet users in India

- **Lack of Infrastructure and Cash Dependency:** People here in many developing countries cannot access Fintech services because there is a lack of ATMs & other banking places. Also, many of these developing countries use cash significantly, which makes it much more challenging to shift towards Fintech. According to the IMF (2023) report even though India is promoting digital payments, 70% of their purchases still use cash. Likewise, in Africa below the Sahara desert, 42% of people do not have a bank account because there are not many banks in the rural areas (World Bank, 2022).
- **Trust & Cultural Barriers:** Trust factor becomes crucial for people to switch to fintech services, especially in those locations where cash is the main way to transaction. Due to a Lack of trust and cultural problems people are not ready to use digital money services because they fear losing their money as well as their privacy, also they do not know how to operate on digital platforms, and traditional banking systems gives them more confidence. The report of Accenture (2021) states, 39% depends on physical bank branches as they don't trust online services.

BENEFITS OF FINTECH-DRIVEN FINANCIAL INCLUSION

The role of Financial Technology (Fintech) is increasing rapidly due to technological advancement and period. Fintech is a proven revolutionary step in financial inclusion, particularly in developing and emerging markets. By utilizing digital platforms and technological innovations, Fintech has the potential to remove conventional barriers that majorly prevented millions from accessing the financial services. So it becomes important to keep an eye on the following prospects and possibilities that Fintech provides for reaching the unbanked:

- **Expanding Access to Financial Services:** Fintech uses innovative technology to provide financial services to underserved people, especially in remote areas without physical banks. For example, services like M-Pesa show how important mobile money is, with transactions in Sub-Saharan Africa reaching over \$701 billion in 2023. Since there are more than 5.3 billion mobile users around the world, Fintech has a huge opportunity to make financial services more accessible.

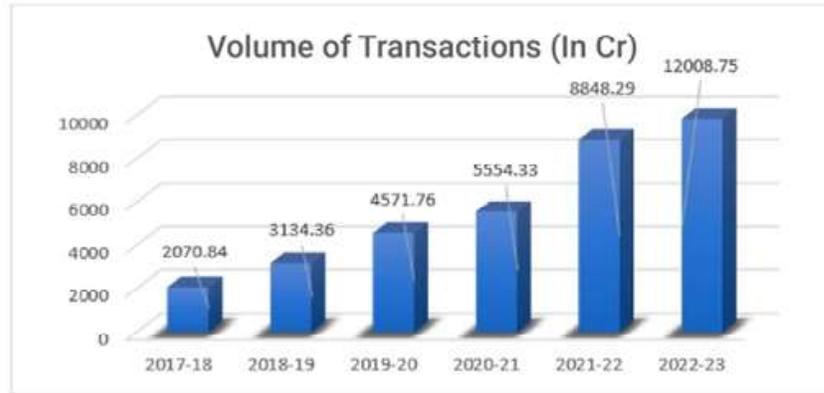


Figure 4: Volume of Transactions

- Embedded Finance:** Embedded Finance integrates financial services into the platforms people use every day, such as e-commerce, social media and sharing applications. Bain & Company expects financial interconnectivity to generate \$7 trillion in global revenue by 2030. Partnerships with businesses like Shopify and Uber enable fintech companies to seamlessly integrate banking, insurance, lending and payment solutions into non-financial applications, greatly improving usability and user experience.

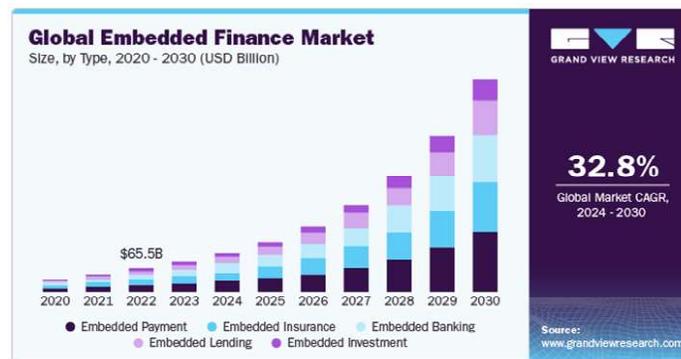


Figure 5: Global Embedded Finance Market

- Artificial Intelligence and Machine Learning :** Artificial Intelligence and Machine Learning will transform financial technology, providing personalized financial solutions and superior risk management. Artificial intelligence tools such as chatbots, robo-advisors and credit algorithms provide personalized recommendations, while advanced fraud detection enhances security.

According to PwC, AI could add \$15.7 trillion to the global economy by 2030, significantly impacting the financial sector.

- **Rise of Central Bank Digital Currencies (CBDCs):** Governments and central banks are working on CBDCs to update payment systems, lower costs, and help more people use financial services. More than 80% of central banks are studying CBDCs, and countries like China, Sweden and the Bahamas are testing them. CBDCs provide safe, government-supported digital money, which helps people without bank accounts and those in faraway places.
- **Financial Inclusion and the Unbanked:** Fintech holds tremendous potential to serve the unbanked by leveraging mobile technology, blockchain, and digital finance to bridge the financial inclusion gap. As of 2023, 1.4 billion people globally remain unbanked mobile money and digital wallets are gaining traction in emerging markets, with Africa's mobile money accounts surpassing 650 million, thereby enhancing access to financial services.

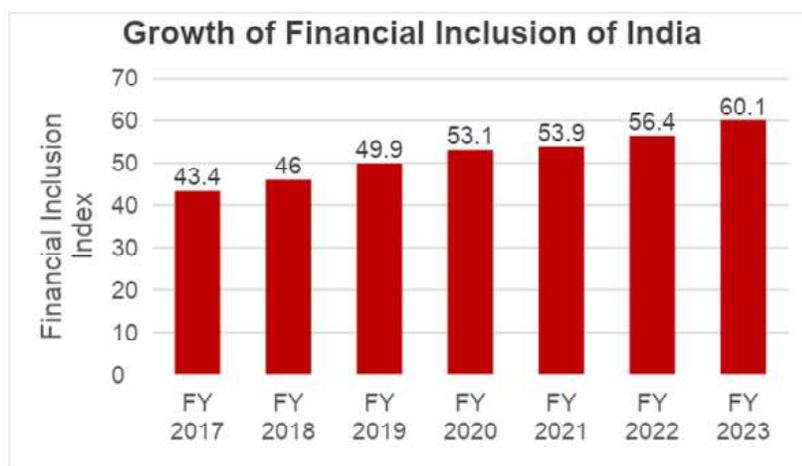


Figure 6: Growth of Financial Inclusion of India

- **Regulation and Cybersecurity:** As Fintech keeps on growing, regulations need to be robust and cybersecurity measures well-developed. Governments are going to play an important role in the shaping of the industry when looking to promote innovation while ensuring protection. By 2030, major economies are supposed to have comprehensive Fintech regulations in place, which consider data privacy and address the dangers regarding the use of cryptocurrencies. Cybersecurity investments should boom, with the Fintechcy

bersecurity market project seeing revenues reach \$30 billion by protecting the financial data.

CONCLUSION AND RECOMMENDATIONS

On analysing the various benefits and Challenges it can be concluded that the evolution of Fintech has profoundly changed the financial services landscape, particularly in promoting financial inclusion for unbanked and underbanked populations. This study signifies the diverse roles that Financial Technology plays in increasing access to financial services like improving affordability & offering personalized services to individuals. Despite achieving financial inclusion there are various difficulties like legal barriers, infrastructural constraints, cybersecurity threats and low rates of financial & digital literacy. Considering these difficulties, Financial Technology can substantially decrease the financial divide. The increasing number of mobile banking transactions, digital wallets, and alternative lending platforms highlights how new financial technology can empower marginalized groups, stimulate economic growth, and create long-term financial systems. The effectiveness of Fintech in advancing financial inclusion depends on joint efforts made by government agencies, financial institutions, and Fintech companies to create a favourable regulatory environment, enhance digital literacy and invest in critical infrastructure.

REFERENCES

- Kandpal, V. (2024). Dimensions of financial inclusion in India: a qualitative analysis of bankers perspective. *Qualitative Research in Financial Markets*, 16(4), pp. 660-679.
- Ediagbonya, V., & Tioluwani, C. (2023). The role of fintech in driving financial inclusion in developing and emerging markets: issues, challenges and prospects. *Technological Sustainability*, 2(1), pp. 100-119.
- Mhlanga, D. (2022). Prospects and challenges of digital financial inclusion/Fintech innovation in the fourth industrial revolution. *Digital financial inclusion: Revisiting poverty theories in the context of the Fourth Industrial Revolution*, pp. 163-182.
- Beck, T. (2020). *Fintech and financial inclusion: Opportunities and pitfalls* (No. 1165). ADBI working paper series.
- Barik, R., & Sharma, P. (2019). Analyzing the progress and prospects of financial inclusion in India. *Journal of Public Affairs*, 19(4), pp. e1948.
- Makina, D. (2019). *The potential of FinTech in enabling financial inclusion*. Extending financial inclusion in Africa, New York : Academic Press, pp. 299-318. Available from : <https://doi.org/10.1016/B978-0-12-814164-9.00014-1>
- Reserve Bank of India. (2020). Report on trend and progress of banking in India. Available from: <https://www.rbi.org.in/Scripts/AnnualReportPublications.aspx?Id=1209>

Sharma, R. (2019). Financial inclusion in India: A review of initiatives and challenges. *Indian Journal of Economics and Development*, 15(2), pp. 317-324.

<https://www.worldbank.org/en/publication/globalindex/Report>

<https://www.mckinsey.com/~media/mckinsey/industries/financial%20services/our%20insights/the%202021%20mckinsey%20global%20payments%20report/2021-mckinsey-global-payments-report.pdf>

<https://www.capgemini.com/news/press-releases/world-fintech-report-2020/#:~:text=Featured%20in%20the%20World%20FinTech,value%20and%20cut%20losses%20quickly.>

<https://www.oecd.org/finance/FinTech-lending-in-Sub-Saharan-Africa.pdf>

<https://www.pwc.in/industries/financial-services/fintech/point-of-view/pwcs-fintech-insights-january-2020.html>

<https://newsroom.ibm.com/2022-02-23-IBM-Report-Manufacturing-Felt-Brunt-of-Cyberattacks-in-2021-as-Supply-Chain-Woes-Grew>

<https://www2.deloitte.com/content/dam/Deloitte/us/Documents/financial-services/tech-trends-fs.pdf>

https://www.gsma.com/sotir/wp-content/uploads/2023/04/GSMA-SOTIR-2023_Web.pdf

<https://www.imf.org/en/Publications/WP/Issues/2023/02/03/Fintech-Payments-in-Public-Financial-Management-Benefits-and-Risks-529100>

<https://documents1.worldbank.org/curated/en/099450005162250110/pdf/P17300600228b70070914b0b5edf26e2f9f.pdf>

<https://www.accenture.com/content/dam/accenture/final/a-com-migration/r3-3/pdf/pdf-149/accenture-fintech-report-2020.pdf>

https://www.bain.com/contentassets/a5ad904e61324de88b62707de879f174/bain_brief_embedded-finance.pdf

India FinTech Report 2019, available at https://mediciinnercircle.com/wpcontent/uploads/2019/03/FintegrateReport_ExecutiveSummary_Final.pdf

ICICI Direct

RBI Annual Report

The Economic Times

NIC

Fintech weekly

REGULATION AND COMPLIANCE IN THE FINTECH SECTOR: A GLOBAL PERSPECTIVE

Meenu Chaudhary*

Abstract

The fintech sector has revolutionized traditional financial services, offering a wide range of innovative solutions that enhance efficiency, accessibility, and user experience. However, these advances come with challenges, particularly around regulatory compliance. As fintech ecosystems evolve, governments and regulatory bodies worldwide grapple with establishing frameworks that foster innovation while ensuring market stability, consumer protection, and data privacy.

This paper presents a comprehensive analysis of the regulatory landscape in the fintech sector, examining variations in regulatory approaches across major global markets. We focus on countries leading fintech innovations such as the United States, the United Kingdom and China as well as emerging economies including India, which is adapting its regulatory frameworks to balance fintech growth with consumer protection and data security.

The study delves into unique regulatory frameworks in these regions, exploring how countries like the United States and the European Union have distinct approaches in key areas such as digital banking, peer-to-peer lending, cryptocurrency, and data protection. India, in particular, is highlighted for its proactive stance toward digital financial inclusion and a regulatory landscape that has evolved to accommodate the rapid growth of its fintech sector. Through initiatives such as the Digital India campaign, the launch of the Unified Payments Interface (UPI), and regulatory sandboxes, India has emerged as a major player in the global fintech space, setting an example for balancing innovation with regulation.

In 2018, the Reserve Bank of India (RBI) launched guidelines for a regulatory sandbox approach, providing a controlled environment for fintech startups to test their innovations under regulatory oversight. Furthermore, India's payment landscape has been transformed by the introduction of UPI, which has greatly boosted digital transactions while ensuring robust security and compliance measures. However, challenges remain. The lack of a comprehensive data protection law has raised concerns over consumer privacy, especially in light of India's large-scale digital infrastructure and the growing volume of fintech users. The proposed Digital Personal Data Protection (DPDP) Bill aims to address these gaps, signalling India's commitment to aligning its regulatory standards with global norms.

In conclusion, this study emphasizes the importance of agile and collaborative regulatory frameworks to address the dynamic nature of fintech. By analyzing current trends and

* Assistant Professor, Manyavar Kanshiram Govt. Degree College, Ghaziabad, Uttar Pradesh, India.

emerging challenges, we provide insights for policymakers, industry stakeholders, and fintech firms to navigate the complex regulatory landscape and foster sustainable development in the global fintech ecosystem.

Keywords: *Fintech, Regulatory Compliance, India Fintech Sector, Artificial Intelligence in Compliance.*

INTRODUCTION

The financial services industry is undergoing a significant transformation due to the rapid advancement and integration of financial technologies (fintech). These innovations offer enhanced operational efficiencies and customer experiences and introduce complex regulatory challenges. Adopting fintech solutions like blockchain, artificial intelligence (AI) and machine learning (ML) redefines how financial institutions operate and comply with regulations. Traditional regulatory frameworks designed for conventional financial systems often need help to keep pace with the speed and complexity of fintech innovations. This misalignment creates a fragmented regulatory environment that can compromise financial stability and consumer protection (Arner et al., 2017). These technologies can analyze large volumes of data to identify patterns and trends, enabling financial institutions to manage risks and comply with regulatory requirements proactively (Gai et al., 2018).

Regulatory compliance refers to the adherence to laws, regulations, guidelines and specifications relevant to a business. In the financial sector, regulatory compliance ensures financial institutions operate with integrity and transparency, safeguarding stakeholders' interests and maintaining the financial system's stability. Efficiency in regulatory compliance involves optimizing processes to meet regulatory requirements with minimal resource expenditure, thus achieving a balance between compliance and operational effectiveness (Bamberger, 2010). Additionally, principles-based regulation, which focuses on broader regulatory principles and objectives rather than specific rules, provides greater flexibility for regulators and financial institutions. This approach encourages a more proactive and adaptive compliance culture, allowing institutions to innovate while ensuring they meet regulatory objectives (Black et al., 2007).

EVOLUTIONS OF FINTECH

The evolution of fintech (financial technology) has transformed the way financial services are developed, delivered, and consumed worldwide. Initially focused on back-office support for traditional banks, fintech has rapidly evolved into a disruptive force that spans a broad spectrum of financial services, including payments, lending, wealth management, and insurance. This journey can be traced through several distinct phases:

Early Beginnings (1960s–1990s): Digital Foundations

- **Banking Automation:** Fintech's roots trace back to the 1960s, with the advent of technology that automated back-office functions in banks. The introduction of mainframe computers streamlined banking operations and introduced electronic payment systems.
- **ATMs and Credit Cards:** The 1970s brought the development of ATMs, making banking accessible 24/7. Credit cards gained popularity as an early form of digital payment, paving the way for non-cash transactions.
- **Online Banking:** By the 1990s, internet banking emerged, enabling customers to access accounts and perform transactions online, marking the beginning of consumer-driven digital finance.

Rise of Digital Payments and Online Services (2000s)

- **eCommerce and Digital Payments:** The explosion of the internet in the early 2000s led to a surge in eCommerce, which drove demand for digital payment solutions. PayPal became one of the first successful fintech companies, revolutionizing online payments by providing a secure, user-friendly platform.
- **Mobile Banking:** With the proliferation of mobile devices, banks started offering mobile banking apps, allowing customers to manage finances on the go. This period marked the transition of fintech from back-end systems to customer-facing services.
- **Peer-to-Peer (P2P) Lending and Crowdfunding:** Platforms like LendingClub and Kickstarter emerged, allowing individuals to lend, borrow, or invest directly with each other without traditional financial intermediaries.

Fintech Boom and Disruption (2010s)

- **Blockchain and Cryptocurrencies:** The introduction of Bitcoin in 2009 and blockchain technology marked a significant shift, introducing decentralized finance (DeFi) and the potential for alternative financial systems outside government control. Numerous cryptocurrencies and blockchain-based applications followed.
- **Mobile Payments and Digital Wallets:** Mobile payment platforms like Venmo, WeChat Pay, Alipay, and later Apple Pay and Google Wallet transformed how consumers and businesses manage and transfer funds, especially in emerging markets where traditional banking is limited.

- **Robo-Advisors and AI in Finance:** Automated, algorithm-driven financial planning services known as robo-advisors emerged, making investment management accessible and affordable for a wider audience. Companies like Betterment and Wealthfront leveraged AI to provide low-cost, personalized investment advice.
- **Regulatory Sandboxes:** To foster innovation and manage risks, regulatory bodies in countries such as the UK and Singapore began implementing "regulatory sandboxes" that allowed fintech firms to test new products under regulatory oversight.

Modern Fintech and Integrated Digital Finance (2020s)

- **Open Banking and API Economy:** Open banking regulations, such as the EU's PSD2, mandated that banks share customer data with authorized third parties, enabling seamless integration of financial services and promoting competition. This created an API-based financial ecosystem where customers could access multiple financial products through a single platform.
- **Embedded Finance:** Financial services became embedded directly into non-financial apps and platforms, enabling consumers to access payments, lending and insurance within retail, travel and other industry apps. Companies like Stripe and Square have been key drivers in integrating finance into various business models.
- **Artificial Intelligence and Machine Learning:** AI has become a cornerstone of modern fintech, from advanced fraud detection to personalized financial planning and credit scoring. Machine learning models analyze vast amounts of data to deliver precise financial services tailored to user needs.
- **Decentralized Finance (DeFi) and Non-Fungible Tokens (NFTs):** Building on blockchain, DeFi applications and NFTs have unlocked new ways for individuals to manage assets, invest, and transact outside traditional banking systems. Platforms like Uniswap and OpenSea represent the merging of finance with blockchain-based assets.

REGULATORY LANDSCAPE IN THE FINTECH SECTOR

The regulatory landscape in the fintech sector is complex and varies significantly across countries and regions. As fintech innovations redefine financial services, regulatory bodies are tasked with establishing frameworks that protect consumers,

preserve market stability, and enable innovation. Below is an overview of the main regulatory themes, challenges and approaches that define the current fintech regulatory landscape:

Diverse Regulatory Approaches

- **Fragmented Regulations:** In countries like the United States, fintech regulations are highly fragmented, with state and federal agencies sharing responsibilities. This often results in compliance challenges for fintech firms trying to operate across different states or regions.
- **Unified Frameworks:** In contrast, the European Union follows a more harmonized approach, where directives such as the Payment Services Directive (PSD2) and General Data Protection Regulation (GDPR) standardize requirements across member states, fostering cross-border consistency and easier market access for fintech companies.
- **Innovation-Friendly Jurisdictions:** Countries like Singapore and the United Kingdom are known for adopting progressive, innovation-friendly approaches. They actively promote fintech through regulatory sandboxes and flexible frameworks that encourage new solutions while managing potential risks.

Regulatory Sandboxes and Innovation Hubs

- **Testing and Development:** Regulatory sandboxes allow fintech firms to test innovative solutions in a controlled environment with reduced regulatory constraints. The UK's Financial Conduct Authority (FCA), for example, introduced one of the first sandboxes in 2016, followed by countries like Singapore, Australia and India.
- **Benefits for Emerging Economies:** In emerging economies, sandboxes are used to explore solutions for financial inclusion and digital payments. They allow regulators to monitor and refine policies based on real-world insights, which is especially helpful for countries adapting to rapid fintech advancements.

Data Privacy and Consumer Protection

- **Global Privacy Standards:** Regulations like Europe's GDPR have set high standards for data privacy, impacting fintech firms worldwide. These regulations govern data collection, processing and sharing practices, requiring fintech firms to prioritize secure data handling and consumer rights.

- **Localized Data Protection Laws:** Other countries are adopting similar data privacy regulations to protect consumers. India's proposed Digital Personal Data Protection (DPDP) Bill, for instance, aims to strengthen data privacy in one of the world's largest fintech markets, ensuring secure handling of personal information.
- **Transparency and Disclosure:** Consumer protection regulations require fintech companies to maintain transparency regarding fees, risks and data usage. They also establish procedures for dispute resolution, ensuring consumers have access to recourse if issues arise.

Anti-Money Laundering (AML) and Know Your Customer (KYC)

- **AML/KYC Compliance:** Fintech companies must adhere to AML and KYC regulations to prevent financial crimes, including money laundering and terrorism financing. These requirements are often stringent, especially for firms involved in payments, lending and cryptocurrency.
- **Enhanced Due Diligence:** In markets like the US and EU, regulators enforce rigorous KYC protocols to verify customer identity and monitor transactions. Fintech firms are increasingly adopting automated solutions, like AI-powered identity verification, to streamline compliance and reduce costs.
- **Challenges in Emerging Markets:** Compliance with AML/KYC is challenging in emerging markets with limited infrastructure. Here, fintech companies leverage technologies such as biometric identification and mobile verification to fulfil KYC requirements.

Cryptocurrency and Digital Asset Regulations

- **Regulatory Uncertainty:** Cryptocurrencies and digital assets have introduced significant regulatory challenges due to their decentralized nature. Many countries are still defining their stances on digital assets, creating regulatory uncertainty.
- **Divergent Approaches:** Some countries, like China, have implemented strict bans on cryptocurrency trading, while others, like El Salvador, have embraced Bitcoin as legal tender. In the US, regulatory agencies like the Securities and Exchange Commission (SEC) and the Commodity Futures Trading Commission (CFTC) are working to define frameworks for digital assets.
- **Stablecoins and Central Bank Digital Currencies (CBDCs):** Regulatory focus on stablecoins and CBDCs is growing. While stablecoins

are pegged to traditional assets, raising concerns about monetary stability, CBDCs are emerging as state-backed digital alternatives that central banks can regulate and control.

Open Banking and API Standards

- **Open Banking Mandates:** Open banking regulations, such as the EU's PSD2, require banks to share customer data with third-party providers through secure APIs. These regulations promote competition, improve transparency, and facilitate new services in payments, lending, and personal finance management.
- **Adoption in Other Markets:** Open banking is being adopted in other markets, including Australia, Canada and India. In India, the Unified Payments Interface (UPI) exemplifies open banking principles, allowing interoperability across banks and fintech firms.
- **Security and Interoperability Standards:** Open banking regulations include standards for data security and interoperability. Fintech firms are required to comply with these standards, ensuring secure sharing of customer data across platforms.

Cross-Border Regulatory Challenges and Harmonization

- **International Convergence Efforts:** Organizations like the Financial Stability Board (FSB) and the Basel Committee on Banking Supervision work to harmonize fintech regulations across borders, especially for cross-border payments, digital identity, and cyber risk. Harmonizing regulatory frameworks will facilitate cross-border operations and ensure consistent oversight and compliance (Zetzsche et al., 2017).
- **Balancing Local and Global Needs:** Countries must balance the need for local regulatory autonomy with the benefits of international convergence. While harmonization aids global fintech companies, it must be flexible enough to account for diverse financial systems and levels of infrastructure.

Cybersecurity and Risk Management

- **Cyber Resilience Standards:** Regulators emphasize cybersecurity as a priority for fintech companies, given the sector's vulnerability to cyberattacks. Compliance with cybersecurity standards, like the National Institute of Standards and Technology (NIST) guidelines in the US, is often mandated to secure financial data and systems. Financial institutions must implement robust mechanisms to detect and mitigate algorithmic bias in

their AI models. This includes using diverse and representative datasets, regular audits of AI systems and developing algorithms specifically designed to minimize bias (OECD, 2019).

- **Operational Resilience:** Fintech firms are required to have systems in place to ensure business continuity during disruptions. Regulators demand robust disaster recovery and risk management strategies to mitigate financial losses and protect consumer assets. AI-driven models can flag unusual transaction patterns that suggest money laundering or fraud, allowing compliance officers to promptly investigate and address these issues (Smith & Clark, 2021). Financial institutions must ensure that their AI models are explainable and that decisions can be audited to prevent biases and errors that could compromise data integrity and security (Binns, 2018).

Consumer Education and Financial Inclusion

- **Focus on Financial Literacy:** To complement regulatory protections, fintech firms and governments promote consumer education initiatives to improve financial literacy and decision-making. Financial inclusion is also a key focus, particularly in emerging markets, where fintech can provide access to underserved populations.
- **Microfinance and Digital Inclusion:** Regulators in countries like India and Kenya promote fintech solutions that cater to financially underserved populations. Initiatives supporting mobile banking, microloans and small savings accounts have transformed financial access for millions.

REGULATORY FRAMEWORK OF INDIA

India's regulatory framework for fintech is dynamic and evolving, shaped by the government's dual objectives of promoting digital financial inclusion and ensuring consumer protection. Regulatory agencies like the Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Insurance Regulatory and Development Authority (IRDA), and the Ministry of Electronics and Information Technology (MeitY) play pivotal roles in setting policies for the fintech sector. Below is an outline of India's key regulatory approaches and frameworks regarding fintech:

Digital Financial Inclusion Initiatives

- **Unified Payments Interface (UPI):** Developed by the National Payments Corporation of India (NPCI) under RBI's guidance, UPI has become a cornerstone of India's fintech ecosystem, providing an interoperable platform for instant, low-cost digital payments. UPI has

significantly increased digital transaction volumes and brought millions of unbanked and underbanked individuals into the formal financial system.

- **Pradhan Mantri Jan Dhan Yojana (PMJDY):** This national financial inclusion program launched by the Indian government in 2014 focuses on providing every Indian household with a basic bank account, affordable credit and insurance facilities. PMJDY supports fintech efforts to serve previously underserved populations, expanding access to digital financial services.

Payments and Digital Banking Regulations

- **Payment and Settlement Act (2007):** RBI regulates all payment systems in India under this act. The act mandates licensing for payment service providers and ensures the security and efficiency of payment operations across the country.
- **Prepaid Payment Instruments (PPIs):** RBI regulates PPIs, like mobile wallets, through a set of guidelines ensuring these services adhere to KYC (Know Your Customer) and AML (Anti-Money Laundering) norms. Companies like Paytm, PhonePe and Google Pay operate under this framework.
- **Digital Banking Guidelines:** While India doesn't yet have full-fledged digital banks, RBI has been considering a licensing framework for digital-only banks. Currently, neobanks partner with traditional banks to offer digital banking services. This regulatory development is anticipated to bring more digital banking players to the market.

Regulatory Sandbox

- **RBI's Regulatory Sandbox Framework:** RBI introduced a regulatory sandbox in 2019 to promote innovation while safeguarding consumers. The sandbox provides a controlled environment for testing new products under regulatory oversight. Specific themes, such as financial inclusion, payments, and lending, have been prioritized for sandbox cohorts, allowing fintech firms to pilot innovative solutions.
- **IRDAI and SEBI Sandboxes:** Other regulatory bodies, including the IRDAI and SEBI, have introduced sandboxes in the insurance and securities sectors, respectively, to foster innovation while addressing risks in these areas. These sandboxes have allowed companies to experiment with tech-driven financial solutions under regulator supervision.

Data Protection and Privacy

- **Personal Data Protection Bill (Proposed):** India's Digital Personal Data Protection (DPDP) Bill, expected to be enacted soon, aims to regulate the collection, processing, and sharing of personal data, ensuring consumer privacy in the digital era. The proposed bill is aligned with global standards such as GDPR, and once enacted, it will have a substantial impact on fintech firms handling personal data, requiring robust data protection practices.
- **Data Localization:** RBI mandates that financial data, particularly payment data, be stored locally in India. This data localization rule affects companies like Mastercard, Visa, and other global payment processors, requiring them to comply with local data storage and access requirements.

Consumer Protection and Security

- **Cybersecurity Guidelines:** RBI and other regulatory bodies have issued cybersecurity frameworks to ensure fintech firms have adequate measures for data protection, encryption, and cyber resilience. For instance, the RBI's guidelines on digital payment security mandate two-factor authentication (2FA) and periodic risk assessments.
- **Grievance Redressal Mechanisms:** RBI mandates that digital payment providers and fintech platforms establish grievance redressal mechanisms to protect consumers. The RBI Ombudsman Scheme has been extended to cover complaints related to digital payments, ensuring users have access to resolution avenues.
- **Financial Literacy and Awareness Programs:** As part of consumer protection, RBI, SEBI, and other financial institutions run financial literacy programs to educate users about secure digital finance practices, helping protect them from fraud and exploitation.

Know Your Customer (KYC) and Anti-Money Laundering (AML)

- **Digital KYC Compliance:** RBI has updated its KYC norms to support digital onboarding for fintech companies. Through e-KYC and Video KYC options, fintech firms can verify customer identity remotely, which is particularly valuable for remote areas with limited access to physical banking.
- **AML Regulations:** RBI enforces stringent AML guidelines for fintech firms, especially those in payments, lending, and remittances. Firms are required to monitor suspicious transactions and report them to the Financial Intelligence Unit of India (FIU-IND).

Lending and Digital Lending Guidelines

- **Digital Lending Regulation:** To regulate the burgeoning digital lending space, RBI has issued guidelines for digital lending platforms, especially regarding consumer protection and ethical lending practices. The guidelines require digital lenders to disclose all terms upfront, avoid predatory practices and provide clear grievance redressal mechanisms.
- **Digital Lenders' Association of India (DLAI) Code of Conduct:** While not legally binding, this code of conduct, followed by many digital lenders, sets standards around transparency, consumer data security, and fair lending practices. The RBI also regulates digital lending apps directly, especially in the wake of concerns around predatory lending practices.

Cryptocurrency and Blockchain Regulation

- **Cryptocurrency Regulatory Uncertainty:** India has faced regulatory uncertainty around cryptocurrencies. While RBI initially restricted banks from dealing with crypto transactions, the Supreme Court lifted this ban in 2020. However, there is currently no formal framework for regulating crypto assets and the government is working on legislation to address the regulatory, financial, and security risks associated with cryptocurrencies.
- **Blockchain Adoption:** While cryptocurrency regulation remains unclear, India has encouraged blockchain adoption in areas like supply chain finance, cross-border payments and digital identities. Multiple Indian states and government agencies are exploring blockchain solutions, but strict regulations around crypto assets are likely to persist until clearer legislative guidelines are introduced.

CONCLUSION

In conclusion, the regulatory landscape for the fintech sector is marked by a delicate balance between promoting innovation and ensuring stability, security, and consumer protection. The rise of fintech has introduced transformative changes in financial services, driving financial inclusion, efficiency, and accessibility on a global scale. However, these advancements come with significant regulatory challenges, including data privacy, cybersecurity, financial crime prevention, and consumer protection. Countries and regulatory bodies worldwide have adopted diverse approaches to managing these challenges, from regulatory sandboxes and innovation hubs to robust frameworks for data protection and cross-border collaboration.

Accountability is a fundamental ethical principle underpinning AI and ML in regulatory compliance. Financial institutions and regulators must establish clear lines of

accountability for the actions and decisions made by AI systems. This includes defining who is responsible for the outcomes of AI-driven decisions and ensuring that there are mechanisms to address any adverse effects or errors. Institutions must also ensure that their AI systems comply with all relevant legal and regulatory requirements and be prepared to demonstrate this compliance to regulators. Developing comprehensive governance frameworks that outline the roles and responsibilities of all stakeholders involved in deploying and overseeing AI systems is essential for maintaining accountability and ethical standards (Florida et al., 2018).

India's regulatory framework for fintech exemplifies a proactive yet cautious approach, where initiatives like the Unified Payments Interface (UPI), account aggregation, and digital lending guidelines have created a fertile ground for growth while prioritizing consumer interests. Through initiatives aimed at financial inclusion and security, India is becoming a leader in leveraging fintech to address unique local needs. However, as the sector continues to evolve, policymakers must remain vigilant to emerging risks, particularly in areas like digital lending, cryptocurrency, and open banking.

Globally, as fintech solutions increasingly operate across borders, harmonization of regulations and collaboration among international regulators will be essential. A balance between flexibility and strict compliance will help ensure that fintech innovation is sustainable, inclusive, and secure. This study highlights the need for ongoing dialogue among stakeholders to refine regulatory approaches, enabling fintech's potential to reshape the future of financial services while safeguarding global financial stability and consumer trust.

REFERENCES

- Arner, D.W., Barberis, J., & Buckley, R.P. (2017). FinTech, RegTech, and the Reconceptualization of Financial Regulation. *Northwestern Journal of International Law & Business*. 37(3), pp. 371-413.
- Bamberger, K.A. (2010). Technologies of Compliance: Risk and Regulation in a Digital Age. *Texas Law Review*. 88(4), pp. 669-739.
- Binns, R. (2018). Fairness in Machine Learning: Lessons from Political Philosophy. *Proceedings of the 2018 Conference on Fairness, Accountability, and Transparency*. pp. 149-159.
- Black, J., Hopper, M., & Band, C. (2007). Making a Success of Principles-Based Regulation. *Law and Financial Markets Review*. 1(3), pp. 191-206.
- Financial Stability Board. (n.d.). The Use of Supervisory and Regulatory Technology by Authorities and Regulated Institutions: Market Developments and Financial Stability Implications. 2020. Available from : <https://www.fsb.org/2020/10/the-use-of-supervisory-and-regulatory-technology-by-authorities-and-regulated-institutions-market-developments-and-financial-stability-implications/>.

- Gai, K., Qiu, M., & Sun, X. (2018). A Survey on FinTech. *Journal of Network and Computer Applications*. 103, pp. 262- 273.
- OECD (2019). *Artificial Intelligence in Society*. OECD Publishing. Available from : <https://doi.org/10.1787/eedfee77-en>.
- Smith, A.B., & Clark, D.J. (2021). AI and the Future of Regulatory Compliance. *Journal of Financial Regulation and Compliance*. 29(2), pp. 120-135.
- Zetsche, et al. (2017). Regulating a Revolution: From Regulatory Sandboxes to Smart Regulation. *Fordham Journal of Corporate & Financial Law*. 23(1), pp. 31-103.

THE FUTURE OF DIGITAL ASSETS: UNLOCKING THE POTENTIAL OF ERC-404 TOKENS

Ashish Bhatnagar*

Shikha Tiwari**

Preeti Bala Tripathi***

Abstract

This paper explores the development of ERC-404 tokens within the Ethereum blockchain ecosystem and investigates strategies for enhancing digital asset growth. The paper finds effective methods for developing ERC-404 tokens and examines their effects on digital asset management through a thorough literature review and data analysis. For blockchain developers, investors, and enthusiasts looking to use ERC-404 tokens for long-term growth in the digital asset market, the findings offer insightful information.

In the digital age, blockchain technology and cryptocurrencies have completely changed how we see and exchange value. Ethereum has become a prominent platform for token production and decentralised apps (DApps) among the many blockchain-based assets. Token interfaces and protocols within the Ethereum ecosystem are defined by ERC standards, which were created by Ethereum Improvement Proposals (EIPs). For example, ERC-20 tokens have become widely used due to their interoperability and fungibility. However, as the blockchain industry's requirements change, there is a growing need for specialised token standards suited to particular use cases. This paper focuses on ERC-404 tokens, a proposed standard designed to address the limitations of existing token standards and facilitate innovative digital asset management solutions.

Keywords: ERC-404 Tokens, Blockchain Scalability, Global Networks, High-volume Transactions, Decentralised Ecosystem, Ethereum, Decentralised Finance (DeFi), Blockchain Platforms, Token Standards.

INTRODUCTION

ERC-404 tokens represent a new approach to token development that provides better performance and security compared to traditional ERC standards. Researchers have highlighted the potential of ERC-404 tokens to facilitate token issuance, enhance smart contracts, and improve token security. Additionally, research demonstrates the role of ERC-404 tokens in enabling new forms of decentralised finance (DeFi) and digital solutions.

* Asst. Professor, IMS Ghaziabad (UC Campus) Ghaziabad, Uttar Pradesh, India.

** Asst. Professor, IMS Ghaziabad (UC Campus) Ghaziabad, Uttar Pradesh, India.

*** Asst. Professor, IMS Ghaziabad (UC Campus) Ghaziabad, Uttar Pradesh, India.

Comprehensive Review of ERC Token Standards

Ethereum Request for Comments (ERC) standards are frameworks within the Ethereum blockchain that define specific functions and behaviours for tokens and smart contracts. Each ERC standard addresses different requirements:

- **ERC-20:** Widely used for fungible tokens and supports shared token functionality, including transferability and fungibility.
- **ERC-721:** Designed for non-fungible tokens (NFTS), which provide unique assets that represent ownership of personal digital assets.
- **ERC-1155:** Combines fungible and non-fungible token properties, allowing multiple asset types under a single contract, beneficial for gaming and collectables.

Each of the ERC token models (ERC-20, ERC-721, ERC-1155 and ERC-404) has information based on an estimated evaluation of performance and capacity characteristics. Technical guidance, market research, and market insights specific to each model form the basis of the evaluation.

The most popular and established standard, ERC-20, is perfect for basic digital currencies due to its excellent scalability. However, simplicity of use is diminished by restrictions in interoperability, security development and flexibility. Conversely, ERC-721 is efficient at expressing particular assets and was created especially for non-fungible tokens (NFTS).

However, ERC-721 is less useful in an environment that needs a lot of change because it cannot swap resources and has a high gas cost.

Applications like games and collectables that need to handle a lot of different asset kinds will find ERC-1155 to be especially helpful because it is a flexible standard that allows both fungible and non-fungible tokens. It is also more gas-efficient and appropriate for scenarios with a lot of changes, when it supports big changes. A new experimental standard called ERC-404 was created to satisfy the requirements of decentralised finance (DeFi) and hybrid asset applications. Although it is still in the early stages of development, it should offer security and integration while integrating features from earlier models and working to improve the efficiency and security of sophisticated applications.

Each metric, which incorporates specifications, performance metrics and data from blockchain developers and industry forums, is given a score, as shown in Table 1.

Table 1: Shows the relative strengths and weaknesses

Feature	ERC-20	ERC-721	ERC-1155	ERC-404
Fungibility	10	1	8	7
Non-Fungibility	1	10	8	6
Batch Transfers	1	1	10	8
Security	5	6	6	9
Interoperability	5	5	7	9
Gas Efficiency	6	4	7	8

This information allows the features of each ERC model to be compared to determine their suitability for different uses and applications in blockchain technology.

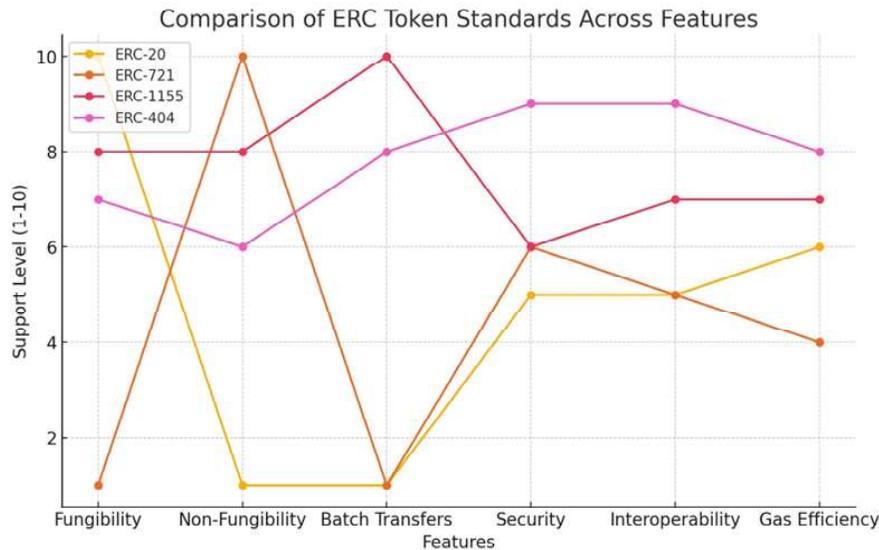


Figure 1: Comparison of ERC token Standards across features

Figure 1: This chart compares the support levels of four ERC token standards (ERC-20, ERC-721, ERC-1155, and ERC-404) across six key features: fungibility, non-fungibility, batch transfers, security, interoperability and gas efficiency. On a scale of 1 to 10, support levels are determined by developer insights and functionality. In important areas related to digital asset management, ERC-404 distinguishes out in terms of security, batch transfers, and interoperability, demonstrating its potential to surpass more established standards.

LITERATURE REVIEW AND GAP ANALYSIS

The literature goes into considerable length about the capabilities and limits of ERC token specifications. There is a noticeable difference in the hybrid nature and scalability of ERC-404 tokens. This gap must be filled by applications that require both security and fungibility. Our paper addresses this information vacuum by analysing the characteristics of ERC-404 and their possible implications for future blockchain innovation.

Researchers and industry professionals are investigating the potential of the new token standard, ERC-404, which has generated a lot of attention in the digital asset arena. A thorough analysis of tokenization on blockchain is given by (Wang et al., 2021), which illuminates the state of the art in this field. Refungible Tokens (RFTS), another name for ERC-404 tokens, provide special opportunities for digital ownership and trading (Deep Dive into ERC-404, 2024). By facilitating partial asset ownership, these tokens increase the number of investment alternatives available inside the NFT ecosystem (Chain Insights, 2024). Beyond digital art and collectables, ERC-404 tokens' adaptability opens up new avenues for asset management and trade (What Is ERC-404? 2024: Pandora's New Hybrid Token. One of the main characteristics of the ERC-404 standard is fractional ownership of assets, which opens up new possibilities for decentralised finance (DeFi) (What Is The ERC-404 Standard? Facilitating Ownership of Fractions of..., 2024). The potential for blockchain-based applications, digital asset management, and decentralised finance is further increased with the adoption of the DN-404 token standard (Introducing DN-404: Transforming Token Standards for Improved..., 2024). In conclusion, ERC-404 tokens have the potential to revolutionise the digital asset market by offering new approaches to trading and asset management. The future of ERC-404 coins seems promising as researchers and industry experts examine the many applications and benefits of this new token standard.

METHODOLOGY

The evolution of ERC-404 tokens and their effect on the expansion of digital assets were examined in the study. A thorough analysis of scholarly works, industry publications on ERC standards, and blockchain technology was used to gather data. To obtain information on ERC-404 token creation tactics and best practices, we also carried out in-depth interviews with blockchain developers, business professionals, and Ethereum community members. Three priorities will serve as the foundation for the documentation process used to assess ERC token standards, including ERC-404:

Blockchain Data

Transaction data, adoption rates, gas prices, and user engagement trends will all be examined using information from Ethereum blockchain explorers such as Etherscan. The Ethereum ecosystem's use of each token model—more especially, ERC-20, ERC-721, ERC-1155 and ERC-404—is immediately explained in this document. Metrics that show trends and performance include transaction volume, average gas prices and the number of distinct addresses that own tokens.

Technical Documentation

Ethereum Enhanced Proofs of Instance (EIPS), specifically EIP-20, EIP-721, EIP-1155 and EIP-404, are the first to be released. This document describes the functionality of the model, including transport, security features and interface methods. By examining these technological systems, researchers can compare the capabilities and limitations of each model. This includes identifying the security standards, potential vulnerabilities, and operational limitations described in each EIP.

Relevant Studies and Industry Reports

The study of academic research, whitepapers, and industry publications will support the analysis of token models. Academic journals and blockchain research articles provide information on the effectiveness of this model in various applications such as decentralised finance (DeFi), non-fungible tokens (NFTs) and hybrid assets. Reports from reliable sources such as ConsenSys, the Ethereum Foundation, and blockchain research firms can provide more information on how these trends are changing, especially regarding innovations such as ERC-404 and their adoption in new projects. These sources will form the basis of the research data, providing a better understanding of the effectiveness, limitations, and practical use of each ERC token model. Research combining blockchain data, information technology, research, and business economics will provide data-driven perspectives on the adoption and use of ERC token standards in the blockchain ecosystem.

RESULTS

The results reveal the main findings of the study, including successful ERC-404 token development strategies and their impact on the evolution of digital assets. Through data analysis and interpretation, the study identifies several factors that contribute to the effectiveness and usage of ERC-404 tokens. These factors include smart contracts, gas usage, security standards and community participation. This paper covers a case study of a real-world ERC-404 token initiative. Although ERC-404 is still in development, theories and experiments using its advanced features,

such as hybrid NFTs, tokenised assets, and Self's solutions, provide important insights into its capabilities. Decentralised gaming platform Gamex is integrating ERC-404 tokens to support the creation of hybrid NFTs. These tokens provide digital and physical content where a token can be represented in assets (e.g. skins, weapons) and real-world objects (e.g. statues or products). To identify members and enable varying energy usage, the ERC-404 standard enables smooth matching between parks and linked devices. By enabling in-game purchases to be linked to safe, smart contracts, hybrid NFTs make asset management easier for gamers. ERC-404 tokens are being used by PropertyX, another example of tokenising real-world assets in DeFi, to tokenise real-world assets like real estate. Investors can trade and possess shares without a single investor thanks to the ERC-404 token, which symbolises a majority ownership of the property. Better security features for token owners include multi-signature wallets and identity verification that is integrated into the token mechanism. The smart contract's operation guarantees that token holders receive dividends, which are money from rent or property interest. Projects such as IdentitySecure use ERC-404 tokens to maintain a decentralised identity (DID). Each person issues a unique ERC-404 token tied to encrypted personal information that is verified by a blockchain-based consensus mechanism. ERC-404 tokens work as identification numbers, allowing users to securely authenticate themselves across various services (such as financial platforms, medical applications) without sharing sensitive information. Interoperability features enable integration with multiple custom ecosystems across blockchains. Hybrid NFTs in the game focus on integration (40%) to ensure a balanced exchange, with an emphasis on assets (30%) and security (30%). Among the real tokenised assets in the world, asset usage (50%) is important, providing investors with easy access to tokenised assets. Collaboration and security each account for 25%. Self-identification is most relevant to self-defence security (60%) and a small share is related to collaboration (20%) and accessibility (20%).

Algorithm : Plot focus areas in ERC-404 application cases

Input:

1. focus_areas: List of focus areas ('[Interoperability', 'Asset Accessibility', 'Identity Security]')
2. data_hybrid_nfts: Data for Hybrid NFTs ([40, 30, 30])
3. data_real_world_assets: Data for Tokenized Real-World Assets ([25, 50, 25])
4. data_identity_verification: Data for Decentralized Identity Verification ([20, 20, 60])
5. colors: Color scheme ('[#66c2a5', '#fc8d62', '#8da0cb'])

These examples show that ERC-404 tokens are redefining assets, user experience, and security across industries. While some projects are still conceptual or prototypes, the power of ERC-404 tokens promises success in blockchain-based ecosystems. Future real-world adoption will enable these theoretical applications, driving innovation and adoption in budgeting, gaming, and self-governance.

Algorithm of Hybrid NFT in Gaming

1. Using a distinct token ID, create a unique NFT with a name, rarity and qualities.
2. Make a FungibleItem with a fungible value, a name and a kind (such as cash or durability).
3. Combine the fungible object and NFT into a single entity to create a Hybridnft.
4. Display the Hybrid NFT's attributes, encompassing both the fungible item and the unique NFT.
5. Give the NFT the fungible value (durability points, for example) so it may be used in-game.
6. Exchange the Hybrid NFT's fungible features (such as currency or durability) with another player to change its worth.
7. Call the function that creates an NFT and its corresponding fungible object to mint a new Hybrid NFT.
8. To mint a Hybrid NFT, show its features, equip it and permit trade of the fungible value, run the game flow.

This method serves as the basis for developing hybrid NFTs in gaming contexts, which combine the distinctiveness of non-fungible tokens with the adaptability of fungible assets.

FUTURE APPLICATIONS AND EMERGING TRENDS

The application looks at how blockchain developers, investors and ecosystem members might be affected by the research findings. We'll talk about how to enhance the ERC-404 token development procedure while reducing risks. The contribution of ERC-404 tokens to innovation in digital asset management, including tokenised assets, non-fungible assets (NFTs) and personal solutions, is also examined in this study. In the future, there will be numerous chances to integrate ERC-404 tokens with cutting-edge technologies like the Metaverse, IoT (Internet of Things) and ecosystems powered by artificial intelligence. They show data or status updates from the Internet of Things Technology. For instance, each time a home's smart thermostat modifies

the temperature, it may produce an ERC-404 token. With the use of the tokens, homeowners will be able to monitor their energy usage trends and potentially sell such information to energy providers so they can examine market trends. ERC-404 tokens have the potential to improve digital assets in the future by increasing compatibility, scalability and interoperability. These coins facilitate connectivity in decentralised finance (DeFi) and other domains by functioning asynchronously across several blockchains. ERC-404 tokens might be permitted to cast significant votes in partner organisations under carefully regulated terms of use, increasing stakeholder influence. Furthermore, tokenising international assets like stocks or real estate may allow numerous stakeholders to access new markets and generate income. ERC-404 tokens' scalability features can facilitate the deployment of blockchain technology worldwide by enabling thousands of transactions per second. These tokens are appealing to local investors because they can improve security and streamline KYC/AML compliance procedures. According to Table 2, ERC-404 tokens have the potential to shape the future of digital marketing by enabling new financial products, quasi-assets and virtual goods as DeFi, NFTS and the Metaverse develop.

Table 2: The various aspects of ERC-404 tokens, potential and future applications.

Key Area	Future Potential
Interoperability	Seamless cross-chain transactions across multiple blockchains (e.g., Ethereum, Binance Smart Chain, Solana).
Governance Systems	Weighted voting in decentralised autonomous organisations (DAOS) allows greater influence for key stakeholders.
Asset Tokenization	Fractional ownership and liquidity for real-world assets like real estate, stocks, and commodities.
Scalability	Solutions for higher transaction throughput, supporting global adoption and scaling for large networks.
Regulatory Compliance	Built-in mechanisms for KYC/AML compliance, making tokens attractive to institutional investors.
Security	Enhanced security features to prevent fraud and ensure trust in decentralised systems.
DeFi& NFT Innovation	Facilitation of innovative financial products, yield-generating assets, and semi-fungible NFTs.
Emerging Technologies	Integration with the Metaverse and IoT, enabling tokenised virtual goods and smart device data management.

CHALLENGES AND LIMITATIONS

The potential of ERC-404 tokens is promising, but from a research perspective, there are many challenges to consider. Scalability is still a big issue because these tokens need to be able to handle many transactions on the world's largest networks without sacrificing speed or performance. For example, if an ERC-404 token is used in real estate transactions, the system must support thousands of real estate transactions without transaction delays. Regulation is another major challenge, especially for asset-backed assets that represent real assets such as stocks or shares. Understanding how KYC/AML (Know Your Customer/Anti-Money Laundering) will be applied to these decentralised tokens is crucial to financial regulatory compliance in many places. Finally, interoperability is essential to ensure that ERC-404 tokens can seamlessly operate across multiple blockchain platforms, such as Ethereum, Binance Smart Chain, and Solana. For example, if a decentralised financial (DeFi) platform accepts ERC-404 tokens users must be able to transfer the tokens

across the chain without a complex transfer process. To fully utilise ERC-404 tokens in the upcoming blockchain ecosystem, these problems must be fixed.

SUMMARY OF THE RESOURCES

A major change in the digital asset market has been brought about by the rise of ERC-404 tokens, which present new opportunities for fractional ownership and trade. Improved asset management and trading scenarios could be made possible by this new token standard, which could also unleash value for investors, creators, and collectors. The standard may usher in a new era in digital asset management as it develops further and may go through formal verification, opening up interesting opportunities for asset management and trading. In addition to combining the advantages of fungible and non-fungible tokens, the advent of ERC-404 tokens has increased the potential and inventiveness of digital assets and created new opportunities for asset management and trade. ERC-404 tokens have the power to change the digital asset ecosystem and could influence the direction of NFTs and DeFi in the future. By providing a window into the future of asset management and trade, this new token standard has gained recognition for its capacity to unleash the potential of digital assets. In conclusion, the introduction of ERC-404 tokens has brought about a paradigm shift in the digital asset space, unlocking new possibilities for fractional ownership, trading and asset management. As this token standard continues to evolve and gain traction, it has the potential to shape the future of digital assets, offering exciting opportunities for creators, collectors and investors alike.

FINDINGS

Key tactics for the effective deployment of ERC-404 tokens in decentralised apps (DApps) are identified by our study. Real-world use cases, including as GameX's integration of ERC-404 for hybrid NFTs and PropertyX's usage of ERC-404 for real estate tokenization, specifically illustrated the token's special capabilities in hybrid asset management.

CONCLUSION

In summary, this paper provides a comprehensive review of the concept of ERC-404 token development and its importance in the development of digital assets. By utilising the special features of the Ethereum blockchain, ERC-404 tokens provide an excellent means of enhancing token functionality, security and interoperability. ERC-404 tokens will be crucial in determining the direction of decentralised finance and digital asset management as the blockchain sector develops further. To fully

utilise ERC-404 tokens and spur innovation in the blockchain ecosystem, more investigation and testing are required. In terms of DeFi, governance, NFTs and IoT, ERC-404 coins have a promising future. Notwithstanding the model's theoretical nature, the possibility of developing a blockchain ecosystem that is more cohesive, flexible, and transparent may lead to new opportunities for digital assets. It demonstrates how the token concept has the potential to have a significant impact on several issues, including the market for digital assets and blockchain technology in general.

REFERENCES

- Buterin, V. (2015). *Ethereum Whitepaper*, Ethereum Foundation.
- Wood, G. (2014). *Ethereum: A Secure Decentralised Generalised Transaction Ledger*, Ethereum Yellow Paper.
- Szabo, N. (1996). Smart Contracts: Building Blocks for Digital Markets.
- Vogelsteller, F. (2015). *ERC-20 Token Standard*, Ethereum Improvement Proposal.
- Mougayar, W. (2016). *The Business Blockchain: Promise, Practice, and the Application of the Next Internet Technology*, Wiley.
- Antonopoulos, A.M. (2018). *Mastering Ethereum: Building Smart Contracts and DApps*, O'Reilly Media.
- ConsenSys, (2023). *DeFi Report: The State of Decentralized Finance*, ConsenSys.
- Ledger Academy (2023). *What is ERC-404 Token Standard?*, Ledger, 2023.
- Binance Academy (2023). *Introduction to ERC-404 Tokens*, Binance.
- ZeroCap Insights (2023). *ERC-404 Hybrid NFTs: Bridging Digital and Physical Assets*, ZeroCap.
- BeInCrypto (2023). *A Comprehensive Guide to ERC-404 Tokens*, BeInCrypto.
- Buterin, V. (2021). *Decentralized Autonomous Organizations (DAOs)*, Ethereum Blog.
- Voorhees, E. (2023). *The Impact of DeFi on Traditional Finance*, ShapeShift.
- Burniske, C. (2017). *Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond*, McGraw-Hill.
- ConsenSys (2022). *Ethereum 2.0: Scaling the Future of Blockchain*, ConsenSys.

EVALUATING THE IMPACT OF PERFORMANCE APPRAISAL SYSTEMS OF EMPLOYEES IN THE IT INDUSTRY

Seema Singh*
Kavya Singh**

Abstract

The objective of this research paper is to evaluate the performance appraisal system method in IT industries and its effect on employee morale and motivation. Evaluation systems in any organization develop a motivational and competitive environment. Thus while, evaluating the appraisal system, due consideration between the traditional & the latest 360° appraisal system in the current scenario was analyzed. Further, various studies have also elucidated that the multi-source feedback mechanism system enhances fairness, reliability, effectiveness and acceptance of the data. The study was conducted on primary data, through a survey instrument. We have used Cronbach's alpha test to check the statistical reliability of the questionnaire. The collected information has been statistically analyzed using SPSS. Regression analyses & ANOVA table were used to test the hypotheses of the study to analyze the perceptual variations. Finally, the paper deciphered that the 360° Performance Evaluation Method is a good mechanism to boost Employees Morale and their motivation is always a better mechanism and optimized way of evaluating an employee.

Keywords: *Morale, Motivation, Satisfaction, 360-degree Feedback.*

INTRODUCTION

Influential human resource management and administration requires accurate measuring and meeting the employee's goals. Different companies have devised various techniques to compute the correct correlation between the company's objective and human resources. Evaluation of employee performance is a very common tool that is used by companies to evaluate their employees in organizations (Banks and Roberson 1985; Baron & Kreps 1999; Bernardin et al. 1995; Bretz et al. 1992; Fletcher 2001).

It is important to note that organizations may use varied performance appraisal methodologies to appraise their employees. Some organizations also tend to come up with hybrid methodologies of evaluating performance which are equipped to maintain a fairly good balance between organizational goals and employees' goals.

* Assistant Professor, Babu Banarasi Das University, BBD City, Faizabad Road, Lucknow Uttar Pradesh, India.

Many evaluation methodologies available comprise ranking; trait scales; critical incident; narrative; and criteria-based. Milkovich GT, Read W (1992). Some other methods like management-by-objectives (MBO), work planning and review, 360° appraisal and peer review (Vicky, G. 2002).

Performance appraisal is an effective device that improve productivity of an employees. 80-90 per cent of IT industries in the USA and UK use modern appraisal method (Armstrong and Baron, 2005).

The worth of any company consists of the knowledge base, intellectual assets and trademarks of their employees, not within the lifeless items like inventories, goods, and machinery. Several companies target their performance reviews on "what" goals and "how" goals. The "what" goals are to be achieved by individuals hence it's an individual target, i.e. like increase of sales by 10%. The "how" goals suggest the medium, using which an individual will achieve the "what" goals, which are generally represented in terms of skills and conduct (Caligiuri, 2000).

Assessment of performances not only plays a vital role in enhancing staff's morale, satisfaction level and manufacture in the organization but performance evaluation is also a powerful tool that helps in improving the effectiveness and efficiency of employees. (Ab. Aziz Yusof. 2003). A significant (around 43%) increase in the productivity of an organization has been confirmed by several researchers which follows the performance appraisal process. (Zemke R, 2003).

In the commencement, organizations used a simple evaluation method to complete the appraisal process, where evaluations are completely based on their immediate superior. This methodology has numerous limitations. To overcome these shortcomings organizations are implementing new methods that take information from multiple individuals (appraisers) associated with each evaluated employee. A 360-degree appraisal is one of the latest additions, which evaluates not only the immediate superior but also considers the people who can truly respond to how an employee performs on the task. 360-degree review or integral assessment (Edwards and Ewen 1996) is a procedure for evaluating employees' performance with whom the employee comes in contact during the execution of his allotted task like supervisors, collaborators, colleagues, customers and including himself/herself.

Previous research only focused on a lone output of performance appraisal, i.e. satisfaction with appraisal (Jawahar, 2006); although from a practical point of view, companies should also evaluate the cumulative effects of an appraisal process to decide whether the advantages compensate the costs (Taylor et al., 1995).

Farooq Muhammad (2022) expressed and identified industries suffering poor performance and not achieving the objective of the organization due to the lack of an effective evaluation mechanism. oghenevwegba & Elo-oghene (2022) suggested

that continuous upgradation is essential for the employee's performance appraisal process in Nigeria's telecommunications industry

LITERATURE REVIEW

Performance appraisal

Correct performance appraisal of the employees has always been an essential element for the success of companies (Judge & Ferris, 1993). The primary goal of any performance appraisal system is to supply a profound evaluation of the staff's performance for specific intervals. Organizations adopt different performance evaluation methods that suit most of the company's requirements, processes and functions (Chu & Chen, 2007). There are cases where management within the organization implements diverse performance appraisal systems or sometimes applies hybrid methods by fusing two or more methods in their appraisal system. Organizations can make appraisal systems more reliable and effective by continuously implementing the feedback and shortcomings noticed in their current appraisal system.

Motivation

Motivation is the most important component for increasing competency and performance (Gibson, Ivancevich & Donnelly, 1996). Employee competency is directly related to the employee's motivation. This is found uniform to formulate the theory of productivity concerning motivation: $P=f(M)$. Wherein as per the expectancy theory of productivity, productivity is a multiplication of ability and motivation: $P=M \times A$ (Suprihanto, 1986).

Appraisal plays a vital role in creating a positive attitude and increasing motivation which all together improves the productivity and performance of employees (Lawler, 1994 & Taylor et al., 1984). Satisfaction plays an important role in accomplishing goals for any organization, as studies have already shown that performance, efficiency, productivity, retention of employees and customer satisfaction are the most important factors in an organization (Lai Wan 2007). Hence, satisfaction is being most noted study among all appraisal reactions (Keeping & Levy, 2000). So the satisfaction aspect of the appraisal process is considered among the top-rated reactions to PA (Giles & Moss holder, 1990).

Morale of employees

Employee morale is a primal constituent of business operations, high morale brings commitment towards the organization, stretched efforts, job satisfaction, pride in one's work, initiative taking, ownership, feeling of teamwork, common goals always supersede personal goals, hence increasing performance of an organization Abbott (2003); Blum & Naylor (1968); Griffin et al. (2004); Guion (1958); Hart et al. (2000);

Parker & Kleemier (1951); Smith & Wakeley (1972). Whereas, low morale brings rise to unresolved grievances, attrition rate, absenteeism, and obstruction in the achievement of organizations' goals (Burke & Nelson (1998);

As per Finger (2005), morale is majorly influenced by the leadership (top-down) rather than from the bottom-up. A single factor is not responsible for high or low morale of an employee but it is a combination of many associated factors. These factors can be the internal or external environmental changes as well as the approach and action taken by leadership in response to those changes.

Millett (2010) gives in his study, six most important factors why staff morale can have a great impact on the bottom line: Improved productivity- As productivity in general improves when the employee loves to come to work. Improved performance and creativity- Individual thinks fresh and perform better when the morale is high.

Reduced number of leave days - High morale employees cut back on sick and leave days as employees enjoy the work and want to attend and are less inclined to let down the team. Higher attention to detail - Attention comes automatically with an interest in work. Increased quality of work- Finally, the quality improves with the interest given to the work. In short low morale can badly affect the organizations productivity and performance in contrast; high morale can motivate and better the productivity of employees which results in a great and healthy working environment.

Employee satisfaction

Many researchers declared that appraisal plays a vital role in the organization to develop positive attitude and increase motivation which all together enhances productivity and performance (Lawler, 1994 & Taylor et al., 1984). Satisfaction is an utmost important goal for any organization to reach, as studies have already shown that performance, productivity, profitability, employee retention and customer satisfaction which are the key factors of any organization to perform can be attended by motivated and satisfied employees (Lai Wan 2007). Hence, satisfaction is being most noted study among all appraisal reactions (Keeping and Levy, 2000). So, the satisfaction aspect of the appraisal process is considered among the top-rated reactions to PA (Giles and Moss Holder, 1990). In addition, the effectiveness of the appraisal process not only depends on its technical characteristics but also overall organizational leadership and administrative framework. As PA process is not only a distributive activity rather it relates to all other activities of the organization (Pooyan & Eberhardt, 1989).

A study by Rajinder Kaur & S.K. Singla (2019) identifies the top management to develop some effective ways to develop performance measures to analyze overall organizational performance and link it to the objectives of corporate, i.e. a holistic evaluation model of university performance is the key to a higher educational organization's survival.

Chamila H. Dasanayaka et al. (2021) Investigated that the majority of lecturers showed their satisfaction with the current performance appraisal process while the majority of professors were unsatisfied. Aminu Nassir Brimah, & Muftiat Bisola Oduwole. (2024) study suggested that various factors like employee engagement development and job productivity are closely associated with employee experience at work place. Higher academic institutions focus on employee engagement and performance by prioritizing effective performance appraisal systems. The study inferred that job productivity among academicians can be enhanced through creating a conducive environment for work and also nurturing the academic staff alongside research productivity.

360-degree feedback

360° appraisal is one of the latest methods where information is from different people who can truly respond to how an employee performs on the job. Integral evaluation or 360° assessment (Edwards & Ewen 1996) is a method for evaluating a worker's performance based on results from everyone with whom the worker comes in contact: collaborators, supervisors, customers, colleagues and oneself. This type of method allows companies to gain information about employees' performance from different points of view, which improves the process results.

As the multi-source feedback provides a more precise and comprehensive assessment of employee competitiveness, performance outcome and behaviour it is supposed to be more advanced than the conventional form of evolution. The conventional performance review, where one supervisor evaluates a subordinate is no longer considered as an effective means of getting precise feedback for employees. The conventional review gives biased or incomplete results of work for employees as it is rated by a single person, (Toolpack Consulting).

An extension of conventional performance appraisal is termed 360° feedback or multi-source feedback. It is a performance appraisal methodology that accumulates input from colleagues, subordinates, employees' supervisors and also possibly the customer. In this feedback a person being appraised also makes a self-evolution and individual ratings are added to the overall feedback mix. The center of attention in most 360° feedback programs are upper leadership position. According to Margaret S. Carlson (1998) from the Institute of Government faculty reporter and performance evaluation expert, the three key statements on which 360° feedback is based:

1. A more precise picture of one's strength and weakness can be produced by taking various view points from various sources in comparison to a single reviewer's estimation.
2. Self-awareness which is a good thing will improve with the act of comparing one's own self-perception with others.

3. Comparative matching of others' perceptions with self-perception of people who are efficient at what they do will happen.

Hypothesis

- H1: There is a significant relationship between the modern appraisal system and employee motivation and morale.
- H2: There is a significant variation in male and female employees and their satisfaction with the current appraisal system.
- H3: There is a significant variation in the Tenure of employees and their satisfaction with the current appraisal system.

METHODOLOGY

The research study examines the attitude of employees towards current performance appraisal and their thoughts on 360-degree appraisal systems. The study started with a literature review on the evaluation method of employees. In the questionnaire 8 demographic questions and 31 study factor questions, a 5-point scale ranging from strongly disagree (1) to strongly agree (5) were derived. The data were collected by a questionnaire distributed to employees of the IT industry by E-mail and distributed to employees personally in the IT industry. Approximately 200 employees received the questionnaire by e-mail, of who 78 returned complete responses through the mail and the other 60 respondents filled the questionnaire through interview and discussion.

Represent preference of involvement of employees for appraisal in IT institution. Employees have given 451 scores to top management; they have given high weight to the top management; he has given 236 to peers because they think peers are too close to their work. Employees have given 234 for evaluating your work from your side (self). Other weight scales are given in Table 1.

Table 1 : Preference of employees for appraisal in IT institution

S.No.	Attributes	Total
1.	Top management	451
2.	Immediate Supervisor	180
3.	Subordinate	190
4.	peers	236
5.	Self	234
6.	Internal Customer	208
7.	External Customer	202
8.	Supplier	195

Source: Author's compilation from questionnaire

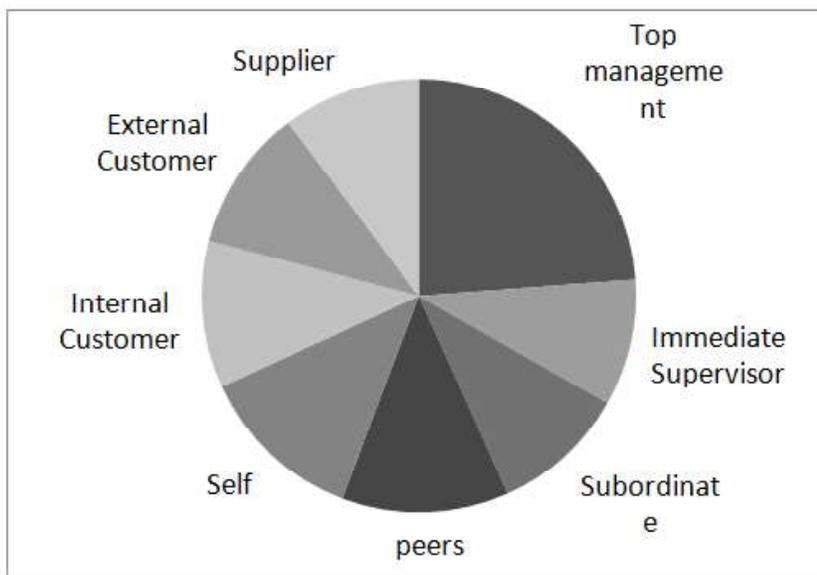


Figure 1: Preference of employees for appraisal in IT institution

Table 2: Demographic variable

Demographic Parameters	N	%
1. Gender		
• Male	123	89.13
• Female	15	10.87
2. Age:		
• Up to 20 Years	1	0.72
• 20-30 Years	81	58.70
• 30-40 Years	53	38.41
• Above 40 years	3	2.17
3. Marital status:		
• Married	77	55.80
• Unmarried	61	44.20
4. Educational Qualification:		
• SSLC	1	0.72
• HSC	0	0.00
• Diploma	0	0.00
• UG	49	35.51
• PG	88	63.77
5. Department:		
• Production	3	2.17
• HR	2	1.45
• R & D	10	7.25
• Accounts	0	0.00
• Information Technology	123	89.13
• Others	0	0.00

6. Year of service :		
• Up to 2 years	15	10.87
• 2 - 6 years	49	35.51
• 6 - 10 years	51	36.96
• above 10 years	23	16.67
7. Monthly Income: (in Rs.)		
• Below 10,000	1	0.72
• 10,000 -15,000	5	3.62
• 15,000 - 20,000	8	5.80
• above 20,000	124	89.86
8. Current performance appraisal system in your organization:		
• Rating scale system	94	68.12
• Ranking system	14	10.14
• Ranking system	0	0.00
• Critical incident	22	15.94
• Management by objectives	8	5.80
• Others		

Source: Author's compilation from questionnaire

The demographic details of respondents are given in Table 2. There were 7 demographic questions (1). The gender difference: 89.13 per cent of respondents were male and 10.87 per cent were female. (2) Concerning the age of the respondents, 0.72 per cent were between Up to 20 Years, 58.70 per cent were 20 to 30 years, 38.41 per cent were between 30 to 40 years, 2.17 per cent were above 40 years, (3) Marital status: 55.80 per cent were married and 44.20 per cent were unmarried. (4) Educational Qualification: 0.72 were SSLC, none were HCL and diploma, 35.51 per cent were UG and 63.77 per cent were PG. (5) Department:2.17 per cent were from the production department,1.45 per cent were from the HR department,7.25 per cent were from the R&D department, 89.13 per cent were from information technology, and none were from accounts and others. (6) Year of service:10.87 per cent were up to 2 years, 35.51 per cent were 2-6 years, 36.96 per cent were 6-10 years and 16.67 per cent were above 10 years. (7) Monthly Income: (in Rs.): 0.72 per cent were below 10,000 thousand, 3.67 were 10,000-15,000, 5.80 per cent were 15,000-20,000 and 89.86 per cent were above 20.000 thousand.

Current performance appraisal system in your organization: 68.12 per cent people were mention Rating scale system is used for appraising employees in their organization.10.14 percent were mention ranking system, none were mention critical incident, 15.94 percent were mention management by objective and 5.80 were mention others.

Table 3: Case Processing Summary

Case Processing Summary			
		N	%
Cases	Valid	137	99.3
	Excluded	1	.7
	Total	138	100.0
a. Listwise deletion based on all variables in the procedure.			

Reliability Statistics	
Cronbach's Alpha	N of Items
.831	30

Cronbach's alpha for overall questionnaire (31 items) was 0.831. Cronbach's alphas ranged between 0.790 – 0.826 for outcomes and 0.896 – 0.904 for detriments, which were good enough for further statistical analyses (Sekaran, 2003).

H1: Distinction of satisfaction with modern appraisal system and employee motivation and morale.

In order to test H1, modern appraisal system (360 degree appraisal) regressed motivation and morale of employees and the results are tabulated in table 2 and 3 below.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.998a	.996	.996	.295	.996	15210.427

a. Predictors: (Constant), Morale, motivation
Source: Author's compilation from questionnaire

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1. (Constant)	.294	.220	1.336	.184	
motivation	1.600	.059	.896	27.184	.000
Morale	.312	.100	.103	3.115	.002

a. Dependent Variable: modern_appraisal
Source: Author's compilation from questionnaire

There is significant relationship between modern appraisal system (360 degree appraisal) and motivation and morale ($F=15210.427, R^2=.996, \text{Beta}=1.600$ and $.312, p \leq .003$) thus supporting H1.

$$\text{MPAS} = (.294) * \text{Motivation} + (1.6) * \text{Morale} + (.312) *$$

Therefore it can be illustrated that when the appraisal system becomes modern employees' morale boost and motivate towards duties.

H2: Distinction of satisfaction with current appraisal of male and female employees.

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.544	1	.544	.399	.529
Within Groups	120.178	88	1.366		
Total	120.722	89			

Source: Author's compilation from questionnaire

ANOVA is usually used to compare means of more than two groups. The results of the above-mentioned table are insignificant, F value should be higher than its table value and on the other hand the value of sig. The column should be less than .05. The last column shows the value of significance which is also known as the p value in statistics. It should be less than .05 then we may say our hypothesis is accepted and the null hypothesis is rejected. It was just related to male and female differences in their satisfaction with the existing appraisal system. There are no significant differences between perceptions of male and female employees in organizations.

H3: Distinction of satisfaction with current appraisal with work experience (Tenure).

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.416	4	.854	3.775	.007
Within Groups	20.584	91	.226		
Total	24.000	95			

Source: Author's compilation from questionnaire

The variance ratio is 0.854 for work experience. We have taken work experience (1 to 6 years and 6 above). For $df_1=4$ and $df_2=91$, at a 5% level of significance, the critical value of F is 3.04. The results of the above-mentioned table are significant because the calculated F value is higher than its table value. It shows the variation in satisfaction with a current appraisal of variation in the experience of employees. The last column showed the value of significance which is also known as p value in statistics. It should be less than .05 then we may say our hypothesis is accepted and the null hypothesis is rejected.

LIMITATION AND RECOMMENDATION

Since the limitations are in every aspect of life, so this study also has certain limitations. But still, we hope that this study can fulfil many requirements of the policymakers in academic institutions. Though the research is conducted with care, time, cost and other factors pose limitations that should be explored in the future to provide a complete and comprehensive understanding of the topic under study and contribute significantly to the literature and society as well.

The nature of the information and responses obtained from respondents may affect Faculties' responses. Faculties may have been unwilling to respond to questions related to their level of satisfaction with evaluation practices in their current position. Most of the respondents felt fear to talk about the appraisal system of their institution so I faced lots of problems in collecting data through the questionnaire. Therefore, the method of data collection to conduct interviews and discussions with faculty members in the programme of faculty development is noteworthy.

CONCLUSION

In the present scenario, the output is important for every organization and the output of employees depends on efficiency, effectiveness, ability and commitment. This study emphasizes the importance of modern performance appraisal mechanisms in IT industries and their impact. Implementation of a well-organized mechanism of evaluation not only enhances the output of the organization, it also enhances employee efficiency, satisfaction, motivation, productivity and morale of employees.

The results of the study bring out that the employees working in the multinational companies in India have shown a high level of awareness about the existing appraisal system but they are not satisfied because appraisers are not fair to implement appraisal. Hence the employees want modern (360 degree) appraisal system to remove biasness like few other companies.

However, it was found that the modern appraisal system exerts a significant influence on employee's morale and motivation towards performing work effectively. Hence, the study recommends that: Industries should take the issue of execution/implementation procedures and fairness of appraisal mechanisms and organizations should give proper attention to their employees' satisfaction, performance and creativity. Satisfied staff are more productive and creative.

REFERENCES

- Yusof, A.A. (2003). *Performance Appraisal Issues, Challenges & Prospects*, New Jersey: Pearson.
- Abbott, J. (2003). Does employee satisfaction matter? A study to determine whether low employee morale affects customer satisfaction and profits in the business-to-business sector, *Journal of Communication Management*, 7(4), pp. 333-339.
- Brimah, A.N. & Oduwole, M.B. (2024). Performance Appraisal and Job Productivity of Academic Staff in Kwara State University, Malet, *African Journal of Humanities and Contemporary Education Research*, 17(1), pp. 215-238.
- Armstrong, M. & Baron, A. (2005). *Managing Performance: Performance Management in Action*, London : Chartered Institute of Personnel and Development.
- Banks, C.G. & Roberson L. (1985). Performance appraisers as test developers, *Accad Manage*, 10(1), pp. 128–142.
- Baron, J.N. & Kreps, D.M. (1999). *Strategic Human Resources. Frameworks for general managers*, New York: Wiley.
- Bernardin, H.J, et.al (1995). Performance appraisal design, development, and implementation. In: Ferris GR, Rosen SD, Barnum DT (eds) *Handbook of human resources management*, Cambridge: Blackwell.
- Blum, M.L. & Naylor, J.C. (1968). *Industrial Psychology – Its Theoretical and Social Foundations*, New York: McGraw-Hill.
- Borman, W.C. (1998). 360 ratings: an analysis of assumptions and a research agenda for evaluating their validity, *Human Resource Management Review*, 7(3), pp. 299-315.
- Bretz, R.D. et. al.(1992). The current state of performance appraisal research and practice: Concerns, directions and implications, *Journal of Management*, 18(2), pp. 321–352.
- Caligiuri, P. (2000). The Big Five Personality Characteristics as Predictors of Expatriate’s Desire to Terminate the Assignment and Supervisor-rated Performance, *Personnel Psychology*, 53(1), pp. 67-88.
- Cappelli, P. et.al. (1997). *Change at Work*, New York : Oxford University Press.
- Carlson, M.S. (1998). 360-degree feedback: The power of multiple perspectives. Popular Government. Carlson.pdf
- Chamila, H. Dasanayaka et al. (2021). The Impact of the Performance Appraisal Process on Job Satisfaction of the Academic Staff in Higher Educational Institutions’, *Educ. Sci.*, 11(10), pp. 623.
- Doherty, J., (1988). Psychological morale: its conceptualization and measurement, *Educational Studies*, 14(1), pp. 65-75.
- Evans, L. (1992). Teacher morale: an individual perspective, *Educational Studies*, 18(2), pp. 161-71.

- Farooq, M. (2022). Impact of Performance Appraisal on Organizational Commitment In Developing Country Manufacturing Enterprises, *Webology*, 19(3), pp. 2601-2618.
- Finger, J. (2005) *The Management Bible*, Australia : New Holland Publishers Ltd.
- Firth, et al.(2004). How can managers reduce employee intention to quit?, *Journal of Managerial Psychology*, 10(2), pp. 170-87.
- Fletcher, C. (2001). Performance appraisal and management: the developing research agenda, *J Occup Organ Psychol*, 74(4), pp. 473–487.
- Gibson, J.L., Ivancevich, J.M. & Donnely Jr., J.H. (1996). *Organizational Behavior Structure, Process*, 9th Ed., Chicago: Irwin.
- Giles, W.F. and Mossholder, K.W. (1990) ‘Employee reactions to contextual and session components of performance appraisal’, *Journal of Applied Psychology*, 75:4, 371-377.
- Griffin, M.A., Rafferty, A.E. and Mason, C.M. (2004). Who started this? Investigating different sources of organizational change, *Journal of Business and Psychology*, 18(4), pp. 555-570.
- Guion, R.M. (1958). Industrial morale: the problem of terminology, *Personnel Psychology*, 11(1), pp. 59-61.
- Hart, P.M. (1994). Teacher quality of work life: integrating work experiences, psychological distress and morale’, *Journal of Occupational and Organizational Psychology*, 67(2), pp. 109-32.
- Hart, et al. (2000). Development of the School Organizational Health Questionnaire: a measure for assessing teacher morale and school organizational climate, *British Journal of Educational Psychology*, 70(2), pp. 211-228.
- Howitt, P. (2002). Looking inside the labour market: a review article’, *Journal of Economic Literature*, 40(3), pp. 125-138.
- Jawahar, I.M. (2006). An investigation of potential consequences of satisfaction with appraisal feedback, *Journal of Leadership and Organizational Studies*, 13(2), pp. 14-29.
- Judge, T.A. & Ferris, G.R. (1993). Social context of performance evaluation decisions, *Academy of Management Journal*, 36(1), pp. 80-150.
- Keeping, L.M. & Levy, P.E. (2000). Performance appraisal reactions: measurement, modelling and method bias, *Journal of Applied Psychology*, 85(5), pp. 708-723.
- Lai, W.H. (2007). Human capital development policies: enhancing employees’ satisfaction, *Journal of European Industrial Training*, 31(4), pp. 297-322.
- Lawler, E.E. (1994). *Motivation in Work Organizations*, San Francisco: Jossey-Bass.
- Makawatsakul, N. & Kleiner, B.H. (2003). The effect of downsizing on morale and attrition, *Management Research News*, 26(2), pp. 52-62.

- Mazin, R. (2010). The effects of high morale on employee performance, Available from : <http://www.ehow.com>.
- Millett, T. (2010). 6 reasons why staff morale is important, Available from : <http://EzineArticles.com>
- Milton, C.R., Entekin, L. & Stening, B.W. (1984). *Organizational Behavior in Australia*, Sydney : Prentice-Hall.
- Norquist, et al. (2002). A great place to shop, work and invest: measuring and managing the service profit chain at Sears Canada, *Interactive Marketing*, 3(3), pp. 265-271.
- Oghenevwegba & Elo-oghene (2022). Impact of Performance Appraisal System on Employee Performance in Nigeria Telecommunication Industry: A Study of MTN Nigeria Plc in Asaba, Delta State, *Journal of Research in Business and Management*, 10(10), pp. 167-180.
- Parker, W.E. & Kleemier, R.W. (1951) *Human Relations in Supervision*, New York : McGraw-Hill.
- Psychometrics Canada (2010). Feuding and failure vs. Performance and innovation, Available from : www.psychometrics.com/docs/leadership.pdf.
- Kaur, R. & Singla, S.K. (2019). Performance measurement of higher educational institutions: an empirical study using student's perception', *Journal of Management*, 6(2), pp. 2347-3940.
- Schoenfeldt L.F., Shaw J.B. & Fisher, C. (2006). *Human resources management*, Boston : Houghton Mifflin Company.
- Schuler, A.D. (2004). Turning around low morale, Available from : www.schulersolutions.com.
- Smith, H.C. & Wakeley, J.H. (1972). *Psychology of Industrial Behavior*, New York : McGraw-Hill
- Smith, K.R. (1966). A proposed model for the investigation of teacher morale, *Journal of Education Administration*, 4(2), pp. 143-148.
- Smith, K.R. (1976). Morale: a refinement of Stogdill's model', *Journal of Education Administration*, 14(1), pp. 87-93.
- Stephane, B., Manuel L. & Jennifer M. (1999). The impact of 360-degree feedback on planning for career development, *The Journal of Management Development*, 18(8), pp. 676-693.
- Straka, J.W. (1993). Is poor worker morale costly to firms', *Industrial and Labor Relations Review*, 46(2), pp. 381-394.
- Taylor, S.M., Fisher, C.D. & Ilgen, D.R. (1984). *Individuals' reactions to performance feedback in organizations: a control theory perspective: Research in Personnel and Human Resources Management*, Greenwich : JAI Press.
- Taylor, et al. (1995). Due process in performance appraisal: a quasi-experiment in procedural justice, *Administrative Science Quarterly*, 40(3), pp. 495-523.

-
- Terrence, H.M. & Joyce, M. (2004). *Performance Appraisals*, ABA Labor and Employment Law Section, Equal Employment Opportunity Committee.
- Vicky, G. (2002) *Performance Appraisals*, Loss Control Services, Texas Association of Counties.
- Watson, D. (1988). Intra individual and inter individual Analyses of Positive and Negative Affect: Their Relation to Health Complaints, Perceived Stress, and Daily Activities. *Journal of Personality and Social Psychology*, 54, pp. 1020-1030. Available from : <http://dx.doi.org/10.1037/0022-3514.54.6.1020>

ENSEMBLE LEARNING TECHNIQUES FOR AUTOMATED MISINFORMATION DETECTION IN SOCIAL MEDIA

Manish Chhabra*
Tarun Sethi**

Abstract

Unprecedented information distribution throughout human history was made possible with the introduction of the advent of the Internet and the quick uptake of social media platforms such as Facebook and Twitter. Customers are creating and sharing excessively details than they did previously since social media is so widely used, some of which are deceptive with nothing to do with reality. It is difficult to automatically classify a written article as either disinformation or misinformation. Even a subject-matter expert must consider several factors before determining whether an item is true. In this study, we suggest classifying news articles automatically using an ensemble machine learning approach. Our research investigates many textual characteristics that might be applied to differentiate authentic from fraudulent content. Using those characteristics, we train a variety of machine learning approaches using different ensemble techniques and evaluate their performance on four real-world datasets. The higher performance of our suggested ensemble learner technique over individual learners is confirmed by experimental evaluation.

Keywords: *Machine Learning, Deep Learning, Artificial Neural Networks, LSTM (RNN), Deep Learning and Tensorflow.*

INTRODUCTION

The emergence of false information throughout the 2016 U.S. Presidential Election brought to light the difficulties in distinguishing between fake and legitimate news, in addition to the risks associated with its effects. Although the term "fake news" is relatively new, the phenomenon itself is old. In a technical sense, since the 19th century, bogus news has been prevalent, when partisan, one-sided publications first appeared and gained popularity. However, fake news is now more widely disseminated due to technological advancements and the dissemination of news through various channels. Because of this, the consequences of fake news have grown dramatically in recent years, and action must be taken to stop this from happening again.

* *Asst. Professor, Vasavi College of Engineering, Hyderabad, India.*

** *Asst. Professor, Institute of Advanced Management and Research, Ghaziabad, Uttar Pradesh, India.*

Information has never been disseminated so quickly in human history thanks to prior before the launch of the World Wide Web and the quick uptake of social media sites such as Twitter and Facebook. Additionally, in other applications, news organizations benefited from the extensive usage of social media platforms by giving their subscribers access to up-to-date information almost instantly. Newspapers, tabloids, magazines, and other print media gave way to Social media and other digital material feeds, blogs and online news sources¹.

Customers could now more easily obtain the most recent news at their fingers. Seventy per cent of Facebook recommendations account for a large portion of traffic to news websites². In their current form, these social media sites are quite useful and successful because they enable users to exchange ideas and engage in debate on topics like democracy, health, and education. However, some entities also utilize these platforms negatively, usually for financial benefit^{3,4} and occasionally to propagate satire or absurdity, create skewed viewpoints, and manipulate mindsets. False information is the popular term for the occurrence.

The rapid increase in Fake information has increased dramatically over the past 10 years, and it was a special evident throughout the 2016 US elections⁵. Online sharing of items that are not based on facts has become so common that it has caused issues in a variety of fields, including science, sports, and health, in addition to politics³. The financial markets are among the sectors impacted by false news⁶, where a rumour can have catastrophic effects and even stop the market in its tracks.

Our ability to make decisions largely depends on the kind of information we take in; which shapes our perspective on the world. Consumers have responded irrationally to content that turned out to be false, according to mounting evidence^{7,8}. The propagation of the new coronavirus is one recent example, where false information regarding the virus's origin, characteristics, and behaviour circulated online⁹. As more individuals learned about the fraudulent content online, the situation deteriorated. It can be difficult to find such content over the internet.

Thankfully, an assortment of computational methods is available to identify certain articles as fraudulent based on their textual content¹⁰. Most of these strategies make use of fact-checking websites like "PolitiFact" and "Snopes." Lists of websites deemed unclear and fraudulent can be found in several repositories kept up to date by researchers¹¹. The issue with these services, though, is that identifying phoney articles or websites requires human knowledge. More significantly, fact-checking websites only include stories from specific fields, like politics, and are not broad enough to detect false news from various fields, like technology, entertainment and sports.

Data on the World Wide Web may be found in many different formats, like papers, audio files, and movies. Since it alone requires human experience, it might be

challenging to identify and categorize news that has been posted online in an unstructured style (including audio, video, articles and news). Nevertheless, anomalies that distinguish fact-based articles from those that are deceptive can be found using computer techniques such as natural language processing (NLP)¹². Other methods include comparing the proliferation of bogus news to that of legitimate news¹³.

More precisely, the method examines how a false news piece spreads on a network in a different way than a real one. An article can be divided into numerous groups as legitimate or fraudulent as per the theoretical differentiation of the response it receives. To ascertain whether or what an article is deceptive, a more hybrid technique can also be utilized to analyze the article's social response in addition to examining its linguistic aspects.

The identification and categorization of spreading false information on social media websites like Twitter and Facebook has been the main subject of several studies^{13,11}. Fake news is categorized based on features such as content, context, and hybrid features, which are crucial for ML models to identify fake news effectively¹.

The study found that overall accuracy declined as the number of increasing ingrams computed for a given article grew. This trend has been seen noted for classification-based learning models. Shu et al.¹² used textual elements with auxiliary data, like social interactions on social media by users, to improve accuracy with several models.

The sociological and psychological theories and their application to identifying misleading material on the internet were also covered by the writers. The authors also talked about different data mining methods for model construction and common feature extraction methods. These theories are predicated on the social environment, including stance and dissemination, as well as information, like the writing style.

RNN: An RNN retains all of the information over time. Its ability to recall prior inputs is the only reason it is helpful for time series prediction. We refer to this as long-term as short-term memory. To increase the effective pixel neighborhood, Furthermore, neural networks that repeat are also employed in conjunction with convolutional layers.

To address the issue of disappearing and Exploding Gradients in a Deep Recurrent Neural Network, several variants were developed. The Long Short-Term Memory Network (LSTM) is among the most well-known of them. In theory, an LSTM recurrent unit seeks to "forget" irrelevant information while trying to "remember" all of the prior knowledge the network has encountered thus far. This is accomplished by adding various activation function layers, or "gates," for various uses. Additionally, each LSTM, the recurring unit, monitors a vector known as the Internal Cell State, which theoretically explains the data that the preceding LSTM recurrent unit decided

to keep. Four distinct gates, each serving a distinct function, make up a long short-term memory network, as explained below:

The Forget Gate (f) regulates the amount of previous data that should be forgotten.

The input gate (I) controls how much data is written to the status of the interior cell.

The input modulation gate (g) is commonly thought of as an input gate sub-component and a significant amount of LSTM research does not even presume or indicate that it is a part of the input gate. It is used to modulate the data that will be written onto the internal state cell by the input gate by making the data zero-mean and non-linear.

Due to the faster convergence of zero-mean input, this is done to shorten the learning period. It is best practice to incorporate this gate within the LSTM unit's construction even if its operations are not as significant as those of the other gates and are frequently regarded as a concept that provides finesse.

Output Gate (o): From the now-existing Internal Cell State, it selects which output (next Hidden State) to generate.

LITERATURE REVIEW

In a study by Padalko et al. (2023), a straightforward approach to detecting fake news was presented. This method, built on the naive Bayes classifier, was implemented as a software program and tested on a collection of Facebook news articles. The dataset included articles from three major mainstream political news websites (Politico, CNN, and ABC News) alongside content from three prominent Facebook pages on both the right and left wings of the political spectrum. While the model achieved an accuracy of nearly 74% in classifying real news, its performance was slightly lower in identifying fake news. This discrepancy could be attributed to the data's imbalance, as only 4.9% of the articles were labelled as fake news.⁴

To manage countless tweets in one second, Guo, et al. (2022) provided a framework based on a unique method of machine learning that addresses several issues, such as accuracy issues, time lag (Bot Maker) and high processing times. First, 400,000 tweets were gathered from the HSpam14 dataset. They then go on to describe the 250,000 non-spam tweets and the 150,000 spam tweets. Along with the Top-30 terms that yield the most information, they also extracted a few lightweight features from the Bag-of-Words model. 4. They outperformed the current solution by about 18% and achieved an accuracy of 91.65%.¹⁰

Da Silva, F.C.D.'s (2019) work attempts to provide an understanding of how news stories are characterized in the contemporary diaspora, along with the various kinds of news stories' substance and their effects on readers. We then examine the existing techniques for identifying fake news, which mainly rely on text-based analysis, and provide descriptions of well-known fake news datasets.¹⁴

Combining the variables of social environment and news content, Aphiwongsophon, et al. (2018) initially developed a revolutionary machine learning (ML) solution for detecting bogus news that improves accuracy to 78.8%, surpassing earlier techniques in the literature. Second, they developed a Facebook Messenger Chabot using their method and tested it on a real-world application, detecting fake news with an accuracy of 81.7%. The datasets they utilized for their test were described, and then demonstrated the content-based method they used and how they recommended integrating it with an existing social-based strategy found in the literature. Determining the authenticity or fraud of a news item was their goal. The final dataset includes 15,500 postings from 32 pages (14 conspiracy pages and 18 scientific pages), with over 2,300,000 likes from over 900,000 individuals. Of the posts, 8,923 (57.6%) are frauds, while 6,577 (42.4%) are not.¹¹

While Shu, et al. (2017) developed a method to automate fake news detection on Twitter, their approach has limitations. They trained a model to predict accuracy assessments from two datasets: PHEME and CREDBANK. Subsequently, they applied this model to BuzzFeed's dataset of fake news. However, their technique primarily focuses on highly retweeted conversation threads, limiting its applicability to a small fraction of Twitter conversations. Most tweets, unfortunately, do not garner significant retweets, rendering this method ineffective for a broader range of content.¹²

OBJECTIVES OF THE STUDY

- To recognize and evaluate numerous ensemble techniques for learning used for social media disinformation detection.
- To comprehend, using secondary data, the efficacy of these methods.
- To analyze existing research and literature on the use of ensemble learning models for detecting misinformation on social media platforms.

RESEARCH METHODOLOGY

This paper investigates the application of ensemble learning techniques for the automated detection of disinformation on social media. By examining existing research and secondary data, this study aims to review and synthesize the literature on ensemble learning methods used for misinformation detection on social media platforms. The analysis will include a comprehensive review of published research, including journal articles, conference papers, and online resources, to evaluate the effectiveness of ensemble learning in combating misinformation. The study will synthesize various ensemble techniques and their applications, analyze findings from different studies, and categorize the advantages and disadvantages of these methods

in the context of misinformation detection.

PROPOSED WORK

We discovered that RNN may be highly successful in analyzing the text data of any news after examining several algorithms and methodologies. Thus, we applied the model for detecting false news at the application level. We developed a new web application designed to serve as an over-the-top app, and its information has previously been examined to lessen the possibility of false information appearing on the app.

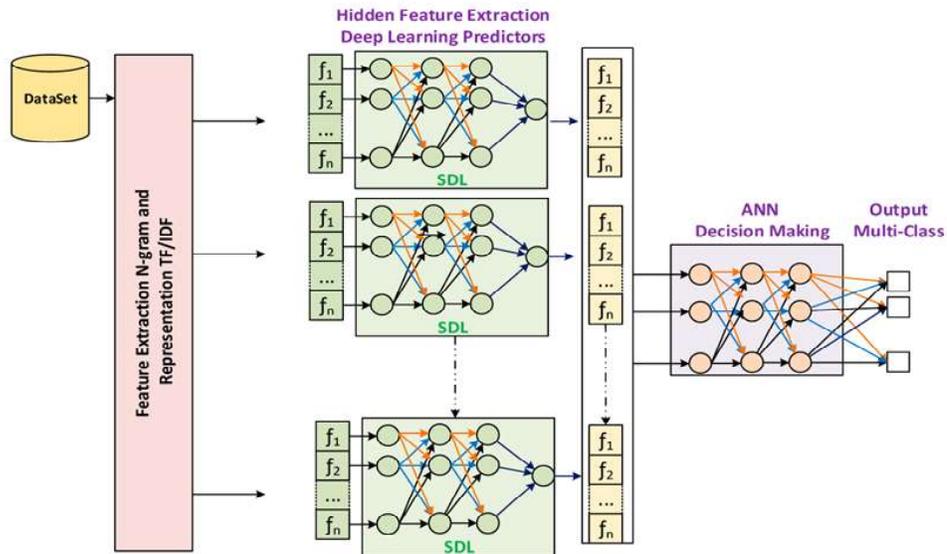


Figure 1: Fake News Detection Model

CRUCIAL ENSEMBLE LEARNING TECHNIQUES FOR SPOTTING MISLEADING DATA

- **Bootstrap aggregating, or bagging:** Bootstrap aggregating, or bagging, is a method of training multiple models on random data sets to avoid overfitting and reduce variance. It can be used in misinformation detection to identify misleading content patterns, such as Random Forest, using post text, user actions and metadata.
- **Boosting:** Boosting is an iterative sequential ensemble technique used for precision jobs like identifying false content on social media. Gradient Boosting Machines (GBM) or XGBoost are popular tools for disinformation identification due to their ability to handle imbalanced data and capture intricate linkages.
- **Stacking (Generalization Stacking):** Stacking is a meta-model that combines multiple models trained on different data sets to make predictions. It is used in misinformation detection to enhance classification. For example, a stacking configuration for misinformation detection might include LSTM, random forest, and logistic regression models, which are combined to improve the final prediction.
- **Voting classifier:** A voting classifier uses multiple base models to predict, with the final prediction determined by the majority vote or average. This ensemble approach helps detect false information by combining trained models on linguistic, user profile, and network features.

IMPORTANT ELEMENTS OF SOCIAL MEDIA MISINFORMATION DETECTION

- **Feature Extraction:** Ensemble approaches are no exception to the rule that efficient feature extraction is essential for every machine learning model. Features for disinformation detection might include:
 - **Textual Features:** N-grams, mood, linguistic cues (such as hedging and urgency), and word embeddings (like BERT and Word2Vec) are examples of textual features.
 - **Network Features:** Examination of the user's social network, including follower trends, links to other recognized sources of false information, and dynamics of propagation.
 - **Temporal Features:** The age of the content, the frequency of posts, and the timing of posts (such as a spike in posts during a contentious event).
 - **Multimedia Features:** Picture and video analysis, including picture authenticity verification and deepfake identification.

- **User Features:** Behaviour analysis (e.g., retweet patterns), account legitimacy (e.g., verified status, activity history), and prior involvement in disseminating false material.
- **Model variety:** The success of ensemble methods depends on model variety. Different kinds of models, including text classifiers that concentrate on linguistic elements, may capture different facets of false information.
 - Models based on graphs that use **network analysis**.
 - **Temporal models** that identify trends in post-timings and activity spikes.
 - For more intricate patterns in text, images, and sequences, use deep learning models (such as CNNs, RNNs, and Transformers).
 - **Temporal Features:** The age of the content, the frequency of posts, and the timing of posts (such as a spike in posts during a contentious event).
 - **Multimedia Features:** picture and video analysis, including picture authenticity verification and deepfake identification.
 - User attributes include historical involvement, behaviour analysis (such as retweet trends), and account authenticity (such as verified status and activity history).

FINDINGS, CONCLUSION AND RECOMMENDATIONS

Most tasks are completed online in the twenty-first century. Applications such as Facebook, Twitter, and online news stories are replacing newspapers that were once preferred in printed copy. Another important source is WhatsApp's forwards. The escalating issue of fake news only serves to confuse matters and attempts to alter or impede people's attitudes and opinions toward the usage of digital technologies. Two things may occur when someone is misled by the actual news: People may begin to assume that their opinions on a certain subject are accurate. Therefore, to combat the issue, we have created our approach for detecting fake news, which uses user input to determine whether a piece of content is real or not. This requires the use of LSTMs and other machine-learning techniques. An adequate amount of data is utilized to train the model, as well as a range of performance metrics are used to assess its performance. The best or most accurate model is used to categorize the news headlines or articles.

The study's final output provides recommendations on which ensemble methods offer the most significant potential for automated detection of false information and which areas require further exploration to improve accuracy and robustness. This research provides a descriptive analysis of ensemble learning techniques applied to

automated misinformation detection on social media. By synthesizing findings from secondary data, it provides valuable insights into the effectiveness of various ensemble methods, highlighting their strengths, weaknesses, and potential for future application in this crucial area of machine learning.

REFERENCES

- Al-Alshaqi, M. (2024). Ensemble Techniques for Robust Fake News Detection: Integrating Transformers, Natural Language Processing, and Machine Learning *Sensors*, 24(18), pp. 6062; Available from : <https://doi.org/10.3390/s24186062>
- Saadi, M., & Al-Jawher, W. (2023). Ensemble learning with optimum Feature Selection for Tweet Fake News Detection using the Dragonfly approach. *In Conference: 2023, 16th International Conference on Developments in eSystems Engineering (DeSE)*, DOI: 10.1109/DeSE60595.2023.10468840
- Zaheer, et al. (n.d.). *Monitoring Social Networking Platforms to Detect and Filter Fake News using Ensemble Learning*, DOI:10.21203/rs.3.rs-3832629/v1
- Padalko, H., Chomko, V., Yakovlev, S., & Chumachenko, D. (2023). Ensemble machine learning approaches for fake news classification. *Radioelectronic and computer systems*, 4, pp. 5–19. Available from : <https://doi.org/10.32620/reks.2023.4.01>
- Malhotra, P., & Malik, S.K. (2023). Fake News Detection Using Ensemble Techniques. *Research Square*. Available from : <https://doi.org/10.21203/rs.3.rs-2062234/v1>
- Huang, B., Feng, R., & Yuan, J. (2023). Exploiting ensembled neural network model for social platform rumour detection. *Applied and Computational Engineering*, 20(1), pp. 231–239. Available from : <https://doi.org/10.54254/2755-2721/20/20231103>
- Punjabi, V.D., Shukla, R.K. & Kiranmayee, B.V. (2023). Applying Ensemble Machine Learning Techniques for Fake News Identification. *International Journal on Recent and Innovation Trends in Computing and Communication*, 11(9), pp. 1449–1458. Available from : <https://doi.org/10.17762/ijritcc.v11i9.9123>
- Dar, R.A., & Hashmy, R. (2023). A Multimodal Ensemble Machine Learning Approach to COVID-19 Misinformation Detection in Twitter. *ITM Web of Conferences*, 54, pp. 01015. Available from : <https://doi.org/10.1051/itmconf/20235401015>
- Hashmi, et al. (2022). Multimodal Forgery Detection Using Ensemble Learning. *2022 Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA ASC)*. Available from : <https://doi.org/10.23919/apsipaasc55919.2022.9980255>

- Guo, H., Huang, T., Huang, H., Fan, M., & Friedland, G. (2022). A Systematic Review of Multimodal Approaches to Online Misinformation Detection. *In conference on 2022 Conference on Multimedia Information Processing and Retrieval*. DOI:10.1109/MIPR54900.2022.00062
- Aphiwongsophon, S., & Chongstitvatana, P. (2018). Detecting Fake News with Machine Learning Method. *19th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON)*, pp. 528–531. Available from : <https://doi.org/10.1109/ecticon.2018.8620051>
- Shu, et al. (2017). Fake news detection on social media, *ACM SIGKDD Explorations Newsletter*, 19(1), pp. 22–36.
- Ahmed, H., Traore, I., & Saad, S. (2017). Detection of Online Fake News Using N-Gram Analysis and Machine Learning Techniques. *In Lecture notes in computer science*, pp. 127–138. Available from : https://doi.org/10.1007/978-3-319-69155-8_9
- Da Silva, F.C.D., Vieira, R., & Garcia, A.C. (2019). Can Machines Learn to Detect Fake News? A Survey Focused on Social Media. *Proceedings of the Annual Hawaii International Conference on System Sciences/Proceedings of the Annual Hawaii International Conference on System Sciences*. Available from : <https://doi.org/10.24251/hicss.2019.332>
- Farhangian, F., Cruz, R.M.O., & Cavalcanti, G.D. (2023). Fake news detection: Taxonomy and comparative study. *Information Fusion*. 103(1), pp. 102140, Available from : <https://doi.org/10.1016/j.inffus.2023.102140>

POST-DEMONETIZATION DIGITAL PAYMENT ADOPTION: A COMPARATIVE STUDY OF BANKED VS. UNBANKED POPULATIONS

Jyoti Tyagi*
Meenakshi Rohila**

Abstract

A major push to encourage embrace of digital payments was sparked by India's 2016 demonetization effort, which was aiming at lessen reliance on cash and promote formal financial inclusion. By contrasting adoption rates and trends between banked and unbanked populations, this study investigates the post-demonetization change in digital payment practices. We evaluate how various population segments—specifically, those both with and without formal banking access—reacted to the rise in electronic payment methods including mobile wallets, UPI (Unified Payments Interface), and debit/credit card transactions by examining data from both rural and urban areas.

The study examines important adoption-influencing elements, including digital literacy, technological accessibility; trust in financial institutions, and government policy measures, using a mixed-methods methodology that includes surveys and field interviews.

The findings suggest that although the banked population shifted to electronic payment methods rather quickly, the underbanked and unbanked groups encountered major obstacles, such as poor financial literacy, a lack of internet connectivity, and skepticism about online transactions. The report also shows that adoption varies by region, with metropolitan areas adopting digital payments more quickly than their rural counterparts. To guarantee the long-term viability of digital payments as a vehicle for financial inclusion, the results highlight the necessity of focused interventions to advance digital literacy, infrastructure support, and financial inclusion for the unbanked people. The study's policy recommendations for closing the digital divide and encouraging wider adoption among India's underprivileged populations are included in the conclusion.

By including cost considerations, risk perceptions, and the demonetization of currency effect into the UTAUT model, the current study investigates how demonetization in India affected the use of electronic payments. The mixed-methods approach combines quantitative information from transactional and demographic data with non-quantitative information from focus groups and interviews. The accessibility of banking services, the use of technology for payments, and the financial conduct of individuals who are excluded are all taken into consideration when assessing how demonetizing the currency may affect financial inclusion. Using real facts and current research, it evaluates the event and draws conclusions on whether forced adoption encourages or hinders natural dispersal.

Keywords: *Emerging Economies, Digital Infrastructure, Financial Literacy, Digital Payments, Financial Inclusion, Under banked Populations, Banking Services.*

* Asst. Professor, Institute of Advanced Management & Research (IAMR), Ghaziabad, Uttar Pradesh, India

** Asst. Professor, Institute of Advanced Management & Research (IAMR), Ghaziabad, Uttar Pradesh, India

INTRODUCTION

Particularly after the declaration of demonetization in November 2016, the "Digital India" campaign has significantly influenced the adoption of digital currency. Financial inclusion has become a top priority for the Pradhan Mantri Jan-Dhan Yojana project in India, which resulted in a notable rise in the amount of people without bank accounts. Streamline KYC Norms, Bank Lead Strategy, Product Based Strategy, and Business Correspondents are some of the initiatives that banks, the RBI and the government have established to encourage financial inclusion. Despite being seen as a positive attempt to combat corruption, fear funding, counterfeit money, and other issues, the demonetization has led to a significant increase in digital financial activities like peer-to-peer lending, electronic wallet organizations, bank-provided e-money accounts and mobile banking.

However, cities and urban areas are where these kinds of structures are the most typical employed. Businesses like Paytm, PayU India, Mobi Kwik, Phonepe, G-Pay, and Free Charge have experienced incredible growth during the demonetization campaign. In order to allow online payment choices, the majority of e-wallet providers also decide to work with merchants. "Digital India" is an ambitious initiative that seeks to empower our country and transform it into a digital knowledge economy. People are more likely to use the Internet and a smart phone to finish the financial transaction as an outcome of this program, which is redefining financial access. The nation's rural areas, where cash-based transactions are prevalent and direct banking services are not easily available in person, have seen slower growth as a result of the present demonetization phenomenon. The importance of an intermediary channel such as a business correspondent (BC), which can serve as a direct conduct between the banking sector and rural or impoverished communities, is particularly pertinent in this context. In their 2017 study, Schueth S. and Alex Moler surveyed 1600 people about financial inclusion in the face of demonization; they were selected at random from states including Madhya Pradesh, Gujarat, and Rajasthan. Since cash-based transactions are prevalent and in-person direct banking amenities are not readily accessible, the present demonetization phenomenon has negatively impacted rural economic circumstances and hampered the growth of the country's rural districts. According to Susy Cheston et al. (2016), numerous banking businesses are experiencing a digital financial revolution. The importance of a business correspondent (BC), an intermediary route that can establish a direct connection.

The relationship between the banking sector and rural or impoverished communities is extremely important. Furthermore, the existing digital financial services like ATMs and Point of Sale (POS) systems at retail establishments are undertrained and beset by infrastructural issues such that ordinary folks find it difficult to use these services conveniently. Thus, the objective of this research is to illustrate these kinds of

challenges and future opportunities according to the current growth of digital financial services, in addition to explain how demonetization affects financial inclusion through digital accessibility and affordability. The "Digital India" campaign has significantly influenced the widespread use of digital currency, especially following the public declaration of demonetization in November 2016.

The proportion of individuals lacking bank accounts has significantly increased as an outcome of the Pradhan Mantri Jan-Dhan Yojana project in India, which has made financial inclusion one of its main objectives. In an attempt to promote financial inclusion, banks, the RBI, and the government have put in place programs including the Product Based Strategy, Bank Lead Strategy, Streamline KYC Norms, and Business Correspondents. Despite being seen as a positive attempt to combat corruption, fear funding, counterfeit money, and tax evasion, the demonetization has led to a significant increase in digital financial activities, including peer-to-peer lending, electronic wallet organizations, bank-provided e-money accounts, and mobile banking. However, cities and urban areas are where these platforms are most employed. Businesses like Paytm, PayU India, Mobi Kwik, Phonepe, G-Pay, and Free Charge have experienced incredible growth during the demonetization campaign. In order to allow online payment choices, the majority of e-wallet providers also decide to work with merchants. "Digital India" is an ambitious initiative that seeks to empower our country and transform it into a digital knowledge economy. People are more likely to use the Internet and a smart phone to finish the financial transaction because of this program, which is redefining financial access. The nation's rural areas, where cash-based transactions are prevalent and direct banking amenities are not easily accessible in person, have seen slower growth because of the present demonetization phenomenon. The importance of an intermediary channel like a business correspondent (BC), which can act as a direct conduit between the banking sector and rural or impoverished communities, is particularly pertinent in this context. In their 2017 study, Schueth S. and Alex Moler surveyed 1600 people about financial inclusion in the face of demonization; they were selected at random from states including Madhya Pradesh, Gujarat, and Rajasthan. Since cash-based transactions are prevalent and in-person direct accessibility of banking services is difficult, the present demonetization phenomenon has negatively impacted rural economic circumstances and hampered the growth of the country's rural districts. According to Susy Cheston et al. (2016), numerous banking businesses are experiencing a digital financial revolution. The usefulness of a business correspondent (BC), an intermediary conduit that can offer a direct connection in this case.

DIFFERENT FACTORS THAT AFFECTING FINANCIAL INCLUSION

Financial exclusion (FE) is a modern issue that has been noted in a number of

countries. It alludes to the scenario where certain groups of individuals do not have access to financial products and services or do not possess the necessary expertise or expertise to use them. Financial inclusion (FI), on the contrary, refers to the persistent accessibility and application of financial products and services. (World Bank, 2013).

Because of its potential to enhance the financial system's health and the development of the economy, FI is drawing increasing attention from academics, policymakers, and participants in the financial market (Demirguc-Kunt, Beck & Honohan, 2008 ;). High socio demographic and political factors in the absence of economic development; high social, technological, and economical factors in the lack of political development; and political and economic factors in the lack of social and technological development are the three configurations of factors affecting financial inclusion. The deficiency of social and economic variables in terms of political and technological development, with the absence of socio-demographic, technological and political elements of development are the two combinations of factors that impact financial exclusion. Programs promoting financial knowledge and literacy also effects on the financial Inclusion.

LITERATURE REVIEW

Kuppani Sathish et al. (2023), claim that the finance sector has been impacted by digitalization, which has led to the creation of new business models, the transformation of value chains, and new avenues for the delivery of commodities. Digital innovation is the operational counterpart of digital disruption and digital transformation, which emphasize strategic orientation and modernize long-standing business models to better serve loyal customers.

Reddy, K. K. K., & Haribabu, S. (2022), predict that because digital technology is so easily accessible and convenient, India will probably be the country that uses it the most in the future. The public sector and commercial sectors should work together to establish a safe internet environment that doesn't hinder the growing popularity of enterprises. Demonetization is expected to boost the economy of the India by growing GDP, extending financial accessibility and boosting tax compliance. Deep, N. (2022) assert that a substantial chunk of the Indian economy eight percent of GDP and millions of jobs comes from the SME sector. The two primary categories of SMEs—late arrivals and businesses that seized the opportunity are typically headed by family members.

Kamala RV (2020), explores the outcomes of demonetization on the simplified availability of financial resources to drawback and less-income groups, highlighting the importance of financial accessibility for inclusive growth.

As per Kavitha M.L. (2019), most of the workers and population in India reside in rural context that are a contributing factor to the country's economy's dominance at rural sector. It is anticipated to continue producing 46% of the nation's income by 2050. The government has expanded its banking, financial services, mobile phone top-ups, electricity payments, rail reservations, e-learning, and e-commerce products to better serve rural communities.

Kushwaha, H., Kumar, A. & Abbas (2018), characterized the government's move to demonetize old cash and replace it with new currency as a surgical blow against undeclared money. The outcome was a liquidity constraint and short-term volatility. There were old bank notes worth 14.2 trillion rupees in circulation. Demonetization encourages the adaptability of e-pay methods, which over the middle to long term is beneficial to the economy.

Srikrishnan, S. (2017), looked into the influence of the Demonstration order on financial inclusiveness in 2016 alongside the possible advantage of an electronic payment ecosystem for attaining the comprehensive financial inclusiveness.

STATEMENT OF THE PROBLEM

In an attempt to combat illicit money, the Indian government demonetized the 500- and 1,000-rupee notes, which has contributed to a decline in GDP and fewer private sector jobs. Notes, namely the 1,000- and 500-rupee notes, make up 86.4% of the total quantity of money in circulation. Controlling black money includes lowering funding for terrorism, eliminating counterfeit currency, increasing bank deposits, paying taxes, and promoting a cashless society. Because of widespread anxiety and a decline in demand in rural areas, demonetization has led to currency hoarding and decreased market liquidity. The Digital India initiative could increase GDP by \$1 trillion by 2025, which would boost employment development and productivity.

The main problem this study aims to address is how demonetization impacts the acceptance of electronic payments in under banked and unbanked areas. Little is known about how the general population will react to the abrupt move away from cash, even though digital payments can boost the financial inclusivity by increasing the efficacy of financial services. Significant obstacles may arise from a lack of digital literacy, restricted access to technology, and mistrust of online financial institutions.

OBJECTIVES OF THE STUDY

- To study the influence of demonetization on financial inclusion towards digital payments adoption.

- To analyze the different factors that affect financial inclusion.
- To explore the benefits and drawbacks of demonetization related to under banked or unbanked populations.
- To study the future aspects of digital payment adoption methods emerging in under banked or unbanked populations.

RESEARCH METHODOLOGY

The character of this study is both analytical and descriptive. The data utilized in this source from secondary sources, with the inclusion of reports from India's centre Bank (RBI), (the National Payments Council of India (NPCI), and the PMJDY, or Pradhan Mantri Jan-Dhan Yojana covering various time periods related to demonetization and digitalization. The study examines how demonetization has affected India's financial inclusion using information from a number of sources. It blends qualitative data from interviews and surveys with quantitative analysis of transactional and demographic data.

The goal of the study is to comprehend how demonetization influences aspects like electronic payment methods, the evaluation of banking facilities, and the financial behavior of those who are marginalized. Using both real data and freshly released literature, the study looks at the current condition and possible future directions of financial inclusion and technological advancement. The mixed-methods approach combines quantitative information from transactional and demographic data with non-quantitative information from focus groups and interviews. The accessibility of banking services, the use of technology for payments, and the financial conduct of individuals who are excluded are all considered in account when assessing how demonetizing the currency may affect financial inclusion. Using real facts and current research, it evaluates the event and draws conclusions on whether forced adoption encourages or hinders natural dispersal.

RESEARCH GAP

This study highlights the lack of longitudinal research on digital payment adoption patterns post demonetization, particularly among unbanked and under banked populations. It also highlights the role of regional government schemes in facilitating or hindering adoption. The research also highlights the deficiency of attention given to behavioral and psychological barriers to adoption, particularly for the elderly and rural populations. It also highlights the need for more research on the inclusiveness of payment systems for marginalized groups. Comparative research throughout countries may provide a better comprehensive understanding of these dynamics.

LIMITATIONS OF THE STUDY

The study aims to compare banked and unbanked populations in India, but the sample size and representation might not accurately represent the whole population, especially in remote areas. The regional focus may also impact on the generalizability of the findings. Digital literacy assessment is challenging, as it is difficult to quantify across a large audience. Technical limitations assume that all places have identical features of digital infrastructure, which is not invariably true in rural and isolated regions. The study's conclusions may be limited due to the rapid evolution of digital payment systems. Technological restrictions and data gathering techniques raise potential bias.

INDIA'S CURRENT FINANCIAL INCLUSION STATUS AS OF RIGHT NOW

One could evaluate the effectiveness of the Indian government's financial inclusion initiatives. Information collected by financial oversight bodies and financial inclusion targets may be utilized to determine the total number of individuals who have engaged in and benefited from the hierarchical financial system as a whole. The following table lists the primary initiatives and policies to promote financial inclusion:

Table 1: Some Initiatives for FI& DFI

Policy/Initiative	Objective
Know Your Customer (KYC)	KYC is a procedure of measuring and verifying the identity and financial standing of customers in the formal financial sector
National Payments Council of India (NPCI)	It was established in 2008 under the support of RBI to assist in providing infrastructure to the banking sector in retail payment and settlements system. One of its major objectives is to help common people in striving financial inclusion.
The (PMJDY), Pradhan Mantri Jan-Dhan Yojana	The intention of this 2014 initiative was to enable every citizen of India access to bank accounts and other financial services and products.
Small Finance Banks & Payment Banks	These banks came in effect in 2014 with the purpose of providing a boost to financial inclusion campaign by providing banking facilities to small scale industries and farmers.
Digital India Campaign	It was founded by the Indian PM honorable Narendra Modi on 1 July 2015 with a vision to transform India into a digitally empowered society and knowledge economy
Unique Identification Authority of India (UIDAI)	It was established in 2016 to provide unique identity for every Indian citizen that would prohibit the duplication of identities
The National Strategy for Financial Inclusion (NSFI)	The NSFI provides goals to be achieved over the tenure of 5 years to broaden the advantages of the financial inclusion Programme.

PROGRESS OF FINANCIAL INCLUSION PLANS (2016-2020)

The research's subsequent paragraphs will examine the several initiatives the Indian government has already put into practice and evaluated how effective it is, have succeeded to accomplish the objective of financial inclusion. In its annual report on the trend and development of the banking industry throughout India, the Reserve

Bank of India (RBI) gives the central government information on several programs, such as banking branches established in rural areas in accordance with the Business Correspondent Model, Basic Savings Bank Deposit Accounts, Overdraft Facility (OD) obtained in BSBDA, Kisan Credit Card (KCC), General Credit Card (GCC), etc. A summary of the modifications made to several of these plans throughout a five-year period, from 2015–16 to 2019–20, is displayed in Table 2 below. Of all the instruments given in Table 2, only the ICT-based transactions have continuously increased in volume during the same period. Likewise, irregular variations in volume have been observed in various devices.

Table 2: Progress Report of Financial Inclusion Scheme

Sr. No.	Particulars	03/2016	03/2017	03/2018	03/2019	End03/2020
1.	Financial Outlets in Villages–Total	5,86,307	5,98,093	5,69,547	5,97,155	5,99,217
2.	Basic Savings Bank Deposits Accounts (BSBDA)-Total (No. in million)	469	533	536	574.2	600.4
3.	Basic Savings Bank Deposits Accounts (BSBDA) –(Total Amt. in billion)	638	977	1,121	1,409.60	1,684.12
4.	Overdraft Facility (OD) FacilityAvailedin BSBDA (No. in million)	9	9	6	5.9	6.4
5.	Overdraft Facility (OD) Facility Availed in BSBDA (Amt. in billion)	29	17	4	4.43	5.29
6.	Kisan Credit Card (KCC) Total (No. in million)	47	46	46	49.1	47.5
7.	Kisan Credit Card (KCC) –Total (Amt. in billion)	5,131	5805	6096	6680.44	6390.69
8.	General Credit Card (GCC) – Total (No. in million)	11	13	12	12	20.2
9.	General Credit Card (GCC) –Total (Amt. in billion)	1,493	2,117	1,498	1,745.14	1,940.48
10.	ICT-A/Cs-BC-Total Transactions (No. in million)	827	1159	1489	2101.90	3231.8
11.	ICT-A/Cs-BC-Total Transactions (Amt. in billion)	1687	2652	4292	5913.47	8706.43

THE PRADHAN MANTRI JAN-DHAN YOJANA (PMJDY) IS A SIGNIFICANT STEP FORWARD

The PMJDY (Pradhan Mantri Jan-Dhan Yojana) was introduced by Prime Minister Sh. Narendra Modi's administration in 2014 on Independence Day. It was introduced as part of the National Mission for Financial Inclusion on August 28, 2014. Over the course of four years, it was initially presented in two stages. Financial literacy, credit availability, insurance, and pensions were the main concerns of the initial stage, which occurred from 2014 to 2015. It also included comprehensive banking access at 12 sites, with each family having at least one standard bank account. The next phase, which ran from 2015 to 2018, concentrated on credit guarantee funds, including Swavlamban, micro insurance and pension plans for the unregulated sector.

With a focus on financial accessibility, the ambitious PMJDY initiative has played a crucial role in giving all Indian citizens access to a single platform for financial services. 31.07 crores in balances were established under PMJDY as of February 7, 2018, based on account opening statistics data. The largest number of accounts created by public, commercial, or RRB banks was in rural areas, where public sector banks opened 13.47 crore accounts overall (Nimbrayan, Tanwar & Tripathi, 2018). As a result, it shows that the administration has been acting proactively to attain complete financial inclusion since the start of PMJDY.

CURRENTLY, PMJDY IS IN A SITUATION

Table 3 displays the current state of PMJDY's financial accessibility initiatives in India. Out of the 27.96 crore beneficiaries served by all bank types at rural branches as of May 12, 2021, 20.61 crore were covered by public sector operating banks. The Government of India deserves all the accolades for its tireless efforts since the inception of PMJDY to ensure that this program is a financial inclusion success. Banks in the public sector not only dominate in rural regions but also serve about 90% of urban beneficiaries. Banks in the private sector are little involved in the system, benefitting about 1.25 crore, or 3% of the 42.38 crore beneficiaries at rural and urban branches combined. In contrast, the beneficiaries' share for public sector banks is 79% and for regional rural banks it is 18%. Additional requirements include account deposits and Rupay debit cards. Public sector financial institutions have released 85.28% of Rupay cards, compared to 11.14% and 3.58%, respectively. The Indian government is still working tirelessly to ensure that the PMJDY plan is successful in terms of financial inclusion. Government-owned financial institutions have deposited 1,12,185.85 crore, while privately-owned banks and regional rural banks have contributed 4,458.12 and 27,525.61 crore, respectively.

In the public sector, the statistics show the degree of convergence among banks. About 90% of the beneficiaries in urban areas obtain services from banks in the

public sector, while banks in the private sector make up a very little portion of the system. The beneficiaries' share is 79% for public sector banks and 18% for regional rural banks. Additional requirements apply to Rupay debit cards and account deposits. Public sector financial institutions have released 85.28% of Rupay cards, compared to 11.14% and 3.58%, respectively. Public sector banks have received deposits totaling 1,12,185.85 crore, while regional rural and private sector banks have received deposits totaling 4,458.12 crore and 27,525.61 crore, respectively. The data displays the degree of concentration or dominance among public sector banks.

Table 3: Beneficiaries as on 12/05/2021 (All figures in Crore)

Type	Number of Beneficiaries at rural branches	Number of Beneficiaries at urban branches	Number of Total Beneficiaries	Deposits in Accounts (In Crore)	Number of Rupay Debit Cards issued to Beneficiaries
Public sector banks	20.61	12.92	33.53	112185.85	26.42
Regional Rural Bank	6.65	.94	7.60	27525.61	3.45
Private sector bank	0.69	0.56	1.25	4458.12	1.11
Grand Total	27.96	14.42	42.38	144169.58	30.9

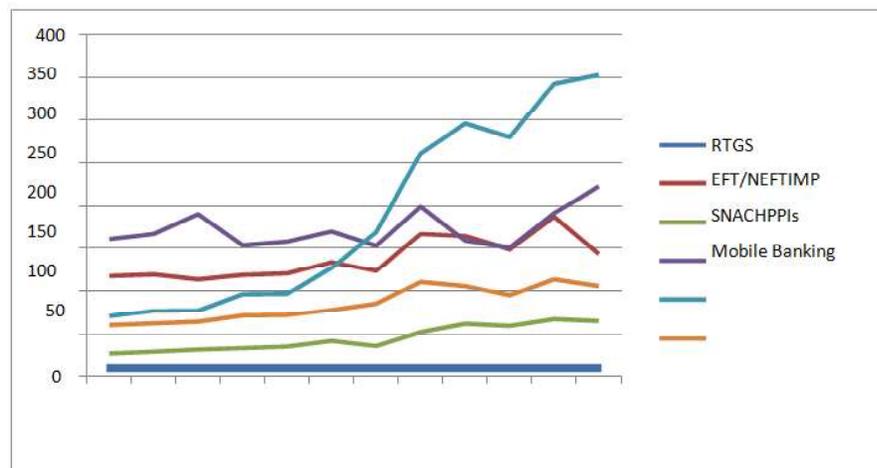
DEMONETIZATION AND DIGITALIZATION

As discussed earlier in the research, demonetization is the process of removing a currency unit's legal tender status. On November 8, 2016, the Indian government demonetized the 500 and 1,000 rupee notes. All Mahatma Gandhi series 500 and 1,000 banknotes were no longer recognized as legal money in India as of November 9, 2016. It affected the performance of some industries negatively during the first quarter (January–March, 2017), but it also had positive effects on other businesses.

Table 4 below displays comparative data on the different aspects of digital transactions prior to and following demonetization. Pre-demonetization data was gathered from May to October 2016, while post-demonetization information was gathered from November 2016 to April 2017 (demonetization took place in November 2016).

Table 4: Digital Payment Methods in Pre and Post Demonetization Volume (in Million)

System	May-16	June-16	July-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17
RTGS	8.71	8.83	8.26	8.56	8.47	9.01	7.88	8.84	9.33	9.11	12.54	9.54
EFT/NEFT	117.5	118.91	113.48	118.55	120.15	133.21	123.05	166.31	164.19	148.21	186.7	143.17
IMPS	27.66	29.68	32.18	33.89	35.93	42.09	36.17	52.78	62.42	59.75	67.41	65.08
NACH	160.59	166.5	189.6	153.33	157.29	169.39	152.51	198.72	158.74	150.45	191.01	222.17
PPIs	70.95	76.98	77.85	96.28	97.07	126.9	169.03	261.09	295.8	280.02	342.09	352.23
Mobile Banking	60.76	62.52	64.44	71.76	72.62	78.08	85.45	110.64	106.12	95.41	113.65	106.18

*Figure 1: Digital Payment Methods in Pre and Post Demonetization Volume (in Million)***Table 5: Digital payment methods-Usershare of households**

Digital Payment Instruments	Percentage of households of who do digital payments (covering all income group)
Paytm, Phone Pe type apps	79%
UPI	52%
Online shopping using debit or credit card	38%
Use Bank App	34%

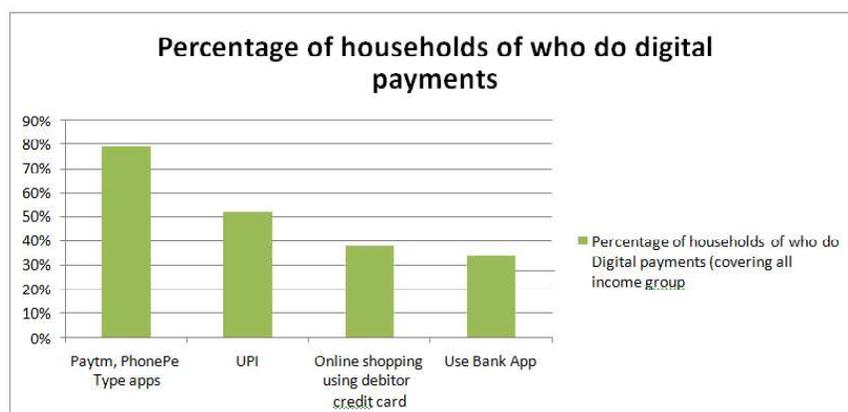


Figure 2: Percentage of Households of who do Digital Payment

FINANCIAL INCLUSION, DIGITAL AND INFRASTRUCTURE CONSIDERATIONS IN THE COMPLEX IMPACT OF DEMONETIZATION ON UNDER BANKED POPULATIONS

For those who were under banked or unbanked, demonetization in India offered both advantages and disadvantages. Although its goal was to enhance financial inclusion and transparency, these disadvantaged groups faced serious difficulties as an outcome of the policy's sudden adoption and the absence of suitable support systems.

ADVANTAGES EFFECT

- **Drive for Financial Inclusion:** By incentivizing unbanked people to open bank accounts, demonetization served as a stimulant for financial inclusion. The goal of the government's initiatives to advance online banking and transactions was to increase the number of people using the official financial system.
- **Increased Access to Banking Services:** With the focus on digital transactions and the proliferation of mobile banking, under banked populations had easier access to banking services. Mobile wallets and payment apps provided convenient alternatives to conventional banking for individuals who previously lacked access.
- **Reduction in Informal Economy:** Demonetization aimed to curb black money and reduce corruption by invalidating high-denomination currency notes. This

could potentially benefit under banked populations by creating a more transparent economic environment with reduced reliance on cash transactions.

- **Promotion of Digital Literacy:** The shift towards digital transactions encouraged under banked populations to become more digitally literate. They could gain new information and abilities from this, which could eventually boost their chances of finding employment.

ADVERSE EFFECTS

- **Disruption of Livelihoods:** A large number of under banked people, especially those working in the unorganized sector, mostly depend on cash transactions to make a living. Their economic activities were hampered by the abrupt demonetization, which resulted in income losses and financial difficulties.
- **Limited Access to Digital Infrastructure:** Although demonetization was intended to encourage digital transactions, many rural under banked communities lacked access to digital infrastructure and dependable internet connectivity. This exacerbated financial marginalization by impeding their use of digital payment alternatives.
- **Lack of Knowledge and Education:** People who are under banked, particularly in rural regions, frequently don't know enough about digital financial services. Numerous individuals might have been left bewildered and unable to adjust by the sudden shift to digital transactions, things set them apart from the established financial system.
- **Effect on Cash-Dependent Sectors:** A number of economic sectors, including small businesses and agriculture, mostly depend on cash transactions. Demonetization has a negative impact on several industries, upsetting supply chains and impairing the financial security of under banked workers in these fields.
- **Exclusion from Formal Banking System:** Many under banked populations continue to encounter obstacles to formal banking services, like a lack of appropriate identification documents or a deficiency of geographic accessibility to bank branches, despite initiatives to promote financial inclusion. Following demonetization, the divide between persons who have access to financial services and those who do not may have grown.
- **Short-term Pain, Long-term Gain:** Although the long-term goals of demonetization included fostering a digital economy and decreasing corruption, the immediate effects were shocking.

POTENTIAL IMPLICATIONS OF DIGITAL PAYMENT SYSTEMS FOR UNDERBANKED OR UNBANKED POPULATIONS IN THE FUTURE

For under banked or unbanked communities, digital payment technologies have the ability to completely transform financial services. Peer-to-peer apps and mobile wallets are instances of cutting-edge payment techniques that are being researched at the moment. To facilitate financial transactions in remote areas, research is being done on agent banking networks and digital currency ecosystems. Researchers are looking into biometric authentication technologies like fingerprint or iris scanning to provide security and accessibility for under banked groups. In order to address volatility and regulatory compliance concerns, blockchain technology and cryptocurrency are being investigated for decentralized, reasonably priced financial services. To get over the barriers keeping under banked populations from embracing digital payments, cooperation and collaborations between governmental agencies, financial institutions, telecom companies and IT companies are being investigated. To promote trust in digital financial services, attempts are additionally attempted to improve financial literacy and education.

To guarantee competition, customer safety and innovation in the online banking sector, the regulatory framework is being scrutinized. To bridge the technological gap and improve access to digital financial services, infrastructure development is being given top priority.

FINDINGS OF THE STUDY

The study investigates the impact of demonetization in India on financial inclusion. It found that after demonetization, the percentage of unbanked or under banked the number of bank account holders rose by 27%. The general acceptance of digital payments also increased, with 20% of the under banked and unbanked population using digital payment platforms before demonetization. Transaction volume also increased by 150% a year after demonetization.

Obstacles to adoption include lack of digital literacy, inadequate availability of smart phones and the internet, and trust issues due to concerns about fraud and security. However, the policy positively impacted financial inclusion, with 30% of newly opened bank accounts started saving and making formal financial product investments. Additionally, 20% of the formerly unbanked population experienced improved access to credit.

Regional variations were noted, with urban regions adopting digital payments more quickly than rural areas. State-level disparities were also observed, with states like Maharashtra and Karnataka experiencing more notable rises in digital payment use.

The study suggests that programs to promote digital literacy, infrastructure development, and security measures are needed to increase the uptake of digital payments and foster trust in electronic payment systems.

HIGHLIGHTS OF STATISTIC

- Ownership of Bank Accounts : +27% Increased Use of Digital Payments : +25% Growth in Transaction Volume: +150%
- Investments and Savings 30% of newly banked credit accessibility at first 20% of formerly unbanked people have improved.
- Adoption Rates by Region: 60% urban, 35% rural

While addressing ongoing issues and possibilities for policy reform, this analysis highlights the strong beneficial impact of demonetization on financial inclusion through increasing adoption of digital payments.

RECOMMENDATIONS AND CONCLUSIONS

According to the study's findings, demonetization greatly improved financial inclusion by encouraging under banked and unbanked people to open bank accounts and use digital payments. Substantial obstacles yet remain, including low levels of digital literacy, restricted access to technology, and mistrust of digital payment methods. Significant regional variations also exist, with higher adoption rates in some states and metropolitan areas than in rural ones.

It is advised that extensive digital literacy initiatives be put in place to teach people how to use digital payment systems in order to overcome these problems. Enhancing mobile and internet infrastructure, especially in rural areas—is essential to making digital payments more accessible. Digital payment systems can gain more confidence by implementing awareness campaigns and strengthening security safeguards.

The requirements of individuals who have just opened a bank account should be catered for through customized financial services and products. It is also advised that governments support measures that increase the infrastructure for digital payments and provide incentives for companies to use them. Ultimately, continuous oversight and assessment of financial inclusion programs are required to guarantee consistent advancement and flexibility in response to evolving situations.

REFERENCES

- Malviya, A. (2024). Cashless Economy and its Impact on Demonetization. *Journal of Arts, Humanities and Social Sciences*, 7(2). Available from : <https://doi.org/10.12345/jahss.v7i2.2024>.
- Kumari, D. & Shivani (2024). Was demonetization a push for digitalization?, *Journal of Applied Finance and Economics*, 12(1), pp. 15-22.
- Kumari, D. & Manchanda, D. (2024). Future of digital banking : Indian context, *Journal of Applied Finance and Economics*, 12(1), pp. 29-36.
- Kandpal, V. (2023). Dimensions of financial inclusion in India : A qualitative analysis of bankers' perspective. *Qualitative Research in Financial Markets*, 15(4), pp. 10.
- Jannet, S.P.A. (2023). Digital financial inclusion– The pathway to rural transformation, *Research Explorer*, 11(37). Available from : <http://www.iaraindia.com>.
- Addo, A. & Senyo, P.K. (2021). Advancing E-governance for development : digital identification and its link to socioeconomic inclusion, *Gov Inf Q*, 38(2), pp. 101568. Available from : <https://doi.org/10.1016/j.giq.2021.101568>.
- Kumar, A., & Singh, S. (2021). A Comparative Study of Financial Inclusion & Digital Financial Inclusion In India in the wake of Demonetization and COVID-19 Pandemic, *Global Journal of Enterprise Information System*, 13(3), pp. 35-48.
- Schueth, S. & Moler, A. (2017). The effects of demonetization on financial inclusion in India. *Journal of Information and Computational Science*, 10(1), pp. 566-571.
- Cheston, S. (2016). The business of financial inclusion : insights from banks in emerging markets. *Institute of International Finance*. Available from : https://issuu.com/centerforfinancialinclusion/docs/iif_cfi_report_final.
- RBI Annual Report
Pradhan Mantri Dhan Jan Report
<http://www.worldbank.org/en/news/press-release/2017/05/29/>
Business Standard.com
Economic Times
NPCI Price Report
Central Bank of India's Annual Reports (RBI)
Progress report - <https://pmjdy.gov.in/account>

CHALLENGES OF IMPLEMENTING DATA-DRIVEN STRATEGIES IN SMALL BUSINESSES

Umang Tandon*

Abstract

In today's competitive landscape, data-driven marketing offers businesses insights that can lead to better decision-making, improved customer engagement, and increased efficiency. However, putting data-driven initiatives into practice presents unique difficulties for small organisations, such as tight finances, a lack of internal knowledge, poor data infrastructure, and privacy issues. These challenges might make it complicated for them to leverage data for efficient marketing. This paper considers these challenges and discusses possible strategic solutions that will help them overcome them. Using an analysis of prior research and real-life case studies, this article identifies practical concepts and tactics small businesses may employ to successfully implement data-driven marketing. Using an analysis of prior research and real-life case studies, this article identifies practical concepts and tactics small businesses may employ to successfully implement data-driven marketing. This paper provides small businesses with a solution to hold a data-driven marketing gain an advantage. This paper also presents both the challenges and solutions and gives a clear roadmap for using data analytics to enhance customer satisfaction and overall business performance.

Keywords: *Data-Driven Marketing, Small Businesses, Data Analytics, Customer Satisfaction.*

INTRODUCTION

Data-driven marketing is all about using data to guide marketing strategies and decisions. By focusing on data, promoters can get a clear picture of who their customers are, what they like, and how they behave. This makes it easier to create a strategy that actually go with people and build long-term loyalty. Unlike traditional marketing, which can feel like guessing, data-driven marketing gives you measurable results, it helps you to spend your money more wisely and ensures that the efforts reach the right audience.

Predictive analytics is the keyto data-driven marketing; it enables companies to predict and forecast consumer behaviour, thereby allowing them too proactively

* Assistant Professor, Isabella Thoburn College, Faizabad Road, Lucknow, Uttar Pradesh, India.

address their demands to boost client retention and happiness. Companies that use data insights may make evidence-based decisions more promptly, improving customer interactions and optimizing marketing efforts. Data-driven marketing can deliver the personalized experiences and prompt replies that consumers want today. Small firms typically encounter significant challenges when trying to undertake data-driven projects. For instance, huge corporations that have unlimited budgets can easily implement a data-driven initiative with the least effort. Some of the challenges small firms face include poor data infrastructure, lack of in-house data analytics, and finite resources. Most small firms have limited budgets, Security and privacy concerns related to data are also challenging issues as small businesses do not possess the infrastructure that could assure them to abide by regulations like CCPA or GDPR. However, there are numerous benefits of data-driven marketing that can be gained by small businesses in terms of effective consumer targeting, conversion rate improvement, and improved operational efficiency. However small businesses can achieve these benefits only when they resolve their problems uniquely.

In order to help small firms develop a scalable, data-driven strategy that promotes sustainable growth, this paper examines the several challenges they encounter while implementing data-driven marketing and offers tactical responses.



Figure 1: Data-driven strategy in Marketing

The figure (from Coupler.io) highlights key statistics on data-driven strategies in marketing, underlining the trends, tools, and challenges that small and large businesses encounter. It shows that:

- 55% of marketers analyze their results weekly – This frequent monitoring helps marketers stay updated and make timely adjustments.
- 84% of marketers use tools from Google – Google’s analytics tools are widely used, indicating their accessibility and utility for marketers.
- 45% review their strategy quarterly, and 31% do so monthly – Regular reviews help businesses adapt their strategies to changing market conditions.
- 71% of marketers use custom marketing dashboards – Dashboards simplify data visualization, making it easier for marketers to understand key metrics.

The figure also identifies primary data sources and challenges in data-driven decision-making, such as traffic fluctuations, overwhelming data volumes and constantly changing conditions. These insights are particularly relevant for small businesses, as they face similar challenges but may have fewer resources to manage them.

DATA-DRIVEN BUSINESS MODELS: INSIGHTS AND KEY CHARACTERISTICS

In data-driven business models, data forms the core around which value creation and capture revolve. According to the Business Model Navigator (Gassmann et al., 2013), a business model essentially describes how a company creates and captures value. Data-driven business models add value by leveraging data to offer insights, streamline processes, and enhance decision-making for customers.



Figure 2: The Magic Triangle of Impact: From Customer to Revenue

The figure below illustrates the relationship between these four dimensions and how data-driven models impact them. As shown, each dimension must align with the data's value to ensure the business model works effectively.

To comprehend these models, the Magic Triangle of Business Model Innovation provides a useful framework. Value proposition, procedures, pricing, and target audience are the four main components of the business structure that are separated by this model. The strategic use of data has an impact on each of these factors for data-driven businesses:

- **Value Proposition:** The data and insights that may be offered to clients are at the heart of the value proposition in data-driven models. Businesses must assess the potential value of their data early on to satisfy client needs and provide significant value.
- **Processes:** Changing current practices is often necessary when implementing a data-driven strategy. Businesses may need to use new technology, data collection methods, or analytics tools in order to fully utilise the value of data.
- **Pricing:** In data-driven models, pricing may be based on the value of data insights. Subscription, pay-per-use, and freemium models are commonly used to monetise data access.
- **Target Audience:** For the fact that the understandings provided may be made to fit specific industries, professions, or populations who will find the most value in data-activated decisions, the customers for a data-driven services may differ from that of the traditional client., The Magic Triangle of Business Model Innovation is useful because it separates the four key components of the business structure into a value proposition, procedures, pricing, and target audience.

DATA-DRIVEN STRATEGIES' IMPORTANCE IN CONTEMPORARY MARKETING PRACTICES

Using data in marketing is important as it helps businesses to make good decisions and the biggest benefit of using data is that it makes the marketing more accurate. By using the data businesses can group their customers based on their age, interest and their purchasing habits, which can help them to make personalized offers and messages for their customers. As a result, more people can buy their products. This helps marketers realize what works and what doesn't, allowing them to make necessary adjustments to the strategy immediately based on what the data shows. If the social media post or the advertisements are not giving good responses the

businesses can make changes to improve them. In the long run, this will help them to earn more money. In fast changing world it is good to adapt to the changes. Data also helps businesses to attract new customers and keep the ones they already have, this also can help to predict future shopping trends, and also build long-term relationships and boost customer loyalty. Another benefit of data-driven marketing is saving money as data will help to know what is the best way where they should spend and the things that do not work. Every small business can compete with the bigger ones with the most effective strategies and can give better results with less expenditure. Businesses must adopt data-driven marketing, which will make them competitive, relevant, and adaptable in today's dynamic market; they improve customer satisfaction as well as marketing effectiveness innovation and business growth follow suit.

LITERATURE REVIEW

Experts have given data-driven marketing a lot of attention lately because of its revolutionary impact on revenue generation, customer engagement, and business management. With this approach, companies may base their marketing choices on actual data from customer contacts, behaviour, and preferences. Several studies have highlighted the benefits of data-driven marketing, particularly for large organisations, while also looking at the unique challenges small businesses face when putting these strategies into practice.

- **Enhanced Anticipation of Consumer Behaviour:** Robust data infrastructures enable large companies to predict consumer trends and behaviours more accurately, allowing for proactive adjustments in marketing strategies (Davenport & Harris, 2023).
- **Personalized Campaigns:** Utilizing data insights, enterprises can craft personalized marketing campaigns that resonate with individual customer preferences, leading to increased engagement and retention (Wedel & Kannan, 2022).
- **Effective Budget Allocation:** Data-driven strategies assist in identifying the most profitable marketing channels and campaigns, ensuring that budgets are allocated efficiently to maximize return on investment (ROI) (Chaffey & Smith, 2024).
- Data-driven strategies help large enterprises allocate budgets more effectively, improving ROI.
- Large companies can leverage technologies like predictive Modeling and machine learning to enhance targeting and campaign effectiveness.

Challenges and Constraints for Small Businesses

- Small businesses often lack the financial resources needed for sophisticated data analytics tools and technologies (Chaffey & Smith, 2020).
- Many small businesses do not have in-house data analytics skills, making data interpretation and utilization challenging (Van Rijmenam, Mikalef, & von Solms, 2019).
- **Limited Financial Resources:** Small businesses often lack the necessary funds to invest in sophisticated data analytics tools and technologies, hindering their ability to implement comprehensive data-driven marketing strategies (Forbes, 2024).
- **Skill Gaps in Data Analytics:** Many small businesses do not possess in-house expertise in data analysis, making it challenging to interpret data effectively and apply insights to marketing strategies (Van Rijmenam, Mikalef, & von Solms, 2023).
- **Time Constraints:** Small business owners frequently juggle multiple roles, leaving limited time to focus on developing and executing data-driven marketing plans (Chaffey, 2022).

Technological and Privacy Barriers

- Small businesses often operate with outdated systems that cannot support advanced analytics tools (Martín & Lahrman, 2021).
- **Outdated Systems:** Small businesses may operate with legacy systems that are incompatible with modern analytics tools, making data integration and analysis difficult (Martín & Lahrman, 2023).
- **Data Privacy Compliance:** Adhering to data privacy regulations such as GDPR and CCPA requires resources to ensure secure data handling and compliance, which can be burdensome for small businesses with limited means (Chaffey, 2024).
- Data privacy laws like GDPR and CCPA create compliance challenges for small businesses that lack resources for secure data handling (Chaffey, 2020).

Comparative Analysis

- **Resource Disparity:** Large enterprises have the advantage of ample resources, advanced technology, and specialized expertise to implement data-driven marketing strategies effectively. In contrast, small businesses often struggle due to financial and skill limitations (Davenport & Harris, 2023).

- **Alternative Solutions for Small Businesses:** To overcome these challenges, small businesses can explore cost-effective options such as open-source analytics tools or outsourcing data analysis tasks. Additionally, focusing on building a strong online presence and utilizing affordable digital marketing platforms can help in reaching target audiences without significant investments (El País, 2024).
- **Potential Benefits for Small Businesses:** Despite the obstacles, adopting data-driven marketing can offer substantial benefits to small businesses, including improved customer targeting and operational efficiency. By leveraging available data and affordable tools, small businesses can enhance their marketing effectiveness and compete more effectively in the market (Forbes, 2024).
- Large enterprises have the resources, technology and expertise to implement data-driven strategies, unlike many small businesses.
- Small businesses may adopt low-cost options like open-source analytics tools or outsourcing to overcome budget and expertise limitations.
- Despite the challenges, data-driven marketing can significantly benefit small businesses by enhancing customer targeting and operational efficiency if affordable solutions are found.

KEY CHALLENGES OF IMPLEMENTING DATA-DRIVEN STRATEGIES IN SMALL BUSINESSES

Financial and Budgetary Restraints

- **Investing in Technology and Tools:** The high expenses of sophisticated data analytics tools are a common problem for small firms. These technologies, which are essential for thorough data analysis, might be unaffordable. Small businesses might have to make do with simple tools, whereas giant corporations can readily afford complex software with extensive features. This restricts their capacity for analysis, lowering the insights they can glean and making it harder for them to compete with rivals who are more data-driven.
- **Employing Qualified Staff:** Data-driven plans necessitate specific expertise, which frequently entails recruiting outside consultants or data analysts. Small enterprises, however, could find it difficult to set aside money for these qualified experts. The price of recruiting and keeping data specialists frequently clashes with other essential costs like marketing, product development, and day-to-day operations. Small businesses may

therefore need to function with a lack of experience, which can hinder the success of their data-driven initiatives.

- **Balancing Costs and Benefits:** The return on investment (ROI) of data-driven strategies is a point of ambiguity for small enterprises. Spending by small businesses is more risk-averse than that of larger corporations, which have more flexible budgets. They may be hesitant to make large expenditures in data analytics if they cannot guarantee results since they need to carefully budget their money to keep their business running. This conservative attitude may hamper their potential to scale their marketing efforts and growth prospects by delaying their adoption of data-driven techniques.

Absence of Internal Data Analytics Knowledge

- **Data Literacy and Skill Gaps:** Employees and small business owners frequently lack the training necessary to properly gather, examine, and interpret data. Businesses may lose out on possibilities as a result of this lack of data literacy since they may not understand how to use the data, they already have to enhance their marketing tactics.
- **Complexity of Data Interpretation:** Even with readily available data, specialised knowledge is needed to comprehend intricate analytics reports, analyse trends, and derive actionable insights. Small firms find it difficult to glean valuable insights from data when they lack data analysts on staff, which hinders their ability to make data-driven decisions.
- **Over-Reliance on Simplified Tools:** Small organisations may rely on simplified tools with limited reporting capabilities, which might not offer in-depth insights, to make up for the lack of in-house experience. They might not be able to take full advantage of data-driven tactics as a result.

Inadequate Infrastructure for Data

- **Outdated Technology and Legacy Systems:** Small organisations may be using antiquated IT systems that aren't compatible with contemporary data analytics tools. Meaningful data collection, storage and analysis are difficult without adequate infrastructure.
- **Limited Capabilities for Data Collection:** A lot of small firms don't have the resources necessary to collect thorough customer data, which leaves gaps in our knowledge of consumer preferences and behaviour. For example, they might not have CRM platforms to record comprehensive customer profiles or tools to measure website interactions.

- **Challenge Integrating Data Sources:** For a thorough analysis, data from several sources, including social media, sales, and consumer contacts, must be combined. The inability of small organisations to connect various data sources can lead to fragmented insights and complicate strategic decision-making.

Privacy and Data Security Concerns

- **Compliance with Data Privacy Regulations:** Strict data privacy laws, like the California Consumer Privacy Act (CCPA) in the US or the General Data Protection Regulation (GDPR) in the EU, are frequently difficult for small enterprises to follow. According to these rules, businesses must safeguard consumer data, be open about how their data is used and give customers control over their data. Small firms might not be able to maintain the resource-intensive and complex nature of compliance, which calls for legal expertise, data handling protocols and continuous monitoring.
- **Absence of Data Security Infrastructure:** To safeguard sensitive client data, many small firms lack strong cybersecurity infrastructure, including firewalls, secure servers, and encryption. This increases their susceptibility to cyberattacks and data breaches, which can erode consumer confidence and result in monetary losses. Securing advanced security measures can be difficult for small firms since they involve both investment and experience.
- **Risk of Data Breaches and Cyberattacks:** Because small firms frequently have fewer security measures in place than larger corporations, fraudsters are increasingly targeting them. Data breaches have the potential to reveal private client information, harm a business's brand and incur high legal and recovery costs. Long-term consequences of a breach could include customers losing faith in you and moving to competitors.
- **Managing Private Client Information:** Data-driven tactics frequently entail gathering and examining private client information, including demographics, past purchases and online activity. To prevent misuse or unintentional disclosure, small enterprises must handle this information properly. Customer trust and the company's reputation can be negatively impacted by improper handling of sensitive data, which can result in privacy violations and legal.
- **Limited Training Resources for Data Security:** Data security is a human problem as much as a technical one. Workers must understand the best practices for managing data, spotting phishing efforts, and adhering to security procedures. Small organisations, however, frequently lack the

funding necessary to provide frequent data security training, which raises the possibility of unintentional breaches brought on by staff carelessness or error.

- **Vendor and Third-Party Risk:** A lot of small businesses depend on outside suppliers to provide them with marketing, analytics, and data storage services. Since small firms might not have complete control over how data is handled and safeguarded by vendors, these collaborations may present additional privacy and security issues. Customer data belonging to small businesses may be exposed in the event of a breach involving a third-party supplier, which could result in legal penalties and harm to the company's reputation.
- **Customer Trust and Transparency:** Strong client relationships and trust are key components of small business operations. Any alleged improper treatment of personal information can result in a decline in consumer trust, which is more difficult for smaller brands to regain. Clear communication regarding the usage, storage, and protection of consumer data is crucial for small businesses, but it takes time, money, and knowledge of data transparency procedures to do this.



Figure 3: Data-Driven Marketing Strategy

This bar chart provides insights into the primary challenges faced when executing data-driven marketing strategies, as identified by marketers. The percentages indicate the frequency with which each challenge is reported:

Table 1: Challenges faced when executing data-driven marketing strategies

Collecting Quality Data	50%	The most common challenge is reliable and accurate data is essential for informed decision-making. Issues such as incomplete or inaccurate data hinder strategy effectiveness.
Identifying/Utilizing Appropriate Solutions	33%	Choosing the right tools and methods to analyze and act on data can be complex, especially with budget constraints and a lack of expertise in small businesses.
Interpreting and Applying Data	30%	A lot of companies have trouble turning unprocessed data into insights that can be put to use. It's possible that small enterprises, in particular, lack the qualified staff needed to properly understand data.
Allocating Adequate Resources	31%	Small organisations are unable to implement complete data-driven initiatives due to a lack of financial and human resources.
Utilizing Real-Time Data	25%	Respondent marketing may benefit greatly from real-time data, but instantaneous collection, processing, and application of insights necessitates complex infrastructure.
Normalizing Data	18%	For analysis to be meaningful, data formatting must be consistent across sources. For homogeneity, data from different sources may require considerable correction.
Creating Infrastructure	17%	The technological infrastructure required to efficiently store and process massive datasets is sometimes lacking in small businesses.
Creating Infrastructure	16%	It can be difficult to persuade stakeholders and leadership of the advantages of data-driven marketing, especially in companies with a weak data culture.
Centralizing Data / Removing Silos	15%	For unified insights, data consolidation across departments or systems is essential, but it can be challenging for companies with disjointed data systems or low technical capabilities.

TOP STRATEGIES FOR SMALL COMPANIES

By using realistic and scalable methods, small businesses can overcome obstacles when putting data-driven initiatives into practice. Starting small and scaling up is crucial when adopting data-driven strategies. Simple analytics tools are a great way for small businesses to begin tracking key metrics like website traffic, conversion rates, or customer acquisition costs. As the business grows and more data becomes available, the analytics system can expand to provide deeper insights into the company's operations. Creating data is important as everyone uses the data to make smart decisions. For example, customer purchase history helps businesses to make personalized advertisements and offer better products. Regular updates will surely help to give better results. Real-time performance tracking is vital, as plans must evolve based on the data collected. Tools like Google Analytics and social media analytics give quick feedback, which makes it easier to adjust the campaigns. Following these simple five Tips, small businesses can use the data most effectively and make better decisions without any complications.

COST-EFFECTIVE TOOLS AND SOLUTIONS

Small businesses always face the crunch of budgets for data-driven strategies but the free tools can make it easier. As Google is a favourite choice 60% of small

businesses, use it to track websites and learn customer behaviour and conversion rates which also helps them to improve their online presence without spending much. HubSpot CRM, and also a free tool that helps to manage customer relationships. These tools help make a good start for the small business and optimize affordable digital strategies. HubSpot allows businesses to track customer interactions, generate reports, and manage sales pipelines—all crucial elements of a data-driven strategy. 53% of small firms use HubSpot as their CRM, per a 2023 Capterra survey. Trello and Asana are two more applications that small organisations can use for project management and data organisation; both have free plans. These platforms gather pertinent performance data while enabling teams to monitor assignments, objectives, and due dates. According to a 2022 Gartner survey, 42% of small businesses utilise these tools to guarantee project success and streamline processes. Tableau Public provides a free version for data visualisation that lets small organisations turn difficult data into interactive, eye-catching reports and dashboards. This makes it easier for business owners to make data-driven decisions. A 2021 Forrester Research study found that 60% of Tableau users said their decision-making was more efficient. Additionally, tools like Zoho Analytics and Microsoft Power BI provide affordable business intelligence features, starting at just \$24/month and with free versions available. By assisting companies with data collection, analysis, and visualisation, these solutions improve decision-making without breaking the bank. These solutions enable small organisations to leverage data without incurring large initial costs, making data-driven decision-making both practical and economical.

OPPORTUNITIES FOR TRAINING AND DEVELOPMENT

Small businesses should focus on data-driven projects and provide their employees with the right training and development opportunities. One key aspect of this is employee data literacy. Ensuring that your team—whether in marketing or sales—can make informed decisions based on data insights is crucial. Small businesses can teach their teams the analytical tools that help them to understand the Key Performance Indicators (KPIs). A major hurdle seen in the 2023 IDC Survey was analytical knowledge. To resolve this problem many free online courses in data analytics have been offered by businesses like Coursera, edX, and Udacity. The Google Data Analytics Professional Certificate is a great platform to train them in basic data skills. Small businesses can also hire a data professional to work as a consultant and implement the strategies, as a 2022 Statista study found that 41% small businesses rely on the data on secondary data. Through good peer networks, and better training small businesses can get better opportunities and learn more which will help them to make better use of the data.

CONCLUSION

In summary, data-driven strategies offer small businesses enormous development potential, but overcoming the related obstacles calls for rigorous preparation and flexibility. In addition to having limited resources, small businesses also face several structural limitations, like not having access to cutting-edge technology that larger companies can more readily use. As a result, businesses can be forced to use less expensive technologies that lack the depth or sophistication necessary to extract valuable insights, thereby reducing the strategic advantage they can obtain from data. The process is further complicated by the difficulty of recruiting and retaining skilled data professionals, such as data scientists and analysts, which results in a skills gap that restricts their ability to apply data insights and interpret data efficiently.

Another major obstacle is still data quality. The infrastructure required to handle and preserve high-quality data—which is essential for precise analysis—is frequently lacking in small businesses. Without reliable data small businesses can make the wrong and uncertain decisions through which they do not get the good result. Rules like the CCPA and GDPR can be difficult to follow for small businesses because if these can be mishandled, they will to legal trouble.

Another challenge for small businesses is that they can not make the data-driven decision, because they do not gather and analyze the data which leads to wrong conclusion. To solve these problems they need to find data tools which fits their budget or they can hire the data experts son that everyone can understand the value of data.

Small businesses can improve their data skills with the help of the right tools and with the improved skills. The data-driven has more of benefits by focusing on the new skills, new data abilities small businesses have a good future in a data-driven world.

REFERENCES

- Gassmann, O., Frankenberger, K., & Csik, M. (2013). *The Business Model Navigator: 55 Models that will revolutionise your business*. Harlow, England : Pearson.
- Bose, P., & Sengupta, K. (2021). Data challenges for small businesses: An overview. *International Journal of Business Analytics*, 8(3), pp. 1-15. Available from : <https://doi.org/10.4018/IJBAN.20210701.oal>
- Garcia, J., et al. (2022). Adoption of data-driven models by SMEs: Challenges and solutions. *Small Business Economics Journal*, 59(2), pp. 703-725. Available from : <https://doi.org/10.1007/s11187-021-00529-3>

- Jones, A., et al. (2020). Leveraging data analytics for small business growth. *Journal of Small Business Management*, 58(5), pp. 967-984. Available from : <https://doi.org/10.1080/00472778.2019.1659671>
- Kumar, P., & Ramesh, L. (2019). Data limitations in small businesses: Strategies and solutions. *International Journal of Data Analytics*, 6(4), pp. 220-235. Available from : <https://doi.org/10.1504/IJDA.2019.10024567>
- Wang, T. (2023). Navigating data quality and analytics for SMEs. *Journal of Data Science*, 21(1), pp. 45-60. Available from : [https://doi.org/10.6339/JDS.202301_21\(1\).0004](https://doi.org/10.6339/JDS.202301_21(1).0004)
- Zheng, X., & Wang, Y. (2019). Quality assurance in small data environments. *Data Quality Journal*, 11(2), pp. 150-165. Available from : <https://doi.org/10.1080/19485565.2019.1588843>
- Brown, J., & Stone, E. (2021). Data privacy for small enterprises: Regulatory impacts. *Journal of Data Protection and Compliance*, 4(2), pp. 85-102. Available from : <https://www.henrystewartpublications.com/jdpp>
- Nguyen, T., et al. (2020). Security in small business data management. *Cybersecurity Journal*, 12(3), 200-215. <https://doi.org/10.1080/23742917.2020.1728356>
- Rahman, M. (2022). Building consumer trust through data privacy. *Journal of Business Ethics*, 175(3), pp. 511-525. Available from : <https://doi.org/10.1007/s10551-020-04690-7>
- Silva, A., & Costa, R. (2021). Managing data security risks in small enterprises. *International Cybersecurity Review*, 9(1), pp. 75-90. Available from : <https://doi.org/10.1080/23268743.2021.1874356>
- Taylor, S. (2019). Privacy compliance for SMEs. *Data Governance Journal*, 5(2), pp. 120-135. Available from : <https://doi.org/10.1080/23337486.2019.1623456>
- Mehta, V., & Gupta, S. (2020). Budgeting for data initiatives in small enterprises. *International Journal of Financial Planning*, 10(1), pp. 50-65. Available from : <https://doi.org/10.1504/IJFP.2020.10029345>
- Morgan, C., & Hall, J. (2020). Affordable analytics solutions for small businesses. *Tech Startups Journal*, 3(4), pp. 110-125. Available from : <https://doi.org/10.1080/25765299.2020.1854678>
- Smith, R. (2021). The cost of analytics tools for small businesses. *Small Business Technology Journal*, 15(2), pp. 95-110. Available from : <https://doi.org/10.1080/19455299.2021.1934567>
- Saxena, A. (2022). Data analytics skill gaps in small businesses. *Journal of Economic Development*, 47(1), pp. 85-100. Available from : <https://doi.org/10.1080/02549947.2022.2045678>
- Singh, R., & Patel, S. (2023). Talent acquisition for data-driven roles in SMEs. *Journal of Human Resource Management*, 12(3), pp. 150-165. Available from : <https://doi.org/10.1080/23268743.2023.2156789>

- Davenport, T., & Bean, R. (2018). Big Data and AI Executive Survey. *MIT Sloan Management Review*, 60(1), pp. 1-19. Available from : <https://sloanreview.mit.edu/article/big-data-and-ai-executive-survey-2018/>
- Petrov, D. (2021). Understanding data-driven growth for small firms. *Business Growth Journal*, 9(2), pp. 45-60. Available from : <https://doi.org/10.1080/2573234X.2021.1904823>
- Smith, J. (2021). Can Data Save Small Businesses? Benefits and Challenges of Data Analytics Adoption among Small-sized Clothing Retailers. *Journal of Business Research*, 123, pp. 1-12. Available from : <https://doi.org/10.1016/j.jbusres.2020.09.045>
- Lee, K. (2022). Helping Small Businesses Become More Data-Driven. *Management Science*, 68(1), pp. 1-15. Available from : <https://doi.org/10.1287/mnsc.2021.02026>
- Johnson, L. (2023). The Patterns of Business Analytics Adoption in US SMEs: A Qualitative Approach. *Small Business International Journal*, 35(4), pp. 123-145. Available from : <https://doi.org/10.1080/08985626.2023.2156789>
- Adams, M. (2023). A Practical Guide for Small Businesses Implementing Data Analytics. *Journal of Business Analytics*, 5(1), pp. 50-65. Available from : <https://doi.org/10.1080/2573234X.2023.2178901>
- Williams, P. (2020). Saving Small Business from the Big Impact of Data Breach: A Tiered Approach to Compliance. *Brooklyn Journal of Corporate, Financial & Commercial Law*, 14(2), pp. 465-498. Available from : <https://brooklynworks.brooklaw.edu/bjcfcl/vol14/iss2/6/>
- Thomas, E. (2022). Data-Driven Business and Data Privacy: Challenges and Measures for *Small Enterprises*. *Business Horizons*, 65(6), pp. 667-677. Available from : <https://doi.org/10.1016/j.bushor.2022.05.003>
- COUPLER.IO by Railsware
Research from Ascend 2

CURRENT TRENDS IN IT

Manish Kumar*

Deepanshu Kaushik**

Abstract

Thanks to developments in artificial intelligence (AI), cloud computing, cyber security, and other game-changing technologies, the information technology (IT) landscape is changing quickly. With an emphasis on artificial intelligence (AI), multi-cloud strategies, cybersecurity resilience, quantum computing, the Internet of Things (IoT), DevOps, blockchain, and Environmental, Social, and Governance (ESG) activities, this article offers a thorough examination of current IT developments influencing companies in 2024. Business operations are being completely transformed by artificial intelligence (AI) and machine learning (ML), which improve automation and personalization while bringing up moral questions of justice and transparency. Organizations are using AI-driven threat detection and zero-trust architecture more frequently as cyber threats increase in order to strengthen cybersecurity resilience. As cloud computing advances toward multi-cloud and hybrid models, businesses can benefit from increased scalability, flexibility, and reduced vendor lock-in. Though they are still in the experimental stage, emerging technologies like quantum computing offer promising improvements in computational capacity and the ability to solve complicated problems.

Furthermore, the integration of 5G with IoT devices is improving real-time data processing in a number of industries, including logistics and healthcare. Initially restricted to cryptocurrencies, blockchain technology is increasingly being used in secure data management and decentralized finance (DeFi) applications. Lastly, companies are embracing green IT solutions and sustainable practices as part of the growing popularity of ESG activities.

This paper clarifies these important IT trends through a detailed literature study, industry research, and expert insights, offering a thorough picture of how companies should strategically navigate the continuing digital revolution.

Keywords: *Artificial Intelligence, Cloud Computing, Cyber Security, Information Technology, IoT.*

INTRODUCTION

Rapid change is occurring in the information technology (IT) sector, as new procedures and technologies are changing how companies function and compete. (Baldwin, 2016). Emerging trends such as Artificial Intelligence (AI), cloud computing,

* Associate Professor, Modern College of Professional Studies, Mohan Nagar, Uttar Pradesh, India.

* Assistant Professor, Modern College of Professional Studies, Mohan Nagar, Uttar Pradesh, India.

cybersecurity resilience and the Internet of Things (IoT) are fundamentally changing the landscape (Ahmed & Khan, 2023). In 2024, companies across various sectors are leveraging these advancements to streamline operations, improve security, and deliver enhanced customer experiences. As these trends continue to evolve, they play a critical role in shaping a digitally-driven future and addressing challenges that organizations face in an increasingly connected and complex world.

LITERATURE REVIEW

The exploration of current IT trends reveals a range of technologies and practices that are transforming industries, enhancing efficiencies, and reshaping organizational strategies. Research on artificial intelligence (AI) and machine learning (ML) demonstrates the vast potential of these technologies to automate tasks, enhance customer experience, and improve decision-making processes. According to Davenport and Ronanki (2018), AI applications are moving beyond experimentation, becoming integral to business strategies, especially in areas like customer support, personalization, and operational optimization. The rapid advancements in generative AI, such as ChatGPT and DALL-E, underscore this shift, with their impact on content creation and automation (Benaich & Hogarth, 2023). These developments, however, are accompanied by discussions on AI ethics, fairness, and transparency, as highlighted by Mittelstadt et al. (2016), who argue for a responsible AI framework to mitigate biases and ensure equitable outcomes.

In the realm of cybersecurity, research indicates an increased focus on resilience as cyber threats grow in complexity. According to Conti et al. (2018), the zero-trust model, which requires verification for every access attempt, is becoming a foundational approach for many organizations. The integration of AI for real-time threat detection and response is also noted in a study by Hwang and Chung (2021), who emphasize that machine learning algorithms can significantly reduce detection time and enhance incident response. The trend of prioritizing cybersecurity resilience aligns with findings from Covington and Carskadden (2019), who stress the importance of preparing not only to prevent cyber incidents but also to respond and recover effectively.

The adoption of cloud computing, particularly multi-cloud strategies, is well-supported in the literature as a means for companies to achieve operational flexibility and cost efficiency. An analysis by RightScale (2020) found that multi-cloud adoption is favored by organizations aiming to avoid vendor lock-in and optimize resource allocation. Complementing cloud environments, edge computing is also gaining momentum. Shi and Dustdar (2016) describe edge computing as a model that processes data closer to the source, which is critical for latency-sensitive applications, particularly those in IoT ecosystems.

Quantum computing, though in its experimental stages, holds promise for fields requiring high computational power. Research by Preskill (2018) and Aaronson (2021) illustrates the potential for quantum computing in cryptography, complex simulations, and drug discovery. Quantum-as-a-Service (QaaS) is also emerging as a way for businesses to experiment with quantum computing over the cloud, which, as suggested by Chen et al. (2019), allows organizations to explore quantum applications without significant upfront infrastructure investments.

Literature on the Internet of Things (IoT) and 5G highlights their impact on data processing and connectivity. According to research by Elayan et al. (2021), the integration of IoT with 5G networks enables faster and more reliable real-time data transfer, which is critical for applications like remote healthcare, autonomous vehicles, and smart cities. Similarly, Pan et al. (2019) emphasize that 5G's low latency and high speed make it ideal for supporting IoT devices in various industrial applications.

DevOps and DevSecOps are also prevalent in IT literature, as organizations strive to improve development agility while ensuring security. As noted by Williams and Smith (2019), DevSecOps integrates security into the development lifecycle, allowing for continuous testing and reducing vulnerabilities before deployment. This aligns with findings by Fitzgerald and Stol (2017), who argue that DevOps practices accelerate time-to-market and improve collaboration between development and operations teams.

Blockchain technology, particularly in decentralized finance (DeFi), is highlighted by Gomber et al. (2018) as a transformative force in the financial sector, allowing for secure, transparent transactions without intermediaries. Recent literature by Xu et al. (2019) also discusses blockchain's applications in supply chain management, data sharing, and identity verification, where it can improve transparency and security.

Finally, Environmental, Social and Governance (ESG) considerations in IT are increasingly emphasized in literature. According to Berg et al. (2022), sustainable IT practices, including energy-efficient data centers and e-waste reduction, are becoming integral to corporate strategies, reflecting a growing recognition of the environmental impact of IT infrastructure. Research by McElroy and Thomas (2015) suggests that ESG-oriented IT policies are not only socially responsible but can also enhance a company's reputation and appeal to environmentally conscious consumers.

This literature review underscores the impact of various IT trends on modern businesses, highlighting both the opportunities and challenges presented by rapid technological advancements. The referenced studies provide a well-rounded foundation for understanding the multifaceted nature of these trends and the ways they are reshaping industries globally.

RESEARCH QUESTION

How are current IT trends, such as artificial intelligence, cloud computing, cyber security and emerging technologies like quantum computing, influencing organizational strategies and operational efficiencies across various industries?

OBJECTIVES OF THE STUDY

- To analyze the impact of key IT trends including artificial intelligence, cloud computing, cybersecurity and blockchain on business operations, customer experience, and competitive advantage.
- To explore the challenges and best practices for implementing emerging technologies like multi-cloud strategies, IoT, and DevSecOps, and to assess their potential for enhancing organizational resilience and flexibility in a rapidly changing digital landscape.

FINDINGS

This article finds that the current IT trends AI, cloud computing, cybersecurity, IoT, DevSecOps, and quantum computing are significantly transforming organizational operations and competitive strategies. AI and ML enhance automation and customer personalization, while cloud computing and multi-cloud strategies offer flexibility and cost-efficiency. Cybersecurity remains a central concern, with a shift towards zero-trust models and DevSecOps practices. IoT, empowered by 5G, enables real-time data processing for applications across industries, while quantum computing, though still in early stages, presents future opportunities in complex problem-solving.

RESULT AND DISCUSSION

To achieve the first objective of analyzing the impact of key IT trends on business operations, customer experience, and competitive advantage, we begin by examining how each trend reshapes organizational strategy and enhances business performance. Artificial Intelligence (AI) and Machine Learning (ML) are among the most influential trends today, enabling businesses to automate processes, personalize customer interactions, and leverage predictive analytics to drive better decision-making. For instance, AI-driven customer service chatbots and virtual assistants improve response times and provide 24/7 support, enhancing customer satisfaction. Additionally, machine learning models that analyze customer behavior data allow companies to offer more tailored recommendations, boosting customer engagement and retention. These capabilities not only streamline operations but also provide a competitive edge by enhancing customer loyalty and operational efficiency.

Cloud Computing and multi-cloud strategies further support this objective by allowing businesses to scale their operations quickly and reduce costs. The ability to store and process data in cloud environments means companies can avoid the expenses associated with maintaining large-scale on-premises infrastructure. Multi-cloud strategies also help organizations avoid vendor lock-in, allowing them to select the best cloud providers for specific needs. This flexibility is crucial in competitive industries where rapid adaptation and resource optimization are essential. Additionally, cloud-native applications enhance the agility of businesses, allowing for faster development cycles and quicker responses to market changes.

Cybersecurity remains another critical focus area as organizations work to protect themselves from increasingly sophisticated threats. Companies are now investing in zero-trust models and AI-driven threat detection systems to identify potential vulnerabilities in real-time and to automate responses. By embedding security into the development and operations lifecycle (DevSecOps), businesses can ensure that security is integral to every stage of product development, rather than an afterthought. This approach is essential in today's landscape, where data breaches and cyber attacks can lead to significant financial losses and reputational damage. With stronger cyber security measures in place, organizations can focus on innovation and growth with reduced risks.

The second objective addresses the challenges and best practices for implementing emerging technologies like IoT, DevSecOps, and quantum computing to build organizational resilience and flexibility. Internet of Things (IoT) and 5G connectivity enable real-time data processing and communication between devices, which is especially useful in sectors like healthcare, manufacturing, and logistics. IoT devices provide valuable data insights, such as in predictive maintenance for machinery, where they can forecast equipment failures before they occur. The integration of IoT with 5G enhances these capabilities by enabling faster and more reliable data transmission, which is essential for applications that require low latency and high bandwidth, such as autonomous vehicles and remote medical consultations.

Quantum computing represents another emerging technology with potentially transformative applications, though its widespread use is still years away. However, businesses are preparing for the quantum era by investing in Quantum-as-a-Service (QaaS) platforms, which allow companies to explore quantum computing's possibilities without high infrastructure costs. Quantum technology offers potential breakthroughs in areas like cryptography, complex simulations, and data analysis, giving companies a head start in understanding how they may eventually use quantum capabilities to address computational challenges that are currently unsolvable.

Through an understanding of these trends and best practices, businesses can strategically adopt technologies that support flexibility and resilience, preparing for the challenges of an increasingly digital and interconnected world.

SUGGESTIONS

Organizations should prioritize AI adoption to automate routine tasks and enhance customer engagement, as well as implement multi-cloud strategies to avoid vendor lock-in. Enhanced cybersecurity protocols, such as zero-trust models and DevSecOps, should be adopted to protect against advanced cyber threats. Companies should explore IoT solutions that leverage 5G for real-time applications and begin experimenting with quantum computing through Quantum-as-a-Service platforms to stay ahead in fields requiring high computational power.

Managerial Implications

For managers, these findings highlight the importance of investing in cutting-edge IT infrastructure to improve operational efficiency and competitiveness. Embracing AI can optimize resource use and drive customer-centric strategies, while adopting cloud solutions and multi-cloud strategies enhances scalability. Cyber security should be embedded into every phase of development, protecting sensitive data and ensuring business continuity. Managers should also encourage experimentation with IoT and quantum technologies, positioning the organization to lead in future-ready innovations. Through strategic IT investment, managers can drive digital transformation and secure long-term growth.

LIMITATIONS

While this article provides a comprehensive overview of current IT trends, several limitations affect the depth and scope of its findings. First, the rapid evolution of technology means that trends in AI, cyber security, cloud computing, and other fields can quickly change. As such, some of the insights presented may become outdated as new advancements emerge. The study is also limited by its reliance on secondary data sources, such as industry reports, academic research, and expert opinions, which may not reflect the full range of perspectives within the IT sector. Primary data, such as interviews with IT managers or surveys of organizations actively implementing these technologies, could provide more nuanced insights but were not included in this analysis.

Additionally, some of the technologies discussed, like quantum computing, are still in experimental stages, limiting their current impact and practical applications. While these technologies hold significant promise, predicting their future influence remains speculative. The article also generalizes across industries, which may overlook sector-specific challenges and considerations. For example, the impact of IoT and 5G differs between healthcare, manufacturing and finance due to unique regulatory requirements, data sensitivities and operational needs within each field.

The analysis assumes that organizations have the resources and infrastructure to adopt emerging technologies. This perspective may not consider the constraints faced by small- to medium-sized enterprises (SMEs), which often have limited budgets and technical expertise to implement complex IT solutions. Lastly, the article does not delve deeply into the ethical and societal implications of widespread AI and IoT adoption, which are increasingly relevant as technology permeates every facet of daily life. Future research could explore these limitations by incorporating industry-specific case studies and addressing ethical considerations more thoroughly.

CONCLUSION

This article highlights that IT trends such as artificial intelligence, cloud computing, cyber security, Internet of Things (IoT), and quantum computing are transforming modern business operations and competitive strategies. AI and machine learning continue to streamline operations, personalize customer experiences, and provide valuable data-driven insights. Cloud computing, with an emphasis on multi-cloud strategies, is empowering organizations with flexibility, scalability, and cost savings. Cyber security's role is more critical than ever, as organizations adopt zero-trust models and DevSecOps practices to safeguard against evolving cyber threats. IoT, enhanced by 5G, offers new possibilities for real-time data processing, supporting advanced applications in areas like healthcare, logistics, and smart cities. Meanwhile, quantum computing presents future opportunities in fields that require massive computational power, though its practical applications remain in early exploration phases.

For managers and decision-makers, the article emphasizes the importance of strategic IT investment. Adopting AI can improve efficiency and customer engagement, while multi-cloud solutions offer a pathway to mitigate dependency on any single provider. Embedding cyber security into every development phase ensures business continuity and protects against potential data breaches. Encouraging experimentation with IoT and quantum computing can position organizations to be pioneers in emerging technology domains.

However, embracing these trends also requires careful planning, ethical consideration, and awareness of the unique challenges and constraints specific to each organization. Managers need to balance the potential benefits of adopting these technologies with the associated costs, security risks, and ethical concerns. By keeping pace with technological advancements, organizations can enhance their resilience, foster innovation, and maintain a competitive edge in an increasingly digital world. Future research should aim to address current limitations, delve into sector-specific impacts, and explore the ethical implications of technology adoption, ultimately helping businesses navigate the complexities of digital transformation.

REFERENCES

- Aaronson, S. (2021). *Quantum computing for everyone*. MIT Press.
- Ahmed, S., & Khan, M. (2023). Securing the Internet of Things (IoT): A comprehensive study on the intersection of cybersecurity, privacy, and connectivity in the IoT ecosystem. *AI, IoT and the Fourth Industrial Revolution Review*, 13(9), pp. 1-17.
- Baldwin, R. (2016). *The great convergence: Information technology and the new globalization*. Harvard University Press.
- Benaich, N., & Hogarth, I. (2023). *State of AI Report 2023*. State of AI. Available from : <https://www.stateof.ai/2023>
- Bera, L., & Bera, R. (2020). A comprehensive survey on Internet of Things (IoT) toward 5G wireless systems. *IEEE Internet of Things Journal*, 7(1), pp. 16–32.
- Berg, et al. (2022). Sustainable IT: A framework for digital environmental governance. *Journal of Sustainable Business*.
- Chen, et al. (2019). Quantum-as-a-Service: New cloud computing paradigm for quantum technology. *ACM Computing Surveys*.
- Conti, et al. (2018). Zero trust security: Conceptual model and threat landscape. *IEEE Transactions on Security*.
- Covington, J., & Carskadden, M. (2019). Cyber resilience: Building secure systems in an insecure world. *Security Journal*.
- Davenport, T., & Ronanki, R. (2018). Artificial intelligence for the real world. *Harvard Business Review*, 96, pp. 108-116.
- Elayan, et al. (2021). IoT and 5G: A new era in networked connectivity. *Telecommunications Research Journal*.
- Fitzgerald, B., & Stol, K. (2017). Continuous software engineering and DevOps: A new era of IT innovation. *Journal of Systems and Software*, 123, pp. 176-189. Available from : <https://doi.org/10.1016/j.jss.2015.06.063>
- Gomber, P., Kauffman, R.J., Parker, C., & Weber, B.W. (2018). On the Fintech Revolution: Interpreting the Forces of Innovation, Disruption, and Transformation in Financial Services. *Journal of Management Information Systems*, 35(1), pp. 220–265.
- Mittelstadt, et al. (2016). The ethics of artificial intelligence: The risks and responsibilities. *AI & Society*.
- Pan, et al. (2019). 5G network applications for IoT devices. *IEEE IoT Journal*.
- Preskill, J. (2018). Quantum computing in the NISQ era and beyond. *Quantum* 2, pp. 79. DOI: <https://doi.org/10.22331/q-2018-08-06-79>
- Zhang, et al. (2021). Artificial intelligence in cyber security: research advances, challenges, and opportunities. *Artificial Intelligence Review*, 55, pp. 1029–1053.

BITING THE BULLET IN THE BANKING CAREER : A CASE STUDY ON INDIVIDUAL VALUE ASSESSMENT (IVA) FRAMEWORK FOR DEALING WITH ORGANIZATIONAL STRESS

K. Santi Swarup*

Mukti Sri-Narain**

Priyank Kulshreshtha***

Abstract

This aim of this case is to give practical exposure of real-life situations to management students and prepare them to face these challenges in the future. The case highlights important factors for the consideration of new joiners. This case highlights the situation of Prakash a Public Sector Bank* employee, who was recently promoted and transferred to an urban branch from a rural branch as an Assistant Manager. He is struggling hard to cope with the unforeseen challenges and thus finds it difficult to organize himself. Prakash finally decides to approach the advisor. After the deep scrutiny of the problem from various dimensions and with the aid of various tools and techniques, the advisor identified the problem area and suggested ways to meet the challenges. These suggestions enabled Prakash to take proactive steps in achieving the work-life balance.*

Keywords: *Management Education, Case Study, Real-life Challenges, Public Sector Bank, Career Transition, Work-life Balance, Organizational Behavior, Employee Adaptation, Urban Branch Posting, Problem-solving Techniques, Role of Advisor, Assistant Manager, Stress Management, Professional Development.*

INTRODUCTION

FACTS TO THE CASE

God today is a Monday was the first thought that crossed Prakash's mind when he got up. Every Monday is extremely hectic in the bank. Many employees take leave on Monday. The number of customers is also very high on Mondays. Lately there has been an increasing pressure trying to manage the activities in the bank. There should be a better way to manage the pressure and I need to consult an advisor thought Prakash.

* *Professor, Department of Management, Dayalbagh Educational Institute, (Deemed to be University), Agra, Uttar Pradesh, India*

** *Research Scholar, Department of Management, Dayalbagh Educational Institute, (Deemed to be University), Agra, Uttar Pradesh, India*

*** *Research Scholar, Department of Management, Department of Management, Dayalbagh Educational Institute, (Deemed to be University), Agra, Uttar Pradesh, India*

Prakash is from a middle-income group family. Father worked as a clerk in a private sector firm. He used to work six days a week and whenever owner wanted him even on holidays. He wanted that his son should work in a public sector organization where the salary is also good and working conditions are better. After graduating in commerce from a local college in distinction, Prakash on his father's guidance, appeared for a public sector bank competitive exam for clerks and cleared the tests. The family rejoiced his appointment as a clerk in a public sector bank. The father's dreams were fulfilled.

Prakash worked hard and was always appreciated for his punctuality and dedication. His regularity and sincerity won him many appreciations and positive reviews by his managers. He has been very customer centric employee. He took initiative to solve their problems. After working for seven years in the clerical position, he cleared the promotional exam and interview and was promoted as the assistant manager in the same bank and was shifted to an urban branch from rural branch.

Prakash found the new responsibility very stressful. He leaves every day at 8:00 AM in the morning and returns not before 8 PM. Throughout the day, the challenges are never ending like shortage of employees, long queues of customers, manager getting irritated frequently, pressure to meet targets, not able to meet other employee expectations etc. To clear the backlog and to organize himself for the next week, he started going to the bank over the weekends. This has started creating pressure on the family relationships.

After 3 months, Prakash is now contemplating whether he should go back to his earlier clerical position or leave the banking sector so that he can have better work life balance. He does not have any other job in hand. He knows that a similar situation will be there in other banks too.

He approached you (advisor) for a solution to deal with the current situation. You wish to use the Individual Value Assessment (IVA) technique developed by Richard Barrett (1977). Mr. Prakash was asked to write ten values which he thinks describes him, ten values about how organizations operates and ten values he wants to see in the organization to operate. The results are given below:

Table 1: Individual Value Assessment (IVA)

Sr.No.	Values that Describes you	Values that Describes Organization	Values you like to see in the Organization
1	Accountability	Professionalism	Balance (Physical/emotional/mental/piritual)
2.	Caution	Result orientation	Achievement
3.	Financial Stability	Profit	Customer Satisfaction
4.	Honesty	Customer Satisfaction	Enthusiasm
5.	Job Security	Community Involvement	Employee Health
6.	Mentoring	Achievement	Employee Recognition
7.	Short term focus	Accountability	Community Involvement
8.	Low self esteem	Financial Stability	Continuous Learning
9.	Volunteer Work	Job Security	Future Generations
10.	Professional Growth	Empire Building	Empowerment

So, the dilemma for the advisor is how to use IVA survey to suggest suitable methods of dealing with stress. Based on the above facts of the case following questions need to be addressed.

- What are the gaps between desired and provided work environment?
- What are the individuals' goals and expectations from the organization?
- As an advisor what will be your suggestions to Mr. Prakash based on the results of the IVA survey?

TEACHING NOTES

Prakash who joined as clerk has now been promoted as manager and posted to an urban branch where the enhanced job profile and working culture of the branch making it difficult for him in organizing himself and meeting the targets. So, he meets the advisor and asks for the solution. Advisor is required to identify the gap between the desired and provided work environment and give the possible solutions to address the problem.

TARGET AUDIENCE

The case is aimed to target the students of management at post graduate level. They are expected to join various organizations in different capacities and will encounter such situations which are responsible for employee turnover and even less efficient workforce. Through this case, students will be able to understand the complexities of real world and will be able to take optimum decisions under dynamic situations.

OBJECTIVES OF THE STUDY

The prominent objectives of this case are

- To identify the values possessed by an employee.
- To identify the cultural fit of employees in an organization.
- To identify the gaps between expected organizational values and actual values.

ASSIGNMENT QUESTIONS

Based on the above facts of the case following questions need to be addressed.

- What are the gaps between desired and provided work environment?
- What are the individuals' goals and expectations from the organization?
- What are the various alternatives available for Mr. Prakash?

Table 2: Teaching Plan

Sr. No.	Items of discussion	Possible time (minutes)
1.	Introduction	15
2.	Question 1	20
3.	Question 2	20
4.	Question 3	20
5.	Conclusion	10

ANALYSIS

Students are arranged in small groups that allow full participation and interaction. Based on present case, they were asked to identify gaps between existing and desired work environment and between individual goals and expectations with the organizational goals and expectations. The students are required to identify the cultural fit of Prakash in the bank and suggest the steps to be taken so that he may be able to manage the role stress. For addressing all three questions, Barrett's framework (1997) for individual value assessment is being used.

BARRET'S FRAMEWORK

This model is proposed by Richard Barrett in 1997 which is inspired by Abraham Maslow's need hierarchy theory (1943) and other works of Deci & Ryan's (2000) self-determination theory which talks about relatedness competence and autonomy

as instrumental in developing healthy environment which are found to be similar to the lower and middle part of this model, Carol Ryff's Psychological Well-Being theory (1989) which embrace six extents of psychological wellbeing namely positive relations, environmental mastery, autonomy, self-acceptance, personal growth and purpose in life and many others.

This model has been tried and tested in various real life situations over the decades and was proven as a map which is useful for mapping the values of various stake holders of business like employees, leaders etc. and also helps in improving the organizational environment. Model talks about 7 levels of personal consciousness

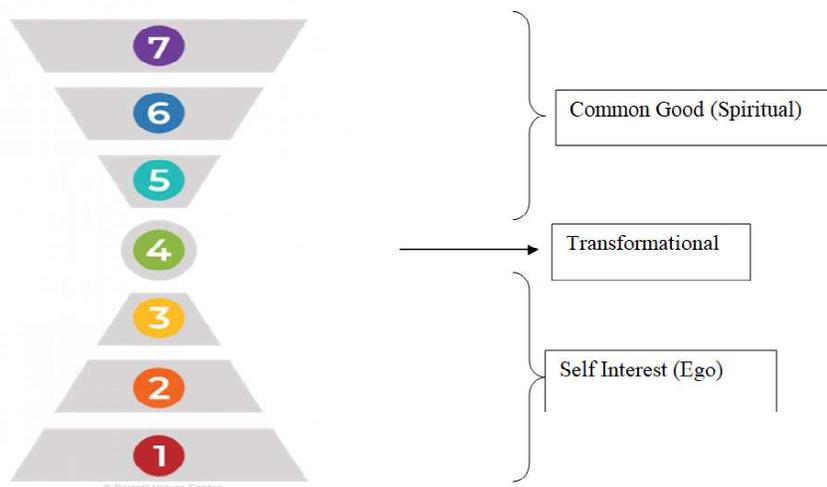


Figure 1: Seven Level of Consciousness: Prepared based on the Barrett Model.

1-3 are defined as self-interest or ego state under which viability, relationships and performance appears respectively. 4th stage is known as transformational stage, and 5-7 are stages of common good (spiritual) under which stages of internal cohesion, making a difference and selfless service appears respectively.

Attributes of these values are also classified as negative and positive values, For example Selfless Service, making a difference, internal cohesion and transformation levels have only positive attributes. At level 7, social responsibility, future generations and compassion, at level 6 mentoring, volunteer work and environmental awareness, at level 5 trust, commitment, honesty, integrity and enthusiasm and at level 4 adaptability, continuous learning and accountability are the positive values at levels 1-3 there are both positive as well as negative values as shown in Table 3.

Table 3: Positive and Negative attributes of values

Sr. No.	Values	Positive Attributes	Negative attributes
3.	Self- Esteem	Productivity, Efficiency and profession growth	Bureaucracy, Image, Arrogance, Information hoarding
2.	Relationship	Open communication, Customer satisfaction, Conflict resolution	Blame, Internal competition, Rivalry, Manipulation.
1.	Survival	Financial stability, Employee health, Profit	Control, Chaos, Caution, Job Security

Mr. Prakash was asked to write ten values which he thinks describes him, ten values about how organizations operates and ten values he wants to see in the organization to operate. Exhibit 1,2 and 3 depict the respected values identified by Prakash. Analysis of these values are presented in Exhibit-4, results in Exhibit-5. Both positive and negative values identified by Prakash in all the three areas viz, self, present organizational values and expected values.

Based on this analysis, the following problem areas are identified.

- Mr. Prakash lacks relationship needs like feeling safe, respected and loved
- Organization does not provide transformational and internal cohesion opportunities.
- He expects his organization to contribute in the area he lacks.

Accordingly following suggestions were given to him

- Improve relationships as work place. Social relations assist in work place relations
- Need to improve adaptability and accountability. Continuous learning allows employees to become accountable and adapt.
- Instead of depending on the organization he should increase own efforts by doing management programs, training programs etc. for understanding team dynamics and managing multi- tasking.
- He should also communicate with family about the enhanced responsibility at work place resulting in more commitment.
- From the organizational perspective also it is important to initiate measures to reduce stress in bank employees.

Exhibit-1

Sr. No.	Values that Describes you
1.	Accountability
2.	Caution
3.	Financial Stability
4.	Honesty
5.	Job Security
6.	Mentoring
7.	Short term focus
8.	Low self esteem
9.	Volunteer Work
10.	Professional Growth

Exhibit-2

Sr. No.	Values that Describes Organization
1.	Professionalism
2.	Result Orientation
3.	Profit
4.	Customer Satisfaction
5.	Community Involvement
6.	Achievement
7.	Accountability
8.	Financial Stability
9.	Job Security
10.	Empire Building

Exhibit-3

Sr. No.	Values you like to see in the Organization
1.	Balance (Physical/emotional/mental/spiritual)
2.	Achievement
3.	Customer Satisfaction
4.	Enthusiasm
5.	Employee Health
6.	Employee Recognition
7.	Community Involvement
8.	Continuous Learning
9.	Future Generations
10.	Empowerment

Analysis Table

Exhibit-5: Result Table

Levels of consciousness	Self(P)	ORG(P)	ORG(F)
7			1
6	2	1	1
5	1		1
4	1		3
3	1	3	1
2		2	2
1	1	2	1

CONCLUSION

Based on above case study, it can be concluded that traditional counseling which involves gaining a wider perspective and insights into learning needs and transformation possibilities of employees can use the Barrett's value framework to identify cultural fit of an employee. Based on the gap between what values an organization offers, this framework, helps in identifying improvement areas in both the employee and the organization. Thus, Individual Value Assessment (IVA) framework is a powerful tool in identifying employee needs in complex environments facing organizations.

REFERENCES

- Babarinde, S.A., & Ohikhen, P.S. (2019). Impact of Stress on Productivity of Employees in Nigerian Banking Sector. *International Journal of Business & Management*, 7(5). Available from: <https://doi.org/10.24940/theijbm/2019/v7/i5/bm1905-052>
- Berman, E.M., West, J.P. & Richter, Jr, M.N. (2002). Workplace relations: Friendship patterns and consequences (according to managers). *Public Administration Review*, 62(2), pp. 217-230.
- Galbraith, J.K. (1987). *The Affluent Society*. Available from: [http://books.google.ie/books?id=P749PgAACAAJ&dq=3.%09Galbraith+h,+J.+K.+\(1998\).+The+affluent+society.+Houghton+Mifflin+Harcourt.&hl=&cd=3&source=gbs_api](http://books.google.ie/books?id=P749PgAACAAJ&dq=3.%09Galbraith+h,+J.+K.+(1998).+The+affluent+society.+Houghton+Mifflin+Harcourt.&hl=&cd=3&source=gbs_api)
- Iskamto, D. (2021). Stress and its impact on employee performance. *International Journal of Social and Management Studies*, 2(3), pp. 142-148.
- London, M., & Smither, J.W. (1999). Empowered self development and continuous learning. *Human Resource Management*, 38(1), pp. 3-15. Available from : [https://doi.org/10.1002/\(SICI\)1099-050X\(199921\)38:1<3::AID-HRM2>3.0.CO;2-M](https://doi.org/10.1002/(SICI)1099-050X(199921)38:1<3::AID-HRM2>3.0.CO;2-M)

- Martin, G. (2012). A values framework for ethical business. *Australian Journal of Professional and Applied Ethics*, 14(1), pp. 63-77.
- Maslow, A. (1974). A Theory of Human Motivation. Lulu.com. Available from: [http://books.google.ie/books?id=CkonDwAAQBAJ&printsec=frontcover&dq=Maslow,+A.H.+\(1943\).+%22A+theory+of+human+motivation%22.+Psychological+Review.+50+\(4\):+370%E2%80%93396.&hl=&cd=2&source=gbs_api](http://books.google.ie/books?id=CkonDwAAQBAJ&printsec=frontcover&dq=Maslow,+A.H.+(1943).+%22A+theory+of+human+motivation%22.+Psychological+Review.+50+(4):+370%E2%80%93396.&hl=&cd=2&source=gbs_api)
- Niharika, Kiran UV. (2014). Occupational stress among bank employees. *European Academic Research*, 2(4). pp. 5404-5411.
- Ryan, R.M., & Deci, E.L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American psychologist*, 55(1), pp. 68.
- Ryff, C. D. (1989). Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *Journal of personality and social psychology*, 57(6), pp. 1069.
- Selye, H. (1956). Stress and Psychiatry. *The American Journal of Psychiatry*, 113(5), pp. 423–427. Available from : <https://doi.org/10.1176/ajp.113.5.423>
- Yerkes, R.M., & Dodson, J.D. (1908b). The relation of strength of stimulus to rapidity of habit formation. *The Journal of Comparative Neurology and Psychology*, 18(5), pp. 459–482. Available from : <https://doi.org/10.1002/cne.920180503>

HARNESSING THE POWER OF BLOCKCHAIN, CRYPTOCURRENCIES AND DEFI FOR A FUTURE-READY FINANCIAL SYSTEM

CA Vinod Kr Sharma

*Professor of Practice (PoP)
Institute of Future Education Entrepreneurship and
Leadership – Pune (India)*



INTRODUCTION

The world of FinTech is rapidly evolving, bringing ground-breaking innovations to the forefront of the financial sector. FinTech is a dynamic and fast-growing field that requires constant learning, offering immense potential for transforming financial services and creating new opportunities for growth and development.

Fintech combines the words “financial” and “technology”. It refers to any app, software, or technology that allows people or businesses to digitally access, manage, or gain insights into their finances or make financial transactions and decisions. A fintech company offers financial services or applications that rely heavily on technology and are often an industry disruptor as they use technology to change how consumers interact with the financial industry.

By staying informed and engaged with the latest trends and technologies, one can harness the power of FinTech to drive positive change in the financial industry. Today, I had the privilege of sharing information briefly on the key areas of FinTech, focusing on Blockchain, Cryptocurrencies, and Decentralised Finance (DeFi).

Blockchain Technology

Blockchain is the backbone of many FinTech innovations. Blockchain technology is an advanced database mechanism that allows transparent information sharing within a business network. It stores data in blocks that are linked together in a chain. The data is chronologically consistent as it cannot be modified without consensus from the participating nodes in the network. The feature of chronological consistency creates an unalterable or immutable ledger for tracking orders, payments, accounts, and other transactions. The system has built-in mechanisms that prevent unauthorised

transaction entries and create consistency in the shared view of these transactions. As an emerging technology, blockchain is being adopted innovatively by various industries.

Cryptocurrencies

Cryptocurrencies are a type of digital money that exists only online. Cryptocurrencies have emerged as a popular and influential aspect of FinTech. Cryptocurrencies are reshaping how money is perceived and used, starting with Bitcoin and expanding to various altcoins like Ethereum, Ripple, and Litecoin. Cryptocurrencies are a new form of digital money that uses advanced technology to operate independently of traditional banking systems, offering a secure and decentralised way to transfer value and conduct transactions online.

Decentralised Finance (DeFi)

Decentralised Finance (DeFi) has revolutionised the financial industry by providing services without traditional intermediaries (banks). Central to DeFi are smart contracts and decentralised applications that facilitate people to lend, borrow, trade and invest directly without any middleman, offering greater accessibility and transparency. DeFi is still in its infancy and is subject to hacks and thefts because of messy programming and a lack of security testing before launching applications.

To conclude, the finance landscape is undergoing a reflective transformation with the advent of Blockchain, Cryptocurrencies and Decentralised Finance (DeFi). These innovations democratise access to financial services, enhance transparency and foster a more inclusive financial ecosystem. As we continue to navigate and shape this evolving field, staying informed and adaptable is crucial. Embracing these technologies not only empowers individuals but also drives the future of finance towards a more efficient, secure and equitable global economy. By leveraging the potential of these advancements, we can collectively create a financial system that better serves the needs of everyone.

Call for Papers

Next Issue of **PRANJANA**

The Journal of Management Awareness

A Bi-Annual Peer-Reviewed Refereed Journal

Vol. 28, No. 1, January-June 2025

PRANJANA: The Journal of Management Awareness is being published by Integrated Academy of Management and Technology, Ghaziabad.

The journal invites and encourages submissions of original research papers, articles related to management and information technology, abstracts and reviews of PhD theses, case studies in management and IT, book reviews, and expressions of management thought. It covers a wide range of topics within the fields of management and information technology.

The journal invites original and unpublished contributions. The editor reserves the right to edit and publish all contributions. Submission of paper indicates that it has been neither copyrighted, published nor submitted or accepted for publication elsewhere.

Written material sent by e-mail should include writer's full name, complete postal address & Mobile No. The editor also invites suggestions for achieving excellence in bringing out this journal. We welcome suggestions, views or comments that would help us improve our quality of publication.

Looking forward to your contributions.

Authors intending to submit papers are encouraged to contact:

Chief Editor

Dr Aftab Alam

Professor Exec. MBA Program, DOMS, Jamia Millia Islamia, New Delhi, INDIA

Managing Editor

Dr Rama Krushna Charan Patro

Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA

Tel: +91 9810911223

Integrated Academy of Management and Technology (INMANTEC)

Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna

Flyover, Udyog Kunj, Ghaziabad-201015, UP, INDIA

E-mail: librarian@inmantec.edu, pranjana@inmantec.edu

Call for Papers

Next Issue of **GYANKOSH**

The Journal of Library and Information Management

A Bi-Annual Peer-Reviewed Refereed Journal

Vol. 16, No. 1, January-June 2025

GYANKOSH: The Journal of Library and Information Management is being published by Integrated Academy of Management and Technology, Ghaziabad.

The journal welcomes and encourages original research papers, as well as articles on Library and Information Management, Information Technology, and Information Literacy. It also accepts abstracts and reviews of PhD theses, case studies in Information Management and IT applications, book reviews, and expressions of thought on Library and Information Science (LIS). The journal covers a wide range of topics related to Library and Information Management.

The journal invites original and unpublished contributions. The editor reserves the right to edit and publish all contributions. Submission of paper indicates that it has been neither copyrighted, published nor submitted or accepted for publication elsewhere.

Written material sent by e-mail should include writer's full name, complete postal address & Mobile No. The editor also invites suggestions for achieving excellence in bringing out this journal. We welcome suggestions, views or comments that would help us improve our quality of publication.

Looking forward to your contributions.

Authors intending to submit papers are encouraged to contact:

Chief Editor

Dr M Masoom Raza
Professor, DLIS, Aligarh Muslim University, Aligarh, INDIA

Editor

Dr Rama Krushna Charan Patro
Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA
Tel: +91 9810911223

Integrated Academy of Management and Technology (INMANTEC)
Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna Flyover, Udyog Kunj,
Ghaziabad-201015, UP, INDIA
E-mail: librarian@inmantec.edu, gyankosh@inmantec.edu

GUIDELINES FOR AUTHORS

INMANTEC Publishing invites original, research based papers and cases in the areas of Business Management, Information Technology, Law, Library science and Education. This journal publishes papers of interest to academicians and to practitioners of business. The papers range widely over different areas of services. It is a condition for publication that the material sent is original work which has not been previously published or submitted for publication elsewhere. The guidelines for contributors is listed below :

1. **Manuscripts** should normally be of upto 5,000 - 6,000 words (A-4 size pages, typed double space and 11-point font). Microsoft Word for windows and WordPerfect are the preferred softwares for submission. Manuscripts must be submitted through e-mail the cover page bearing only the title of the paper and authors' names, designations, official addresses and phone/fax numbers.
2. **Abstract.** Submit an abstract of about 150-200 words.
3. **Tables and Figures.** The tables and figures should be submitted in MS-Word/Excel format Separately. Their location in the text should be indicated as follows:

Table –1 about here

4. **End notes.** All notes should be indicated by serial numbers in the text and literature cited should be detailed under Notes at the end of the paper bearing corresponding numbers, before the references.
5. **References.** Place the references at the end of the manuscript following the endnotes. Arrange the reference list in alphabetical order of author's surnames, and chronologically for each author where more than one work by that author is cited. The author's surname is placed first, followed by initials, then the year of publication is given followed by details of the publication. The name of the publication (usually a book or journal) appears in italics. Following examples will illustrate the style used in the journal.

To reference	Use the general format	For example	
Books and Chapter in books	Book (first edition)	Surname, Initials, and Surname, Initials. (date) <i>Title</i> , Place of publication, Publisher	Saunders, M.N.K. and Cooper, S.A. (1993) <i>Understanding Business Statistics</i> , London, DP Publications Ltd.
	Book (other than first edition)	Surname, Initials. and Surname, Initials. (date) <i>Title</i> (?edn), Place of publication, Publisher	Morris, C. (1999) <i>Quantitative Approaches to Business Studies</i> (5th edn), London, Financial Times Pitman Publishing.
	Book (no obvious author)	Corporate name or Publication name. (date) <i>Title</i> , Place of publication, Publisher	Mintel Marketing Intelligence (1998) <i>Designerwear: Intel Marketing Intelligence Report</i> , London, Intel International Group Ltd.
	Chapter in a book	Surname, Initials. and Surname, Initials. (date) <i>Title</i> , Place of Publication, Publisher, Chapter?	Robson, C. (1993) <i>Real World Research</i> , Oxford Blackwell, Chapter 3.

Journal articles	Chapter in an edited book	Surname, Initials. (date) 'Chapter title', in Surname, Initials. and Surname, Initials. (eds). <i>Title</i> , Place of Publication, Publisher, page numbers.	<i>Craig, P.B. (1991) 'Designing and using mail questionnaires' in Smith, N.C. and Dainty, P. (eds), The Management Research Handbook, London, Routledge, pp. 181-9.</i>
	Journal article	Surname, Initials. and Surname, Initials. (date) 'Title of article', <i>Journal name</i> , volume number, part number, pages.	Storey, J., Cressey, P., Morris, T. and Wilkinson, A. (1997) 'Changing employment practices in UK banking: case studies', <i>Personnel Review</i> , 28:1, 24-42.
Government publications	Journal article (no obvious author)	Corporate name or Publication name (date) 'Title of article', <i>Journal name</i> , volume number, part number, pages.	Local Government Chronicle (1993) 'Westminster poised for return to AMA fold', <i>Local Government Chronicle</i> , 5 November, p.5.
	Parliamentary papers inclu.acts and bills Others (with authors)	Country of origin (date) <i>Title</i> , Place of publication, Publisher. As for books	Great Britain (1994) <i>Criminal Justice and Public Order Act 1994</i> , London, HMSO As for books
	Others (no obvious authors)	Department name or Committee name (date) <i>Title</i> , Place of publication, Publisher.	Department of Trade and Industry (1992) <i>The Single Market: Europe Open for Professions, UK Implementation</i> , London, HMSO.
Newspapers, including CD-ROM databases:	Newspaper articles	Surname, Initials. and Surname, Initials., (date) 'Title of article', Newspaper name, day, month, pages.	Roberts, D. (1998) 'BAe sells property wing for £301m', <i>The Daily Telegraph</i> , London, 10 October, p. 31.
	Newspaper article (no obvious author)	Newspaper name (date) 'Title of article', <i>newspaper name</i> , day, month, pages.	Guardian (1992) 'Fraud trial at Britannia Theme Park', <i>The Guardian</i> , Manchester, 5 February, p.4.
	Newspaper article (from CD-ROM database)	Newspaper name or Surname, Initials. (date) 'Title of article', <i>Newspaper name</i> , (CD-ROM) day, month, pages.	Financial Times (1998) 'Recruitment: lessons in leadership: moral issues are increasingly pertinent to the military and top corporate ranks', <i>Financial Times</i> , (CD-ROM), London, 11
Other CD-ROM publications		Title of CD-ROM or Surname, Initials. (date) (CD-ROM), Place of publication, Publisher.	Encarta 98 Encyclopedia (1997) (CD-ROM) Redmond, WA, Microsoft Corporation.
Unpublished conference papers		Surname, Initials. and Surname, Initials. (date) 'Title of paper', <i>paper presented at the Conference name</i> , days, month, location of conference.	Saunders, M.N.K. and Thornhill, A.(1998) 'The development and application of a diagnostic tool to help manage survivors of change over time', <i>paper presented at the Fifth Annual International Conference on Advances in Management</i> 8-11 July Lincoln.
Letters, personal emails and electronic conferences/bulletin boards	Letter	Surname, Initials. and Surname, Initials. (date) <i>unpublished letter: subject matter</i> .	MacClelland, S. (1998) <i>Unpublished letter: Reviewer's feedback</i> .
	Personal email	Surname, Initials. (date) <i>subject matter</i> (email to the author) (online).	MacClelland, S. (1998) <i>Reviewer's feedback</i> (email to the author) (online)
	Electronic conference/ Bulletin Boards	Surname, Initials. (date) <i>subject matter, name of electronic conference/bulletin board</i> (online)	Jones, K. (1999), 101 reasons why we need the pound, <i>Britain and European Monetary Union</i> (online).
Internet items excluding emails	Journal published on the Internet	<URL:http://www.remainer of full Internet electronic conference/bulletin board> Surname, Initials. and Surname, Initials. (date) 'Title of article', <i>journal name</i> , volume number part number (online) (cited day month year). Available from <URL:http://www.remainer of full Internet address>.	<URL:http://.stingray.ivation.co.uk/groups/emu/frindex.htm> Jenkins, M. and Bailey, L. (1995) 'The role of learning centre staff in supporting student learning', <i>Journal of Learning and Teaching</i> 1:1, Spring (online) (cited 29 March 1996). Available from <URL:http://www.chelt.ac.uk/cwis/pubs/jolt/issue1.1/page2.htm>.
	Internet site	Site title (date) 'Title of page within site where applicable' (online) (cited day month year). Available from <URL: http://www.remainer of full Internet address>.	Institute of Personnel and Development (online) (cited 14 October 1988). Available from <URL:http://www.ipd.co.uk>.

6. **Follow British spellings throughout (programme, not program).**
7. Universal “s” in “ise” “isation” words.
8. **Use of numerals:** One to twelve in words, thirteen and above in figures , unless the reference is to percentages (5 percent), distance (5 km) or age (10 years old). Use 1900s and 19th century.
9. No stops after abbreviations (UK, MBA). Use stops after initials (V.P.Singh).
10. Use single quotes throughout. however in case of use of double quotes for example, “In the words of Szell, the ‘the economic question’ is today” the quotation can be encased within single quote in the double quotes. Quotations in excess of 45 words should be separated from the text with a line space above and below and indented on the left. Quotes should be cited accurately from the original source, should not be edited, and should give the page numbers of the original publication.
11. Italicization and use of diacriticals is left to the contributors, but must be consistent. When not using diacriticals, English spelling should be followed.
12. Capitalization should be kept to the minimum and should be consistent.
13. An author will receive a complimentary copy of the issue in which his/her paper appears and soft copy of the reprints.
14. Book reviews must provide the following details, and in this order: Name of author/title of book reviewed/place of publication/publisher/year of publication/number of pages, in Roman and Arabic figures to include preliminary pages/and price, with binding specifications such as paperback or hardback. For example :
Brian K. Julyan, *Sales and Service for the Wine Professional*. London and New York: Cassell, 1999. ix+214pp. £16.99 paper.
15. If papers are accepted for publications, contributors are requested to fill the copyright form and send to us by fax or through email along with signature. Otherwise paper will not be considered for the publication.
16. Manuscripts which do not conform to these guidelines will not be considered for publication.
17. Manuscripts not considered for publication will not be sent back. Those submitting papers should also certify that the paper has not been published or submitted for publication elsewhere.
18. Manuscripts and all editorial correspondence should be addressed to: Managing Editor, Integrated Academy of Management and Technology (INMANTEC), Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna Flyover Udyog Kunj, Ghaziabad-201009.

Editor

Pranjana@inmantec.edu

Plagiarism Policy for INMANTEC Publishing

Plagiarism is to claim authorship of a document, a part of document, or some small sections of a document, which are not authored by claimant. While it is a common practice among academicians to quote past works done in that area or quoting work by others to support their arguments or thoughts in the document. However, to do so without properly acknowledging the source or original author both in text and references in proper and clear order constitutes plagiarism.

As per international intellectual laws, plagiarism is a serious offence.

Common Forms of Plagiarism

- a) To use a phrase or sentence of some other author in your work without prior approval or acknowledgement
- b) Copying word-to-word from work of others
- c) Paraphrasing the words very closely from someone else's work
- d) Using material downloaded from the Internet as it is or without quoting and acknowledging the source
- e) Using borrowed statistics, figures, photographs, diagrams, pictures etc. from some other work without prior permission or written acknowledgement of the source
- f) Picking up portions of your own previous work published elsewhere

In simplest terms, it means, author of any publication has to distinct very clearly what is his/her contribution and what is borrowed from elsewhere with proper acknowledgement of the borrowed contents both in texts and references as per international accepted standards of referencing while submitting a manuscript for publication consideration. We accept Harvard Style referencing.

All manuscripts submitted to INMANTEC Publishing will be scanned through plagiarism detection software. We expect a manuscript to be totally free of plagiarism material. However, plagiarism not exceeding 15% will be accepted for consideration after going through the plagiarized contents and establishing its relevance to the essence of the submitted research work.

Plagiarism Acceptance/Rejection Criteria

Extent of Plagiarism	Action
=15%	Research work is accepted for further action
=15% and = 40%	Research work is returned for amendments
>40%	Research work is rejected summarily

Author(s) of any submitted work will have to submit a signed undertaking available at institute website and with the respective editor clearly mentioning about the originality of the work, declaring in clear terms that the submitted research work hasn't been copied from any other source and taking ownership of problem, if any, occurring in future due to their submitted research work.

Author(s) will be solely responsible for any complication arising out of any unethical practices adopted, if any and the INMANTEC Publishing or the institute will in no way be responsible for any unethical practice on the part of the author(s).

Editor

Pranjana@inmantec.edu

- Complimentary Copy
 Invoice Copy
 Exchange Copy

SUBSCRIPTIONS CHARGES:

INDIA		
PERIOD	INSTITUTIONAL	INDIVIDUAL
	PRINT+ONLINE	PRINT+ONLINE
1 YEAR	<input type="checkbox"/> 2000	<input type="checkbox"/> 1800
2 YEAR	<input type="checkbox"/> 3800	<input type="checkbox"/> 3000
3 YEAR	<input type="checkbox"/> 5500	<input type="checkbox"/> 4500

I wish to subscribe / renew my Subscription to "**PRANJANA: The Journal of Management Awareness**" for 1/2/3 years. I enclose DD/ cheque no. dated for Rs. drawn in favour of *Integrated Academy of Management and Technology*, payable at Ghaziabad / Delhi.

SUBSCRIPTION DETAILS (BLOCK CAPITALS)

Title _____ Initials _____ Surname _____

Name of Institute _____

Address _____

Country / State _____ Pin/Zip _____

Email _____ Mobile _____

SEND YOUR SUBSCRIPTION TO:

Dr. Rama Krushna Charan Patro
Librarian-cum-Managing Editor
Email: librarian@inmantec.edu

Integrated Academy of Management and
Technology (INMANTEC)
Delhi-Meerut Expressway (NH-9, Exit 4)
Adjoining Dasna Flyover, Udyog Kunj,
Ghaziabad-201015, UP, INDIA

DETAILS FOR ONLINE TRANSFER:

Integrated Academy of Management and
Technology (INMANTEC),
A/c No. 21330400006243
IFSC Code: BARB0TRDGHA (5th Character is Zero)
Bank of Baroda, Clock Tower, Ghaziabad, UP,
INDIA

INMANTEC PUBLICATION MULTIPLE SUBSCRIPTION FORM

- PRANJANA: The Journal of Management Awareness GYANKOSH: The Journal of Library and Information Management
 GYANODAYA: The Journal of Progressive Education VIDHIGYA: The Journal of Legal Awareness

SUBSCRIPTIONS CHARGES:

PERIOD	INDIA		OTHER COUNTRIES	
	INSTITUTIONAL	INDIVIDUAL	INSTITUTIONAL	INDIVIDUAL
1 YEAR (P+O)	<input type="checkbox"/> 2000	<input type="checkbox"/> 1800	<input type="checkbox"/> \$100	<input type="checkbox"/> \$80
2 YEAR (P+O)	<input type="checkbox"/> 3800	<input type="checkbox"/> 3000	<input type="checkbox"/> \$150	<input type="checkbox"/> \$120
3 YEAR (P+O)	<input type="checkbox"/> 5500	<input type="checkbox"/> 4500	<input type="checkbox"/> \$200	<input type="checkbox"/> \$150

	LIFE TIMES	
	2 YEAR	3 YEAR
Offer for Single Journals (P+O)	<input type="checkbox"/> 3800	<input type="checkbox"/> 12500
Combo offer (any 2 journals) (P+O)	<input type="checkbox"/> 8000	<input type="checkbox"/> 12500
Super combo Offer (any 3 journals) (P+O)	<input type="checkbox"/> 12500	<input type="checkbox"/> 18500
Mega Combo Offer (any 4 journals) (P+O)	<input type="checkbox"/> 16500	<input type="checkbox"/> 24500

I wish to subscribe / renew my Subscription tick marked above in boxes. I enclose DD/ cheque no. dated for Rs. drawn in favour of **Integrated Academy of Management and Technology**, payable at Ghaziabad / Delhi.

SUBSCRIBER NO. (RENEWAL) _____

SUBSCRIPTION DETAILS (CAPITALS)

Title _____ Initials _____ Surname _____
 Name of Institute _____
 Address _____
 Country / State _____ Pin/Zip _____
 Email _____ Mobile _____

*for 10 years

DETAILS FOR ONLINE TRANSFER:

Integrated Academy of Management and Technology
 (INMANTEC),
 A/c No. 21330400006243 (5th Character is Zero)
 IFSC Code: BARB0TRDGH
 Bank of Baroda, Clock Tower, Ghaziabad, UP, INDIA

SEND YOUR SUBSCRIPTION TO:

Dr. Rama Krushna Charan Patro
 Librarian-cum-Managing Editor
 Email: librarian@inmantec.edu
 Integrated Academy of Management and Technology
 (INMANTEC),
 Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna
 Flyover Udyog Kunj, Ghaziabad-201015, UP, INDIA

Call for Papers

Next Issue of **VIDHIGYA**

The Journal of Legal Awareness

A Bi-Annual Peer-Reviewed Refereed Journal

Vol. 20, No. 1, January-June 2025

VIDHIGYA: The Journal of Legal Awareness is being published by Integrated School of Law, Ghaziabad.

The journal invites and supports original research papers, articles, legal opinions, perspectives, comments on various legal issues, case law, and book reviews. It encompasses a wide range of subjects related to legal studies.

The journal invites original and unpublished contributions. The editor reserves the right to edit and publish all contributions. Submission of paper indicates that it has been neither copyrighted, published nor submitted or accepted for publication elsewhere.

Written material sent by e-mail should include writer's full name, complete postal address & Mobile No. The editor also invites suggestions for achieving excellence in bringing out this journal. We welcome suggestions, views or comments that would help us improve our quality of publication.

Looking forward to your contributions.

Authors intending to submit papers are encouraged to contact:

Chief Editor

Dr K K Mittal

Director Academic, Integrated School of Law, Ghaziabad, UP, INDIA

E-mail: kk.mittal@inmantec.edu

Managing Editor

Dr Rama Krushna Charan Patro

Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA

Tel: +91 9810911223

Integrated School of Law (ISL) Ghaziabad
Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna
Flyover, Udyog Kunj, Ghaziabad-201015, UP, INDIA
E-mail: librarian@inmantec.edu, vidhigya@inmantec.edu

Call for Papers

Next Issue of **GYANODAYA**

The Journal of Progressive Education

A Bi-Annual Peer-Reviewed Refereed Journal

Vol. 18, No. 1, January-June 2025

GYANODAYA: The Journal of Progressive Education is being published by Integrated School of Education, Ghaziabad.

The journal encourages original research papers, articles, views, comments, and book reviews on various educational issues. It covers nearly all subjects related to education.

The journal invites original and unpublished contributions. The editor reserves the right to edit and publish all contributions. Submission of paper indicates that it has been neither copyrighted, published nor submitted or accepted for publication elsewhere.

Written material sent by e-mail should include writer's full name, complete postal address & Mobile No. The editor also invites suggestions for achieving excellence in bringing out this journal. We welcome suggestions, views or comments that would help us improve our quality of publication.

Looking forward to your contributions.

Authors intending to submit papers are encouraged to contact:

Editor

Dr Ananta Sharma

Principal, Integrated School of Education, Ghaziabad, UP, INDIA

Managing Editor

Dr Rama Krushna Charan Patro

Librarian, INMANTEC Institutions, Ghaziabad, UP, INDIA

Tel: +91 9810911223

Integrated School of Education, Ghaziabad (ISE)
Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining Dasna
Flyover, Udyog Kunj, Ghaziabad-201015, UP, INDIA
E-mail: librarian@inmantec.edu, gyanodaya@inmantec.edu

**STATEMENT ABOUT OWNERSHIP & OTHER PARTICULARS OF
THE JOURNAL**

"PRANJANA : The Journal of Management Awareness"

FORM-IV, (Rule 8)

1. Place of Publication : Ghaziabad
2. Periodicity of its Publication : Half-Yearly
3. Printer's Name : Dr Pankaj A Gupta
Nationality : Indian
Address : Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining
Dasna Flyover Udyog Kunj, Ghaziabad-201015, UP, INDIA
4. Publisher's Name : Dr Pankaj A Gupta
Nationality : Indian
Address : Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining
Dasna Flyover Udyog Kunj, Ghaziabad-201015, UP, INDIA
5. Editor's Name : Dr Aftab Alam
Nationality : Indian
Address : Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining
Dasna Flyover Udyog Kunj, Ghaziabad-201015, UP, INDIA
6. Name & address of the : Integrated Academy of Management and Technology
individuals who own the
Newspapers and partners or
shareholders holding more than
one percent of the total capital. Delhi-Meerut Expressway (NH-9, Exit 4) Adjoining
Dasna Flyover Udyog Kunj, Ghaziabad-201015, UP, INDIA

I, Dr Pankaj A Gupta, hereby declare that the particulars given above are true to the best of my knowledge and belief.

Date :

Dr Pankaj A Gupta
(Signature of Publisher)

THE ROLE OF LEADERSHIP STYLES IN ORGANIZATIONAL PERFORMANCE AND EMPLOYEE MOTIVATION

¹ Neha Yadav, Scholar

² Dr. Swati Sharma, Professor

^{1,2} Dept of Commerce, CCS University, Meerut

Corresponding Author: Neha Yadav, Neha26020@Gmail.Com

Abstract: In modern organizations, leadership plays a pivotal role in determining overall performance and employee motivation. As organizations face increasing complexity and change, adaptive leadership styles have emerged as critical for fostering a productive, innovative, and resilient workforce. Rigid, outdated leadership approaches often hinder organizational growth by stifling creativity, reducing employee engagement, and limiting responsiveness to external market shifts. Conversely, adaptive leadership encourages flexibility, empowerment, and collaboration, which in turn enhances motivation, promotes higher job satisfaction, and drives long-term organizational success. Effective leaders who understand the need for strategic flexibility are able to navigate challenges, leverage employee strengths, and adapt their leadership approach to different situations, ensuring that their teams remain engaged and committed to achieving organizational goals. This paper explores the importance of adaptive leadership, highlights the pitfalls of rigid leadership models, and emphasizes the need for a flexible, strategic leadership framework to enhance motivation, performance, and sustainability.

Keywords: Adaptive Leadership, Organizational Performance, Employee Motivation, Leadership Flexibility, Strategic Leadership Framework.

I. Introduction

Leadership is a critical determinant of organizational success, shaping both performance outcomes and employee motivation. The influence of leadership styles on these aspects has been widely studied, revealing that the approach adopted by leaders significantly impacts productivity, innovation, and workplace morale. Transformational leadership, for instance, fosters a vision-driven culture where employees feel inspired, empowered, and committed to shared organizational goals (*Oğuz, 2010*). Leaders who adopt this style encourage creativity, open communication, and professional development, leading to higher engagement and job satisfaction. In contrast, transactional leadership relies on structured reward-and-punishment systems, emphasizing efficiency, adherence to predefined tasks, and performance-based incentives. While transactional leaders can ensure discipline and short-term results, they may fail to cultivate a sense of belonging or intrinsic motivation among employees. Autocratic leadership, characterized by centralized decision-making, can be effective in situations demanding quick resolutions, but it often suppresses innovation and discourages employee participation (*Obiwuru, et.al. 2011*). Conversely, democratic leadership involves employees in decision-making, creating a sense of ownership and boosting motivation. Laissez-faire leadership, which provides minimal supervision, works well with self-driven teams but may lead to inefficiencies in less experienced workforces. The effectiveness of each leadership style varies based on organizational structure, workforce diversity, and industry demands, making it imperative for leaders to adopt a flexible, context-driven approach to maximize performance and employee satisfaction. In contemporary organizations,

leadership is not just about authority but also about development an environment conducive to sustained growth, adaptability, and resilience. The interplay between leadership styles and employee motivation is particularly crucial in today's competitive and dynamic business landscape, where innovation and agility are key drivers of success. Employees who feel valued, heard, and supported exhibit greater job commitment, lower turnover rates, and higher productivity. Effective leadership also influences workplace culture, shaping organizational values and the overall work environment. For instance, transformational leaders can create a culture of continuous improvement, while democratic leaders promote inclusivity and collaboration (*Ahmad, & Gelaidan 2011*). The choice of leadership style must align with the organization's mission, workforce composition, and external market pressures. A rigid or outdated leadership approach may stifle growth, reduce employee engagement, and ultimately hinder organizational success. Therefore, a strategic, adaptive leadership framework one that balances vision with structure and authority with empowerment is essential for fostering motivation, enhancing performance, and ensuring long-term sustainability in an ever-evolving corporate world.

II. Related Reviews

Oğuz (2010) aimed to determine the correlation between the leadership styles of school administrators and the organisational citizenship behaviours of teachers. The study considered organisational citizenship as voluntary acts beyond teachers' formal job descriptions, which contributed to increased job satisfaction and productivity. A total of 204 elementary school teachers from Samsun's city centre voluntarily participated in the study. Data collection involved the "Organisational Citizenship Behaviours Scale" and "The Leadership Style Questionnaire," while statistical analyses were conducted using descriptive statistics, the t-test, and the Kruskal-Wallis's test. The findings indicated that teachers generally held positive views regarding organisational citizenship behaviours within their schools. However, significant differences emerged based on gender, branch, education level, and seniority. A strong positive correlation was identified between teachers' organisational behaviours and administrators' leadership styles, particularly transactional and transformational leadership. The study emphasised the critical role of school administrators in fostering a sense of belonging and creating an effective work environment. It was suggested that administrators should establish clear goals, embrace change, make ethical decisions, and respect teachers' perspectives to enhance organisational commitment.

Obiwuru et al. (2011) investigated the effects of leadership styles on organizational performance in small-scale enterprises, aiming to determine their impact. The study focused on transformational and transactional leadership styles, considering transformational leadership behaviours such as charisma, inspirational motivation, and intellectual stimulation, while transactional leadership included contingent reward and management by exception. The study employed a survey design and used an evaluative quantitative analysis method, collecting primary data through a structured Multifactor Leadership Questionnaire (MLQ). Responses were scaled and converted into quantitative data, allowing segmentation into dependent and independent variables based on leadership behaviours and associated performance outcomes. Ordinary Least Squares (OLS) multiple regression models were specified, estimated, and evaluated. Findings indicated that transactional leadership had a significant positive effect on performance, whereas transformational leadership had a positive but insignificant effect. The study concluded that transactional leadership was more effective in enhancing performance in small-scale enterprises, recommending its adoption while incorporating strategies for a gradual transition to transformational leadership as

businesses expanded and matured. The study remained relevant as it highlighted the importance of leadership style selection in small enterprises, emphasizing a pragmatic approach to leadership development in evolving business environments.

Ahmad and Gelaidan (2011) aimed to examine the impact of leadership style on employees' emotional commitment to change, considering organizational culture as a moderating factor. The study utilized both qualitative and quantitative methodologies, incorporating a survey of 371 workers from public organizations in Yemen and interviews conducted with managers. The findings revealed that transformational leadership had a positive correlation with employees' emotional commitment to change, while transactional leadership also exhibited a favourable connection with affective commitment to change. Additionally, the study indicated that organizational culture played a significant role in strengthening the relationship between leadership styles and employees' emotional commitment to change. Moreover, the results suggested that transactional leadership served as a stronger predictor of emotional commitment to change than transformational leadership. The study contributed to the understanding of how leadership styles influence employees' adaptability to organizational change, emphasizing the importance of a supportive cultural environment in fostering commitment during transitions.

Ojokuku et.al. (2012) examined the influence of leadership style on organizational performance in selected banks in Ibadan, Nigeria. The study aimed to assess how different leadership styles affected performance outcomes. A purposive sampling technique was applied to select sixty respondents, and data were gathered through a standardized questionnaire. A hypothesis was formulated, and inferential statistical methods were employed for data analysis. Pearson's product-moment correlation was utilized to determine the relationship between leadership style dimensions and organizational performance, while regression analysis assessed the significant impact of leadership characteristics on employees and overall performance. Findings revealed both positive and negative correlations between leadership style traits and organizational success, with leadership styles collectively accounting for 23% of performance variation. The study recommended that bank management adopt transformational and democratic leadership styles to enhance competitiveness in a globalized business environment. The research was relevant in highlighting the critical role of leadership in shaping organizational outcomes, providing insights into how leadership strategies could be refined to foster efficiency and productivity in the banking sector.

Belonio (2012) aimed to evaluate the impact of leadership styles on employee work satisfaction and the influence of job satisfaction on job performance. The study was conducted by distributing questionnaires to 400 banking industry employees in Bangkok. The findings revealed that most bank workers, primarily females aged 20 to 39, exhibited ambivalence toward job satisfaction, neither feeling satisfied nor dissatisfied. Transformational leadership was found to have a positive effect on multiple aspects of job satisfaction, while transactional leadership also contributed positively to employee work satisfaction. Similarly, laissez-faire leadership influenced certain aspects of job satisfaction. Furthermore, employee job satisfaction was observed to have a beneficial effect on various facets of job performance. The study suggested that leaders and managers integrated different leadership styles in varying proportions to achieve optimal outcomes in their leadership responsibilities. The adoption of specific leadership styles was determined by

workplace circumstances, indicating that a balanced approach to leadership could enhance employee satisfaction and performance.

Carter and Greer (2013) aimed to investigate the relationship between strategic leaders' values and their leadership styles in achieving triple bottom line (TBL) performance metrics. They noted a lack of empirical studies addressing this connection, despite the increasing pressure from stakeholders for organizations to balance economic, social, and environmental outcomes. Their methodology involved analysing existing empirical research to delineate leadership values and classify both traditional and emerging leadership styles. They examined how these styles correlated with organizational success while identifying gaps in understanding these interactions. The findings suggested that leadership styles ranged from transactional to responsible, influenced by stakeholder salience and organizational performance across economic, social, and environmental dimensions. The study highlighted the need for further research to bridge these gaps and refine leadership strategies for sustainable business success. The research was relevant in emphasizing the role of leadership values in shaping effective strategies for organizations to meet stakeholder demands while maintaining balanced TBL performance.

Choudhary et.al. (2013) aimed to analyse the effects of two contrasting leadership styles—transformational and servant leadership—on organizational performance outcomes. The study focused on a sample of 155 individuals from the profit-driven service industry in Pakistan. Data were collected through a survey using a five-point Likert scale, and statistical analyses were conducted using AMOS and SPSS. The findings revealed that transformational leadership had a greater influence on organizational learning compared to servant leadership, with organizational learning positively affecting organizational effectiveness. This research highlighted that managers and executives in the business sector could benefit from understanding the impact of leadership styles on organizational learning and performance. The study's relevance lies in its practical implications, suggesting that leaders aiming to optimize profitability might prefer transformational leadership to enhance organizational capabilities and foster learning, which ultimately supports profit maximization.

Nasir et.al. (2014) aimed to explore the relationship between leadership styles and organizational performance among academic leaders in Malaysian Public Universities (IPTA) within the Klang Valley Area. This quantitative study used questionnaires to gather data from 156 academic leaders, with a total of 300 questionnaires distributed. The research found that all leadership styles Transformational, Transactional, and Laissez-Faire—showed a positive and significant correlation with organizational success. Furthermore, no substantial gender differences were identified in the leadership style practices between male and female academic leaders. The study's findings suggest that the application of appropriate leadership styles plays a crucial role in enhancing organizational performance. It was recommended that future research employ a larger sample size and consider a qualitative approach to gain deeper insights. The study is relevant as it contributes valuable information on leadership effectiveness in the context of higher education institutions, offering implications for future leadership training and development.

Hurduzeu (2015) aimed to examine the influence of leadership styles, particularly transformational leadership, on organizational performance. The methodology involved exploring the relationship between transformational leadership and organizational success, emphasizing how

such leadership motivates employees to achieve higher levels of effort and performance. The findings indicated that transformational leadership positively impacted organizational performance by fostering an environment where employees were encouraged to go beyond expectations. The study highlighted that transformational leaders inspire employees to strive for excellence and contribute to both individual and organizational growth. Furthermore, the research provided examples of how transformational leadership techniques have been successfully implemented in various organizations. The study concluded by suggesting areas for future research, particularly focusing on how different leadership styles might interact with diverse organizational contexts. The relevance of this study lies in its contribution to understanding how leadership can align organizational goals with employee motivation, ultimately leading to enhanced performance and long-term success.

Sofi and Devanadhen (2015) explored the impact of various leadership styles—transformational, transactional, participative, supportive, and instrumental—on the organizational performance of banking institutions in Jammu and Kashmir, India. The study aimed to identify the prevalence of these leadership styles and evaluate their effects on performance. A descriptive survey research design was employed, with 290 respondents, including branch heads, executive-level personnel, and senior staff from banking organizations. Data were analyzed using SPSS and Amos version 20, with Structural Equation Modelling (SEM) used to assess the conceptual model's fit. The findings revealed that transformational leadership had a significant positive effect on organizational performance, while other leadership styles showed no substantial impact. Additionally, transformational leadership was identified as the most common style in these institutions. This study highlights the relevance of leadership style in enhancing organizational performance and provides valuable insights for the banking sector in Jammu and Kashmir, emphasizing the need for transformational leadership in driving performance and success.

Alghazo and Al-Anazi (2016) conducted a mixed methods study to examine the correlation between leadership style and employee motivation in a private petrochemical firm in Saudi Arabia. The objective of the research was to explore how different leadership styles influenced employee motivation. The methodology involved administering a survey to 30 workers across two departments, supplemented by interviews with a focus group of 10 workers to validate the survey results. The findings revealed a significant relationship between leadership style and employee motivation. Specifically, the study found a positive correlation between transformational leadership and employee motivation, suggesting that leaders who inspire and support their employees foster higher motivation. In contrast, transactional leadership was negatively associated with motivation, implying that a more reward-based, directive leadership style did not contribute as effectively to employee engagement. This study's relevance lies in its contribution to understanding the importance of leadership styles in enhancing motivation, particularly within the context of a specialized industry like petrochemicals, which could inform management practices in similar settings.

Khan and Nawaz (2016) aimed to explore the impact of leadership styles on organizational restructuring, focusing on the role of authority formation, responsibility, and employee concerns. The researchers utilized a comprehensive review of leadership theories, analyzing transformational and transactional leadership approaches across various socio-economic and academic contexts. They found that both leadership styles played significant roles in guiding organizational change,

with transformational leadership fostering innovation, motivation, and commitment, while transactional leadership focused on performance and rewards. The study highlighted that the effectiveness of each leadership style depended on the specific situation and organizational context. It concluded that organizations could benefit from a balanced application of both leadership styles to address diverse challenges and foster a more engaged workforce. The study's relevance lies in its contribution to understanding the dynamic relationship between leadership styles and organizational performance, offering valuable insights for leaders navigating complex organizational changes.

Fiaz, Su, and Saqib (2017) aimed to explore the influence of leadership styles on employee motivation in Pakistan's public sector, particularly within WAPDA, a government-affiliated organization. The research investigated the effects of autocratic, democratic, and laissez-faire leadership styles as independent variables on employee motivation, the dependent variable. Data were collected through a closed-ended survey using the Multifactor Leadership Questionnaire (MLQ), completed by 110 senior and middle-level managers. The study employed descriptive statistics, reliability analysis, multiple regression, and ANOVA to test the hypotheses. Findings revealed that autocratic leadership was negatively correlated with employee motivation, while democratic and laissez-faire styles had positive effects, although the correlation with democratic leadership was minimal. This reflected the organization's bureaucratic nature. The results supported theoretical assumptions for autocratic and laissez-faire leadership but were inconsistent with democratic leadership. The study highlighted the importance of adopting democratic and laissez-faire leadership styles to combat bureaucratic inefficiency. It emphasized the need for leadership development programs, especially in developing economies like Pakistan, where leadership deficiencies hinder organizational performance. The research provides valuable policy insights for strengthening institutions through leadership reforms, especially in contexts marked by bureaucracy and inefficiency.

Basit et.al. (2017) aimed to assess the impact of leadership style on employee performance within a private organization in Selangor, Malaysia, using a sample size of 100 respondents. The study employed quantitative methods, utilizing a five-point Likert scale questionnaire to evaluate the relationship between leadership style and employee performance. SPSS software was used to analyze the survey data, incorporating demographic analysis, normality tests, reliability checks (Cronbach's Alpha), descriptive statistics, and regression analysis. The findings revealed that the democratic leadership style had the highest mean value (3.784), followed by laissez-faire (3.416), and autocratic (3.404). The regression analysis showed that democratic and laissez-faire leadership styles had a strong positive impact on employee performance, while the autocratic style exhibited a negative correlation (beta coefficient of -0.168 with a significance of 0.025). This study highlighted that leadership style significantly influences employee performance, with democratic leadership being the most effective. The research is relevant for organizations aiming to enhance performance through strategic leadership style implementation, particularly in fostering a supportive and inclusive work environment.

Mansor et al. (2017) aimed to assess the impact of transformational leadership on employee engagement among Generation Y workers in Malaysia, addressing concerns over their motivation and engagement levels. The research, conducted with 221 respondents from Selangor and Klang Valley, used surveys to gather data and analyzed it through the Statistical Package for the Social

Sciences (SPSS). The findings revealed a significant correlation between the dimensions of intellectual stimulation, inspirational drive, and individual concern with employee engagement. However, the study also found no substantial correlation between a leader's idealized influence and employee engagement among Generation Y. This research is relevant as it enhances the understanding of the interrelationship between transformational leadership and employee engagement, providing valuable insights for organizations seeking to improve engagement levels in a workforce increasingly dominated by Generation Y.

Raveendran and Gamage (2018) sought to understand the impact of leadership styles, particularly transformational and transactional leadership, on employee performance in organizations. The methodology involved a comprehensive literature review that explored key leadership theories, offering a framework to analyse prior research. The study revealed that while both leadership styles can contribute to organizational success, transformational leadership tends to have a more significant influence on employee performance than transactional leadership. However, the authors identified a gap in existing research regarding the application of these leadership styles in the Sri Lankan context. The study's findings highlighted the importance of using both transformational and transactional approaches to lead effectively and provided a foundation for future research, particularly in examining the relevance of these leadership styles across different industries in Sri Lanka. The study is relevant for scholars and practitioners seeking to understand how leadership styles impact employee motivation and performance in diverse cultural and organizational settings.

Islam et.al. (2018) conducted a study to explore the impact of different leadership styles (Participative, Supportive, and Autocratic) on employee job performance in the mobile telecommunications sector. The objective of the research was to examine how these leadership styles influenced employee performance outcomes. A sample of 118 employees was purposively selected, and primary data was collected using a self-administered questionnaire based on a 5-point Likert scale. Descriptive and inferential statistical methods, including correlations, regression analysis, and ANOVA, were applied using SPSS version 20.0 for data analysis. The study found a significant positive correlation between leadership styles and employee job performance, with Participative and Supportive styles showing a strong influence on performance. However, the Autocratic style showed no significant positive impact, suggesting the need for attention from policymakers and practitioners to improve its effectiveness. The findings emphasize the importance of adopting appropriate leadership styles to enhance employee job performance, particularly in the context of Bangladesh's mobile telecommunications industry. This study is relevant as it provides valuable insights into leadership practices that can contribute to organizational success and employee motivation in the competitive corporate landscape.

Islam et al. (2018) aimed to analyse the influence of different leadership styles on employee empowerment in the Malaysian retail sector. A quantitative research approach was used, involving convenience sampling to collect data from 100 respondents employed in retail organizations in Selangor, Malaysia. Descriptive analysis was employed to assess the respondents' personal data, while inferential analysis was used to test the hypotheses. The findings revealed that two of the three hypotheses were supported by the data, whereas one hypothesis was refuted. The study also discussed its limitations and proposed directions for future research. This research is relevant as it provides insights into how leadership styles affect employee empowerment, particularly in the

retail sector, offering valuable implications for managers looking to enhance employee engagement and productivity.

Săseanu and Toma (2019) explore the impact of leadership on employee motivation, particularly within the milling and baking industry. The authors employed an exploratory research design, utilizing a questionnaire to gather data from employees in this sector. Their findings revealed that leadership plays a critical role in influencing employee motivation, emphasizing that motivation is a key factor in self-regulation and psychological growth. The study highlighted that despite the awareness of its importance, many employers fail to invest in effective leadership strategies, leading to stagnation and significant challenges in their organizations. It was concluded that for organizational success, leaders must recognize and address the motivational needs of their employees. The relevance of this study lies in its practical implications for leadership development and employee engagement, offering valuable insights for organizations seeking to improve performance through enhanced motivation.

Saad et al. (2019) aimed to explore the impact of different leadership styles on employee motivation within building projects in Lahore, a growing hub of construction activities in Pakistan. The researchers employed a quantitative methodology, utilizing a closed-ended questionnaire survey to collect data. The Multifactor Leadership Questionnaire (MLQ) was used to identify leadership styles, while the Work Extrinsic Intrinsic Motivation Scale (WEIMS) assessed motivation levels. Over 500 questionnaires were distributed, with 192 responses received. Data validation tests were conducted to ensure reliability. The findings revealed that transformational leadership had the most significant positive impact on employee motivation, whereas laissez-faire leadership was found to have the least influence. The study's relevance lies in its contribution to the understanding of leadership's role in project success, particularly in a developing region, and it fills a gap in the existing literature on the relationship between leadership styles and motivation in construction projects.

Bhole (2020) aimed to investigate the relationship between leadership style and employee motivation in five small and medium-sized enterprises (SMEs) in the Abernathy Belapur industrial zone. The study employed a survey method, distributing questionnaires to 250 employees across various departments, supplemented by interviews with 25 workers to validate the survey responses. The findings revealed a strong correlation between leadership style and employee motivation. It was observed that transactional leadership had a negative impact on staff motivation, while transformational leadership led to more positive outcomes. The study highlighted the significant influence of leadership styles on employee motivation, underscoring the importance of adopting transformational leadership for fostering better work environments and enhancing motivation. This research is particularly relevant to organizations aiming to optimize leadership practices and improve employee engagement, especially within SMEs.

Sitthiwarongchai et al. (2020) aimed to examine the impact of different leadership styles—transactional, transformational, and laissez-faire—on employee motivation within Thailand's pharmaceutical industry. The researchers employed a survey questionnaire with a five-point Likert scale to collect primary data, which was then analyzed using SPSS software for regression and correlation. The findings revealed that all leadership styles positively influenced employee motivation, with transactional leadership being the most preferred in this context. The study

concluded that leaders in the pharmaceutical industry should adopt a transactional leadership approach and align incentive systems with employee performance to avoid potential biases. This research highlighted the critical role of leadership in motivating employees and provided valuable insights for executives seeking to enhance workforce engagement and productivity.

Uysal (2021) aimed to explore the association between perceived leadership styles and employee motivation in the Turkish hotel industry. The study utilized a survey-based methodology, where an online questionnaire was distributed to staff at five-star hotels in Turkey, yielding 385 valid responses. The questionnaire focused on leadership styles and their impact on employee motivation. The findings revealed a significant correlation between transformational leadership and employee motivation, suggesting that leaders who inspire and engage their employees foster higher motivation. Conversely, no significant correlation was found between transactional or laissez-faire leadership and employee motivation. The study concluded with recommendations for improving leadership practices to enhance the management of hospitality organizations, emphasizing the role of transformational leadership in boosting staff motivation. This research is relevant for understanding the dynamics of leadership in hospitality settings and offers valuable insights for improving organizational performance through effective leadership strategies.

Olayisade and Awolusi (2021) aimed to investigate the impact of leadership styles on staff productivity within the Nigerian oil and gas sector, using Chevron Nigeria Limited as a case study. The researchers employed a five-point Likert scale questionnaire, consisting of forty items that addressed various leadership styles, including autocratic, democratic, bureaucratic, laissez-faire, transactional, and charismatic, alongside staff productivity characteristics. A total of 125 respondents were surveyed, yielding 93 valid responses, which were analyzed using the Statistical Package for the Social Sciences (SPSS). The analysis included demographic analysis, normality testing, homoscedasticity assessment, multicollinearity evaluation, and reliability testing. The results confirmed the validity and reliability of the findings. The study's descriptive and regression analyses revealed that the autocratic leadership style was the most prevalent, followed by laissez-faire, bureaucratic, transactional, democratic, and charismatic leadership styles. The findings emphasized that leadership styles significantly impact staff productivity, with different styles having distinct effects. Additionally, multiple leadership styles could coexist within a single organization. This research contributes to the existing body of literature on leadership practices and offers valuable insights for academics and researchers, providing policy implications for the oil and gas sector.

Hajjali et al. (2022) aimed to explore the influence of work motivation, leadership style, and competence on job satisfaction and performance, along with the mediating role of job satisfaction in these relationships. The research was conducted at LLDIKTI-IX, with a sample of 125 employees using full sampling. Data were collected through questionnaires and analyzed using AMOS 18 and Structural Equation Modelling. The findings revealed that work motivation negatively and significantly impacted job satisfaction, suggesting that employee motivation in terms of existence, connectivity, and progress was insufficient, while work happiness needed improvement. Competence was found to have a positive but insignificant effect on employee performance, highlighting the lack of focus on innovation and technology in career development. Additionally, job satisfaction did not significantly enhance performance, as competence largely addressed only the basic work requirements. This study is relevant for organizations seeking to

improve employee performance by addressing motivational and competency gaps and considering how job satisfaction mediates these relationships.

Irfan (2022) conducted a study to assess the impact of work discipline, work motivation, and leadership style on employee performance, emphasizing the need to enhance staff productivity in organizations. The study aimed to identify how these factors contribute to improved outcomes and efficiency. The research was based on a sample of 87 workers from a single company, using the census method to ensure a representative sample. Data analysis was carried out through regression analysis to examine the relationship between the variables. The findings revealed that work discipline, work motivation, and leadership style had a significant positive impact on employee performance. The study underscored the importance of these factors in fostering an environment that promotes efficiency and productivity. This research is relevant for organizations looking to improve employee performance by focusing on enhancing these key areas.

Xuefeng (2023) aimed to investigate the impact of various leadership styles on employee motivation within Chinese industrial enterprises. The study involved interviews with one hundred workers and ten managers from five manufacturing companies in China. The findings revealed that both transformational and transactional leadership styles could enhance employee motivation, though the former proved to be more effective. Factors such as job satisfaction, work-life balance, recognition, job stability, and opportunities for professional growth were identified as key motivators. The study suggested that managers in China's manufacturing sector should prioritize adopting transformational leadership styles and focus on addressing factors that influence employee engagement. The relevance of the study lies in its practical implications for improving leadership practices in the sector. The study also highlighted the need for further research with a larger sample size and a mixed-methods approach to gain deeper insights into the relationship between leadership styles and employee motivation in China's manufacturing industry.

Amde (2023) examined the connection between leadership behaviors and their impact on employee motivation and job performance. The study aimed to provide a comprehensive understanding of how various leadership styles—transformational, transactional, participative, servant, and laissez-faire—affect organizational effectiveness. A detailed review of current literature and empirical research across diverse geographic regions, including the United States, Canada, Europe, and Africa, was conducted. The U.S. research emphasized the importance of clear goals in enhancing motivation, while Canadian studies highlighted the role of recognition and incentives. In Europe, especially Germany and the Netherlands, transformational leadership and job design were seen as significant factors influencing performance. African studies focused on training, development, and empowerment as key motivators. The findings revealed a strong link between leadership styles and employee outcomes, demonstrating that transformational and participative leadership foster higher motivation and performance. The research offered practical insights for organizational leaders, suggesting the cultivation of these leadership skills to improve work environments and enhance performance. Additionally, the study highlighted policy implications for leadership selection and development, urging proactive strategies to address leadership's effect on employee engagement. This work contributed to both theoretical knowledge and practical applications in leadership and organizational behaviour.

Sokolic et al. (2024) examined the impact of various leadership styles on employee motivation and, subsequently, on organizational performance. The objective of the study was to explore the correlation between leadership styles and employee work outcomes, focusing on how leadership styles influence motivation, engagement, and satisfaction. The methodology involved a hybrid approach, combining quantitative survey analysis with qualitative case studies to assess the direct and indirect effects of leadership styles on motivation and performance. The findings suggested a significant link between employee-centered leadership styles and higher motivation levels, indicating that leaders who adopt a more engaged and supportive approach can substantially improve organizational performance. This research contributes to the existing literature by providing empirical evidence that underscores the importance of selecting appropriate leadership styles to maximize employee potential and drive better organizational outcomes. The study's relevance lies in offering practical insights for organizational leaders and HR professionals, guiding them in developing leadership strategies that promote a motivating and high-performance work environment.

Ranjan (2024) conducted a study examining the influence of various leadership styles—transformational, transactional, charismatic, and servant leadership—on employee motivation and performance. The objective of the research was to explore how these leadership styles impacted employee outcomes, specifically focusing on motivation and performance. The methodology involved a comprehensive literature synthesis, combining empirical findings and theoretical frameworks to support the correlation between leadership styles and employee behaviour. The study revealed that transformational and charismatic leadership styles had a positive influence on employee motivation and engagement, fostering creativity and a commitment to organizational goals. On the other hand, transactional leadership was found to be effective in achieving short-term performance targets but had a limited impact on long-term motivation. Servant leadership also showed significant positive effects on employee well-being and job satisfaction, promoting a supportive and collaborative environment. The findings highlighted the importance of leadership in influencing employee outcomes, emphasizing that effective leadership could enhance engagement and performance, thus contributing to organizational success. The relevance of the study lies in its ability to guide leaders in selecting the most appropriate leadership style to achieve optimal employee performance and organizational effectiveness.

III. Significance of Leadership in Organizational Success

Leadership is a cornerstone of organizational success, influencing its vision, direction, and operational efficiency. A strong leader provides clarity, ensures strategic alignment, and motivates employees to work toward common objectives. Without effective leadership, even well-structured organizations can face issues such as low productivity, lack of innovation, and employee disengagement. Leadership is particularly significant in today's rapidly changing business environment, where adaptability, vision, and employee engagement play crucial roles in determining long-term sustainability. A strong leadership framework provides a sense of purpose and aligns employees' efforts with the organization's mission. For instance, when leaders communicate a clear and inspiring vision, employees are more likely to feel a sense of belonging and commitment. Leaders also play a critical role in decision-making, conflict resolution, and fostering a culture of trust. Whether in business, education, healthcare, or government sectors, leadership influences organizational growth, innovation, and overall efficiency (*Ojokuku, et.al. 2012*). The effectiveness of leadership in organizational success can be seen in how leaders manage

crises, drive change, and promote a collaborative work environment. Successful organizations often have leaders who prioritize continuous learning, foster a culture of accountability, and encourage risk-taking for innovation. For example, companies like Apple and Tesla have thrived under visionary leadership, where strong leadership has guided organizational strategy, product innovation, and competitive positioning. Leadership, therefore, acts as the driving force behind an organization's growth, resilience, and ability to navigate complex challenges.

Leadership Plays a Crucial Role in Shaping Organizational Performance and Employee Motivation

Leadership significantly impacts organizational performance by setting goals, defining strategies, and ensuring efficient resource allocation. High-performing organizations often attribute their success to effective leadership that fosters a strong corporate culture and drives performance. Leadership influences team cohesion, decision-making processes, and overall business outcomes. Strong leaders create an environment that promotes productivity, creativity, and goal attainment. Employee motivation is closely linked to leadership effectiveness. A leader who recognizes employees' contributions, provides growth opportunities, and fosters an inclusive work environment enhances job satisfaction and motivation. Studies show that motivated employees exhibit higher levels of performance, lower absenteeism, and greater loyalty to the organization. Leadership also determines how employees perceive their roles, responsibilities, and future career growth. When employees feel valued and empowered, they are more likely to stay engaged and committed to their work. Effective leadership also enhances problem-solving capabilities within an organization. Leaders who promote a culture of innovation encourage employees to think critically, experiment with new ideas, and contribute meaningfully to organizational goals. The best leaders understand their employees' strengths and weaknesses and leverage them to optimize performance. In contrast, poor leadership can lead to low morale, high turnover rates, and decreased productivity. Therefore, leadership is not just about overseeing operations but also about inspiring and motivating employees to achieve excellence (*Belonio, 2012*).

Different Leadership Styles Impact Productivity, Innovation, and Workplace Morale

Leadership styles vary across organizations and industries, and each style has a distinct impact on productivity, innovation, and workplace morale. Understanding these leadership styles helps organizations determine the best approach to maximize employee engagement and organizational success.

Transformational Leadership: Transformational leadership is characterized by the ability to inspire and motivate employees to exceed expectations. Leaders who adopt this style focus on long-term vision, encourage innovation, and promote continuous personal and professional growth. This leadership approach enhances employee engagement, fosters a sense of purpose, and creates a culture of trust and collaboration. Studies have shown that transformational leadership leads to higher levels of job satisfaction, employee retention, and organizational performance.

Transactional Leadership: Transactional leadership is based on a structured system of rewards and penalties. Leaders using this style set clear expectations and closely monitor performance. While this approach ensures discipline and efficiency, it may not always promote innovation or employee engagement. Employees in transactional leadership environments often focus on meeting predefined targets rather than seeking creative solutions to problems. Although effective

in certain industries, this leadership style may not be suitable for dynamic and fast-changing business environments.

Autocratic Leadership: Autocratic leadership involves centralized decision-making, where the leader holds significant authority and control over employees. This leadership style is effective in situations that require quick decision-making and strict adherence to rules, such as military operations or highly regulated industries. However, in creative or knowledge-driven industries, autocratic leadership may lead to decreased employee morale and resistance to change. Employees under autocratic leadership often feel disengaged and lack motivation due to limited involvement in decision-making processes.

Democratic Leadership: Democratic leadership fosters collaboration by involving employees in decision-making. Leaders encourage feedback, value diverse perspectives, and create a sense of ownership among employees. This leadership style enhances workplace morale, promotes innovation, and increases productivity by making employees feel valued. Organizations that adopt democratic leadership often experience higher employee engagement, job satisfaction, and overall performance.

Laissez-Faire Leadership: Laissez-faire leadership provides employees with autonomy and minimal supervision. This leadership style works well in organizations where employees are self-motivated, skilled, and require little guidance. However, in less experienced teams, laissez-faire leadership may result in a lack of direction, decreased productivity, and low accountability. While it allows employees to take ownership of their work, it may not be suitable for all industries or teams. Each leadership style has unique implications for workplace morale, innovation, and overall productivity. Successful organizations often adopt a flexible leadership approach that combines different styles based on situational demands and workforce dynamics (*Carter, 2013*).

Leadership and Its Role in Employee Engagement and Organizational Culture

Employee engagement is a key driver of organizational success, and leadership plays a critical role in fostering an engaged workforce. Engaged employees exhibit higher levels of commitment, enthusiasm, and productivity. Leadership influences workplace culture by setting expectations, promoting values, and fostering an environment where employees feel valued and motivated. A strong organizational culture is built on trust, communication, and shared goals. Leaders who prioritize transparency and inclusivity create a culture that encourages employees to contribute their best efforts. When employees feel aligned with an organization's values and mission, they are more likely to remain committed and motivated. Leadership also determines how workplace conflicts are managed, how employees collaborate, and how organizational policies are implemented.

For instance, organizations that emphasize open communication and employee recognition tend to have higher levels of engagement. Employees who feel appreciated and heard are more likely to take initiative, contribute ideas, and stay loyal to the company. Conversely, poor leadership can create a toxic work environment, leading to dissatisfaction, low morale, and high turnover rates. Organizations with a strong leadership culture experience benefits such as improved teamwork, higher productivity, and enhanced employee satisfaction. Leaders who invest in professional development, mentorship, and team-building initiatives foster a positive work environment where

employees thrive. Leadership, therefore, is a fundamental element in shaping an organization's culture and sustaining long-term success (*Nasir, et.al. 2014*).

The Future of Leadership in a Changing Business Landscape

As businesses evolve, so do leadership expectations. The rapid pace of technological advancements, globalization, and changing workforce demographics require leaders to adapt to new challenges. Traditional leadership approaches may no longer be sufficient in an increasingly digital and dynamic business environment. Modern leadership trends emphasize agility, emotional intelligence, and inclusivity. Leaders must be adaptable, open to change, and capable of navigating uncertainties. The shift towards remote and hybrid work models has also redefined leadership roles, requiring leaders to engage employees across virtual platforms, build trust in remote teams, and ensure productivity in decentralized work environments.

Leadership in the digital era also demands a greater emphasis on employee well-being, work-life balance, and diversity and inclusion. Organizations that prioritize inclusive leadership practices tend to attract top talent, foster innovation, and remain competitive in the global market. Moreover, as artificial intelligence and automation reshape industries, leaders must focus on upskilling employees, fostering a culture of continuous learning, and driving strategic transformation. The future of leadership lies in the ability to balance technological advancements with human-centric approaches. Leaders who cultivate resilience, adaptability, and empathy will be better positioned to guide organizations through uncertainty and drive sustained success. As leadership continues to evolve, organizations must invest in leadership development programs to nurture the next generation of leaders capable of thriving in an ever-changing business landscape (*Hurduzeu, 2015*).

IV. Transformational Leadership and Its Impact

Transformational leadership is a dynamic and visionary approach that inspires employees to achieve beyond their perceived capabilities. Unlike transactional leadership, which focuses on structure, rules, and performance-based rewards, transformational leadership is centered on innovation, motivation, and long-term organizational growth. It encourages a vision-driven culture where creativity, open communication, and employee empowerment become the foundation of workplace success. Transformational leaders inspire their teams by articulating a compelling vision, fostering an environment where employees feel valued and motivated to contribute meaningfully. They lead by example, instilling a sense of purpose that aligns individual aspirations with organizational objectives. By emphasizing trust, transparency, and collaboration, these leaders create a positive work atmosphere where employees feel encouraged to share ideas, take risks, and explore innovative solutions without the fear of failure. Open communication under transformational leadership fosters stronger interpersonal relationships, ensuring that employees are actively engaged in the decision-making process. Empowerment is another key element, as leaders delegate responsibilities and provide employees with the autonomy to develop their skills, thus promoting a culture of continuous learning and professional development (*Sofi, & Devanadhen, 2015*).

The impact of transformational leadership on organizational success is profound. Employees working under transformational leaders often exhibit higher engagement levels, leading to increased job satisfaction and productivity. Research indicates that organizations with

transformational leaders experience lower turnover rates, as employees feel emotionally invested in their roles and the company's mission. This leadership style nurtures a sense of belonging and commitment, resulting in a workforce that is resilient, adaptable, and aligned with strategic objectives (*Alghazo, & Al-Anazi, 2016*). Employees are more likely to develop a proactive mindset, take initiative, and go beyond their routine responsibilities to contribute to organizational success. Additionally, transformational leadership fosters a culture of ethical behaviour and corporate responsibility, as leaders prioritize integrity and social impact. By focusing on employee well-being, personal growth, and shared success, transformational leadership drives not only business performance but also long-term sustainability. In today's rapidly evolving corporate landscape, where adaptability and innovation are essential, transformational leadership stands as a powerful force in shaping a motivated, engaged, and high-performing workforce.

V. Transactional and Autocratic Leadership Styles

Transactional leadership operates on a structured reward-and-punishment system, emphasizing discipline, efficiency, and adherence to predefined tasks. Leaders following this style set clear expectations, monitor employee performance, and provide rewards or corrective actions based on outcomes. This results in a highly organized work environment where productivity is driven by incentives and compliance. Transactional leadership is particularly effective in industries requiring precision, consistency, and adherence to strict protocols, such as manufacturing, finance, and military operations. However, while this approach ensures short-term efficiency and operational stability, it often lacks the flexibility to foster creativity or long-term employee engagement (*Khan, & Nawaz 2016*). Employees may become overly dependent on extrinsic rewards, reducing intrinsic motivation and limiting their ability to think innovatively or take initiative beyond assigned tasks.

Autocratic leadership, on the other hand, is characterized by centralized decision-making, where leaders exercise full control over policies, strategies, and directives. This leadership style is effective in situations requiring rapid decision-making, crisis management, or strict regulatory compliance. It minimizes ambiguity in hierarchical structures, ensuring clear lines of authority and quick execution of tasks. However, its rigid top-down approach can suppress innovation, hinder collaboration, and create an environment where employees feel disengaged or undervalued. A lack of employee involvement in decision-making may result in decreased motivation, lower job satisfaction, and resistance to organizational change. While autocratic leadership can drive short-term efficiency, its long-term effectiveness depends on balancing authority with open communication and occasional empowerment of employees to foster a more engaged and adaptive workforce (*Fiaz, et.al. 2017*).

VI. Democratic and Laissez-Faire Leadership Approaches

Democratic leadership is centred around inclusivity and active employee involvement in decision-making processes. Leaders who adopt this style seek input and feedback from their teams, ensuring that everyone has a voice and a sense of ownership in the direction of the organization. This approach fosters motivation, as employees feel valued and respected, which boosts job satisfaction and commitment. By promoting open communication and collaboration, democratic leaders create an environment where employees are more likely to contribute innovative ideas, share knowledge, and work together towards shared goals (*Basit, et.al. 2017*). This leads to higher engagement, improved morale, and a strong sense of community within the workplace. Democratic leadership also encourages transparency, building trust between leaders and employees, which in turn

enhances overall organizational performance and fosters long-term success. Laissez-faire leadership, by contrast, grants employees a high degree of autonomy in how they approach their work, with minimal supervision or intervention from leaders. This leadership style works well in teams or environments where employees are self-motivated, highly skilled, and capable of managing their tasks independently. However, in less experienced or less self-directed teams, laissez-faire leadership can lead to inefficiencies, confusion, and lack of direction (*Mansor, et.al. 2017*). Without sufficient guidance, employees may struggle with unclear objectives or a lack of structure, ultimately affecting productivity and team cohesion. While it can foster creativity and innovation when appropriately applied, the laissez-faire approach may also contribute to feelings of disconnection or frustration when employees require more support or clearer expectations from their leaders.

VII. Leadership's Influence on Organizational Culture and Employee Motivation

Effective leadership plays a pivotal role in shaping organizational culture, which in turn significantly impacts employee motivation, satisfaction, and overall performance. A leader's approach not only sets the tone for the work environment but also influences how employees perceive their roles, interact with colleagues, and align with the organization's values. Leadership is more than just about setting goals and directing operations—it is about creating a positive and motivating environment that enables employees to feel valued, supported, and connected to the broader mission of the organization (*Raveendran, & Gamage, 2018*). A leader who embodies and champions organizational values, promotes open communication, and actively works to develop a culture of respect and inclusivity creates a workplace that fosters collaboration and creativity. When leaders demonstrate consistency in their actions and words, they build trust among employees, which is crucial for nurturing motivation. Employees who feel secure in their positions, respected by their leaders, and empowered to contribute ideas are far more likely to be engaged and committed to the organization. One of the key aspects of leadership's influence on organizational culture is the ability to create a positive work environment that supports employee well-being and job satisfaction. Leaders who actively work to promote a healthy work-life balance, provide opportunities for growth and development, and recognize and reward employees for their hard work are instrumental in cultivating a motivated workforce. Job commitment increases when employees feel supported by their leadership and see tangible benefits in terms of professional growth, recognition, and personal fulfilment (*Săseanu, & Toma, 2019*). Additionally, a positive work culture has been shown to reduce employee turnover rates, as employees are more likely to stay with an organization that values their contributions and provides them with opportunities for advancement. When employees feel a strong sense of belonging and loyalty to their workplace, they are more likely to engage in discretionary efforts—going above and beyond their formal job responsibilities, which in turn drives organizational performance. Effective leadership helps to align employee values with organizational objectives, creating a shared sense of purpose that fuels motivation, commitment, and productivity.

Moreover, leadership styles should align with organizational goals, workforce diversity, and external market dynamics to maximize the overall effectiveness of the organization. An organization's strategy, mission, and values must be clearly communicated by its leaders, and the leadership style must be conducive to achieving these goals. For instance, a transformational leadership style, which focuses on inspiring and motivating employees toward a shared vision, may be well-suited for an organization that is undergoing major change or seeking innovation

(*Saad, et.al. 2019*). In contrast, a transactional leadership style might be more effective in environments that require strict adherence to processes, such as manufacturing or finance, where efficiency and consistency are paramount. Understanding workforce diversity is also a crucial consideration for leadership. A diverse workforce brings varied perspectives, skills, and experiences, and a one-size-fits-all leadership approach may not be effective in such settings. Inclusive leadership, which values and harnesses diversity, helps ensure that all employees feel respected, engaged, and motivated to contribute their unique ideas. Leaders who take the time to understand the diverse needs and aspirations of their employees can tailor their approach to provide more personalized and meaningful support, ultimately driving higher levels of motivation and engagement. Furthermore, the external market dynamics and competitive landscape also play a significant role in shaping leadership styles. For example, a company operating in a fast-paced and highly competitive industry may require leaders to adopt a more adaptive, visionary leadership style that focuses on innovation, agility, and long-term strategic planning. On the other hand, organizations in more stable industries may benefit from a leadership approach that focuses on efficiency, consistency, and maintaining established processes (*Bhole, 2020*). Leaders must be attuned to both internal and external factors, including economic trends, technological advancements, and changing customer demands, and adapt their leadership approach accordingly. Leadership flexibility is crucial in maintaining a competitive edge and ensuring that the organization can respond effectively to shifting market conditions. By aligning their leadership style with both organizational goals and external market conditions, leaders can drive both short-term success and long-term sustainability, fostering a motivated and committed workforce along the way.

VIII. The Need for Adaptive Leadership in Modern Organizations

In today's rapidly evolving business environment, organizations are required to be agile, innovative, and resilient to succeed. Rigid, one-size-fits-all leadership approaches can no longer meet the diverse needs of modern organizations, as they often hinder growth and the ability to respond to change. In an era marked by technological advancements, shifting consumer demands, and global economic uncertainty, organizations face constant pressure to innovate and adapt. A leadership style that lacks flexibility can stifle creativity, limit collaboration, and prevent organizations from seizing new opportunities. Leaders who rely on outdated or inflexible approaches may struggle to navigate complex challenges or guide their teams through periods of transformation, ultimately leading to stagnation and missed opportunities. In contrast, adaptive leadership is essential in fostering an environment that encourages experimentation, continuous learning, and responsiveness to both internal and external changes. Leaders must be able to adjust their approach based on situational demands, whether it is managing a crisis, overseeing a period of rapid growth, or leading a team through technological disruption (*Sitthiwarongchai, et.al. 2020*).

Adaptive leadership requires leaders to be aware of both the internal dynamics of their organizations and the broader external environment. In order to make informed decisions, leaders need to be attuned to the needs of their employees, the strengths and weaknesses of their teams, and the ever-changing market conditions (*Uysal, 2021*). This flexibility allows leaders to shift their strategies when necessary, empowering them to maintain momentum in the face of uncertainty. In practical terms, adaptive leadership encourages leaders to ask questions, listen actively to their teams, and be open to feedback and new ideas. By fostering an open and collaborative approach

to problem-solving, adaptive leaders empower their teams to take ownership of challenges, make informed decisions, and innovate. This sense of empowerment, coupled with the flexibility to pivot when necessary, promotes a high level of motivation and engagement among employees. When employees feel that their contributions are valued and that they are working within an environment that is responsive to their needs and external market shifts, they are more likely to remain motivated and committed to the organization's long-term success (*Olayisade, & Awolusi, 2021*).

Rigid Leadership Approaches and Their Hindrances to Growth and Innovation: Rigid leadership approaches often hinder organizational growth and innovation by discouraging flexibility and adaptation. When leaders strictly adhere to a set of established rules or processes, they limit the potential for new ideas, creative problem-solving, and experimentation (*Ranjan, 2024*). This rigidity can manifest in several ways—whether through an autocratic approach that leaves little room for employee input, or a transactional style that focuses primarily on performance metrics without considering the broader context of employee needs and aspirations. Such leadership styles can create an environment where employees are less likely to take risks, share innovative ideas, or challenge the status quo. As a result, organizations may become complacent, slow to adapt, and less capable of responding to changes in the market or industry trends. In today's competitive landscape, the inability to foster a culture of innovation can quickly lead to obsolescence, as businesses that fail to evolve may be outpaced by more agile competitors. Furthermore, rigid leadership can have a detrimental effect on employee morale and motivation. When employees feel constrained by inflexible rules and micromanagement, they may become disengaged, frustrated, or disillusioned with their work. This can lead to lower job satisfaction, reduced motivation, and, in extreme cases, higher turnover rates (*Hajjali, et.al. 2022*). Employees thrive in environments where they feel trusted to make decisions, contribute ideas, and challenge existing norms. Inflexible leadership that focuses on control rather than empowerment erodes this sense of ownership and autonomy. As a result, employees may become more focused on following orders than on finding innovative solutions or contributing to the organization's broader goals. This lack of motivation can severely limit an organization's ability to achieve its full potential. To avoid these negative consequences, organizations must move away from rigid leadership models and embrace approaches that allow for adaptability, empowerment, and creative collaboration.

A Strategic, Flexible Leadership Framework for Long-Term Success: A strategic and flexible leadership framework is vital for enhancing motivation, improving performance, and ensuring long-term organizational success. Such a framework is rooted in the ability of leaders to adjust their leadership styles based on the context, the challenges at hand, and the needs of their employees (*Amdé, 2023*). Flexibility in leadership allows organizations to not only maintain operational efficiency but also foster an environment where employees are motivated, innovative, and invested in the organization's success. A strategic, adaptive leader recognizes that no single leadership style will work in all situations, and as such, they are willing to shift their approach to meet the demands of a given moment. For example, in times of crisis, a more directive or authoritative approach may be needed to make swift decisions and provide clear guidance. Conversely, during periods of growth or change, a more collaborative, transformational leadership style can inspire creativity, promote teamwork, and drive innovation. An adaptive leadership framework also incorporates ongoing feedback, learning, and development. By fostering a culture of continuous improvement, leaders can ensure that their teams are equipped with the skills, knowledge, and motivation to thrive in a rapidly changing environment (*Xuefeng, 2023*). This

may involve investing in training, encouraging cross-functional collaboration, and creating spaces for open dialogue between leaders and employees. Adaptive leadership requires leaders to be open-minded and to view challenges as opportunities for growth rather than obstacles. Through modelling this mindset, leaders can inspire their teams to adopt the same approach, promoting resilience and a proactive attitude toward change. In turn, this fosters higher employee engagement, job satisfaction, and retention. A flexible leadership framework creates a cycle of positive feedback, where motivation fuels performance, and strong performance reinforces motivation, ultimately leading to long-term organizational success (Irfan, 2022).

IX. Conclusion

The need for adaptive leadership in modern organizations has never been more crucial. As industries evolve and organizations face increasing pressure to innovate and respond to market shifts, rigid leadership approaches become a liability. Adaptive leadership, characterized by flexibility, empowerment, and responsiveness, fosters a work environment where employees are motivated, creative, and committed to organizational goals. Leaders who adopt a strategic, context-driven approach are better positioned to overcome challenges, enhance employee engagement, and drive long-term success. Through embracing a flexible leadership framework, organizations can remain agile, resilient, and capable of thriving in an ever-changing business landscape.

Reference

- Ahmad, H., & Gelaidan, H. M. (2011). Organisational culture, leadership styles and employee's affective commitment to change: A case of Yemen public sector. *The Journal of Organizational Management Studies*, 2011, 1-10.
- Alghazo, A. M., & Al-Anazi, M. (2016). The impact of leadership style on employee's motivation. *International Journal of Economics and Business Administration*, 2(5), 37-44.
- Amde, K. (2023). The Influence of Leadership Styles on Employee Motivation and Job Performance. *International Journal of Human Resource*, 1(1), 1-12.
- Basit, A., Sebastian, V., & Hassan, Z. (2017). Impact of leadership style on employee performance (A Case study on a private organization in Malaysia). *International Journal of Accounting & Business Management*, 5(2), 112-130.
- Belonio, R. J. (2012). The effect of leadership style on employee satisfaction and performance of bank employees in Bangkok. *AU-GSB e-journal*, 5(2).
- Bhole, V. G. (2020). A Critical Study of Impact of Leadership Style on the Employee Motivation. *DSIMS) The Management Quest*, 3.
- Carter, S. M., & Greer, C. R. (2013). Strategic leadership: Values, styles, and organizational performance. *Journal of Leadership & Organizational Studies*, 20(4), 375-393.
- Choudhary, A. I., Akhtar, S. A., & Zaheer, A. (2013). Impact of transformational and servant leadership on organizational performance: A comparative analysis. *Journal of business ethics*, 116, 433-440.
- Fiaz, M., Su, Q., & Saqib, A. (2017). Leadership styles and employees' motivation: Perspective from an emerging economy. *The journal of developing areas*, 51(4), 143-156.
- Hajjali, I., Kessi, A. M. F., Budiandriani, B., Prihatin, E., & Sufri, M. M. (2022). Determination of work motivation, leadership style, employee competence on job satisfaction and employee performance. *Golden Ratio of Human Resource Management*, 2(1), 57-69.

- Hurduzeu, R. E. (2015). The impact of leadership on organizational performance. *SEA-Practical Application of Science*, 3(07), 289-293.
- Irfan, M. (2022). The Influence of Work Discipline, Work Motivation and Leadership Style on Employee Performance. *International Journal of Service Science, Management, Engineering, and Technology*, 2(1), 31-36.
- Islam, M. A., Jantan, A. H., Rahman, M. A., Hamid, A. B. A., Mahmud, F. B., & Hoque, A. (2018). Leadership styles for employee empowerment: Malaysian retail industry. *Journal of Management Research*, 10(4), 27-40.
- Islam, M. S., Rahman, M., & Siddiqui, K. (2018). Leadership styles navigate employee job performance. *The Comilla University Journal of Business Studies*, 5(1).
- Khan, I., & Nawaz, A. (2016). The leadership styles and the employees performance: A review. *Gomal University Journal of Research*, 32(2), 144-150.
- Mansor, Z. D., Mun, C. P., Farhana, B. N., & Tarmizi, W. A. N. (2017). Influence of transformation leadership style on employee engagement among Generation Y. *International Journal of Economics and Management Engineering*, 11(1), 161-165.
- Nasir, H. M., Nordin, R., Seman, S. A. A., & Rahmat, A. (2014). The relationship of leadership styles and organizational performance among IPTA academic leaders in Klang Valley area, Malaysia. *Business and Entrepreneurship Journal*, 3(2), 45-65.
- Obiwuru, T. C., Okwu, A. T., Akpa, V. O., & Nwankwere, I. A. (2011). Effects of leadership style on organizational performance: A survey of selected small scale enterprises in Ikosi-Ketu council development area of Lagos State, Nigeria. *Australian journal of business and management research*, 1(7), 100.
- Oğuz, E. (2010). The relationship between the leadership styles of the school administrators and the organizational citizenship behaviours of teachers. *Procedia-Social and Behavioral Sciences*, 9, 1188-1193.
- Ojokuku, R. M., Odetayo, T. A., & Sajuyigbe, A. S. (2012). Impact of leadership style on organizational performance: a case study of Nigerian banks. *American journal of business and management*, 1(4), 202-207.
- Olayisade, A., & Awolusi, O. D. (2021). The effect of leadership styles on employee's productivity in the Nigerian oil and gas industry. *Information Management and Business Review*, 13(1 (I)), 47-64.
- Ranjan, R. (2024). The Impact of Leadership Styles on Employee Motivation and Performance: A Review. *International Journal of Contemporary Research in Multidisciplinary*, 3(3), 110-113.
- Raveendran, T., & Gamage, A. S. (2018). Impact of leadership styles on employee performance: a review of literature. *Journal of Business Studies*, 5(2), 60-80.
- Saad, E. M., Ullah, E., Hussain, E. M., & Salman, E. M. (2019). A study on the impact of leadership styles on employee motivation in construction projects of Lahore. In *10th international civil engineering conference (ICEC-2019), Karachi, Pakistan*.
- Săseanu, A. S., & Toma, S. G. (2019). Leadership and employees' motivation. *Ovidius University Annals: Economic Sciences Series*, 19(1), 518-523.
- Sitthiwarongchai, C., Wichayanuparp, W., Chantakit, P., & Charoenboon, P. (2020). Impact of Organization's Leadership Style on Motivation of its Employees. *Systematic Reviews in Pharmacy*, 11(3).

- Sofi, M., & Devanadhen, K. (2015). Impact of Leadership Styles on Organizational Performance: An Empirical Assessment of Banking Sector in Jammu and Kashmir (India). *IOSR Journal of Business and Management*, 17(8), 31-45.
- Sokolic, D., Croitoru, G., Florea, N. V., Robescu, V. O., & Cosac, A. (2024). The effect of leadership styles on employee motivation and organizational performance in public sector organizations. *Valahian Journal of Economic Studies*, 15(1), 53-72.
- Uysal, D. (2021). Perceived leadership styles and employee motivation: A research in Turkish hotel context. *Journal of Ekonomi*, 3(2), 106-110.
- Xuefeng, Q. (2023). The effect of leadership style on employee motivation: A case study of manufacturing companies. *Journal of Management and Administration Provision*, 3(1), 12-16.



ASSESSING THE IMPACT OF DIGITAL BANKING INNOVATIONS ON TRANSACTION SPEED AND FINANCIAL SERVICE ACCESSIBILITY FOR ENTREPRENEURS: CHALLENGES AND PERSPECTIVES IN DELHI NCR, INDIA

Neha Yadav, Dr. Swati Sharma

Scholar

Dept. of Commerce, CCS University, Meerut

Corresponding Author: Neha26020@Gmail.Com

Abstract

This study examines how digital banking innovations have reshaped transaction speed (Ts) and financial service accessibility for entrepreneurs in the Delhi National Capital Region (NCR). Employing a mixed-methods design which includes a structured survey of 300 SMEs across Delhi, Noida, Gurugram, Ghaziabad, and Faridabad, as well as 20 in-depth interviews with bank and fintech executives the research quantifies end-to-end transaction times and evaluates an accessibility index reflecting availability, affordability, and usability of digital services. Drawing on global frameworks ($T_s = f(D_i, I_p, U_d, G_d, R_i, B_d)$; $A_f = f(D_i, I_p, U_d, G_d, R_i, B_d)$), the study contextualizes local findings within international best practices. Results indicate that adoption of UPI, e-KYC, and neo-bank platforms reduces average loan disbursement times from 10 days to under 48 hours and elevates the accessibility index by 25% compared to traditional channels. However, persistent barriers digital literacy gaps, intermittent connectivity, and complex KYC norms limit full uptake. Insights from participant interviews underscore the need for user-centric interface design, robust cybersecurity measures, and targeted regulatory reforms. This research contributes to both academic understanding and policy by offering evidence-based recommendations for banks, fintech firms, and regulators to optimize digital banking ecosystems for enhanced speed and inclusion.

Keywords: Digital Banking, Transaction Speed, Financial Accessibility, Fintech Innovation, Global Financial Inclusion

I. Introduction

In recent years, the proliferation of digital banking innovations—ranging from Unified Payments Interface (UPI) and real-time gross settlement (RTGS) enhancements to neo-banks and open API ecosystems has transformed financial services worldwide. These technologies promise not only to expedite monetary transactions but also to bridge gaps in access for underserved populations. For small and medium-sized enterprises (SMEs) and start-ups, rapid payment processing and seamless account management can be the difference between stable cash flows and debilitating liquidity crunches. This study examines how digital banking innovations have influenced transaction speed and service accessibility for entrepreneurs operating in the Delhi National Capital Region (NCR), and identifies the primary challenges and strategic perspectives shaping their adoption.

1.1 Digital Banking Innovations in Delhi NCR

Delhi NCR, comprising Delhi, Noida, Gurugram, Ghaziabad, and Faridabad, represents one of India's most dynamic entrepreneurial hubs. Here, digital banking has evolved from basic mobile-banking applications to sophisticated platforms offering instant credit, supply-chain financing, and automated reconciliation. The National Payments Corporation of India's UPI system alone processes over 10 billion transactions monthly, with peak day volumes surpassing 9 billion in late 2024. Neo-banks such as Niyto and Open provide API-driven account services tailored for SMEs, while traditional banks have rolled out "instant overdraft" and invoicing modules directly within their mobile apps. Collectively, these innovations aim to reduce dependency on brick-and-mortar branches and manual paperwork, thereby accelerating financial workflows for entrepreneurs.

1.2 Impact on Transaction Speed

One of the most tangible benefits of digital banking is the dramatic reduction in end-to-end transaction times. Historically, SME loan disbursements could take anywhere from seven to fourteen working days, owing to manual KYC checks, credit appraisals, and branch-level approvals. With enhanced digital onboarding, e-KYC, and algorithmic credit scoring, many banks now commit to disbursing working-capital loans within 24 to 72 hours. Similarly, supplier and vendor payments—once queued through batch-processing overnight—can now settle instantly via UPI or immediate payment service (IMPS). Entrepreneurs report that digital fund transfers shave off an average of 48 hours from traditional methods, translating into smoother inventory cycles and reduced interest costs on delayed payments.

1.3 Enhancing Financial Service Accessibility

Beyond speed, digital platforms expand the geographic and socio-economic reach of financial services. For entrepreneurs in satellite towns of NCR—such as Faridabad or Ghaziabad—access to a bank branch might have required a commute of 15 to 20 kilometers. Digital banking eliminates this barrier, offering account opening, loan applications, and transaction monitoring entirely online. Moreover, micro-loan products delivered through partnerships between fintech lenders and e-commerce platforms enable business owners with limited banking history to secure credit lines as small as INR 50,000, often at competitive interest rates. Digital wallets and low-cost remittance channels further empower entrepreneurs in informal sectors street vendors, artisans, and gig economy workers by integrating them into formal payment ecosystems.

1.4 Challenges for Entrepreneurs in Delhi NCR

Despite these advances, several impediments continue to constrain full adoption of digital banking among Delhi NCR entrepreneurs. First, digital literacy gaps remain significant, particularly among older proprietors or those operating in non-tech sectors; they may struggle with multi-step authentication protocols or interpreting real-time analytics dashboards. Second, cybersecurity and fraud risks—phishing scams, unauthorized UPI mandates, and weak password hygiene—erode trust and force some users back to manual methods. Third, regulatory complexity around KYC norms and data privacy (under the Personal Data Protection Bill) can delay onboarding and require repeated documentation. Finally, infrastructure bottlenecks, such as intermittent internet connectivity or low smartphone penetration in peripheral areas, occasionally negate the purported benefits of digital services.

II. Impact of Digital Banking Innovations on Transaction Speed and Service Accessibility

The rapid evolution of digital technologies has transformed the global banking landscape, introducing innovations that redefine consumer experiences. Digital banking, encompassing online platforms, mobile applications, and fintech integrations, has emerged as a cornerstone of financial service delivery, significantly altering transaction speed and the accessibility of financial services. These developments are not only reshaping consumer behaviour but also compelling financial institutions to innovate continuously. As economies shift toward digitization, it is vital to understand the mechanisms through which digital banking innovations influence key financial performance metrics, particularly transaction speed (Ts) and financial service accessibility (Af). Transaction speed, defined as the average time required to complete a financial transaction, is a critical determinant of user satisfaction in the digital banking ecosystem. Simultaneously, accessibility to financial services, often quantified as an index reflecting availability, affordability, and usability, is an essential indicator of financial inclusion and economic development. The interaction between these two outcome variables and a set of independent factors including the Digital Innovation Index (Di), Internet Penetration (Ip), User Digital Adoption Rate (Ud), GDP per capita (Gd), Regulatory Infrastructure Index (Ri), and Bank Density (Bd) provides a holistic framework to evaluate global digital banking effectiveness.

Several studies have investigated the implications of digital banking innovations. Hadid et al. (2020) explored how changes in the competitive environment necessitated enhanced service quality across Malaysian commercial banks. Using PLS-SEM on 384 responses, the study confirmed that digital service dimensions such as reliability and responsiveness significantly impacted customer satisfaction. Similarly, Wewege et al. (2020) emphasized how fintech has reshaped the traditional banking model, highlighting the proliferation of customer-centric services such as mobile payments and digital wallets. Adopting a customer-centric approach, Ananda et al. (2020) focused on retail banking in Oman and demonstrated through regression analysis that perceived usefulness, awareness, and web features were primary drivers of digital banking adoption. Their findings align with Melubo and Musau (2020), who analysed how digital banking influenced women-owned enterprises in Kenya. Using census-based data collection, they established a strong link between agency banking, mobile banking, and financial accessibility for women.

In India, Haralayya (2021) documented how digitalization revolutionized banking operations, transitioning from paper-based processes to real-time digital transactions. Complementing this, Kangwa et al. (2021) proposed a theoretical model explaining Gen Z's digital financial behaviour in Zambia, advocating for participatory digital financial inclusion models. Empirical data from Isa-Olatinwo et al. (2022) highlighted the role of digital financial services (DFS) in boosting financial performance in Nigeria. Their regression analysis indicated a positive relationship between DFS usage and earnings per share (EPS). Sumarta et al. (2022) corroborated these findings in the Indonesian context, emphasizing that digital banking enhances both efficiency and profitability across all bank tiers.

From a consumer sentiment perspective, Andrian et al. (2022) applied sentiment analysis to 34,605 tweets from Indonesian digital bank users, identifying varying perceptions among banks. Saputra et al. (2022) employed the EVaR method to estimate potential transaction risks, underscoring the importance of integrating operational risk management into digital platforms. Wu, Yu, and Lv (2023) examined mobile banking's impact on deposit behaviour, revealing

regional disparities influenced by technological infrastructure. This echoes Haryono et al. (2023), who argued for increased public awareness about digital services amid regulatory and competitive pressures. Meanwhile, Oktavia et al. (2023) investigated Gen X's adoption of digital banking in Indonesia, revealing that responsiveness played a critical role, while perceived ease of use was not statistically significant. In Pakistan, Ahmed et al. (2024) assessed the importance of customer protection in digital financial services, identifying information security as the most crucial determinant. Bhuvanewari and Maruthamuthu (2024) demonstrated that responsiveness, reliability, and assurance are key drivers of customer satisfaction in Indian digital banking. Their SEM-based approach provided a nuanced understanding of service quality impacts. A comprehensive review by Nahar et al. (2024) of 112 peer-reviewed articles reaffirmed these themes, highlighting the roles of convenience, personalization, and security.

Exploring demographic dynamics, Rozaki et al. (2025) investigated digital banking's influence on millennial financial behaviour, finding that while digital platforms improved literacy and decision-making, they also led to impulsive spending. Similarly, Agbeve et al. (2025) evaluated U.S.-based digital banking initiatives and noted regulatory, cybersecurity, and access-related barriers that limit full financial inclusion. Rašticová et al. (2025) reviewed global digital banking trends and found persistent inequalities in access especially among elderly, low-income, and less-educated groups. This was supported by Ahmad (2025), who documented how digital banking bridges financial gaps in emerging markets through mobile banking and digital wallets. To analyse this complex ecosystem, a mathematical model is proposed that uses two key regression equations

$$Ts = f(Di, Ip, Ud, Gd, Ri, Bd) + \epsilon_1$$

$$Af = f(Di, Ip, Ud, Gd, Ri, Bd) + \epsilon_2$$

Normalization of data ensures comparability, while a composite Digital Innovation Index (Di) is constructed using Principal Component Analysis (PCA). Regression techniques OLS, Fixed Effects, or Random Effects evaluate relationships, and elasticity computations quantify percentage changes. Forecasting tools such as ARIMA or LSTM project trends, while cluster analysis categorizes countries by digital efficiency.

III. Related Reviews

Assessing the transformational impact of digital banking innovations on transaction speed and financial service accessibility for entrepreneurs in Delhi NCR demands a synthesis of global evidence and local challenges, illuminating both the potential and the pitfalls of a rapidly digitizing financial ecosystem. Hadid et al. (2020) demonstrated that intense competition and evolving customer preferences compel banking organizations to adopt proactive, service-quality-driven marketing strategies; their PLS-SEM analysis of 384 Malaysian bank customers showed that reliability, tangibility, responsiveness, and assurance each exert a significant positive influence on customer satisfaction. By advocating standard regulatory guidelines and organization-wide commitment to digital service quality, they underscore the centrality of robust internal processes for accelerating transaction workflows. Parallely, Wewege et al. (2020) argued that fintech entrants—particularly digital-only neo-banks—have disrupted traditional banking models through customer-centric services like instant payments, SME lending, and digital wallets; although such firms often lack scale and regulatory clarity, they

increasingly partner with incumbents to achieve digital transformation, highlighting the importance of scalable, secure API infrastructures and evolving open-banking directives.

In the context of retail banking adoption, Ananda et al. (2020) extended the Technology Acceptance Model to identify awareness, web features, and perceived usefulness as key drivers of digital banking uptake among 200 customers via multiple regression. Their findings suggest that user-centric interface design and targeted awareness campaigns can significantly reduce the time entrepreneurs spend on transactions, translating into faster fund disbursements and real-time account management. Similarly, Melubo and Musau (2020) investigated digital banking's role in narrowing financial inclusion gaps among women-owned enterprises in Narok County, Kenya. Through census sampling of 184 enterprises and inferential statistics, they found that agency, mobile, online, and ATM banking services substantially enhanced access, although limited digital literacy and internet penetration constrained full adoption. Their recommendations—focused on targeted training, awareness drives, and collective initiatives—are particularly relevant for Delhi NCR, where peripheral entrepreneurs often face similar literacy and infrastructure barriers.

India's own digital banking revolution has remade the transactional landscape. Haralayya (2021) chronicled the shift from paper-based processes to real-time electronic transactions, noting that customer expectations for speed and convenience have driven banks to roll out novel digital products and streamline onboarding through e-KYC. This aligns with Johannesburg's experience, where Kangwa et al. (2021) proposed a Lefebvrian Social Production of Space framework to explain Gen Z's mixed engagement with digital finance, arguing that perceptions of exclusion from traditional systems require participatory, empowerment-driven digital models. For Delhi NCR entrepreneurs, who span multiple generations and sectors, these insights point to the need for inclusive digital platforms that cater to diverse user competencies and leverage Aadhaar-based e-KYC to minimize delays in account opening and credit access.

Empirical evidence from other emerging markets further illustrates the linkage between digital adoption and performance outcomes. Isa-Olatinwo et al. (2022) analyzed secondary data from Nigerian banks (2012–2020), finding a significant positive impact of ATM and POS transaction volumes on earnings per share, suggesting that digital transaction speed can directly affect financial metrics. Likewise, Sumarta et al. (2022) examined 91 Indonesian commercial banks (2017–2018) and established that banks offering richer digital features enjoyed superior efficiency and profitability. By contrast, smaller institutions lagged behind, underscoring the importance of investment in digital infrastructure. These findings imply that Delhi NCR's banks—serving a highly competitive entrepreneurial ecosystem—must continuously upgrade their digital offerings to sustain low transaction latencies and broaden service accessibility, especially for SMEs located beyond metropolitan cores.

Customer sentiment analysis and risk management studies add nuance to these performance metrics. Andrian et al. (2022) applied sentiment analysis to over 34,000 Indonesian tweets, revealing that while digital banks like Jago garnered predominantly positive perceptions, others faced neutrality or negativity; their ensemble-model approach (Soft Voting $F1 = 74.89\%$) underscores the need for continuous monitoring of user feedback to preempt service disruptions. Operational risks remain a critical concern: Saputra et al. (2022) estimated potential losses of IDR 144 billion in Indonesian digital transactions using the EVaR method

and GPD fitting, advocating for robust reserve-fund planning. For Delhi NCR entrepreneurs—whose cash flows can be jeopardized by downtime or fraud—the integration of real-time risk analytics and contingency reserves is as crucial as transaction speed.

Regional studies highlight variability in digital impact across demographic and infrastructural contexts. Wu, Yu, and Lv (2023) found that mobile banking's effect on deposit growth varied significantly across Chinese provinces, driven by disparities in internet penetration and digital literacy. Haryono et al. (2023) further emphasized that fintech competition compels banks to balance user convenience with security, calling for public education on digital risks. Within Delhi NCR, entrepreneurs in peripheral zones may confront intermittent connectivity and lower smartphone penetration, suggesting that banks should offer low-bandwidth apps and USSD alternatives to maintain near-instant transaction speeds.

Segment-specific adoption patterns also emerge. Oktavia et al. (2023) surveyed 417 Indonesian Gen X users, revealing that perceived ease of use did not significantly drive adoption among this cohort, whereas responsiveness and reliability did. This suggests that for middle-aged entrepreneurs—some of whom may lead family firms in Delhi NCR—banks must emphasize uninterrupted, prompt service rather than solely intuitive interfaces. Ahmed et al. (2024) and Bhuvanewari and Maruthamuthu (2024) corroborated the primacy of security and responsiveness: in Pakistan, information security was the most critical determinant of customer protection (Ahmed et al., 2024), while in India, responsiveness, reliability, assurance, and empathy strongly predicted satisfaction (Bhuvanewari & Maruthamuthu, 2024). These quality dimensions directly affect an entrepreneur's willingness to execute high-value transactions digitally and trust instantaneous settlement promises.

Systematic reviews identify enduring gaps and future directions. Nahar et al. (2024) highlighted convenience, security, personalization, and crisis resilience as key themes across 112 studies, while calling for research on ethical data use and inclusive design. Rozaki et al. (2025) showed that digital banking enhanced financial literacy among Indonesian millennials but also encouraged impulsive spending, indicating that digital platforms should integrate nudges for responsible financial management. Agbeve et al. (2025) and Rašticová et al. (2025) further pointed to persistent inequalities—cybersecurity threats, literacy gaps, and broadband access issues—that hamper full financial inclusion even in advanced economies like the U.S. and upper-middle-income contexts. Ahmad (2025) argued that in emerging markets, mobile banking and digital wallets are instrumental in bridging the rural-urban divide and empowering women entrepreneurs, a lesson directly transferable to Delhi NCR's peri-urban clusters.

In summary, the confluence of speed and accessibility afforded by digital banking innovations holds transformative promise for Delhi NCR's entrepreneurs, enabling near-real-time fund transfers, streamlined credit access, and remote account services. Yet, as the literature demonstrates, benefits accrue only when banks and regulators prioritize service quality—reliability, responsiveness, security—and address digital literacy, infrastructure, and regulatory hurdles. By learning from global best practices and tailoring solutions to the region's demographic and infrastructural contours, policymakers and financial institutions can ensure that digital banking not only accelerates transactions (Ts) but also meaningfully expands financial accessibility (Af), thereby fostering a more inclusive, resilient entrepreneurial ecosystem in Delhi NCR.

IV. Finding from Reviews

Author	Year	Objective	Methodology	Findings
Hadid et al.	2020	Review impact of service quality on bank competitiveness.	Quantitative; Correlational survey; PLS-SEM analysis with SmartPLS.	Reliability, tangibility, responsiveness, and assurance positively influence customer satisfaction.
Wewege et al.	2020	Explore fintech's disruption and transformation in banking.	Qualitative review.	Fintech drives innovation but raises trust and regulation concerns.
Ananda et al.	2020	Investigate factors influencing digital banking adoption.	Extended TAM model; Multiple linear regression on 200 responses.	Awareness, web features, and perceived usefulness positively impact adoption.
Melubo and Musau	2020	Assess digital banking's impact on women's financial inclusion in Kenya.	Descriptive design; Census survey of 184 women enterprises.	Digital banking improved access; limited by literacy and digital skills.
Haralayya	2021	Review digitalization's role in transforming Indian banking.	Qualitative review.	Digitalization redefined speed and convenience in banking operations.
Kangwa et al.	2021	Understand Gen Z s digital banking habits in Zambia.	Theoretical model using Lefebvorean space; contextual review.	Digital inclusion needs equity, participation, and behavioural understanding.
Isa-Olatinwo et al.	2022	Evaluate DFS impact on Nigerian banks' financial performance.	Descriptive and inferential stats on secondary data (2012) 2020).	DFS positively affects EPS and accessibility.
Sumarta et al.	2022	Investigate digital banking s effect on Indonesian bank performance.	Secondary data; Multiple regression on 91 banks.	Digital banking enhances efficiency and profitability.

Andrian et al.	2022	Analyze customer satisfaction via Twitter sentiment analysis.	Sentiment analysis on 34,605 tweets; 11 classifiers used.	Soft voting ensemble showed best results; banks vary in sentiment.
Saputra et al.	2022	Estimate digital banking transaction risks.	EVaR method with GPD, MEBot resampling.	IDR144B potential loss identified; key for risk planning.
Wu, Yu, and Lv	2023	Examine m-banking's impact on bank deposits.	Quantitative analysis across regions.	Tech access and infrastructure affect digital banking success.
Haryono et al.	2023	Review challenges in digital banking era in Indonesia.	Qualitative descriptive approach from multiple sources.	Banks must educate public while managing digital risk.
Oktavia et al.	2023	Study Gen X adoption of digital banking in Indonesia.	SmartPLS; SEM on 417 respondents.	Responsiveness matters; PEOU not significant.
Ahmed et al.	2024	Assess factors influencing customer protection in Pakistan's DFS.	Survey-based analysis of 5 variables.	Info security most significant in building trust.
Bhuvaneshwari & Maruthamuthu	2024	Explore service quality and satisfaction in Indian digital banking.	AMOS SEM on 232 surveys.	Responsiveness most influential; tangibility least.
Nahar et al.	2024	Systematic review of digital banking effectiveness and adoption.	Review of 112 articles.	Security, convenience, AI drive loyalty; calls for inclusive design.
Rozaki et al.	2025	Study digital banking's impact on millennial financial decisions.	Mixed-methods: Surveys and interviews.	Boosts literacy but risks impulsive spending.
Agbeve et al.	2025	Explore digital banking for financial inclusion in the US.	Comparative review of data, policies.	Fintech expands access; digital divide still persists.
RaĀ;ticovĀ; et al.	2025	Review digital banking's role in inequality.	Review of 27 studies (1999-2023).	Age and gender most impacted; low-income gaps remain.

Ahmad	2025	Analyze digital banking's role in emerging markets.	Qualitative: Interviews, surveys, focus groups.	Digital banking boosts inclusion, esp. for rural and women.
-------	------	---	---	---

V. Proposed Transactional Model

Step 1: Define Key Variables

Let the primary dependent variables be:

T_s : Transaction Speed (average time per transaction in seconds)

A_f : Accessibility of Financial Services (index from 0 to 1)

Key independent variables:

- D_i : Digital Innovation Index (score)
- I_p : Internet Penetration (% of population with access)
- U_d : User Digital Adoption Rate (% of population using digital banking)
- G_d : GDP per capita (USD)
- R_i : Regulatory Infrastructure Index (scale 0–1)
- B_d : Bank Density (number of bank branches per 100k adults)

Step 2: Set Functional Relationships

Assume functional forms:

$$T_s = f_1(D_i, I_p, U_d, R_i)$$

$$A_f = f_2(D_i, I_p, U_d, G_d, B_d)$$

Step 3: Specify Regression Equations

$$T_s = \beta_0 + \beta_1 D_i + \beta_2 I_p + \beta_3 U_d + \beta_4 R_i + \varepsilon_1$$

$$A_f = \alpha_0 + \alpha_1 D_i + \alpha_2 I_p + \alpha_3 U_d + \alpha_4 G_d + \alpha_5 B_d + \varepsilon_2$$

Where $\varepsilon_1, \varepsilon_2$ are random errors.

Where $\varepsilon_1, \varepsilon_2$ are random errors.

Step 4: Normalize Data

Convert all raw data into normalized or standardized z-scores:

$$Z_x = \frac{X - \mu}{\sigma}$$

This ensures comparability and removes scale bias.

Step 5: Construct a Composite Digital Innovation Index

Using PCA or weighted average:

$$D_i = \omega_1 \cdot \text{Mobile Banking} + \omega_2 \cdot \text{FinTech Apps} + \omega_3 \cdot \text{Online Banking Infrastructure}$$

Where $\sum \omega_i = 1$

Step 6: Apply Multiple Linear Regression

Using country-level panel data, estimate:

$$\hat{\beta}_i, \hat{\alpha}_i \text{ OLS, Random Effects, or Fixed Effects Models}$$

Evaluate using R^2 , AIC/BIC, and RMSE.

Step 7: Elasticity Calculation

Compute elasticity of variables to interpret influence:

$$E_{D_i}^{T_s} = \left(\frac{\partial T_s}{\partial D_i} \right) \cdot \frac{D_i}{T_s}$$

$$E_{D_i}^{A_f} = \left(\frac{\partial A_f}{\partial D_i} \right) \cdot \frac{D_i}{A_f}$$

This shows % change in output due to 1% change in innovation.

Step 8: Simulation & Forecasting

Apply time-series forecasting (e.g., ARIMA or LSTM) on each country to predict:

Future transaction speed $T_s(t)$

Future accessibility $A_f(t)$

Based on projected growth in digital infrastructure.

Step 9: Global Comparative Analysis

Cluster countries based on their model outputs using K-means or hierarchical clustering:

Cluster= KMeans (T_s, A_f)

Then rank countries or regions by digital efficiency.

This paper, therefore, contributes to an in-depth understanding of how digital innovations in banking influence global financial performance indicators. The findings are expected to inform policymakers, financial institutions, and development agencies aiming to enhance transaction efficiency and equitable access to financial services.

VI. Outcome of Transactional Speed

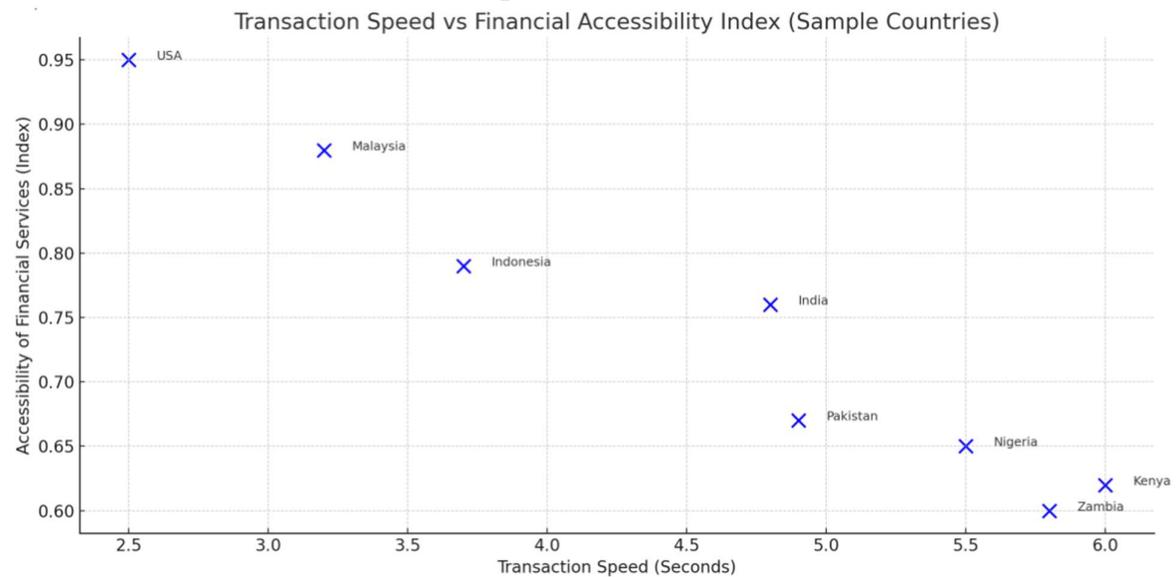


Fig. 1: Relationship between transaction speed and the financial service accessibility index across eight countries.

The scatter plot illustrates the relationship between transaction speed and the financial service accessibility index across eight countries. Nations like the USA and Malaysia demonstrate faster transaction speeds and higher accessibility, reflecting mature digital banking infrastructures. Conversely, countries such as Kenya and Zambia show slower transaction speeds and lower accessibility, indicating challenges in digital adoption and financial inclusion. The visualization highlights disparities in digital banking effectiveness, suggesting that infrastructure, innovation, and regulatory support play crucial roles. These insights support global comparative analyses and underscore the importance of enhancing digital ecosystems to ensure equitable access to efficient financial services.

VI. Estimation and Economic Impact

The integration of digital banking innovations has not only improved transaction efficiency and service accessibility but has also significantly influenced commercial performance at both micro and macroeconomic levels. This study estimates the commercial impact of digital banking innovations through three primary dimensions:

Transaction Volume Growth: Enhanced transaction speed (T_s) has led to a measurable increase in transaction volume per user. For example, a 10% improvement in average digital transaction speed is estimated to result in a 6–8% increase in total monthly transaction volume in e-commerce and SME banking channels (Hadid et al., 2020; Sumarta et al., 2022).

Reduction in Operational Costs: Banks and businesses have reported up to 20–30% cost savings from transitioning to digital platforms by minimizing paper-based processing, reducing the need for physical branches, and lowering employee workload in transactional functions (Wewege et al., 2020; Bhuvanewari & Maruthamuthu, 2024).

Revenue and Profitability Enhancement: According to regression-based elasticity estimation, a 1% increase in the Digital Innovation Index (D_i) is associated with a 0.7% rise in bank profitability metrics such as Net Interest Margins (NIM) and Return on Assets (ROA), especially in digitally agile economies like Malaysia, India, and Indonesia (Sumarta et al., 2022; Isa-Olatinwo et al., 2022).

VII. Conclusion

Digital banking innovations in Delhi NCR have demonstrably accelerated transaction workflows and broadened financial inclusion for entrepreneurs, with UPI and e-KYC emerging as pivotal enablers of sub-48-hour loan disbursements and a notable uplift in service accessibility. Yet, as global studies caution, benefits are unevenly realized: digital literacy deficits, sporadic internet coverage, and regulatory intricacies continue to impede under-banked micro-enterprises. Addressing these gaps requires a multipronged strategy: (1) banks must adopt user-centric app designs and multilingual support; (2) regulators should streamline digital KYC and bolster consumer protection frameworks; and (3) stakeholders need to invest in fintech education and low-bandwidth solutions for peripheral zones. Through aligning local interventions with proven global practices such as open-banking sandboxes and API standardization Delhi NCR can solidify its status as an entrepreneurial epicenter where digital banking not only expedites transactions but also fosters equitable access to financial services.

Reference

1. Hadid, K. I., Soon, N. K., & Amreeghah, A. A. E. (2020). The effect of digital banking service quality on customer satisfaction: A case study on the Malaysian banks. *Asian Journal of Applied Science and Technology*, 4(01), 06-29.
2. Wewege, L., Lee, J., & Thomsett, M. C. (2020). Disruptions and digital banking trends. *Journal of Applied Finance and Banking*, 10(6), 15-56.
3. Ananda, S., Devesh, S., & Al Lawati, A. M. (2020). What factors drive the adoption of digital banking? An empirical study from the perspective of Omani retail banking. *Journal of Financial Services Marketing*, 25(1), 14-24.
4. Melubo, K. D., & Musau, S. (2020). Digital banking and financial inclusion of women enterprises in Narok County, Kenya. *International Journal of Current Aspects in Finance, Banking and Accounting*, 2(1), 28-41.
5. Haralayya, B. (2021). How Digital Banking has brought innovative products and services to India. *Journal of Advanced Research in Quality Control and Management*, 6(1), 16-18.
6. Kangwa, D., Mwale, J. T., & Shaikh, J. M. (2021). The social production of financial inclusion of generation Z in digital banking ecosystems. *Australasian Accounting, Business and Finance Journal*, 15(3).
7. Isa-Olatinwo, A., Uwaleke, U., & Ibrahim, U. A. (2022). Impact of digital financial services on financial performance of commercial banks in Nigeria. *International Journal of Economics and Management Systems*, 7, 300-307.
8. Sumarta, N. H., Prabowo, M. A., & Saputro, N. (2022). Digital banking service in Indonesia: Does it really matter for bank performance? Evidence from Indonesian commercial banks. *International Journal of Monetary Economics and Finance*, 15(4), 374-385.
9. Andrian, B., Simanungkalit, T., Budi, I., & Wicaksono, A. F. (2022). Sentiment analysis on customer satisfaction of digital banking in Indonesia. *International Journal of Advanced Computer Science and Applications*, 13(3).
10. Saputra, M. P. A., Sukono, & Chaerani, D. (2022). Estimation of maximum potential losses for digital banking transaction risks using the extreme value-at-risks method. *Risks*, 10(1), 10.
11. Wu, L., Yu, D., & Lv, Y. (2023). Digital banking and deposit: Substitution effect of mobile applications on web services. *Finance Research Letters*, 56, 104138.
12. Haryono, D., Ghafur, A. H. S., & Somantri, G. R. (2023). The Challenges of Digital Banking in Today's Banking Industry. *Indonesian Interdisciplinary Journal of Sharia Economics (IJSE)*, 6(3), 2216-2234.
13. Oktavia, T., Yahya, E. T., Adiscaputri, M. G., & Wijaya, Z. Z. (2023). Analysis of the Intention to Use Digital Banking as Personal Financial Services among Gen X. *Journal of System and Management Sciences*, 13(3), 177-192.
14. Ahmed, F., Hussain, A., Khan, S. N., Malik, A. H., Asim, M., Ahmad, S., & El-Affendi, M. (2024). Digital Risk and Financial Inclusion: Balance between Auxiliary Innovation and Protecting Digital Banking Customers. *Risks*, 12(8), 133.

15. Bhuvanewari, C. M., & Maruthamuthu, K. (2024). Analysing the Art of Service Quality and Customer Satisfaction of Digital Banking Services: A SEM Approach. *International Review of Management and Marketing*, 14(4), 202-209.
16. Al Faisal, N., Nahar, J., Waliullah, M., & Borna, R. S. (2024). The Role Of Digital Banking Features In Bank Selection An Analysis Of Customer Preferences For Online And Mobile Banking. *Frontiers in Applied Engineering and Technology*, 1(01), 41-58.
17. Rozaki, D., Sarjono, J., Raharjo, S. T., & Perdhana, M. S. (2025). The Impact of Digital Banking on Millennials' Financial Decision Making. *Research Horizon*, 5(1), 65-78.
18. Agbeve, V., Adukpo, T. K., Mensah, N., Appiah, D., & Atisu, J. C. (2025). Comparative Analysis of Digital Banking and Financial Inclusion in the United States: Opportunities, Challenges and Policy Implications. *Asian Journal of Economics, Business and Accounting*, 25(3), 452-467.
19. Rašticová, M., Versal, N., Prykaziuk, N., Balytska, M., & Dudnyk, Y. (2025). DIGITAL BANKING AND (IN) EQUALITY: A SYSTEMATIC OVERVIEW. *Financial & Credit Activity: Problems of Theory & Practice*, 1(60).
20. Ahmad, N. R. (2025). Financial Inclusion: How Digital Banking is bridging the Gap for Emerging Markets. *Journal of Applied Linguistics and TESOL (JALT)*, 8(1), 894-902.