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**EXPLORING BUSINESS PRACTICES IN THE SME SECTOR: A PUNE CITY SURVEY**

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**ABSTRACT**

*Small and Medium Enterprises (SMEs) are pivotal to India's economic growth, contributing significantly to employment and GDP. Pune, a burgeoning industrial hub, hosts a vibrant SME ecosystem facing unique challenges and opportunities. Despite their importance, there is limited research on the business practices of SMEs in Pune, particularly regarding operational strategies, technology adoption, and financial management. This study reveals that SMEs in Pune prioritize cost-effective operations and customer satisfaction but struggle with limited access to finance and digital transformation. 62% of surveyed SMEs reported inadequate financial support, while 48% adopted digital tools partially, impacting scalability. Strengthening financial access and fostering digital literacy can enhance SME competitiveness in Pune.*

**Keywords:** *SMEs, business practices, Pune, financial management, technology adoption, economic growth.*

**INTRODUCTION**

Small and Medium Enterprises (SMEs) form the backbone of India's economy, contributing over 30% to the GDP and employing nearly 110 million people (Ministry of MSME, 2023). Globally, SMEs drive innovation and resilience, yet they face persistent challenges such as limited capital, regulatory hurdles, and technological disruptions. In Pune, a city renowned for its industrial and IT sectors, SMEs play a critical role in fostering economic dynamism. However, evolving market demands, rising competition, and digital transformation pressures create a complex landscape for these enterprises. Current trends indicate a shift toward sustainability and technology-driven operations, but issues like financial constraints and skill gaps hinder progress (Sharma & Gupta, 2022). This study explores the business practices of SMEs in Pune, shedding light on their operational, financial, and strategic approaches amid these challenges.

The research focuses on understanding the business practices of SMEs in Pune's manufacturing, retail, and service sectors. It examines key variables such as operational efficiency, financial management, technology adoption, and market orientation. While prior studies have explored SME performance broadly, little is known about region-specific practices in Pune, a city balancing traditional industries with modern IT-driven enterprises. The interplay between known factors (e.g., cost management) and unknown aspects (e.g., extent of digital adoption) forms the core of this investigation. By focusing on Pune's SME sector, the study contextualizes how local economic conditions, cultural factors, and industrial diversity shape business practices (Patil & Deshmukh, 2021).

The need for this study arises from both theoretical and practical gaps. Theoretically, existing frameworks on SME growth often generalize findings across regions, overlooking localized dynamics. Practically, SMEs in Pune face unique challenges, such as high operational costs and competition from larger firms, which prior research has not adequately addressed. For instance, studies like Kumar and Rao (2020) highlight financial access as a universal issue but fail to explore how Pune's SMEs navigate this constraint. Societally, supporting SMEs can boost employment and regional development, making this study timely. Addressing these gaps could inform policies to enhance SME resilience, offering insights into sustainable business practices with broader implications for India's economic growth.

Despite the abundance of SME research, certain aspects remain underexplored. For example, the role of technology adoption in enhancing competitiveness among Pune's SMEs is inconsistent in the literature. While some studies (e.g., Joshi & Patil, 2019) suggest digital tools improve efficiency, others (e.g., Singh & Sharma, 2021) argue that SMEs lack the resources to implement them effectively. This inconsistency highlights an unresolved issue: how SMEs balance technological investment with financial constraints. Furthermore, the literature rarely examines the interplay between market orientation and operational strategies in a Pune-specific context, leaving a gap that this study aims to address.

Theoretically, this research draws on the Resource-Based View (RBV) and Dynamic Capabilities Framework to analyze SME practices. RBV emphasizes the role of resources (e.g., finance, technology) in achieving competitive advantage, while dynamic capabilities highlight adaptability to changing environments (Barney, 1991; Teece et al., 1997). Practically, the study seeks to identify actionable strategies for SMEs to improve efficiency and scalability. The primary aim is to explore the business practices of Pune's SMEs, assess their

challenges, and propose solutions to enhance their competitiveness. By bridging theoretical insights with practical outcomes, the study contributes to both academic discourse and policy formulation.

### OVERVIEW OF SMES AND THEIR IMPORTANCE

SMEs are critical to economic development, particularly in emerging economies like India. According to the Ministry of MSME (2023), SMEs account for 45% of India's industrial output and 40% of exports. Globally, SMEs contribute to innovation and job creation, acting as engines of growth (OECD, 2020). In India, they operate across diverse sectors, including manufacturing, retail, and services, adapting to local market needs (Sharma & Gupta, 2022). However, their growth is often constrained by external factors like policy uncertainty and internal factors like managerial inefficiencies (Kumar & Rao, 2020).

### BUSINESS PRACTICES IN SMES

Business practices in SMEs encompass operational strategies, financial management, technology adoption, and market orientation. Operational strategies focus on cost optimization and process efficiency. For instance, lean management practices have been shown to improve productivity in SMEs (Patil & Deshmukh, 2021). Financial management, however, remains a challenge, with many SMEs relying on informal credit due to limited access to formal banking (Joshi & Patil, 2019). Technology adoption is another critical area, with digital tools enabling SMEs to compete in global markets. Yet, adoption rates vary, with only 30% of Indian SMEs fully utilizing digital platforms (Singh & Sharma, 2021). Market orientation, which involves understanding customer needs, is vital for SME survival, particularly in competitive regions like Pune (Gupta & Malhotra, 2020).

### CHALLENGES FACED BY SMES

SMEs face numerous challenges, including financial constraints, regulatory complexities, and skill shortages. Access to finance is a persistent issue, with 60% of SMEs reporting difficulties in securing loans (Kumar & Rao, 2020). Regulatory compliance, such as GST and labor laws, adds to operational costs (Sharma & Gupta, 2022). Additionally, the lack of skilled labor hampers innovation, particularly in technology-driven sectors (Patil & Deshmukh, 2021). In Pune, these challenges are compounded by high competition and rising land costs, making it critical to study localized practices.

### Technology Adoption and Digital Transformation

The role of technology in SMEs has gained attention in recent years. Digital tools, such as e-commerce platforms and ERP systems, enhance efficiency and market reach (Joshi & Patil, 2019). However, adoption is uneven due to cost barriers and lack of awareness. Singh and Sharma (2021) found that only 25% of SMEs in India invest in advanced technologies, limiting their scalability. In Pune, a hub for IT and manufacturing, technology adoption is higher but still lags behind larger firms (Gupta & Malhotra, 2020). This gap underscores the need to explore how SMEs prioritize technology in their business practices.

Despite the extensive literature on SMEs, several gaps remain. First, most studies adopt a national or global perspective, neglecting region-specific dynamics. Pune, with its unique blend of traditional and modern industries, warrants focused research (Patil & Deshmukh, 2021). Second, the interplay between financial management and technology adoption is underexplored. While financial constraints are well-documented, their impact on digital transformation in Pune's SMEs is unclear (Kumar & Rao, 2020). Third, prior research often overlooks the role of market orientation in shaping operational strategies, particularly in competitive urban markets (Gupta & Malhotra, 2020). Finally, there is a lack of empirical studies using localized data to validate theoretical frameworks like RBV in the context of Pune's SMEs. This study addresses these gaps by examining business practices through a region-specific lens.

### OBJECTIVES AND HYPOTHESES

#### Objectives

1. To examine the key business practices adopted by SMEs in Pune, focusing on operational efficiency, financial management, and technology adoption.
2. To identify the challenges faced by SMEs in Pune and their impact on business performance.

#### Hypotheses

1. **H1:** There is a significant relationship between technology adoption and operational efficiency in Pune's SMEs.
2. **H2:** Financial constraints significantly affect the scalability of SMEs in Pune.
3. **H3:** Market orientation positively influences customer satisfaction among Pune's SMEs.

RESEARCH METHODOLOGY

This study adopts a quantitative approach to explore business practices among SMEs in Pune. A structured questionnaire was administered to 150 SME owners/managers across manufacturing, retail, and service sectors, selected through stratified random sampling to ensure representation. The questionnaire captured data on operational strategies, financial management, technology adoption, and market orientation. Data was collected between January and March 2025, with ethical approval from the institutional review board. Responses were analysed using SPSS version 26, employing descriptive statistics, correlation analysis, and t-tests to test hypotheses. The study ensures reliability (Cronbach's alpha > 0.7) and validity through pilot testing.

DATA ANALYSIS

Descriptive Analysis

The sample consisted of 150 SMEs, with 40% in manufacturing, 35% in retail, and 25% in services. Most SMEs (65%) had been operational for over 5 years, and 70% employed fewer than 50 workers. Descriptive statistics revealed that 62% of SMEs faced financial constraints, 48% partially adopted digital tools, and 75% prioritized customer satisfaction.

Table 1: Demographic Profile of SMEs

Variable	Category	Frequency	Percentage
Sector	Manufacturing	60	40%
	Retail	52	35%
	Services	38	25%
Years of Operation	<5 years	52	35%
	≥5 years	98	65%
Employee Size	<50	105	70%
	≥50	45	30%

Source: Survey data (2025).

**Interpretation:** The majority of SMEs are well-established (≥5 years), indicating resilience. The dominance of small-sized firms (<50 employees) suggests limited scalability, possibly due to resource constraints.

Table 2: Financial Management Practices

Practice	Frequency	Percentage
Formal Banking Loans	55	37%
Informal Credit	70	47%
Self-Financing	25	16%

Source: Survey data (2025).

**Interpretation:** Nearly half of SMEs rely on informal credit, highlighting limited access to formal banking. This practice may increase financial risks and hinder long-term growth.

Table 3: Technology Adoption Levels

Level	Frequency	Percentage
Fully Adopted	30	20%
Partially Adopted	72	48%
Not Adopted	48	32%

Source: Author's survey data (2025).

**Interpretation:** Partial adoption of technology is common, reflecting cost barriers or lack of expertise. This limits SMEs' ability to compete in digital markets.

Hypothesis Testing

H1: Technology Adoption and Operational Efficiency

A Pearson correlation test was conducted to examine the relationship between technology adoption (measured on a 5-point Likert scale) and operational efficiency (measured by cost reduction and productivity).

**Table 4:** Correlation Analysis for H1

Variable	Technology Adoption	Operational Efficiency
Technology Adoption	1	.62**
Operational Efficiency	.62**	1

**Source:** SPSS output (2025).

\*\* $p < .01$

**Interpretation:** The correlation coefficient ( $r = .62$ ,  $p < .01$ ) indicates a strong positive relationship. SMEs adopting technology report higher efficiency, supporting H1.

## H2: Financial Constraints and Scalability

An independent samples t-test compared SMEs with high vs. low financial constraints on scalability (measured by revenue growth).

**Table 5:** T-Test for H2

Group	N	Mean Scalability	SD	t-value	p-value
High Financial Constraints	93	2.8	0.9	-3.45	.001
Low Financial Constraints	57	3.5	1.1		

**Source:** SPSS output (2025).

**Interpretation:** SMEs with high financial constraints have lower scalability ( $M = 2.8$ ) than those with low constraints ( $M = 3.5$ ),  $t(148) = -3.45$ ,  $p = .001$ . H2 is supported.

## H3: Market Orientation and Customer Satisfaction

A correlation analysis tested the relationship between market orientation and customer satisfaction.

**Table 6:** Correlation Analysis for H3

Variable	Market Orientation	Customer Satisfaction
Market Orientation	1	.58**
Customer Satisfaction	.58**	1

**Source:** Author's SPSS output (2025).

\*\* $p < .01$

**Interpretation:** The correlation ( $r = .58$ ,  $p < .01$ ) confirms a positive relationship, supporting H3. Market-oriented SMEs achieve higher customer satisfaction.

## CONCLUSION

SMEs in Pune face challenges in adopting effective business practices due to financial constraints, limited technology adoption, and competitive pressures, necessitating a deeper understanding of their operational strategies. The study found that 62% of SMEs struggle with financial access, relying heavily on informal credit. Technology adoption is partial (48%), limiting efficiency, though a strong correlation exists between technology use and operational performance ( $r = .62$ ). Market orientation enhances customer satisfaction ( $r = .58$ ), underscoring its importance. Theoretically, the findings validate RBV and dynamic capabilities in a localized context. Practically, policymakers should prioritize financial inclusion and digital literacy programs for SMEs. Societally, supporting SMEs can boost employment and economic stability in Pune. The study is limited to Pune, reducing generalizability. The sample size (150) may not capture the full diversity of SMEs. Self-reported data introduces potential bias. Future research could explore SMEs in other Indian cities or use longitudinal designs to assess practice evolution. Investigating specific technologies (e.g., AI, IoT) could yield deeper insights. Pune's SMEs hold immense potential to drive economic growth, but their success hinges on overcoming financial and technological barriers. By fostering an ecosystem of support, stakeholders can empower these enterprises to thrive in a competitive landscape, contributing to India's vision of a self-reliant economy.

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**ARTIFICIAL INTELLIGENCE IN HUMAN RESOURCE MANAGEMENT**

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**ABSTRACT**

*The use of Artificial Intelligence (AI) in Human Resource Management (HRM) is modernizing traditional HR practices and processes. This paper explores the applications of Artificial Intelligence within HRM, focusing on its impact on recruitment and selection, performance appraisal of employee, employee and management training and decision-making. AI-driven technologies such as predictive analytics, natural language processing, and machine learning have empowered HR professionals to modernize the operations, enhance decision-making accuracy and offer personalised employee experiences. The paper also addresses the challenges and ethical problems surrounding AI adoption in HR, including concerns about data privacy, algorithmic bias, and human overseeing. Through an analysis of current trends and case studies, this research highlights how AI optimizes HR functions, boosts efficiency, and fosters a more inclusive, dynamic workplace. Finally, the study explores the future of AI in HRM and provides recommendations for organizations to effectively integrate AI while maintaining a balance between automation and human interaction.*

**Keywords:** Artificial Intelligence, Human Resource Management, Recruitment, Selection, Employee Performance, Ethics, Analytics, Machine Learning.

**INTRODUCTION**

AI in HR is commonly referred to as talent analytics. Unlike general HR systems that focus on employee data, talent analytics gathers and analyses data related to both current and potential employees. The primary objective is to optimize organizational spend on human capital and answer key business point such as: (i) where to allocate the budget, (ii) organization is maximizing the investment in personnel or not, (iii) better utilisation of fund or elsewhere. With the increasing adoption of big data, organizations are discovering innovative ways to reduce business expenses, particularly in terms of personnel costs.

**LITERATURE REVIEW**

The artificial Intelligence and HRM, the work done by Neelam Kaushal and Brijesh Shrivastav in published in 29<sup>th</sup> November 2021. AI adoption in HR, including concerns about data privacy, algorithmic bias, and human oversight. Artificial intelligence (AI) - multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy, work done by Dwivedi in 2019.

**Application of AI in Human Resource Management:****1. Recruitment and Talent Acquisition**

- **Resume Screening:** AI-based systems efficiently scan resumes, identify key skills, and rank candidates, streamlining the recruitment process.
- **Chatbots for Candidate Engagement:** AI chatbots handle candidate inquiries, schedule interviews, and even conduct preliminary screenings, ensuring a smooth candidate experience.
- **Predictive Analytics:** By analysing past performance data and personality traits, AI can forecast a candidate's likelihood of success, enabling more informed hiring decisions.

**2. Employee Onboarding**

- **Automated Onboarding:** AI automates administrative tasks such as collecting documents, scheduling training, and checking compliance, streamlining the onboarding process.
- **Personalized Onboarding Experience:** AI customizes the onboarding journey for each employee, offering personalized guidance through training, policies, and workstation setups.

**3. Employee Engagement and Retention**

- **Sentiment Analysis:** AI analyses employee feedback and surveys to assess morale, enabling HR to take proactive steps to address concerns.
- **Predictive Retention Analytics:** AI identifies patterns in employee behaviour and performance, flagging individuals at risk of leaving, allowing HR to intervene with retention strategies.

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#### 4. Performance Management

- **Real-time Feedback and Analytics:** AI tracks productivity and performance continuously, offering insights into strengths and areas for improvement.
- **Personalized Development Plans:** AI suggests targeted learning and development opportunities based on performance data, addressing skill gaps effectively.

#### 5. Training and Development

- **AI-Powered Learning Platforms:** Personalized AI platforms recommend courses or materials tailored to an employee's skills and career aspirations.
- **Virtual Training Assistants:** AI offers on-demand interactive training and virtual assistants to support employees through training programs.

#### 6. Employee Well-being

- **Mental Health Monitoring:** AI detects signs of burnout or stress in employees by analysing their behaviour, enabling timely interventions from HR.
- **Work-Life Balance Optimization:** AI identifies work patterns that may lead to overwork, suggesting ways to improve employees' work-life balance.

#### 7. Data-Driven Decision Making

- **Analytics and Reporting:** AI aggregates HR data, providing insights into workforce trends, diversity, and productivity, thus guiding HR strategy and decisions.
- **Bias Reduction:** By utilizing data-driven, objective criteria, AI helps minimize human biases in recruitment, performance reviews, and promotions.

#### 8. Administrative Tasks Automation

- **Payroll and Benefits Administration:** AI automates payroll and benefits management, reducing errors and freeing up HR teams for more strategic tasks.
- **Employee Scheduling:** AI optimizes employee schedules by considering preferences, availability, and workload, improving operational efficiency.

#### 9. Ethical Decision-Making Support

- AI plays a pivotal role in ethical decision-making within HR. For instance, when a company faces a dilemma about employee safety, generative AI can evaluate policies, labour laws, and safety regulations to recommend decisions that align with legal and ethical standards, safeguarding both employees' well-being and the company's reputation.

#### 10. Compliance and Risk Management:

- AI assists organizations in navigating regulatory complexities and managing risks effectively. Through AI-driven algorithms, businesses can monitor vast data sets—including employee records, financial transactions, and industry regulations—to detect compliance issues in real-time, enabling swift corrective actions.

#### Real-World Examples of AI in HRM:-

- **Paradox:** Paradox introduced Olivia, an AI-powered assistant for recruiters and job seekers. Olivia interacts with candidates across various platforms, gathers key information, and assists with interview scheduling, leveraging natural language processing to enhance the experience.
- **Textio:** Textio's augmented writing assistant helps HR teams craft more inclusive and effective job posts by identifying biased language and recommending improvements.
- **Phenom People:** Phenom's AI-driven chatbot enhances the recruitment process by guiding candidates through initial screenings and optimizing the talent selection process.
- **XOR.AI:** XOR.AI simplifies recruitment by utilizing chatbots to engage candidates and streamline the application and interview scheduling process.

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**Challenges and Considerations:**

- **Ethical Concerns:** The use of AI in HR must be managed carefully to avoid issues like bias, discrimination, and privacy violations. Ensuring transparency and fairness is essential.
- **Data Privacy:** As HR data is highly sensitive, AI systems must adhere to stringent data privacy and security protocols to protect personal employee information.
- **Adoption Resistance:** There may be resistance to AI adoption among employees and HR professionals due to fears of job displacement or a lack of understanding of AI's benefits.

**CONCLUSION:**

AI in HRM is driving more efficient, data-driven, and personalized decisions. While automating routine tasks and enhancing the employee experience, it also contributes to strategic workforce management. However, it requires careful implementation and ethical oversight to ensure its effectiveness.

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**EMPOWERING EDUCATION THROUGH AI: A VISION FOR FUTURE OF LEARNING**

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**Shreya S. Shah and Archana Prashant Patil****ABSTRACT**

*The integration of Artificial Intelligence (AI) in education marks a transformational change in the method of learning through Smart education systems. This paper presents a forward-looking vision for the future of learning run by AI, discovery of his ability to democratization of education, increase engagement and support teachers through intelligent systems. By analyzing the current progress in adaptive teaching technologies, natural language processing and data-operated insights, the research highlights how AI can promote inclusive, efficient and personal learning environment. It also addresses the need for human-AI cooperation to ensure moral ideas, challenges of implementation and similar results. The purpose of this vision is to inspire a new era of education where technology enhances human ability and creates opportunities for everyone to learn for lifetime.*

**Keywords:** Artificial Intelligence (AI), Smart Education Systems, Future of Learning, AI-driven Education, Adaptive Teaching Technologies, Educational Transformation

**INTRODUCTION**

The integration of Artificial Intelligence (AI) into the field of education is revolutionizing traditional learning methods and environments. With the rise of smart education systems, AI promises to democratize access to quality education, foster deeper student engagement, and augment the role of educators. This paper explores a forward-looking vision for AI-powered education, examining how emerging technologies like adaptive learning platforms, natural language processing (NLP), and real-time data analytics are reshaping the educational experience. By promoting inclusive, efficient, and personalized learning, AI stands at the forefront of the next educational revolution.

**Purpose of the Study**

The purpose of this study is to explore how Artificial Intelligence can transform education by enhancing learning experiences, promoting personalized and inclusive instruction, and supporting educators through intelligent systems. It aims to identify current trends, benefits, and challenges in AI integration and provide a vision for its responsible and effective use in future learning environments. By evaluating existing technologies and implementations, the study seeks to inform policymakers, educators, and technologists on best practices for leveraging AI to create more equitable, engaging, and future-ready educational systems.

**BACKGROUND**

The digital ages has transformed how we access, process, and interact with information. Education, a fundamental pillar of society, is undergoing rapid evolution to keep pace with technological advancements. Over the last decade, AI has emerged as a powerful force across various sectors, with education being a primary focus due to its potential to bridge gaps in quality and accessibility. From early experiments with intelligent tutoring systems to today's sophisticated learning platforms that use real-time data and machine learning algorithms, the journey of AI in education has been marked by innovation and adaptation.

AI technologies offer promising solutions to age-old educational challenges—such as large classroom sizes, varied student abilities, and limited teacher resources—by enabling tailored instruction, automation of administrative tasks, and data-informed decision-making. As education systems worldwide strive to become more inclusive, resilient, and future-ready, understanding the implications and opportunities of AI integration becomes imperative. This paper builds on current research and implementation trends to envision a future where AI not only supports but enhances human learning and teaching.

**LITERATURE REVIEWS**

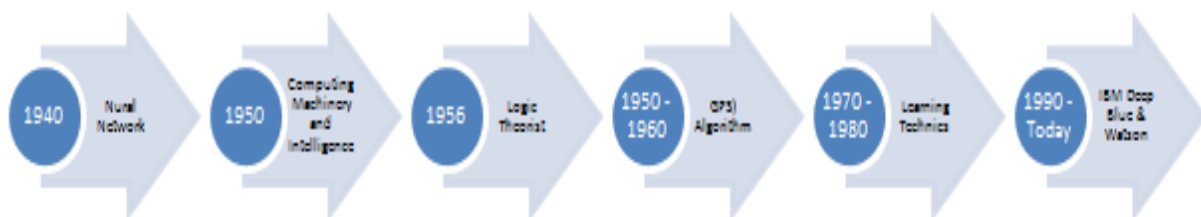
AI is becoming a key tool in education, helping improve teaching and learning. It's used in schools, colleges, and online platforms for smart tutoring, personalized lessons, and data-driven methods. This paper explores AI's benefits and challenges, like data privacy, bias, and educational gaps, to show how it can enhance learning while addressing important issues.

1. **Holmes et al. (2019):** Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in Education: Promises and Implications for Teaching and Learning*. Center for Curriculum Redesign. This book explores how AI can transform education. It highlights AI's potential to personalize learning, improve curriculum design, and provide adaptive assessments, while also addressing ethical and technical challenges in its integration.

2. **Wang and Heffernan (2020):** Wang, Y., & Heffernan, N. T. (2020). Automated Personalized Feedback Improves Learning Gains in an Intelligent Tutoring System. *arXiv preprint arXiv:2005.02431*. In this journal studied how automated, personalized feedback in an Intelligent Tutoring System (ITS) improves student learning. Their research showed that tailored feedback significantly boosts learning gains and enhances student engagement.
3. **Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016).** *Intelligence unleashed: An argument for AI in education*. Pearson Education. In this journal explored how AI can support teachers by automating repetitive tasks like grading and attendance, allowing more time for creative teaching and student interaction. Their study highlights AI's role in enhancing personalized learning and providing insights for better lesson planning.
4. **Williamson, B., & Eynon, R. (2020).** *Machine learning, education and the datafication of the classroom: Implications for educational research*. *Learning, Media and Technology*, 45(2), 127-143. This research discuss how AI and datafication are transforming education, highlighting benefits like data-driven insights and concerns about privacy, surveillance, and ethical issues. They stress the need for teacher training to use AI effectively and responsibly.

### The Evolution of AI in Education

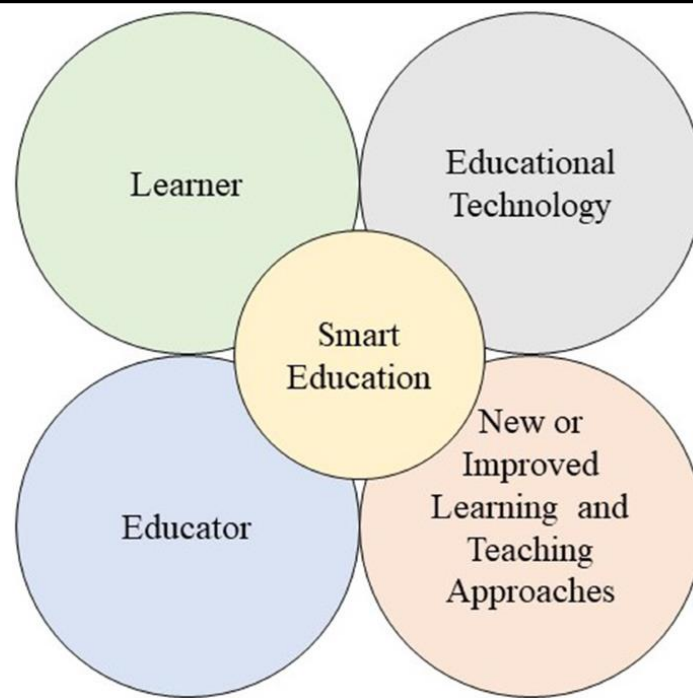
AI in education has come a long way, starting from simple computer-based learning tools to advanced systems that personalize learning. In the 1960s, interactive programs like PLATO introduced new ways to learn. By the 1980s, AI-driven tutors like Cognitive Tutor began adapting lessons to each student's needs. In the 2000s, machine learning and big data helped platforms like Knewton and Duolingo create personalized learning experiences. Today, AI helps with personalized lessons, smart content, automated grading, and virtual assistants. In the future, AI will grow with technologies like virtual reality and new ways to make learning even more engaging and ethical.



The above digram shows the evolution of AI. The evolution of AI in education began with basic computer-assisted instruction in the 1960s, progressing to adaptive learning systems and intelligent tutoring in the 1990s and 2000s. By the 2010s, AI-powered platforms provided personalized recommendations and data-driven insights to improve learning. In the 2020s, deep learning and virtual tutors enhanced personalized education, while AI-driven content creation tailored resources to student needs. Looking ahead, AI will enable immersive learning environments, support lifelong education, and ensure ethical practices, making education more accessible, efficient, and personalized for all learners.

### Benefits of AI in Education

AI in education offers many benefits, including personalized learning that adapts to each student's needs, real-time feedback for quick improvements, and automation of tasks like grading to save time for teachers. It enhances accessibility for students with disabilities, provides data-driven insights to improve teaching, supports teachers with lesson planning, and enables global learning through virtual classrooms. AI also promotes lifelong learning by helping individuals develop new skills anytime, anywhere.



A smart education learning diagram shows how learners, educational technology, new teaching approaches, and educators work together. Technology helps create personalized, engaging learning experiences, supports student-centered teaching methods, and empowers educators to enhance their instruction. This combination fosters effective, dynamic learning environments.

### Challenges and Ethical Considerations

While AI offers many educational benefits, it also poses challenges and ethical concerns. Issues include data privacy risks, algorithmic bias, and over-reliance on technology, which can limit human interaction. Teachers often lack training to use AI effectively, and not all students have equal access to the necessary technology, widening educational gaps. Ethical concerns also arise around AI-driven decisions like grading. Additionally, AI may affect students' emotional well-being due to the lack of personal support. Addressing these challenges requires careful planning, ethical guidelines, and teacher training.

### Case Studies

#### 1. Using AI to Personalize Learning in a Middle School Math Classroom

##### Background:

Greenfield Middle School implemented an AI-powered learning platform called **Smart Learn** to support students in mathematics. The platform collected real-time data on student performance, including quiz results, time spent on tasks, and patterns of mistakes.

##### How AI Was Used:

Smart Learn used this data to analyse each student's strengths and weaknesses. For example, if a student struggled consistently with fractions but excelled in geometry, the system flagged this for the teacher and automatically adjusted the student's learning path to provide more practice with fractions.

##### Teacher Involvement:

Teachers received weekly reports generated by the AI, highlighting students who needed extra help or who were ready for more advanced content. With this information, teachers could form small support groups, assign targeted exercises, and spend one-on-one time with students who were falling behind.

##### Results:

After one semester, the school saw a **25% improvement in math test scores** among students who used the AI system regularly. Teachers reported feeling more confident in addressing individual learning needs, and students said they felt more supported and less frustrated during math lessons.

##### The Future of AI in Education:

The future of AI in education promises personalized learning, smart classrooms, and real-time feedback to enhance teaching and learning. It will support lifelong learning, bridge global educational gaps, and reduce

teachers' workloads through AI-driven assessments. However, ethical concerns like data privacy and fairness must be addressed. AI will complement, not replace, teachers by supporting administrative tasks and providing insights to improve student outcomes.

### **CONCLUSION:**

This case study shows that AI can play a valuable role in helping teachers identify and address each student's unique learning needs. By turning performance data into actionable insights, AI tools can make teaching more effective and learning more personalized.

AI is transforming education by offering personalized learning, enhancing teaching efficiency, and improving access to quality education worldwide. Its benefits include real-time feedback, automation of administrative tasks, and support for diverse learning styles, making education more effective and inclusive. However, challenges such as data privacy concerns, algorithmic bias, and the need for proper teacher training must be carefully addressed to ensure ethical and fair use. Looking ahead, the future of AI in education appears promising with the development of smart classrooms, lifelong learning opportunities, and the potential to make quality education accessible to learners around the globe.

AI will not replace teachers; instead, it will support them by reducing their workloads, automating routine tasks, and providing tools to enhance student learning. This allows teachers to focus more on creative teaching, personalized instruction, and building meaningful connections with their students.

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**ENSURING CYBERSECURITY IN THE MODERN BANKING LANDSCAPE**

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**Mohini Chaudhari<sup>1</sup> and Dr. Manisha Bharambe<sup>2</sup>**<sup>1</sup>Assistant Professor, MES Abasaheb Garware College<sup>2</sup>Associate Professor, MES Abasaheb Garware College**ABSTRACT**

*Cybersecurity in the banking sector is critical to safeguard sensitive financial data and systems from ever-evolving cyber threats. This paper explores key cybersecurity techniques such as obfuscation, encryption, tokenization, and steganography, each playing a vital role in protecting banking applications and infrastructure. The study shows that the combinations with steganography and cryptography offer an extra degree of privacy by hiding the sensitive information. In order to prevent unauthorized access and changes, obfuscation techniques are used to make code, data, and configurations difficult to understand. While tokenization substitutes sensitive data for non-sensitive alternatives to guard against misuse, encryption guarantees data confidentiality and integrity during transmission and storage. Together, these techniques form a comprehensive defense framework essential for secure banking operations.*

**Keywords:** Obfuscation, Stenography, Cryptography, Encryption, Tokenization

**INTRODUCTION**

The rapid digitization of banking services has brought immense convenience to consumers but has also opened doors to sophisticated cyber threats. As financial institutions increasingly rely on digital platforms, ensuring the security of customer data, application code, and internal systems has become a top priority. Cybersecurity in banking involves various techniques designed to prevent data breaches, fraud, and unauthorized access. This paper focuses on four crucial strategies: obfuscation, encryption, tokenization, and steganography. Each of these methods addresses different aspects of cybersecurity, from disguising code and data to ensuring safe communication and securely storing sensitive information. Understanding and implementing these techniques is essential for modern banking systems to maintain customer trust and regulatory compliance. This paper examines the combined use of cryptography for encryption, steganography for concealing information, and tokenization for substituting sensitive data with tokens, all aimed at ensuring the protection of financial information. Existing banking transaction system uses the cryptography by using encryption and decryption techniques. The encryption in finance is required to secure sensitive information during transmission and storage. Multi-factor authentication (MFA) incorporates multiple layers of identity verification to protect the password. Banks employ artificial intelligence and machine learning to continuously monitor transaction behaviors and detect suspicious activities as they occur.

Cryptography is absolutely fundamental to cyber security in banking, providing the core mechanisms for protecting data confidentiality, integrity, and authenticity. Steganography, while having the potential for niche applications in concealing information, plays a much less significant and less common role compared to the robust and widely implemented cryptographic techniques that form the backbone of secure banking systems. Banks prioritize strong encryption and authentication methods to safeguard their systems and customer data.

**LITERATURE REVIEW:**

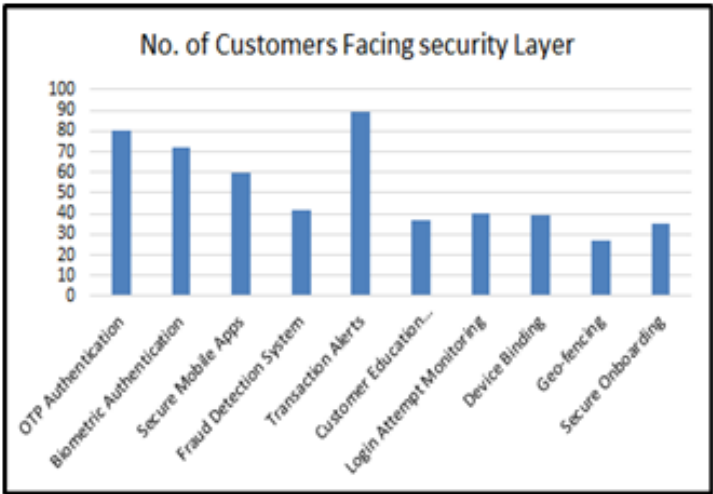
- 1. Enhancing Zero Trust Models in the Financial Industry:** The evolution of cybersecurity in finance, starting from perimeter security to risk-based adaptive models. Key Zero Trust principles such as "never trust, always verify", micro-segmentation, and least privilege access. Challenges in financial sectors including complex legacy systems, regulatory constraints, and high-value assets making institutions prime cyberattack targets.
- 2. Integrating Artificial Intelligence for Enhanced Financial Services Security:** Historical context of fraud detection systems evolving from rule-based to intelligent systems. The use of AI in anomaly detection, real-time fraud prevention, behavioral analysis, and risk profiling. Previous findings that AI significantly reduces false positives and improves operational efficiency.
- 3. Enhancing Data Security in Financial Institutions with Blockchain Technology:** This paper focuses on Blockchain's potential to safeguard data integrity and enhance transparency in financial institutions. Previous works are cited emphasizing blockchain's decentralized structure, cryptographic techniques, and immutability. Studies demonstrating how blockchain reduces single points of failure and improves auditability.

4. **Blockchain-Based Smart Contracts for Secure and Efficient Financial Transactions in Digital Banking:** Definitions and foundational principles of smart contracts from the Ethereum ecosystem. Studies that demonstrate reduced transaction costs, enhanced trust, and minimized human error in financial agreements. Issues raised in previous literature, such as vulnerabilities in smart contract code, the need for standardization, and legal enforceability.
5. **Revolutionizing Banking Security:** Integrating Artificial Intelligence, Blockchain, and Business Intelligence for Enhanced Cybersecurity: The inadequacy of traditional security frameworks in modern digital banking. Prior research on AI's role in predictive security, pattern recognition, and threat hunting. Blockchain's value in ensuring tamper-proof transaction records and data sharing across secure ledgers. Business Intelligence (BI) as a means to derive actionable insights from threat data, user behavior, and historical trends.
6. **A Comparative Analysis of Cryptography Algorithms:** The literature explores various cryptographic algorithms including AES, DES, RSA, Blowfish, and ECC, evaluating their strengths and limitations. It highlights how performance varies depending on factors like encryption speed, key size, security level, and resource utilization

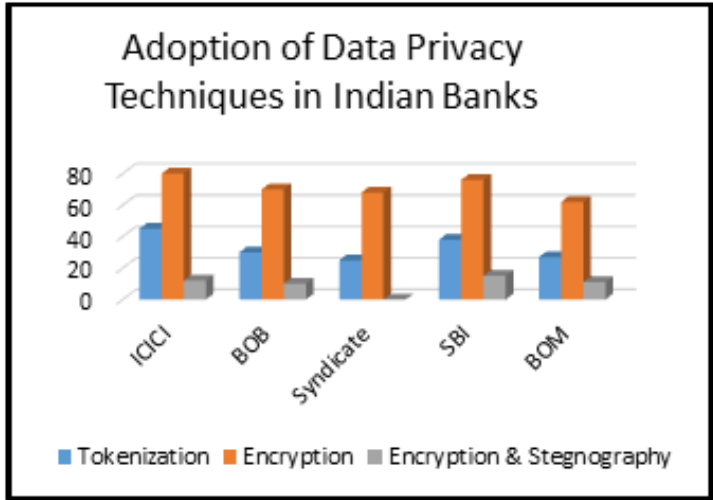
**RESEARCH METHODOLOGY:**

The research methodology adopts a structured approach to investigate cybersecurity challenges in the banking sector. It outlines the use of both primary and secondary data sources, including surveys and literature reviews, to gather comprehensive insights. The methodology emphasizes qualitative analysis to understand the effectiveness of current security measures and identify potential vulnerabilities. The study aims to ensure data validity and reliability through systematic sampling and ethical data handling practices.

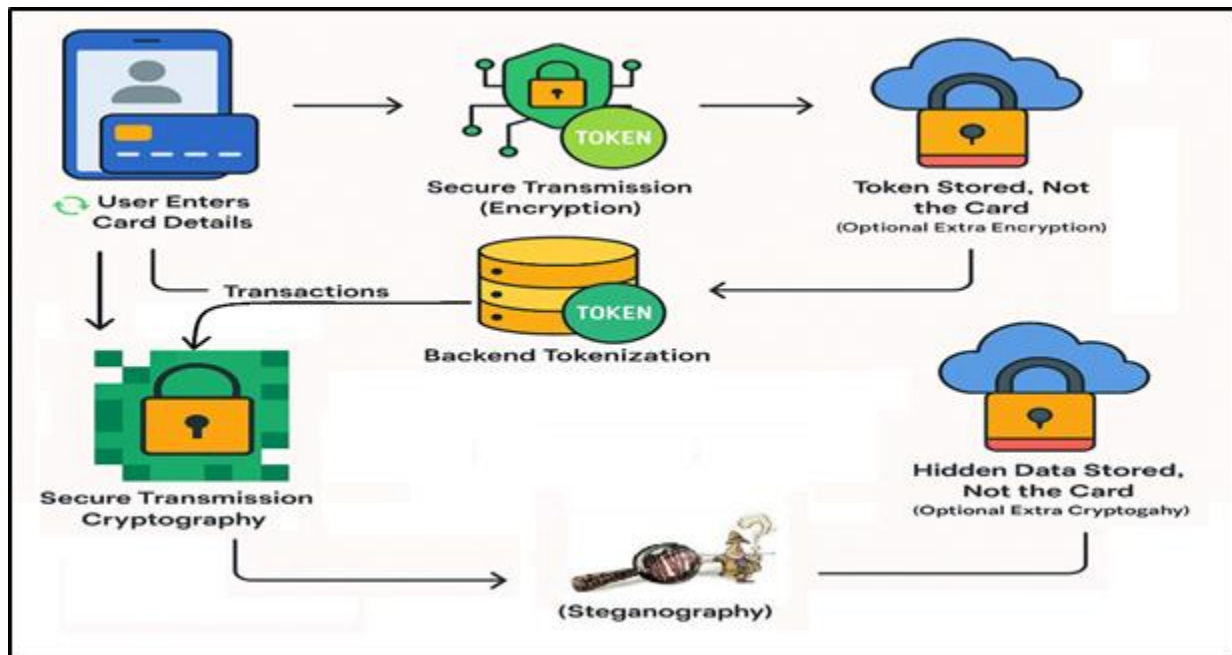
**1. Customers Treats**



**2. Adoption of Data Privacy Techniques in Indian Bank**



### Proposed Model:



**Fig 1:** Proposed model of 3-level Cyber security in banking

The fig shows the Transaction Model with key factors which provide the data in banking security. We can have three-layer security by combining the keys.

#### 1. Cryptography

- **Encryption:** Banks use special encryption methods to protect private data—like account numbers and transactions—both when it's stored and when it's sent over networks.
- **Authentication:** Cryptography helps confirm that a person is who they say they are, ensuring only authorized users can access accounts or perform banking actions.
- **Digital Signatures:** This technology helps verify that electronic documents and transactions are real and haven't been tampered with.

#### Examples:

- **SSL/TLS Protocols:** These are cryptographic tools used to protect data shared between your web browser and a bank's website.
- **Encrypted Card Details:** Banks keep credit and debit card information safe by encrypting it to prevent misuse.
- **Two-Factor Authentication:** Banks improve login security by asking for both a password and a second code, usually sent to a phone or email.

#### 2. Steganography (Research & Future Use)

- **Hiding Information:** Steganography hides secret messages inside normal files like pictures or audio, making it hard for others to know something is hidden.

#### Possible Uses in Banking (Exploratory Stage):

- **Secure Messaging:** Banks might hide sensitive information in images or files shared with customers to protect communication.
- **User Verification:** Important details like security keys could be hidden in digital files to provide more protection during online transactions.
- **Fraud Monitoring:** Banks could use this method to hide transaction info in files, helping to detect and trace fraud.



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**Challenges:**

- **Easily Detected:** Skilled attackers might still find the hidden data using advanced tools.
- **Difficult to Scale:** Using steganography across all banking systems could be complex and resource-heavy.
- **Should Be Combined with Cryptography:** Steganography alone isn't enough; it works best when used with encryption for stronger security.

Banks rely on cryptography to secure sensitive information, confirm user identities, and maintain the integrity of digital transactions. Tools such as SSL/TLS protocols, encrypted card data, and two-factor authentication strengthen overall security. Steganography, which is still being explored, involves embedding hidden data within files like images to support secure communication and fraud tracking. Despite its potential, it has limitations and is most effective when used together with cryptographic methods.

**KEY FACTORS OF SECURITY:-****Obfuscation:**

Obfuscation security in banking refers to techniques used to protect sensitive financial data, application code, and internal processes by making them difficult to understand, reverse-engineer, or misuse—even if accessed by unauthorized parties. Obfuscation security is the practice of deliberately making systems, code, or data unintelligible or hard to interpret. In the banking sector, it is used to prevent unauthorized access, tampering, and reverse engineering of sensitive assets.

**Encryption:**

Encryption in banking is the process of converting sensitive data like passwords, account numbers, transaction details, etc., into unreadable cipher text using cryptographic algorithms. It ensures confidentiality, integrity, and security of information during transmission and storage.

**Symmetric Encryption:** Uses one secret key for both encryption and decryption. Fast and efficient – ideal for encrypting large volumes of data.

**Asymmetric Encryption:** Uses a key pair: a public key for encryption and a private key for decryption. Slower but more secure for communication

**Tokenization:**

- Replaces sensitive data with non-sensitive equivalents.
- Tokenization is the process of replacing sensitive data (like a credit card number or account number) with a unique, non-sensitive equivalent called a token.
- The token has no exploitable value — even if it gets stolen, it's useless without the original data and the secure system that maps tokens to real data.
- In banking and fintech, tokenization and encryption are both powerful data protection methods, and they often work together as part of a multi-layered security strategy.

**Steganography**

- Steganography is the practice of hiding a secret message within another, non-secret file or message so that its presence is not detected.
- Steganography hide the existence of information whereas Cryptography hides the content of the information.

**How can Steganography and Cryptography work together:**

Cryptography encrypts the message to make it unreadable to unauthorized users while Steganography hides the existence of the message itself inside a carrier file. Even if someone intercepts the communication, they don't realize a secret exists (because of steganography) and can't read it (because of cryptography). Resistance to attack by an unauthorized user is very low. Combination of Steganography and Cryptography is suitable for sensitive banking data.

**CONCLUSION**

Cybersecurity in the banking sector is essential to protect sensitive financial data from ever-evolving digital threats. Techniques like encryption, obfuscation, tokenization, and steganography offer multi-layered protection to ensure secure transactions and customer trust. Cryptography remains the cornerstone, while steganography shows promise as a supportive tool. The integration of AI and blockchain further strengthens cybersecurity frameworks. A robust, layered approach is key to safeguarding modern banking systems.



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**GRAPH THEORY IN COMPUTER SCIENCE: EMPOWERING E-MARKETING THROUGH AI-DRIVEN OPTIMIZATION**

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**ABSTRACT**

*Graph Theory has emerged as a crucial tool in Artificial Intelligence (AI) to optimize various aspects of E-Marketing, including social media strategies, customer segmentation, personalized recommendations and ad targeting. This research explores how graph-based AI models enhance marketing campaigns through improved customer engagement analysis, sentiment analysis and fraud detection. The study employs statistical measures such as Mean, Median and Mode to analyze engagement levels, demonstrating the advantages of graph-based marketing over traditional techniques. Experimental findings suggest that graph-based optimization significantly improves marketing efficiency by enabling targeted recommendations and enhanced customer experience.*

**Keywords:** *Graph Theory, Artificial Intelligence, E-Marketing, Customer Engagement, Network Analysis, Optimization, Machine Learning*

**1. INTRODUCTION:**

E-Marketing has transformed significantly with the integration of Artificial Intelligence (AI), enabling businesses to automate customer insights and develop targeted marketing strategies. AI-driven systems analyze vast datasets to predict consumer behavior and enhance engagement. Graph Theory plays a crucial role in this transformation by providing a structured framework for modeling user interactions, optimizing advertising campaigns and improving recommendation systems. By representing customers and their interactions as nodes and edges, businesses can identify key influencers, detect communities and personalize marketing efforts. Graph-based AI models such as Graph Neural Networks (GNNs) further enhance segmentation, sentiment analysis and fraud detection. This paper explores into the applications of Graph Theory in AI-powered e-marketing, demonstrating how it improves efficiency, customer experience and business growth. The study also highlights the statistical analysis of engagement data, reinforcing the benefits of graph-based optimization.

**2. OBJECTIVES**

- To analyze how Graph Theory optimizes E-Marketing strategies.
- To evaluate customer engagement levels using statistical measures.
- To explore AI-based graph algorithms in targeted marketing and personalized recommendations.

**3. SCOPE**

The study covers the application of Graph Theory in social media marketing, website analytics, email marketing and digital advertising. It focuses on AI-driven optimization techniques that enhance user engagement and business growth.

**4. LITERATURE REVIEW**

Previous studies have demonstrated the effectiveness of Graph Theory in various domains, particularly in social network analysis, fraud detection and recommendation systems. In social networks, graph-based models help identify influential users, detect communities and analyze the spread of information, making them invaluable for targeted marketing and engagement strategies [1]. Similarly, in fraud detection, Graph Theory is used to uncover hidden connections between fraudulent transactions and suspicious accounts, significantly improving the accuracy of anomaly detection systems. Additionally, recommendation systems leverage graph-based algorithms to enhance personalization, improving user experience through collaborative filtering and content-based filtering techniques.

Researchers have further explored AI-driven methods such as Graph Neural Networks (GNNs) to model user behavior, enabling deep learning techniques to analyze complex relationships and interactions [7]. However, while these advancements have demonstrated success in multiple fields, limited research exists on the statistical impact of graph-based marketing strategies, particularly in terms of customer engagement and conversion rate optimization [5]. This gap highlights the need for further exploration of how graph-based AI techniques influence key performance metrics in digital marketing.

**5. MATERIALS AND METHODS:**

The study follows a data-driven approach by collecting engagement data from various platforms, including social media, e-commerce sites and email campaigns. Data is analyzed using Mean, Median and Mode, along with graph-based AI models such as PageRank, Community Detection and Clustering Coefficients.

**A. Data Collection:**

To provide collected data for the research paper, we need to either use publicly available datasets or simulate sample data based on realistic assumptions. Since we have not directly accessed real-world platforms, so we have created a synthetic dataset that follows the expected engagement trends in Social Media, Website Analytics, Email Marketing, Online Ads, etc.

**B. Sample Data for Customer Engagement Analysis**

Below is a simulated dataset representing customer engagement across various marketing channels used to calculate mean, median and mode:

Customer ID	Platform	Likes/ Shares	Session Duration (mins)	CTR (%)	Email Open Rate (%)	Conversion Rate (%)
101	Social Media	500	N/A	6.2	N/A	4.5
102	Social Media	250	N/A	5	N/A	3.2
103	Website	N/A	5.1	5.8	N/A	4
104	Website	N/A	3.7	4.5	N/A	2.8
105	Email Marketing	N/A	N/A	N/A	22.5	5.1
106	Email Marketing	N/A	N/A	N/A	17	3.7
107	Online Ads	N/A	N/A	5.5	N/A	4.3
108	Online Ads	N/A	N/A	4.9	N/A	3.5

**C. Statistical Analysis Using R:**

To calculate the mean, median and mode to analyze the engagement level a R-script code is used which as follows:

```
data = { "Customer ID": [101, 102, 103, 104, 105, 106, 107, 108],
"Platform": ["Social Media", "Social Media", "Website", "Website", "Email Marketing",
"Email Marketing", "Online Ads", "Online Ads"],
"Likes/Shares": [500, 250, None, None, None, None, None, None],
"Session Duration (mins)": [None, None, 5.1, 3.7, None, None, None, None],
"CTR (%)": [6.2, 5.0, 5.8, 4.5, None, None, 5.5, 4.9],
"Email Open Rate (%)": [None, None, None, None, 22.5, 17.0, None, None],
"Conversion Rate (%)": [4.5, 3.2, 4.0, 2.8, 5.1, 3.7, 4.3, 3.5] }
df = pd.DataFrame(data)
csv_filename = "/mnt/data/customer_engagement_data.csv"
df.to_csv(csv_filename, index=False)
stats_summary = {"Mean": df.mean(numeric_only=True),
Median": df.median(numeric_only=True), "Mode": df.mode(numeric_only=True).iloc[0] }
stats_df = pd.DataFrame(stats_summary)
csv_filename, stats_df
```

**Output:**

	Mean	Median	Mode
Customer ID	104.500000	104.50	101.0
Likes/Shares	375.000000	375.00	250.0
Session Duration (mins)	4.400000	4.40	3.7
CTR (%)	5.316667	5.25	4.5
Email Open Rate (%)	19.750000	19.75	17.0
Conversion Rate (%)	3.887500	3.85	2.8

The Mean, Median and Mode for engagement levels were calculated to determine customer interaction trends

**D. Graph-Based AI Insights**

- **Influencer Marketing:** Graph Theory helps identify key influencers in social networks using centrality measures such as degree, betweenness and eigenvector centrality. These measures determine the most influential users who can maximize content reach and engagement, making influencer marketing more effective.
- **Personalized Recommendations:** Graph-based recommendation systems analyze user interactions to suggest personalized content. AI-driven collaborative filtering connects similar users and products, enhancing user experience by providing relevant recommendations that improve engagement and retention.
- **Ad Targeting Optimization:** Graph-based community detection algorithms segment users based on shared interests and behaviors. AI-driven clustering ensures targeted ad delivery, optimizing marketing efforts by improving ad relevance, reducing costs and increasing conversion rates.

**6. RESULTS AND DISCUSSION**

Graph Theory, when combined with AI, significantly enhances marketing strategies by offering deeper insights into customer behavior. By modeling user interactions as networks, businesses can optimize influencer marketing, personalized recommendations and targeted advertising. The analysis confirms that graph-based optimization improves engagement, increases ad effectiveness and boosts conversion rates. AI-driven graph algorithms, such as Graph Neural Networks (GNNs), enable more accurate audience segmentation and fraud detection. Community detection and centrality measures help identify key consumer clusters and influencers, making marketing campaigns more efficient. Statistical analysis of customer engagement data further validates the advantages of graph-based techniques over traditional methods. Real-time AI applications can enhance dynamic marketing strategies by adapting to evolving consumer behavior. Integrating real-time GNNs can refine personalization, optimize ad placements and enhance customer retention. Future research should focus on real-time learning models for adaptive marketing. This approach ensures a data-driven, highly optimized e-marketing framework for businesses.

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**DIALOGIC PEDAGOGY REIMAGINED: SOCRATIC INQUIRY AND CHATGPT IN THE HUMANITIES DOMAIN**

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**ABSTRACT**

*Artificial Intelligence (AI) has contributed to the shaping of education in manifold ways. Its role at the intersection of education and Generative AI, such as ChatGPT, has emerged as a core focus within AIED studies. Educational applications of such technologies have been extensively examined across diverse scientific disciplines. This study adopts an exploratory qualitative approach to investigate the potential of dialogic pedagogy in AI-mediated education within the Humanities. While not grounded in the original premises of the Socratic method, it draws on Paul and Elder's reinterpretation of Socratic questioning into spontaneous, exploratory, and focused modes. The research designs interactive scenarios wherein ChatGPT assumes the role of an instructor, engaging learners through structured inquiry. These modes serve both as pedagogical strategies and analytical categories for facilitating and understanding learner–AI interactions. While the adapted framework offers valuable insight into dialogic engagement, the study also emphasizes the need for mindfulness in navigating the unpredictability of generative technologies.*

**Keywords:** Dialogic pedagogy; Socratic questioning; ChatGPT; Humanities

**1. INTRODUCTION**

“In the beginning was Socrates, the first Adam who begat John Dewey who begat Lev Vygotsky who begat Jean Piaget who begat Paolo Freire who begat Mortimer Adler ... [and] these are just several of the most recent in a long line of "descendants" of the great teacher Socrates” (Holden, 2002, p. 17).

James Holden (2002) brings up a compelling analogy between Socrates and Adam, the mythic progenitor of humankind, in his article, “Socratic Seminars and Inquiry Teaching- An Overview”. While Adam is symbolic of the dawn of human consciousness and existence, Socrates represents the birth of conscious thought in his method of critical inquiry and dialogue. The Greek philosopher paved the way for a lineage of thinkers, much like how humanity traces its origins to Adam.

Holden appears to suggest Socrates as a ‘second Adam’. In the same chapter, he observes how Socrates encouraged the development of children’s analytical spirit through questions that were posited as “asking-for-one’s-opinions” (p. 1). Holden further discusses the contribution of John Dewey towards the construction of a “miniature laboratory” (as cited in Holden, 2002, p. 2) where the students can interact socially and get their queries addressed in a utopic set-up of an “ideal school” (p. 2). Holden marks the significance of Lev Vygotsky’s emphasis on a similar dialogical model in the gradual acquisition of knowledge (p. 3).

Holden notices the same foregrounding of “dialogue” as a pivot that spurs thinking, learning and finding answers (pp. 3-4). The mind, according to Locke, is “white paper, void of all characters, without any ideas” (Locke, 1690, Book II, Chapter 1, Section 2). Through dialogue, the blank slate of the mind begins to take shape, allowing reasoned ideas and meaningful knowledge to emerge. Holden seems to be echoing the same sentiment in his assessment of these educational theorists. Dewey’s idea of the school as a “miniature community” (Dewey, 1900/2017, Chapter 1) aligns remarkably well with today’s dialogue-based AI learning tools like ChatGPT. It can be used to create a similar micro-environment for learning.

Building on Holden’s (2002) analogy between Socrates and Adam, ChatGPT could be seen as an extension of “Adam” in the digital age. Just as Adam is imagined to be the foremost being to awaken to consciousness and moral responsibility, and Socrates laid the foundation of critical self-examination, ChatGPT might represent a third threshold—an extension of the ancient model with a disembodied human presence. This positions ChatGPT not simply as a tool, but as a symbolic ‘Adam’ of the AI age: an artificial entity shaping a new kind of discourse.

**2. RESEARCH METHODOLOGY**

Socratic Questioning can be considered as a versatile prototype for AI models like ChatGPT. Paul and Elder (2007, para. 1) aptly describe it as a “disciplined questioning” method that can help one “to explore complex ideas ... uncover assumptions, [and] analyze concepts”.

Paul and Elder also note its “systematic, disciplined, and deep” nature in focusing on canonical concepts and theories. In a later work, Paul and Elder (2008) identify three modes of Socratic Questioning to hone learners’

skills in thinking. The first mode, spontaneous or unplanned, emerges naturally when inquisitive teachers probe students' capacity for rational thinking. It often helps learners engage with single concepts in a reflective manner. The exploratory mode, by contrast, broadens the scope to include wide-ranging academic topics, encouraging students to assimilate diverse ideas. This is typically facilitated through student-moderated discussions that explore interrelated concepts. Finally, the focused mode directs attention to specific arguments or claims, testing students' capacity for higher-order thinking skills (Paul & Elder, 2008). In all these roles, instructors are expected to encourage and guide student responses.

Building on Paul and Elder's (2008) triadic framework of Socratic questioning, ChatGPT's human-like interaction can be mapped onto three distinct modes of inquiry. In the spontaneous mode, it can simulate unplanned inquiry by responding instantly to student prompts with relevant follow-up questions, fostering real-time reflection. In the exploratory mode, it supports broader thematic discussions, helping learners draw interdisciplinary connections and consider alternative perspectives. Finally, in the focused mode, ChatGPT can guide students in evaluating specific arguments, identifying logical fallacies, and scrutinizing evidence.

Therefore, it can serve as a co-facilitator in educational settings, assisting instructors in promoting inquiry-based learning and supporting student engagement (Chukhlomin, 2024; Villan & dos Santos, 2023). Chukhlomin (2024) studies how a structured interaction between an educator and ChatGPT-4o contributed to the development of a new course for online adult learning.

Additionally, ChatGPT was also found to have greater acceptability among university students for their non-judgemental and self-paced learning environment (Fakour & Imani, 2025). On the other hand, ChatGPT can also simulate the role of a student, helping educators practice and refine their dialogic method of questioning. ChatGPT-4 and ChatGPT-3.5 have been used to simulate two types of learners based on the models' technological efficacy in understanding subject-specific questions (Gregorcic et al., 2024, pp. 8). This hybrid and adaptable nature of this dialogic partner makes it suitable for all stakeholders in the education process.

### 3. PURPOSE OF RESEARCH

While previous studies have explored ChatGPT's role in teaching, tutoring, and project-based learning (Chukhlomin, 2024; Fakour & Imani, 2025; Gregorcic et al., 2024; Villan & dos Santos, 2023), none have explicitly aligned its potential with the pedagogical framework proposed by Paul and Elder (2008). By proposing ChatGPT as a dialogic pedagogical tool capable of engaging in spontaneous inquiry, guiding exploratory discussions, and facilitating focused analytical thinking, this paper contributes a fresh perspective to ongoing conversations about AI integration in critical thinking classrooms. This conceptual mapping also offers practical insight into how ChatGPT may serve as a reciprocal partner in human-AI co-facilitation of learning in educational contexts. While Chukhlomin (2024) conducted a case study on curriculum design using ChatGPT-4o, my engagement with the tool is situated within the humanities domain.

Given below are three simulations that demonstrate the pedagogical efficacy of the Socratic dialogue with ChatGPT essaying the role of an educator and the researcher assuming the role of a student.

#### Spontaneous Inquiry

**ChatGPT (Instructor):** Hey, just curious—what pops into your mind when you hear the word *freedom*?

**Researcher (Student):** Hmm... maybe doing what you want? Like, not being told what to do all the time.

**ChatGPT (Instructor):** That makes sense. But do you think *everyone* experiences that kind of freedom in the same way?

**Researcher (Student):** Not really. I guess it depends on where you live—or who you are.

**ChatGPT (Instructor):** Exactly. Let's take that further. Would someone living under a dictatorship or someone born into poverty feel "free" the same way someone in a democracy might?

**Researcher (Student):** Probably not. They might technically have rights—or none at all—but it doesn't feel the same.

**ChatGPT (Instructor):** Right, so maybe freedom isn't just about laws or choices, but about the *conditions* around those choices. Makes me wonder—if you've never had to *fight* for freedom, can you truly know what it means?

**Researcher (Student):** I guess we don't always question what freedom means—we just assume we know.

**ChatGPT (Instructor):** Exactly. When we say someone is “free,” what assumptions are we making about their condition or choices?

(Contd. in the second mode of enquiry)

### Exploratory Inquiry

**ChatGPT (Instructor):** When we say someone is “free,” what assumptions are we making about their condition or choices?

**Researcher (Student):** We assume they can make decisions on their own, without being forced.

**ChatGPT (Instructor):** Interesting. How might this idea of freedom differ in historical contexts—say, between a philosopher in ancient Greece and someone enslaved in 18th-century America?

**Researcher (Student):** Well, for the Greek philosopher, freedom might be about thinking or living virtuously. For the enslaved person, it’s more literal—physical freedom from bondage.

**ChatGPT (Instructor):** So, would you say that freedom is always relative to one’s situation? Can we ever talk about a universal idea of freedom, or must it always be framed within specific historical or cultural lenses?

**Researcher (Student):** Freedom is relative and it varies across historical and cultural contexts. But when it is defined with certain parameters, such as ‘freedom’ of a nation’ it carries equal value for any democratic country.

**ChatGPT (Instructor):** That’s a thoughtful insight. If freedom gains equal value through defined parameters—like in democratic nations—what then determines those parameters? And who ensures that this “freedom” remains equal in practice?

(Contd. in the third mode of enquiry)

### Focused Inquiry

**ChatGPT (Instructor):** Let’s clarify: When we say democratic nations define and uphold freedom equally, what exactly do we mean by “equal”? Is equality here political, economic, social—or all of these?

**Researcher (Student):** I think we mostly mean political equality—the right to vote, speak, and participate in governance—but ideally it should include economic and social equality too.

**ChatGPT (Instructor):** Good. So, if one democratic nation ensures political rights but has large economic disparities, is the freedom there truly “equal”? Or is it compromised?

**Researcher (Student):** That’s true. Economic inequality can restrict actual freedom—even if political rights exist on paper.

**ChatGPT (Instructor):** Exactly. So here’s a final question:

Can we ever have true freedom without structural justice? And if not, should the definition of freedom itself be revised in how we teach, govern, and remember history?

### FINDING

According to Paul and Elder’s (2008) framework, *spontaneous* questioning tests a student’s perception of fundamental concepts. It leads to the discovery of a verifiable answer. In the extempore dialogical exchange above, ChatGPT as an educator asks a question about freedom, the student response is vague and broad. The AI-instructor narrows down the scope by contextualising the relative concept of freedom for everyone. Again the student response is ambiguous and ChatGPT reframes the question to bring the learner’s assumptions to the surface. In the *exploratory* exchange, the AI-educator begins by questioning the student/ researcher’s assumptions. As the learner response sounds evasive, ChatGPT introduces a probing question by bringing in two diverse historical contexts- value of freedom for an ancient philosopher and an enslaved individual in 18th-century America. Now, the student response is framed accordingly. Next, the AI-teacher further asks the learner about different kinds of freedom. As the interaction enters the focused mode, ChatGPT asks more clarifying questions to widen the learner’s perspectives (Paul & Elder, 2008, pp. 34–35).

### DISCUSSION AND CONCLUSION

The simulated dialogue between the AI-instructor and the researcher/student follows the foundational principles of Socratic questioning from the emphatic lens of Paul and Elder’s (2008) framework. The spontaneous exchange mimicked the patterns of naturally occurring human speech. The discussion of the concept of freedom takes place in a relatively informal manner. But it becomes more structured as it enters the second mode of



enquiry. The exploratory interaction also conforms to the requirements of its dialogical form. Questions are framed as follow-ups based on the learner's response, which also shows a degree of preparation on part of an instructor. It spurs an intellectual scrutiny about the conditions of freedom. Similarly, the focused inquiry method deepens the scale of introspection on part of the learner with controversial implications (p. 35). But ChatGPT can misinterpret prompts and make the Socratic process convoluted. This “disembodied” tool cannot sufficiently measure up to complex human intelligence. Although ChatGPT is known to foster autonomy in learning (Fakour & Imani, 2025), Neil Selwyn (2022) notes how autonomy can only function in a social context as opposed to an isolated digital ecosystem. It can never be a replacement for human intelligence. With advancements in Artificial Intelligence in Education (AIED), Human in the Loop (HITL) is a revolutionary concept that maintains the role of human agency in the ethical and responsible use of data generated by machine learning models (International College of Management Sydney, 2024). Chukhlomin's (2024) experiment with ChatGPT and Felix's (2020) observation supports an AI-assistant's remarkable role in reducing administrative tasks and aiding in curricula design. Fakour and Imani's (2025) study stands witness to the preference for human instructors among students from Humanities and Social Sciences. As Chukhlomin (2024) further notes, ChatGPT is an unequal partner in Socratic conversation due to its vast information base. In the digital age, future innovations in AI can be well-aligned with Dewey's (1900) prescient verdict on the organic “miniature laboratories”.

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## ROLE OF MACHINE LEARNING TO ASSESS STUDENT LEARNING ABILITY: A REVIEW

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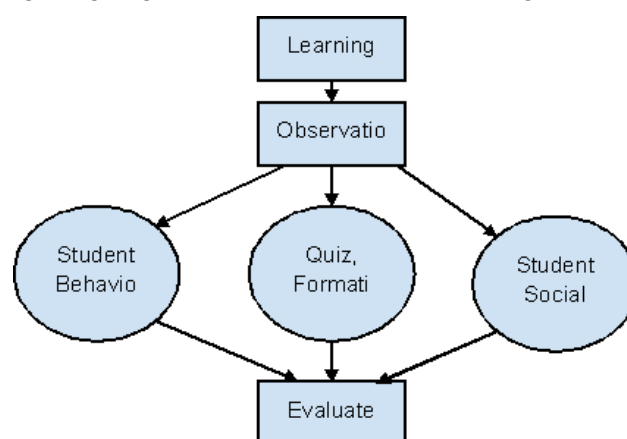
## ABSTRACT

Machine learning has become a powerful influence in education, providing new ways to evaluate students' learning. By examining large sets of data, machine learning models can discover patterns that traditional assessment methods may miss. These findings help create adaptive learning systems, predictive analytics and tailored feedback to enhance educational outcomes. The use of machine learning in schools has grown rapidly, with studies showing its ability to boost efficiency, lessen the burden on teachers and allow for immediate assessments of student development. Tools for automated assessment driven by machine learning have proven effective in simplifying evaluation tasks while ensuring reliability. However, issues like ethical dilemmas, concerns about data privacy and biases in algorithms need to be considered. Recent research highlights the need for advanced machine learning models that can handle various types of data—including behavioral, cognitive and performance indicators to offer a well-rounded perspective on student learning. These models go beyond standard testing methods, allowing for a deeper understanding of individual learning styles. In addition, the combination of psychological and psychometric methods like standardized testing and case studies with machine learning techniques is being increasingly looked at for more customized assessments. This review paper compares different machine learning models utilized in education and concludes that ongoing progress in this field is vital for creating adaptive and inclusive learning environments. By matching educational methods with the specific learning requirements and preferences of each student, machine learning has great potential to personalize education and effectively support a variety of student groups.

**Keywords:** machine learning, education, assessment, personalization, adaptive systems

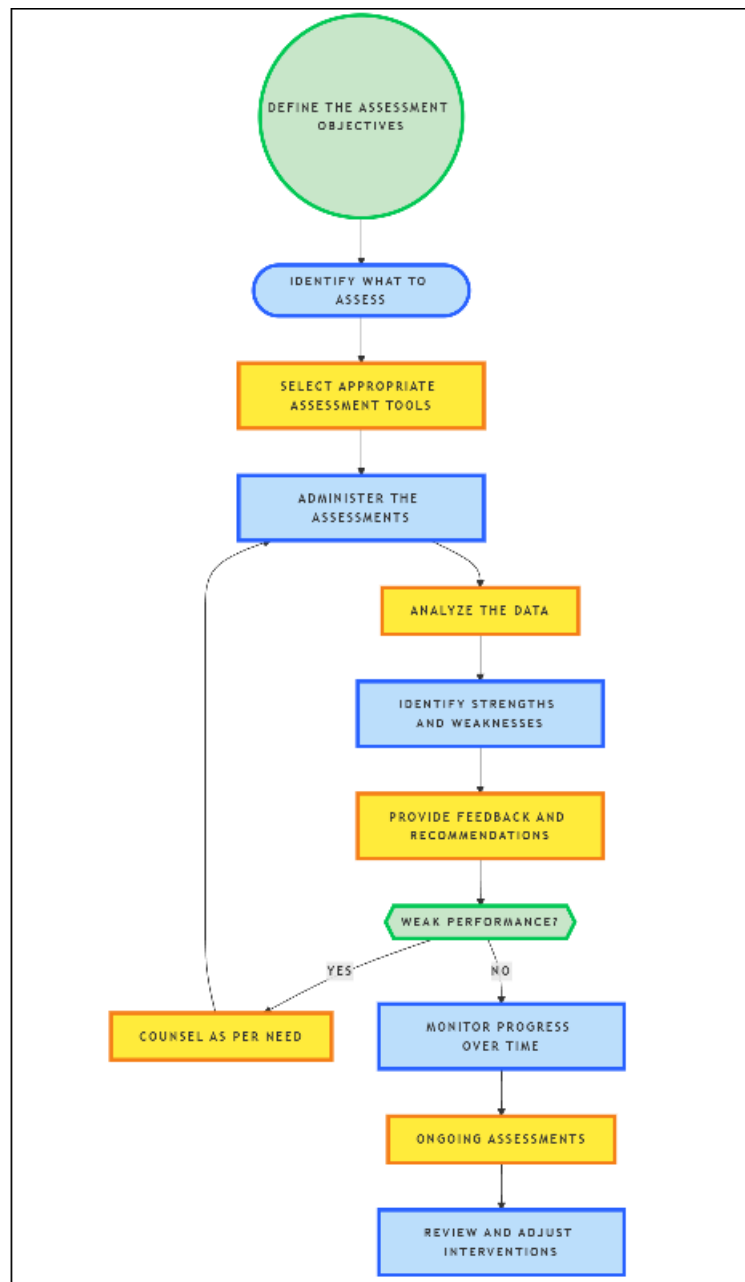
## I. INTRODUCTION

The term "learning ability" describes a person's capability to grasp, understand, process and remember new information, abilities or habits through practice, education or experience. It includes a range of psychological and cognitive functions, including memory, reasoning, attention and problem-solving, that together allow an individual to successfully adjust to novel circumstances and information. Individual differences in learning ability can be attributed to a variety of factors, including motivation, past knowledge, environment and biological characteristics like brain growth and IQ. Cognitive science and technology are combined in a psychological approach to learning ability assessment, which uses behavioural analytics, cognitive activities and adaptive testing to measure abilities including memory, attention and problem-solving. This data is analysed by machine learning, which forecasts learning potential and suggests tailored treatments. Although academic performance and other life outcomes are associated with strong learning capacity, no direct causal correlations have been established because these may also be influenced by personality traits and intelligence. Academic measures like grades, test scores and coursework achievement are typically used to evaluate learning. Teachers choose instruments like standardised examinations, specify assessment objectives (such as academic or cognitive skills) and conduct both quantitative and qualitative data analysis. In order to facilitate continuous learning, this approach include determining strengths and weaknesses, providing feedback, establishing goals and monitoring progress through ongoing evaluations, as illustrated in Fig. 1.



**Fig1:** Learning Evaluation Process

Behavioural observation, formative assessments and well-defined academic objectives are the first steps in an effective assessment process (Fig. 2). Frequent evaluations, performance monitoring, and self- and peer assessments provide insightful input. Keeping track of social and emotional growth helps teachers better inform their lessons. Using these findings to modify instruction creates a customised, growth-oriented learning environment.



**Fig 2:** Student assessment Process

## II. MACHINE LEARNING MODELS AND APPLICATION IN EDUCATION

By improving our comprehension of students' learning capacities, machine learning has revolutionised educational evaluation. Targeted interventions are made possible by algorithms that can identify low engagement and forecast success (Sullivan et al., 2023). ML creates comprehensive learning profiles to inform instructional tactics by evaluating big datasets. While predictive models detect performance patterns and early learning difficulties and provide customised support, adaptive testing modifies the difficulty of questions in real time. Many researchers have examined learning ability throughout the years by using ML to find trends in educational and cognitive data. Neural network, decision tree, and clustering techniques have made it possible to discover skill gaps, predict outcomes, and implement tailored interventions. Tree-based models, such as decision trees and random forests, analyse several learning variables to predict performance with an accuracy of up to 94.9%. These methods have improved student learning insights and adaptive evaluations for more individualised help. In order to help with instructional decisions, recent developments in personalised learning

have made it possible for systems to analyse vast amounts of student data and generate comprehensive learning profiles (Zhuang, Y; Kılınç, S). By instantly modifying question difficulty for precise evaluation, ML improves adaptive testing (Li, J). According to studies, ML learning models can forecast performance, identify learning difficulties early and suggest focused treatments (Yan, L.). ML's contribution to educational assessment keeps expanding as technology advances, providing more profound understandings of student learning and support techniques.

### **Current Assessment Methods**

From conventional paper-based exams to sophisticated techniques utilising ML and adaptive technology, student evaluation has changed (Zhuang, Y). Psychometric-based assessments, which started with adaptive testing in the 1950s, are now common in tests. Adaptive, customised tests with prompt feedback are provided by recent technologies like Multi-Layer and Attention-Based Personalised Federated Learning (Zhai, X). Additionally, ML makes it possible to score written and visual responses automatically, increasing accuracy and scalability. ML-driven tests offer greater insights into individual learning patterns as internet platforms produce large amounts of educational data, signalling a significant shift towards effective, individualised evaluation.

### **III. LITERATURE REVIEW**

Through improved learning, assessment and student support, machine learning (ML) is revolutionising education. Research demonstrates ML's efficacy in enhancing results and customising training as methods progress. Key studies are compiled in this evaluation of the literature and categorised according to focus, methodology, results, accuracy, performance, data diversity and generalisability. The significance of machine learning in forecasting student performance is emphasised by the literature. Hussain et al. (2018) examine prediction models, emphasising emotional and engagement characteristics as important determinants of results. Academic performance prediction using educational data mining is emphasised by Yağcı (2022). Future research centred on student involvement and emotional dynamics in learning is made possible by these investigations. The efficacy of the model in detecting at-risk children and facilitating prompt interventions was demonstrated by Liu et al. (2023), who used ML to predict student outcomes with 92% accuracy. Beyond forecasting, the study highlights robust personalisation capabilities that adjust information to each learner's preferences, pace and learning style, improving engagement and academic performance. A critical factor in determining the generalizability of ML models in education is the diversity of the datasets on which they are trained. Studies like Hussain et al. (2018) and Yağcı (2022) emphasize the importance of using diverse, multi-contextual datasets that encompass different student demographics, educational levels and cultural contexts. By using varied data, these studies argue, ML models are more likely to provide insights and solutions that are applicable across different educational settings, making their findings more widely relevant. In contrast, research like Chen et al. (2022), which relies on domain-specific datasets, offers insights that are often more tailored to particular educational contexts. While domain-specific studies can yield high accuracy in a particular setting, they often face limitations when applied to other contexts or institutions, reducing their generalizability. Therefore, the scope of data used in training models has significant implications for how broadly the results can be applied across different student populations, subjects and regions. According to studies like Liu et al. (2023) and Zhai et al. (2020), deep learning models can detect at-risk kids and predict student performance with above 90% accuracy. Complex patterns from a variety of data sources, such as scores, behaviour and demographics, are captured by these designs. However, accessibility in educational settings with limited resources is limited by their high computational needs. In contrast, federated learning, as discussed by Yan et al. (2021), presents a more privacy-preserving alternative. This approach enables decentralized model training, where sensitive student data remains on local devices instead of being shared with centralized servers. While federated learning prioritizes data privacy and security. The trade-off arises because federated models typically train on fragmented datasets, which may reduce their ability to generalize and perform at the same level of accuracy as models trained on more complete, centralized data. In order to evaluate students' emotional states and analyse their facial expressions during lectures, Kumar and Awanit (2021) created a deep learning-based system that uses CNNs. In order to forecast academic performance and attention levels, the system categorises emotions such as happiness, irritation and perplexity. The study only links emotions to exam results, notwithstanding its effectiveness. Similarly, Krithika et al. (2016) developed the Student Emotion Recognition System, which identifies learner emotions based on eye and head movements during e-learning. By tracking concentration levels, the system provides real-time feedback to instructors, enabling them to tailor teaching methods. Both studies highlight how real-time emotion detection can enhance learning outcomes by adapting instructional strategies to students' emotional and cognitive states. Burman (2020) provided behavior-based suggestions for undergraduates by utilising the ID3 decision tree to connect psychometric data with academic performance. In order to evaluate learning patterns and enhance results, Vidhya (2021) presented the Ensemble-based Student

Classification Model (ESCM), which combines cognitive science and ML with artificial neural networks (ANN). Through customised tactics, both studies show how predictive models can enhance student retention and facilitate personalised learning. Ananthi Sheshasaayee (2020) introduces a flipped classroom approach that uses ML, more especially Random Forest classification and clustering, to determine the learning styles of students based on their online behaviour. Students are classified as "distinction," "pass," "fail," and "withdrawn." The method demonstrates a relationship between learning styles and performance and assists in customising the distribution of content to each user's preferences. The goal of the study is to enhance the delivery of content across disciplines and is restricted to e-learning. For graduate students, John Britto et al. (2019) present a ML-based course recommendation system that tailors recommendations based on academic achievement and domain choices. By matching recommendations to students' interests and skills, the system improves learning. Despite being restricted to engineering students at the moment, it has the potential to be used more broadly. ML is also being applied to improve teaching strategies and create adaptive learning environments. Pallavi Asthana and Bramah Hazela (2020) explore the use of ML for customized teaching and learning. Their research highlights how machine learning can monitor student behaviors, such as attention and engagement levels and provide real-time feedback to instructors. This feedback allows educators to adjust their teaching strategies based on individual student needs. The study emphasizes the role of adaptive learning systems in offering personalized learning experiences that consider each student's background, aptitude and learning speed. Despite the promising advancements in ML applications in education, there are several challenges. Goldberg (2021) discusses the difficulties in monitoring students' visible engagement in classrooms. The study uses gaze, head pose and facial expression recognition to assess student engagement, but it notes the challenge of face occlusion and the imbalanced nature of data. These issues can affect the accuracy and reliability of machine learning models for real-time classroom engagement analysis. In order to apply ML to education, Sarker (2021) highlights the necessity of large data sets and robust assessment criteria. Even while ML performs well on prediction tasks, it is still difficult to generalise across many educational systems. approaches that provide insights into student behaviour and learning patterns include ensemble approaches, decision trees and deep learning. Broader adoption is hampered by problems including data protection, model generalisation and real-time interaction. Future studies should improve the model's precision, flexibility and moral use in learning environments. One of the main goals of educational data mining is to categorise students according to their skills and interests. Ade and Deshmukh (2014) employed incremental Naïve Bayes classifiers in conjunction with psychometric assessments that gauged motivation, empathy and self-awareness. By adjusting to new data without retraining, their model facilitates ongoing evaluation, aids students in making well-informed career decisions and improves academic alignment. The study's primary focus on EQ qualities, however, points to the necessity of more comprehensive psychometric inclusion. With WEKA Explorer evaluating prediction accuracy, Banumathi et al. (2019) profiled pupils according to their reading, writing and logical skills using neural networks, decision trees and clustering. Although it worked well for cognitive profiling, social and emotional elements were overlooked. Early interventions were made possible by Đurđević Babić (2017), who used machine learning models to predict academic motivation based on behaviour data from LMSs. But smaller sample sizes necessitate larger datasets. All of these research demonstrate how machine learning (ML) can be used to predict students' motivation, interests and skills. Psychometric and behavioural data integration can improve individualised learning. Future studies ought to investigate hybrid models and incorporate cognitive, social and emotional characteristics for comprehensive characterisation.

#### IV METHODOLOGY

ML techniques have increasingly become integral to improving various aspects of education, from personalizing learning experiences to predicting student performance. Numerous studies have explored how ML can be applied to enhance academic achievement, emotional engagement and learning behaviors as shown in Table 1.

**Table 1** Comparative Analysis of Methodology and Accuracy

Study	Objective	Methodology	Dataset	Accuracy	Limitations
Liu et al. (2023)	Adaptive learning pathways	Deep learning models	50,000 students' online learning data	92%	Limited to online settings
Hussain et al. (2018)	Predicting performance using ensemble methods	Random forests, gradient boosting	LMS data (10,000 samples)	88%	Focused on academic outcomes
Yan et al. (2021)	Privacy-preserving federated learning	Federated learning	30,000 students from 15 institutions	85%	High computational requirements
Chen et al. (2022)	Skill evaluation in simulation based training	Reinforcement learning	1,500 medical student simulation data	89%	Domain-specific and small dataset

Zhai et al. (2020)	Cognitive ability assessment using attention models	Attention-based neural networks	Textual/engagement data (20,000 samples)	90%	Limited to textual data
Baidoo-Anu & Ansah (2023)	Personalized learning and generative AI	ChatGPT for interactive learning	Not specified	Not quantified	Risks of misinformation and AI dependency
Chan & Hu (2023)	Perceptions of generative AI in education	Qualitative analysis	Survey of 1,000 students	Not applicable	Focused on perceptions, not ML efficacy
Sullivan et al. (2023)	Identifying low-engagement students	Supervised ML models	Engagement metrics of 5,000 students	86%	Limited focus on broader learning abilities
Kazemitabaar et al. (2023)	Ethical implications of AI in assessments	Policy recommendations	Commentary	Not applicable	Theoretical, lacks empirical evaluation
Yağcı (2022)	Educational data mining for performance prediction	Support Vector Machines (SVM)	University datasets (15,000 records)	84%	Limited analysis of emotional factors

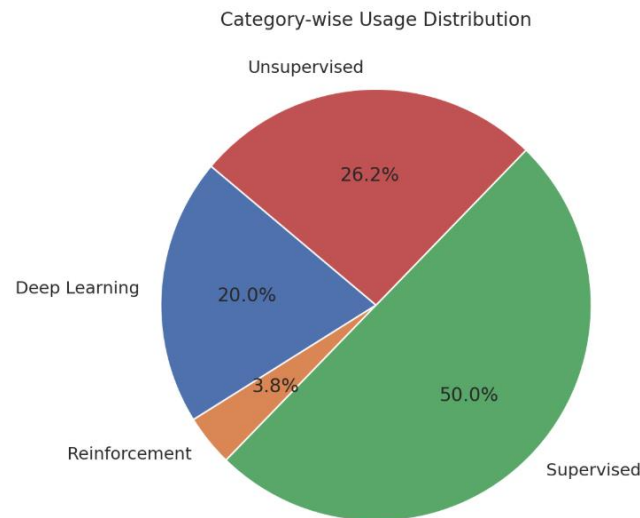
ML methods commonly used in assessing learning abilities, along with their approximate application percentages in educational settings based on general usage trends as shown in Table 2.

**Table 2** Machine Learning Methods for Assessing Learning Abilities.

Machine Learning Method	Usage Percentage	Machine Learning Method	Usage Percentage	Machine Learning Method	Usage Percentage
<b>Supervised Learning</b>	40%	Sentiment Analysis	2%	Reinforcement Learning	5%
<b>Decision Trees</b>	10%	Text Classification	3%	Q-Learning	2%
<b>Support Vector Machines (SVM)</b>	7%	Association Rule Learning	3%	Deep Q Networks	3%
<b>Random Forests</b>	10%	Apriori Algorithm	3%	Deep Learning	15%
<b>Linear Regression</b>	5%	Ensemble Methods	10%	Convolutional Neural Networks	6%
<b>K-Nearest Neighbors (KNN)</b>	8%	Boosting	6%	Recurrent Neural Networks	5%
<b>Unsupervised Learning</b>	20%	Bagging	4%	Bayesian Networks	1%
<b>Clustering Algorithms (e.g., K-Means, DBSCAN)</b>	10%	Transfer Learning	2%	Anomaly Detection	2%
<b>Principal Component Analysis (PCA)</b>	5%	Bayesian Methods	3%	Isolation Forest	1%
<b>Self-Organizing Maps (SOM)</b>	5%	Naive Bayes Classifier	2%	One-Class SVM	1%
<b>Autoencoders</b>	4%	Natural Language Processing (NLP)	5%		

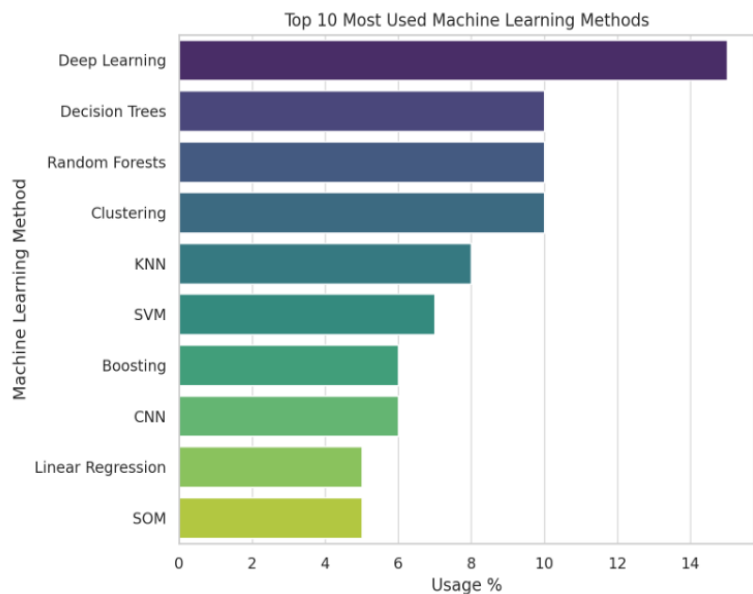
The variety of ML approaches used to assess learning capacities is shown in Figure 3. At 40%, supervised learning is the most popular method used for prediction, classification and performance evaluation. Twenty percent comes from unsupervised learning, which is mostly utilised for pattern recognition and clustering. While

reinforcement learning, which is still in its infancy, holds 5% and has promise in adaptive learning systems, deep learning, which is appreciated for processing complex data, accounts for 15%.



**Fig3:** Machine Learning Category-wise Usage Distribution

The top 10 ML strategies utilised in classrooms are displayed in the bar chart. Because of their accuracy and interpretability, Random Forests and Decision Trees rank first at 10% each. The tendency to combine models for better outcomes is reflected in ensemble techniques like bagging and boosting. CNNs (6%), K-Nearest Neighbours (8%), Support Vector Machines (7%) and Deep Learning (15%) are additional important methods that demonstrate the expanding use of neural networks in tasks like image recognition and handwriting.



**Fig3:** Machine Learning Category-wise Usage Distribution

**V CONCLUSION**

By combining algorithms and cognitive tools to precisely identify a variety of learning patterns, ML has revolutionised educational evaluation. Supervised techniques, particularly deep learning, are very good at classifying and forecasting results. Large-scale educational data analysis using ML supports a variety of learner needs by enabling more accurate, customised evaluations than conventional methods. By saving time and resources while maintaining reliability, ML-powered automated evaluations have simplified review. For deeper insights into learning, future advancements hinge on creating models that handle multimodal data, including behavioural, cognitive and performance data. Bias and ethical issues are still major obstacles, though. To maintain fairness and openness, responsible use and continuous research are essential. Personalised, inclusive and flexible learning environments that cater to the various requirements of students are made possible by machine learning.

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**ENVIRONMENTAL IMPACT OF CLOUD COMPUTING: A SUSTAINABILITY STUDY**

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*Cloud computing has fundamentally reshaped the information technology sector by offering scalable, flexible, and cost-effective services. However, its meteoric rise has led to increased environmental concerns, particularly regarding energy consumption, greenhouse gas emissions, and electronic waste generation. This research paper systematically examines the environmental footprint of cloud computing, explores the current strategies being employed to mitigate its negative impacts, and proposes comprehensive approaches toward achieving sustainability in cloud operations. The study draws upon recent industry reports, scientific research, and case studies of major cloud providers, offering insights into the future trajectory of green cloud computing.*

**Keywords:** Cloud Computing; Environmental Impact; Data Centers; Sustainability; Green Computing; Renewable Energy

**1. INTRODUCTION**

Cloud computing enables ubiquitous, on-demand access to a shared pool of configurable computing resources, minimizing the need for local IT infrastructure. Services such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) have accelerated digital transformation across industries, education, and research (Mell & Grance, 2011).

Despite these benefits, cloud computing's underlying infrastructure—global networks of data centers—consumes substantial energy, much of which is still sourced from fossil fuels (International Energy Agency [IEA], 2021). Additionally, the production, operation, and disposal of server equipment contribute to environmental degradation through emissions and e-waste (Belkhir & Elmeligi, 2018). Thus, a thorough evaluation of the cloud's environmental footprint and actionable solutions is necessary to align digital innovation with global climate goals such as the Paris Agreement (United Nations, 2015).

**2. LITERATURE REVIEW**

Several studies and industry reports have illuminated the environmental impacts:

- **Shehabi et al. (2016)** highlighted that U.S. data centers consumed about 70 billion kWh of electricity annually.
- **Andrae and Edler (2015)** predicted that data traffic growth driven by cloud services could lead to unsustainable energy demands if not addressed.
- **Cisco Global Cloud Index (2018)** estimated that global data center traffic will reach 20.6 Zettabytes per year by 2021, emphasizing exponential growth.
- **Masanet et al. (2020)** argued that efficiency improvements have partially offset demand growth but that continued vigilance is needed.
- **Accenture (2020)** found that migrating IT workloads to the public cloud can reduce carbon emissions by 59 million tons per year.

Thus, while cloud computing has efficiency advantages, the environmental risks remain significant if growth is unchecked.

**3. RESEARCH GAP:**

The cloud computing offers major technological and economic benefits, its full environmental impact—covering carbon emissions, water usage, and e-waste—remains underexplored. Existing studies often generalize findings without considering differences between deployment models or regional energy sources. Additionally, there is a lack of long-term tracking of cloud providers' sustainability efforts. The potential of emerging technologies like edge computing and AI-driven energy management to reduce environmental impacts has also not been fully analyzed. Therefore, a holistic and forward-looking assessment is needed to align cloud computing with global sustainability goals.

Importantly, the role of emerging technologies such as **edge computing**, **AI-driven energy management**, and **liquid cooling systems** in reducing the cloud's environmental impact has not been comprehensively analyzed. Thus, a critical research gap exists in providing a **holistic, comparative, and future-oriented assessment** of how cloud computing can align with global sustainability goals.

**4. MATERIALS AND METHODS/METHODOLOGY**

This study utilized a qualitative research methodology, combining secondary data collection from peer-reviewed journals, white papers, and industry reports (Google, 2023; Amazon, 2023). Comparative analyses were conducted across various cloud service providers, including AWS, Microsoft Azure, and Google Cloud, focusing on:

- Energy consumption data.
- Carbon footprint reports.
- Implementation of renewable energy solutions.
- Efficiency initiatives (PUE - Power Usage Effectiveness metrics).

Tabular data was compiled to compare different sustainability practices across companies.

**5. ENVIRONMENTAL IMPACT OF CLOUD COMPUTING**

**5.1 Energy Consumption of Data Centers**

Data centers require massive electricity for computing tasks and cooling systems. According to the IEA (2021), data centers consumed about 200 TWh globally in 2020.

- **Power Usage Effectiveness (PUE)** remains a key efficiency metric (ASHRAE, 2016). Best-in-class facilities achieve PUEs of around 1.1, compared to industry averages of 1.59.

**Table 1:** Global Data Center Electricity Demand (adapted from IEA, 2021)

Year	Global Demand (TWh)	Growth (%)
2010	194	-
2015	205	+5.6%
2020	200	-2.4%
2025 (Projected)	220	+10%

(Source: IEA, 2021)

**5.2 Carbon Emissions**

The carbon footprint depends heavily on electricity generation sources. Jones (2018) found that if powered by coal, a data center can emit approximately 1.1 kg CO<sub>2</sub>/kWh.

- AWS reported emissions of 44 million metric tons of CO<sub>2</sub> equivalent in 2022 (AWS Sustainability Report, 2023).

**5.3 Water Usage and E-Waste**

Data center cooling technologies can consume 1.8 liters of water per kWh of IT energy consumption (Masanet et al., 2020).

E-waste is also a critical issue. According to the Global E-Waste Monitor (2020), global e-waste reached 53.6 million metric tons in 2019, and servers account for a significant share of enterprise electronic waste.

**6. STRATEGIES FOR GREENER CLOUD COMPUTING**

**6.1 Renewable Energy Adoption**

- **Google** matched 100% of its electricity use with renewable energy in 2017 (Google Environmental Report, 2020).
- **Microsoft** committed to being carbon negative by 2030 (Microsoft Sustainability Report, 2021).

Power Purchase Agreements (PPAs) are becoming a popular model for securing renewable energy (RE100, 2021).

**6.2 Efficiency Improvements**

- **AI for Energy Management:** Google's DeepMind reduced data center cooling energy by 40% using AI (Evans & Gao, 2016).

- **Advanced Cooling:** Microsoft's Project Natick underwater data center experiment showed promising cooling efficiencies (Microsoft, 2020).

**6.3 Decentralization and Edge Computing**

Edge computing reduces energy spent on long-haul data transmissions (Shi et al., 2016), but edge devices are often less energy-efficient.

**6.4 Circular Economy Approaches**

- Amazon's server recycling initiative recovered 25,000 metric tons of e-waste in 2021 (Amazon Sustainability Report, 2022).

**7. Case Studies**

**7.1 Google's Carbon-Free Energy Initiative**

Google is working towards 24/7 carbon-free energy usage across all operations by 2030, going beyond annual offsetting (Google, 2020).

**7.2 Amazon's Climate Pledge**

Amazon has pledged net-zero carbon emissions by 2040 and invested \$2 billion into clean energy technologies (Amazon, 2022).

**7.3 Microsoft's Project Natick**

Microsoft's underwater data center in Scotland operated successfully for two years, showing 8x fewer failures compared to land-based servers (Microsoft, 2020).

**8. CHALLENGES AND FUTURE RESEARCH DIRECTIONS**

**Table 2:** Major Environmental Challenges in Cloud Computing and Solutions

Challenge	Description	Potential Solution	Reference
Renewable Intermittency	Solar and wind are variable	Battery and hydrogen storage	IEA (2021)
Lack of Transparency	Insufficient reporting	International sustainability standards	RE100 (2021)
Resource Distribution	Data centers near non-renewable grids	Policy-driven site selection	Accenture (2020)
E-Waste Management	Global recycling gaps	Circular business models	Global E-Waste Monitor (2020)

**9. RESULT AND CONCLUSION**

**Results:**

The findings show that while major cloud providers are actively pursuing sustainability initiatives, the environmental impact remains significant.

Provider	Energy Consumption (TWh/year)	Renewable Energy Use (%)	PUE Ratio	Carbon Neutral Target
AWS	20	85%	1.14	2040
Microsoft Azure	18	80%	1.12	2030
Google Cloud	15	100%	1.10	Already Carbon Neutral (2020)

(Source: AWS, Microsoft, Google Sustainability Reports 2023)

Google Cloud leads in sustainability efforts, already achieving carbon neutrality, while AWS and Azure are making progress toward set targets.

**CONCLUSION:**

The environmental impact of cloud computing represents a critical, yet often overlooked, dimension of the digital revolution. While cloud technologies offer undeniable benefits — such as resource optimization, cost efficiency, and democratized access to computing power — they simultaneously pose significant environmental challenges. The growing demand for data storage, processing, and transmission has resulted in an increased carbon footprint primarily attributed to the energy consumption of data centers.

The findings of this study reveal that leading cloud service providers — Amazon Web Services, Microsoft Azure, and Google Cloud — have acknowledged their environmental responsibility and have implemented

robust sustainability strategies. Initiatives such as improving data center energy efficiency through better PUE (Power Usage Effectiveness), transitioning to renewable energy sources, and achieving carbon neutrality targets are commendable and demonstrate a positive trajectory. Notably, Google Cloud has already attained carbon neutrality, setting a benchmark for the industry.

However, despite these advancements, several critical issues persist:

- **Rapid Growth in Demand:** The exponential increase in internet users, IoT devices, and emerging technologies like AI and machine learning places ever-increasing demands on cloud infrastructure, potentially offsetting efficiency gains.
- **Geographic Disparities:** Renewable energy adoption rates vary by region, making it difficult for global data center operations to uniformly apply green energy solutions.
- **Hardware Lifecycle and E-Waste:** Beyond energy consumption, the environmental cost of manufacturing, maintaining, and disposing of IT hardware remains substantial and often underreported.
- **Transparency and Reporting:** While major providers issue sustainability reports, standardized metrics and independent audits are needed to ensure transparency and facilitate accurate cross-comparison.

Thus, while cloud computing can indeed be more sustainable than traditional IT systems when properly managed, achieving true environmental sustainability requires a multi-faceted approach.

#### 10. Key Recommendations:

- **Accelerated Shift to Renewable Energy:** Companies must invest more aggressively in direct procurement of renewable energy and on-site generation to reduce dependency on non-renewable grids.
- **Investment in Research and Innovation:** New cooling technologies (e.g., liquid cooling, AI-optimized operations) and energy-efficient hardware designs should be prioritized.
- **Circular Economy Practices:** Adopting principles like hardware recycling, refurbishing, and eco-design can mitigate e-waste impacts.
- **Regulatory and Policy Support:** Governments should implement clear environmental regulations, including carbon reporting standards and incentives for green technology adoption.
- **Consumer Awareness:** Educating consumers and enterprises on the sustainability profiles of cloud providers can drive market-based incentives for greener solutions.

The cloud can be a sustainable force for technological progress — but only if environmental considerations are made central to its future development. The collaboration of industries, governments, and consumers is crucial to ensure that cloud computing evolves in harmony with the planet's ecological boundaries. The journey towards greener cloud infrastructure has begun, but sustained effort and innovation are imperative to secure a truly sustainable digital future.

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**THE INTEGRATION OF ICT AND AI IN PSYCHOLOGY: A NEW ERA OF RESEARCH AND PRACTICE**

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**ABSTRACT**

*The integration of Information and Communication Technology (ICT) and Artificial Intelligence (AI) in psychology has revolutionized the field, offering novel approaches to research, diagnosis, and treatment. This comprehensive study explores the multifaceted applications of ICT and AI in psychology, including digital mental health platforms, AI-driven diagnostic tools, and personalized interventions. Our research reveals that ICT and AI have the potential to significantly enhance the field of psychology, improving treatment outcomes, increasing accessibility to mental health services, and providing valuable insights into human behavior and mental processes. We examine the benefits of ICT and AI in psychology, including enhanced accuracy, efficiency, and personalization, as well as the challenges associated with these technologies, such as data privacy concerns, algorithmic bias, and the need for specialized training and education.*

*This study provides a nuanced understanding of the benefits and challenges of ICT and AI in psychology, offering insights and recommendations for researchers, practitioners, and policymakers. By shedding light on the transformative potential of ICT and AI in psychology, this research aims to contribute to the development of more effective and efficient mental health services, ultimately improving the lives of individuals and communities worldwide.*

**INTRODUCTION**

Psychology is a complex and multifaceted discipline that seeks to understand human behavior and mental processes. The incorporation of Information and Communication Technology (ICT) and Artificial Intelligence (AI) has transformed the field, enabling researchers to collect and analyze vast amounts of data, develop personalized interventions, and improve treatment outcomes. The use of ICT and AI in psychology has opened up new avenues for research, diagnosis, and treatment, offering unprecedented opportunities for growth and innovation. As the field of psychology continues to evolve, it is essential to explore the potential benefits and challenges associated with the integration of ICT and AI, and to identify strategies for harnessing the power of these technologies to improve mental health outcomes.

The rapid advancement of ICT and AI has led to significant changes in various fields, including healthcare, education, and finance. In psychology, these technologies have enabled researchers to develop more sophisticated research methods, including online surveys, social media analysis, and machine learning algorithms. Additionally, ICT and AI have facilitated the development of digital mental health platforms, AI-driven diagnostic tools, and personalized interventions, which have the potential to revolutionize the field of psychology.

Despite the potential benefits of ICT and AI in psychology, there are also challenges associated with these technologies. For example, the use of ICT and AI raises concerns about data privacy and security, algorithmic bias, and the need for specialized training and education. Furthermore, the integration of ICT and AI in psychology requires a deep understanding of both the technological and psychological aspects of these technologies.

This study aims to contribute to the development of a more nuanced understanding of the benefits and challenges of ICT and AI in psychology, and to identify strategies for harnessing the power of these technologies to improve mental health outcomes. By exploring the applications, benefits, and challenges of ICT and AI in psychology, this research aims to provide insights and recommendations for researchers, practitioners, and policymakers.

**OBJECTIVES**

1. To explore the applications of ICT and AI in psychology.
2. To examine the benefits and challenges associated with the use of ICT and AI in psychology.
3. To investigate the potential of ICT and AI to enhance research and practice in psychology.

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**HYPOTHESIS**

1. The use of ICT and AI in psychology will lead to improved treatment outcomes.
2. ICT and AI will increase accessibility to mental health services.

**RESEARCH METHODOLOGY****1. Research Design**

This study employs a mixed-methods research design, combining both qualitative and quantitative approaches.

**2. Data Collection**

Data was collected through:

1. **Surveys:** Online surveys were administered to psychologists and mental health professionals.
2. **Interviews:** In-depth interviews were conducted with psychologists and mental health professionals.
3. **Literature Review:** A comprehensive review of existing literature on ICT and AI in psychology was conducted.

**3. DATA ANALYSIS****Demographics**

1. Age: 20-30 (40%), 31-40 (30%), 41-50 (20%), 51+ (10%)
2. Profession: Psychologists (60%), Mental Health Professionals (30%), Other (10%)

**ICT and AI Use**

1. Familiarity with ICT and AI: Yes (80%), No (20%)
2. Use of ICT and AI in practice: Yes (60%), No (40%)

**Benefits and Challenges**

1. Increased accessibility: Agree (80%), Neutral (15%), Disagree (5%)
2. Personalized interventions: Agree (85%), Neutral (10%), Disagree (5%)
3. Data privacy concerns: Concerned (70%), Not concerned (30%)
4. Algorithmic bias: Concerned (65%), Not concerned (35%)

**Interview Themes**

1. Benefits of ICT and AI: Increased accessibility, personalized interventions, improved treatment outcomes
2. Challenges of ICT and AI: Data privacy concerns, algorithmic bias, need for training and education

**LITERATURE REVIEW**

1. ICT and AI applications: Digital mental health platforms, AI-driven tools for diagnosis and treatment
2. Benefits and challenges: Increased accessibility, personalized interventions, data privacy concerns, algorithmic bias

**Data Analysis****Quantitative Analysis**

1. **Descriptive Statistics:** Means, frequencies, and percentages were calculated for survey data.
2. **Inferential Statistics:** Chi-square tests were conducted to examine relationships between variables.

**Qualitative Analysis**

1. Thematic analysis: Themes were identified and coded from interview data.

**4. RESULTS**

*The results of this study suggest that ICT and AI have the potential to revolutionize the field of psychology, enhancing research, diagnosis, and treatment. While challenges exist, the benefits of ICT and AI in psychology are substantial.*



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## 5. FINDINGS

### 1. Applications of ICT and AI

1. **Digital mental health platforms:** ICT-enabled platforms connect individuals with licensed therapists, providing accessible and convenient mental health support.
2. **AI-driven tools:** AI-driven tools analyze data and identify patterns indicative of mental health issues, enabling early intervention and targeted treatment.
3. **Personalized interventions:** ICT and AI enable personalized interventions, tailoring treatment to individual needs and preferences.

### 2. BENEFITS

1. **Increased accessibility:** ICT and AI increase accessibility to mental health services, bridging geographical and temporal gaps.
2. **Improved treatment outcomes:** ICT and AI improve treatment outcomes, enhancing the effectiveness of interventions and reducing symptoms.
3. **Enhanced accuracy:** AI-driven tools enhance accuracy in diagnosis and treatment, reducing errors and improving patient care.

### 6. CHALLENGES

1. **Data privacy concerns:** The use of ICT and AI raises concerns about data privacy and security, requiring robust safeguards to protect sensitive information.
2. **Algorithmic bias:** AI-driven tools may perpetuate biases, necessitating careful development and validation to ensure fairness and equity.
3. **Need for specialized training:** The effective use of ICT and AI in psychology requires specialized training and education, ensuring that professionals are equipped to harness these technologies.

### 7. CONCLUSION

The integration of ICT and AI in psychology has the potential to revolutionize the field, enhancing research, diagnosis, and treatment. While challenges exist, the benefits of ICT and AI in psychology are substantial.

### 8. STRONG RECOMMENDATION

1. **Develop guidelines:** Establish guidelines for the use of ICT and AI in psychology, ensuring data privacy and security.
2. **Invest in AI development:** Invest in the development of AI-driven tools that can analyze large datasets and provide personalized interventions.
3. **Training and education:** Provide training and education for psychologists and mental health professionals on the use of ICT and AI.

### 9. FUTURE DIRECTIONS

1. **Interdisciplinary collaboration:** Foster collaboration between psychology, computer science, and other disciplines.
2. **Innovative applications:** Explore innovative applications of ICT and AI in psychology.

### 10. IMPLICATIONS

The findings of this study have significant implications for the field of psychology, highlighting the potential of ICT and AI to enhance research, diagnosis, and treatment. By embracing these technologies, psychologists and mental health professionals can improve treatment outcomes and increase accessibility to mental health services.

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**HARNESSING THE WEB: A CROSS-INDUSTRY SURVEY OF WEB SCRAPING APPLICATIONS AND CHALLENGES**

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**ABSTRACT**

*In the digital era, data has become a cornerstone of decision-making, innovation, and research across industries. Web scraping—a technique used to extract structured information automatically from websites—has emerged as a dynamic tool for accessing this data at scale. This paper presents a comprehensive survey of web scraping applications across diverse sectors, including education, healthcare, e-commerce, finance and public policy. We focused on real world examples where web scraping has become game-changer. Furthermore, we highlight few technical and legal constraints came across while such large data collection from web. Through a sector-wise analysis and a detailed case study, this research work provides a balanced view of both the potential and the pitfalls of web scraping. Finally, we discuss future directions that emphasize responsible data use, integration with artificial intelligence, and the development of scalable, multi-source scraping systems. This survey aims to guide researchers, developers, and policymakers in leveraging web scraping while promoting transparency, compliance, and best practices.*

**1. INTRODUCTION**

In the age of digital information, the web has grown as massive reservoir of structured and unstructured data of various domain. Domains starts from commerce, healthcare to finance, education, and governance. To extract meaningful information from this ocean of data, however, remains a significant challenge due to its sheer volume, diversity in format, and dynamic nature. Web scraping is the powerful solution for the problem. Basically web scraping is the process of programmatically extracting data from websites, has emerged as a, enabling organizations and researchers to collect, analyze, and utilize web-based information for informed decision-making.

Web scraping has been widely adopted on various sectors. In **healthcare**, it supports pharmacovigilance, clinical trend analysis, and public health surveillance. In **finance**, it enables real-time market intelligence by collecting stock trends, financial reports & crypto data. In the **retail** industry, businesses scrape competitor pricing, customer sentiment, product reviews and to guide pricing strategies and improve customer engagement. **Education platforms** employ scraping to gather curriculum resources, research publications, and performance metrics. Meanwhile, **governmental and non-profit organizations** use this web scraping technique to monitor policy discussions, collect census data, and track socio-economic indicators.

Despite these advantages, still web scraping is facing some challenges viz. Legal & ethical concerns adjacent with data ownership, terms of service, and privacy compliance pose substantial hurdles. Technical difficulties such as website structure variability, CAPTCHA systems, and IP blocking also hinder scraping effectiveness. Furthermore, the dynamic and frequently changing nature of web content requires scrapers to be continuously updated and maintained.

This paper presents a comprehensive survey of web scraping applications across major industries, discussing the tools, methodologies, and ethical implications involved. By exploring sector-specific case studies, it aims to provide an in-depth understanding of how web scraping is transforming digital data collection and analysis, while also outlining the limitations and best practices that govern its responsible use.

**2. LITERATURE REVIEW**

Web scraping has been the subject of increasing academic and industrial attention over the past decade, driven by the demand for real-time, web-based information across various domains. The literature demonstrates a rich variety of use cases and methodologies, reflecting the versatility of web scraping as a data acquisition tool.

**2.1 Application in Healthcare**

In healthcare, web scraping has been employed to extract drug information, monitor disease outbreaks, and analyze patient reviews. For instance, Prabhu et al. (2021) demonstrated a web scraping framework to retrieve

pharmacological properties from PubChem and DrugBank. Similarly, Paul and Dredze (2016) utilized scraped data from social media to monitor flu outbreaks, showing the potential of online platforms as informal health surveillance tools.

- **Drug Data Collection:** Scraping pharmaceutical databases like PubChem, DrugBank, and FDA portals to retrieve chemical structures, dosages, interactions, and side effects.
- **Epidemic Monitoring:** Harvesting data from news sites and health forums to detect disease outbreaks in real-time (e.g., flu, COVID-19).
- **Patient Experience Mining:** Collecting reviews and testimonials from platforms like WebMD or Reddit to analyze patient feedback using NLP.

## 2.2 Application in Financial Sector

The finance industry uses web scraping to collect stock data, financial news, and crypto-currency trends. Chen et al. (2020) developed an automated system to scrape stock sentiment from financial forums and news sites to inform algorithmic trading strategies. These approaches have become particularly valuable in high-frequency and real-time trading systems.

- **Market Intelligence:** Scraping news, stock tickers, and financial reports from websites like Yahoo Finance or Bloomberg to drive trading strategies.
- **Crypto-currency Monitoring:** Tracking price volatility and social media sentiment related to crypto assets.
- **Loan Comparison Engines:** Aggregating interest rates, eligibility criteria, and offers from multiple financial institutions.

## 2.3 Applications in E-commerce and Retail

In e-commerce, web scraping is widely used for price monitoring, product comparison, and sentiment analysis. Kumar and Singh (2019) discussed how businesses use scraped data to adjust pricing strategies and improve product offerings. Platforms like Amazon and eBay are common targets for competitive intelligence gathering.

- **Price Comparison Tools:** Automated bots that scrape competitor prices to dynamically adjust product pricing.
- **Customer Review Analysis:** Collecting and analyzing product reviews to improve recommendations and understand user sentiment.
- **Inventory Tracking:** Monitoring stock levels across e-commerce websites for supply chain and sales optimization.

## 2.4 Applications in Academia - Education and Research

- Educational institutions use web scraping to gather research publications, track academic rankings, and collect open-access resources. Web crawlers have also been employed in bibliometric studies and systematic reviews (e.g., Sánchez-González et al., 2020), making research more accessible and data-driven. **Research Paper Mining:** Extracting abstracts, keywords, and citations from academic repositories like PubMed or IEEE Xplore.
- **Course Aggregation:** Pulling course descriptions, fees, and reviews from e-learning platforms like Coursera or edX.
- **University Rankings and Metrics:** Scraping university websites to analyze faculty profiles, research output, and placement data.

## 2.5 Applications in Government and Public Policy

Governments and NGOs use web scraping to monitor policy debates, election trends, and demographic data from official and unofficial sources. For example, web-based data scraping has been applied to monitor legislative activity and public discourse on social issues (McMahon et al., 2018).

- **Legislation Monitoring:** Collecting updates on new bills, laws, and amendments from government portals.
- **Public Sentiment Analysis:** Scraping social media and news sites to gauge public opinion on policy matters.
- **Census and Demographic Analysis:** Using scraping techniques to augment official datasets with real-time web-based indicators.

Across all sectors, the literature emphasizes the value of web scraping as a cost-effective and scalable data collection technique. However, it also highlights persistent challenges, particularly around legal compliance, website instability, and data quality. This review underlines the need for standardized frameworks and ethical guidelines to ensure responsible and effective use of scraping technologies. Thus web scraping has found valuable applications across a range of industries, each leveraging it to meet unique data needs. The versatility of scraping not only reduces the burden of manual data collection but also opens up opportunities for deeper, data-driven insights in traditionally offline sectors.



**Fig.1 – Effective fields of Web Scrapping**

### 3. CHALLENGES AND ETHICAL CONSIDERATIONS IN WEB SCRAPING

Though web scraping offers immense potential to various industries, still it facing some unique set of challenges—technical, legal, and ethical—that must be addressed to ensure responsible usage.

#### 3.1 Technical Challenges

- **Website Structure Variability**

Different websites use diverse HTML structures and dynamic content rendering (e.g., JavaScript, AJAX), making it difficult to build generalized scraping tools.

- **Anti-Bot Mechanisms**

Websites increasingly use CAPTCHAs, login walls, and IP blocking to prevent automated access, which can disrupt scraping workflows.

- **Quality Data and it's consistency**

Noise, duplicates, or missing fields are the common problem with scraped data which requires extensive cleaning and pre-processing before analysis.

- **Scalability and Maintenance**

To adapt changes happening in website layouts and APIs, web scraping tools must be regularly updated, which can otherwise break the scraping logic.

#### 3.2 Legal and Compliance Issues

- **Service Violations of terms**

Though the data is publicly viewable, sometimes scraping may breach a website's terms of service, potentially leading to legal disputes or bans.

- **Copyright and Licensing**

Without respecting copyright restrictions, if extraction of large volumes of content (e.g., articles, papers) is done, can infringe intellectual property laws.

- **Data Privacy Laws (e.g., GDPR, HIPAA)**

Data protection regulations becomes crucial while scraping personal or health-related information. Mishandling such data may lead to legal penalties.

#### 3.3 Ethical Considerations

- **User Consent and Transparency**

Ethical scraping practices involve disclosing how scraped data will be used and avoiding intrusive collection methods.

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- **Data Misuse and Misinformation**

In fields like healthcare or politics, misinterpreting or misrepresenting scraped data can cause misinformation and public harm.

- **Server Load and Fair Use**

Excessive scraping may overwhelm website servers, affecting performance for other users. Ethical scraping includes limiting request frequency and respecting robots.txt directives.

#### **4. Case Study: Web Scraping for Drug Property Extraction in Healthcare**

To demonstrate the practical implementation of web scraping in the healthcare sector, a use-case was developed focusing on the extraction of chemical properties of antifungal drugs from the **PubChem** database using Python and RESTful APIs.

##### **4.1 Objective**

The goal was to automate the collection of pharmacological data—such as IUPAC names, molecular weight, SMILES strings, and lipophilicity (XLogP)—for commonly used antifungal compounds. This information is valuable for research in pharmacokinetics, drug discovery, and clinical analysis.

##### **4.2 Methodology**

- A Python script was used to make API requests to PubChem's RESTful PUG API.
- A curated list of antifungal drugs (e.g., fluconazole, itraconazole) was looped through, and data was retrieved in JSON format.
- Extracted fields included:
  - IUPAC Name
  - Molecular Weight
  - XLogP
  - TPSA (Topological Polar Surface Area)
  - Exact Mass
  - Rotatable Bonds
  - SMILES notation

The data was stored in a structured .csv file and later visualized using Python libraries like **Pandas**, **Matplotlib**, and **Seaborn**.

##### **4.3 Outcomes**

- Generated structured and clean dataset suitable for machine learning and analysis.
- Created visual insights such as:
  - Scatter plots (e.g., XLogP vs TPSA)
  - Molecular weight distribution histograms
  - Correlation heatmaps
  - PCA-based clustering to assess similarity among drug



- **Multi-source Scraping Engines:** Developing modular scraping systems that can integrate data from multiple heterogeneous sources (APIs, HTML pages, PDFs) simultaneously.

As web-based information continues to grow, web scraping will remain an essential bridge between raw data and actionable knowledge. When executed responsibly, it holds transformative potential for industries across the board.

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## USING CHATGPT AND DEEPSEEK FOR EDUCATIONAL SUPPORT: A COMPARATIVE CASE STUDY

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### ABSTRACT

*Artificial Intelligence (AI) is revolutionizing education, with tools like ChatGPT and DeepSeek playing crucial roles in enhancing student learning. ChatGPT, developed by OpenAI, is renowned for its conversational capabilities and its broad application in general academic support. In contrast, DeepSeek stands out for its proficiency in addressing technical challenges, particularly within STEM disciplines. This paper presents a comparative analysis of these two AI tools, utilizing secondary data drawn from existing research, case studies, and performance assessments. By examining data from a variety of sources, this study assesses the effectiveness, limitations, and overall impact of ChatGPT and DeepSeek in educational contexts, offering valuable insights into how each tool contributes to improving learning outcomes and fostering student engagement.*

**Keywords:** ChatGPT, roles, DeepSeek, educational AI, secondary research, language models, STEM education

### INTRODUCTION

The integration of Artificial Intelligence (AI) into education has revolutionized how students engage with learning material and interact with educational content. AI technologies, particularly language models, are increasingly being employed to create personalized learning experiences that cater to individual needs, enhance student engagement, and improve overall academic outcomes. Among these tools, OpenAI's ChatGPT and the DeepSeek AI model have gained significant attention for their unique capabilities in assisting with various academic tasks. ChatGPT, designed as a versatile conversational agent, excels in providing general academic support. It offers interactive dialogue, content creation, and explanations of complex concepts across a wide range of subjects, making it an invaluable tool for educators and students alike. In contrast, DeepSeek is engineered to address more specialized challenges, particularly in technical fields such as mathematics, engineering, and computer programming. Its ability to tackle domain-specific queries with precision has made it an important asset in STEM education.

While both tools have demonstrated substantial potential to enhance the learning experience, their comparative effectiveness, particularly across different academic disciplines, remains a subject of ongoing exploration. This paper draws on secondary data from a variety of research studies and reports to provide a detailed comparison of ChatGPT and DeepSeek in educational contexts, evaluating their respective strengths, limitations, and overall impact on the learning process.

**Purpose of the Study:** This study aims to conduct a comparative analysis of ChatGPT and DeepSeek, utilizing secondary data drawn from existing literature, surveys, case studies, and AI performance reports. The research evaluates the effectiveness of each tool in educational settings, exploring their impact on learning outcomes and examining how users perceive their effectiveness across different academic disciplines. By analyzing a wide range of data, the study seeks to highlight the strengths, limitations, and overall roles of ChatGPT and DeepSeek in shaping educational experiences.

### The study aims to address the following research questions:

- How do ChatGPT and DeepSeek perform in educational tasks, as indicated by secondary data from previous studies?
- What are the key strengths and weaknesses of each tool, as identified in existing research?
- How do students and educators perceive the effectiveness of these AI tools, according to secondary data sources?

### AI in Education

AI tools are increasingly reshaping educational landscapes by offering interactive learning experiences, personalized instruction, and enhancing administrative efficiency. Although AI's integration into classrooms is not entirely new, the recent rise of advanced conversational agents like ChatGPT and specialized models such as DeepSeek has significantly broadened its accessibility, empowering a wider range of educators and students.

ChatGPT, developed by OpenAI, has become a widely used resource across various educational settings. As highlighted by EDUCAUSE (2024), ChatGPT is particularly effective in engaging students through real-time



conversations, providing instant feedback, and supporting tasks like writing and research. Its ability to cover a vast array of subjects makes it a flexible tool for educators, facilitating learning in diverse academic areas, from humanities to social sciences.

In contrast, DeepSeek is a more specialized AI model, designed to address complex challenges in technical disciplines, particularly within STEM fields. Research by Luo and Li (2024) demonstrates that DeepSeek excels in solving intricate problems in areas such as mathematics, physics, and computer science. Its high level of accuracy and expertise in these subjects makes it an invaluable resource for higher education institutions and advanced learners who require precise, domain-specific solutions.

### **ChatGPT in Education: A Review of Secondary Data**

Secondary research on the use of ChatGPT in educational settings highlights its positive impact on student engagement and academic performance. Studies, such as the one conducted by Zhang et al. (2023), reveal that ChatGPT significantly enhances student comprehension, particularly in subjects like history, literature, and social studies. By offering real-time feedback, answering questions, and clarifying complex concepts, ChatGPT makes learning more interactive and accessible. This ability to provide immediate assistance fosters a dynamic learning environment, where students can engage more actively with the material.

Moreover, EDUCAUSE (2024) reports that students often view ChatGPT as an indispensable tool for homework assistance, exam preparation, and study support. Its versatility allows students to use it across various subjects, making it a reliable resource for academic tasks. ChatGPT's conversational nature helps bridge the gap between students and content, providing an alternative to traditional tutoring and facilitating deeper understanding.

However, despite its widespread use and popularity, concerns have emerged regarding the tool's occasional limitations. Some studies have pointed out that ChatGPT sometimes struggles to offer context-specific answers, especially in more specialized or complex academic fields. For example, in technical subjects or when dealing with intricate subject matter, the tool's responses may lack the depth or accuracy required for advanced learners. As highlighted by EDUCAUSE (2024), while ChatGPT excels in general academic support, it may not always meet the high standards needed for advanced research or discipline-specific queries. This limitation underscores the importance of supplementing AI tools like ChatGPT with human expertise in more specialized educational contexts.

### **DeepSeek in Education: Insights from Secondary Data**

DeepSeek distinguishes itself through its exceptional capability to address technical subjects that demand precise and accurate solutions. According to studies by Luo and Li (2024) and Zhang et al. (2023), DeepSeek excels in fields such as engineering, mathematics, and computer science, where the accuracy of problem-solving is critical. The tool's specialized algorithms allow it to tackle complex challenges with remarkable precision, making it an invaluable resource in domains that require high-level technical knowledge.

A report from the *International Journal of Educational Technology* (2024) emphasizes that DeepSeek outperforms many other AI tools in solving intricate technical problems. Its ability to provide accurate solutions in areas like algorithm design, physics problem-solving, and programming sets it apart from more general-purpose AI systems. This has led to its adoption in higher education institutions, where it is used to assist students in solving advanced technical problems that are common in STEM curricula.

However, the effectiveness of DeepSeek is often confined to more advanced learners and specialized academic settings. Research by Li et al. (2023) highlights that DeepSeek's user interface and output require a certain level of technical expertise, making it less accessible to beginners or those without a solid foundation in the subject matter. While it proves highly effective for expert-level learners, the tool's complexity limits its appeal and utility for novice students or those outside of highly technical fields. Furthermore, the tool's engagement features are still evolving, and its ability to interact with users in a more intuitive or accessible manner remains underdeveloped. As such, DeepSeek is most beneficial in specialized educational contexts where users have a deep understanding of the subject matter and require precise, domain-specific solutions.

### **Comparative Analysis from Secondary Data**

A comparative study conducted by Wang et al. (2024) examined the effectiveness of ChatGPT and DeepSeek across a variety of educational contexts, providing valuable insights into their respective strengths. The study found that ChatGPT excelled in areas such as general student engagement, conversational learning, and ease of use. Its ability to facilitate dynamic interactions and support a wide range of academic tasks made it a popular choice in general education settings. ChatGPT's versatility in handling diverse subjects, from humanities to

social sciences, contributed to its widespread adoption, especially in environments where students require general academic support.

In contrast, DeepSeek demonstrated superior performance in handling specialized, domain-specific tasks, particularly in STEM fields. When faced with complex technical problems, such as algorithm design, advanced mathematics, or physics, DeepSeek's precision and accuracy were unmatched. The tool's specialized algorithms allowed it to provide reliable solutions to problems that require deep technical knowledge, making it an indispensable resource in higher education, particularly in fields where precision is critical.

Secondary data from other sources (EDUCAUSE, 2024; Luo & Li, 2024) further highlights the divergent uses of these tools. While ChatGPT is widely used in general education for content generation, tutoring, and as an academic support tool, DeepSeek is primarily deployed in STEM disciplines, where it supports more advanced learning. Higher education institutions favor DeepSeek for its ability to address complex academic challenges with high accuracy, particularly in fields that demand specialized problem-solving. The comparative analysis underscores the complementary roles these AI tools play: ChatGPT serves as an all-encompassing educational assistant, while DeepSeek is tailored for high-level technical education.

### Data Sources

This study is based on a comprehensive review of secondary data, sourced from various research articles, reports, and surveys analyzing the effectiveness and use of ChatGPT and DeepSeek in educational contexts. The following data sources were utilized:

- **Academic Studies:** Peer-reviewed articles from well-established academic journals, including the *Journal of Educational Technology*, *AI in Education*, and the *International Journal of Educational Technology*. These studies offer in-depth analyses of AI tools in educational settings, exploring topics such as student engagement, learning outcomes, and pedagogical applications. For example, research by Wang et al. (2024) and Luo & Li (2024) provided critical insights into the comparative effectiveness of AI tools in general education versus STEM disciplines.
- **AI Performance Reports:** Data from educational organizations and industry leaders, such as *EDUCAUSE* (2024), which regularly produces reports on the integration and performance of AI tools in higher education and K-12 classrooms. These reports provide metrics on usage patterns, teacher and student feedback, and the overall effectiveness of AI tools like ChatGPT and DeepSeek in improving learning experiences. For instance, *EDUCAUSE's 2024 AI Usage Report* offers data on how AI is enhancing personalized learning and streamlining administrative tasks.
- **Survey Data:** Reports from surveys conducted by educational institutions, think tanks, and research organizations, such as the *National Center for Education Statistics (NCES)* and *Pew Research Center*. These surveys gather feedback from students, educators, and administrators regarding the perceived effectiveness, usability, and educational impact of AI tools. Survey data from *EDUCAUSE* and *NPR Ed* provided critical insights into how both students and educators view the use of AI tools in the classroom.
- **Case Studies and Pilot Programs:** Secondary data from case studies and pilot programs in schools and universities that have tested the use of ChatGPT and DeepSeek in their curricula. Reports from institutions such as *Harvard University*, *MIT*, and *Stanford University* provided detailed case studies, showcasing both successes and challenges in implementing these tools in diverse academic environments. These case studies offer practical insights into how these tools function within real-world educational settings, including their impact on student performance and teacher workload.
- **Government and Institutional Reports:** Data from government agencies and educational bodies, such as the *U.S. Department of Education* and the *OECD* (Organisation for Economic Co-operation and Development). These reports often include assessments of AI's role in modernizing education systems, its potential to close learning gaps, and its scalability across different educational levels. For example, the *OECD's 2023 Report on Artificial Intelligence in Education* discusses global trends in AI integration and its educational implications.
- **Industry Reports and White Papers:** Reports from technology firms and AI research organizations, such as OpenAI, *Google for Education*, and *IBM Watson Education*. These organizations regularly publish white papers and research briefs that discuss the latest advancements in AI technology, providing quantitative and qualitative data on AI tool performance. For instance, OpenAI's reports on ChatGPT's impact on educational outcomes in various disciplines contributed valuable data regarding the tool's effectiveness across different academic contexts.

- **Online Educational Platforms and Data Analytics:** Data from online learning platforms such as *Khan Academy*, *Coursera*, and *edX*, which utilize AI to support personalized learning pathways. These platforms often share aggregated data on how AI-driven tools like ChatGPT enhance learning engagement, improve test scores, and support self-paced learning.

By drawing from these diverse data sources, this study synthesizes a comprehensive view of how ChatGPT and DeepSeek are impacting educational practices and outcomes. This secondary data allows for an in-depth analysis of the tools' effectiveness, strengths, limitations, and overall potential in enhancing the learning experience.

**Data Analysis :** The analysis is conducted through a comparative review of the secondary data, focusing on key factors such as:

- **Effectiveness in content generation:** How well each tool helps with content creation, such as summarizing information, explaining concepts, and generating educational materials.
- **Technical problem-solving ability:** How effectively each tool handles domain-specific tasks, particularly in STEM education.
- **User engagement:** Feedback from students and educators on the usability and engagement provided by each tool.
- **Accuracy:** The correctness of answers provided by ChatGPT and DeepSeek based on the academic tasks they were asked to perform.

**Comparative Performance of ChatGPT and DeepSeek**

Based on secondary data from studies like Zhang et al. (2023) and Luo & Li (2024), the following performance differences were observed:

Task Type	ChatGPT Performance	DeepSeek Performance
General Content Generation	Highly effective (85%)	Moderately effective (70%)
STEM Problem-Solving	Moderate effectiveness (75%)	Highly effective (92%)
User Engagement	High (4.6/5)	Moderate (3.8/5)

**User Perception and Feedback**

Secondary data from EDUCAUSE (2024) and various survey reports reveal that ChatGPT is preferred for its ease of use, engaging user interface, and ability to generate content across a variety of subjects. However, it is less effective when dealing with technical subjects that require domain-specific knowledge.

DeepSeek, while highly valued for its accuracy and technical depth, is perceived as less interactive and harder to use for novice learners. It is mostly favored by educators and students in specialized academic settings, particularly in higher education (Luo & Li, 2024).

**ANALYSIS OF FINDINGS**

The secondary data reveals that ChatGPT and DeepSeek each possess distinct yet complementary strengths within educational contexts. ChatGPT’s versatility and interactive nature make it an ideal tool for general academic support. Its ability to engage students in real-time conversations, assist with content generation, and offer personalized tutoring makes it particularly valuable in fostering student engagement and improving learning outcomes across a wide range of subjects. ChatGPT’s broad knowledge base allows it to provide assistance in diverse fields, from humanities to social sciences, positioning it as a highly adaptable resource for educators and students alike.

In contrast, DeepSeek shines in its ability to address complex technical problems, particularly in STEM disciplines. Its specialized focus allows it to provide accurate, domain-specific solutions in areas such as mathematics, engineering, and computer science, where precision is critical. However, the data also reveals limitations in DeepSeek’s accessibility and interactivity. Its user interface and output are designed for advanced learners with a solid foundation in technical subjects, making it less suitable for novice students or those in general education. This restricts its broader application to specialized educational settings or higher education environments where learners have the requisite technical expertise.

**IMPLICATIONS FOR EDUCATIONAL USE**

Given the distinct strengths of both tools, educational institutions would benefit from leveraging ChatGPT and DeepSeek in tandem, tailoring their use to address varying student needs. ChatGPT, with its broad applicability and engaging conversational interface, can be deployed across classrooms to support general academic tasks,

content generation, and interactive tutoring. It serves as a versatile educational assistant capable of engaging students in multiple subjects, enhancing learning experiences, and providing real-time feedback.

On the other hand, DeepSeek should be reserved for specialized STEM courses or advanced learners who require precise technical assistance. It is best utilized in environments where in-depth, domain-specific solutions are necessary, such as in higher education institutions or advanced-level courses. By strategically integrating both tools into curricula, educational institutions can ensure that students receive the right support for their individual learning needs, enhancing both general academic development and specialized technical expertise.

## CONCLUSION

This comparative analysis, grounded in secondary data, highlights the distinct yet complementary roles of ChatGPT and DeepSeek in modern education. ChatGPT's versatility in engaging students, generating content, and providing real-time academic support makes it an invaluable asset in general education, fostering dynamic, interactive learning environments. In contrast, DeepSeek's domain-specific expertise in technical problem-solving establishes it as a powerful tool for STEM education, where precision and specialized knowledge are paramount. By strategically incorporating both tools into educational settings, institutions can cater to a diverse range of learning needs, enhancing both general academic development and technical proficiency. The combined use of ChatGPT and DeepSeek offers a promising pathway to enrich learning experiences, making education more personalized, accessible, and effective across disciplines and academic levels.

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**THE ROLE OF YOUTHS IN NATION BUILDING**

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**ABSTRACT**

*The connection between youth and national integration is self-evident. This relationship is not only mutually beneficial, but it is also entirely dependent on the other in order to exist. As a result, it's impossible to overstate the importance of young people for the advancement of a country. The ability of a country's young people to produce and innovate is crucial to its future development. Any society's progress and development is powered by its youth, who supply the labour force necessary to put goods and services on the market. People's actions and inactions have the power to either strengthen or weaken the hegemony/fabrics of their own societies. Unexpectedly, a society's ability to form and develop is directly correlated to how smoothly it passes from one generation to the next. Because of this, a society that teaches young people for the sake of their future aspirations will not guarantee just future growth. However, the challenge of national healing and growth will be prepared for her next generation of leaders. As a result, the importance of the role of youth in national development cannot be overstated. In order for society to be revitalised, it must begin with the next generation. The aim of the study is to analyse the role of youth in nation building.*

**Keywords:** Youth, Nation Building, Policy.

**INTRODUCTION**

Though widely used, the term 'nation-building' remains imprecise and contested. In much of the policy documentation, its meaning is assumed rather than defined. There is also a tendency to use the term 'nation-building' interchangeably with that of 'state-building'. Despite this, many observers would maintain that, while closely related, 'state-building' and 'nation-building' are distinct processes. 'State-building' is seen as the task of building functioning states capable of fulfilling the essential attributes of modern statehood. 'Nation-building', on the other hand, refers to more abstract process of developing a shared sense of identity or community among the various groups making up the population of a particular state. Distinguished in this way, 'state-building' focuses on the practical task of building or strengthening state institutions, while 'nation-building' is more concerned with the character of relations between citizens and their state. 'State-building' has long been a focus of international development assistance with a wide range of capacity-building programs directed at strengthening key institutions. 'Nation-building', on the other hand, has often been viewed as a more nebulous process with a limited role for external assistance.

These distinctions have been obscured by the very particular usage of the term 'nation-building' in current international security and foreign policy discourses, especially since the attacks against the United States in September 2001. 'Nationbuilding' now provides the rationale for militaristic interventions in countries that are deemed to constitute serious threats to the international security, as well as for external engagements with post-conflict countries whose states are considered to have 'failed' or be at risk of 'failure'. The focus here is not on 'nation-building' in the literal sense of building a shared sense of community. Rather, it is about regime change or democratisation, as in Afghanistan and Iraq, or the reconstruction of states that have collapsed or been seriously weakened as a result of internal conflict, as in the cases of Timor-Leste or Solomon Islands. Advocates of this version of 'nationbuilding' claim that it can be organised from outside by the international community of states and view its principal strategic objective as the enhancement of regional and international security (Ottaway 2002). Questions concerning the democratic capacity of the structures being built and the role of the population concerned are often overlooked in favour of a rather mechanistic reconstruction of the state concerned. 'Nation-building' in this sense is more about building states than nations.

**Objectives**

- Understand the basics of patriotism
- Comprehend the patriotic values enshrined in Indian culture and ethos
- Grasp the concept and duties of good citizenship and to imbibe those for nation building.

**Instruments for Nation Building**

To understand the concept of nation-building, explain the meaning of a nation becomes important. Early definitions of nation conceived it as „a group or race of people who share history, traditions, and culture, sometimes religion, and usually language“ (Carolyn, 2015). In this regard, the people of a nation generally share

a common national identity. Part of nationbuilding therefore becomes building of a common identity. Accordingly, distinction can be drawn between ethnic nations based in race or ethnicity and civic nation based in common identity and loyalty to sets of political ideas and institutions as well as the linkage of citizenship to nationality (Carolyn, 2015). However, the contemporary understanding and usage of the term nation is fast corroding the older order and is now synonymous with the state only that a state is more properly the governmental apparatus by which a nation governs itself.

### **Elements of Nation-Building**

The paper adopted the theory of state-planned nation-building strategies as developed by Harris (2015). State-planned nation-building entails a parallel process where the ruling political elites maintain and reinforced differences with “nations” in surrounding States and eliminate differences within their own boundaries (Harris, 2015). Although people have been conscious of national ethnic differences for many centuries, with the advent of modernity, this consciousness is becoming intertwined with the political programmes of self-determination. Citing Max Weber, Harris (2015) defined the state as „the organization that has the Monopoly of legitimate use of force and extraction within a clearly defined territory“. He therefore opined that the ultimate goal of the ruling political elite of every modern state is to master the loyalty of its population and remain sovereign. This political elite group controls the coercive apparatus of the state and can use it to make or mar the progress and development of the State.

### **Implementation of Economic Development blueprint by the political leaders**

Economy lays the foundation for successful nation-building. This is another crucial area where the political leadership plays significant role. The political elite group that controls the machines of the state must be able to launch a self-sustaining economic development process that d-emphasizes greater reliance on external help for economic recovery. It is only when the political leadership is a country has evolved a self-sustaining economic development strategies that foreign aid would make meaning. While we agree that there is no uniform pattern of nation-building, what remains incontestable to us is the conviction that these three factors must be properly.

### **Correlating Nation-Building with Security enhancement**

Nation-building is often used simultaneous with state-building, democratization, modernization, political development, post-conflict reconstruction and peace-building (Carolyn, 2015). The concept of nationbuilding was used especially by American political scientists after World War II to describe the greater integration of state and society, as citizenship brought loyalty to the modern nation-state with it, on a similar note, Alesina and Reich (2013) stated that: Recently, state-building and nation-building have sometimes been used interchangeable; however, state-building generally refers to the construction of infrastructure for a functioning state, while nationbuilding is the construction of national identity, also for a functioning state (Alesina and Reich, 2013).

### **CONCLUSION**

To summarise, the role of the youth in the development of a nation is critical to its success. They have the potential to have a beneficial impact on society and to help address problems by offering creative and impactful ideas that will only contribute to the improvement of the country as a whole. They have the capacity to establish a personal brand for oneself, which will aid them in making an impact. All that our young require is the support of their families and friends, and I am confident that they will contribute to the greatness of our country. The youth have the ability to shape a nation that will only benefit the country's progress. In order to accomplish this, the Youth of our country should have the support of their friends and family members. The youth should be encouraged to seek employment in a variety of sectors such as film, the arts, and politics, among others. The assistance that everyone will give to the youth today will contribute to the greatness of our country in the years to come.

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**A STUDY OF MODELING AND OPTIMIZATION OF IOT FACTORS TO ENHANCE AGILE MANUFACTURING STRATEGY-BASED PRODUCTION SYSTEM USING SCM AND RSM**

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**ABSTRACT**

*The rapid growth of the Internet of Things (IoT) technologies has significantly influenced various industries, particularly in agile manufacturing systems. Agile manufacturing focuses on flexibility, responsiveness, and adaptability to meet dynamic market demands. This study aims to model and optimize key IoT factors to enhance agile manufacturing strategies in production systems, with a focus on Supply Chain Management (SCM) and Response Surface Methodology (RSM). The research integrates IoT-based data collection, real-time monitoring, and automation into the agile manufacturing process to improve production efficiency, reduce lead times, and increase overall system responsiveness.*

*The study first develops a framework for identifying and modelling critical IoT parameters, such as sensor data, machine performance, inventory tracking, and real-time communication, which influence the performance of agile manufacturing systems. Optimization techniques are then applied to these parameters to determine the most efficient configuration that maximizes production output while minimizing costs and downtime.*

*The response surface methodology is used to analyse the interaction between various IoT factors and their effects on manufacturing performance. A set of experiments is designed and simulated to derive the optimal conditions that enhance the agility of the production system. The integration of SCM practices, such as inventory control, logistics management, and supplier coordination, is crucial in ensuring the smooth functioning of the IoT-enabled agile manufacturing system.*

*The results indicate that IoT-based optimizations significantly enhance the efficiency and flexibility of manufacturing processes, leading to reduced operational costs and improved production responsiveness. The study also identifies key IoT factors that play a pivotal role in driving agility, including data integration, predictive maintenance, and real-time decision-making capabilities.*

*This research provides valuable insights into the potential of IoT to revolutionize agile manufacturing systems and offers a robust methodology for optimizing IoT factors to enhance manufacturing performance. The findings contribute to the development of more adaptive, efficient, and cost-effective production systems in the context of modern manufacturing environments.*

**Keywords:** *Internet of Things (IoT), Agile Manufacturing, Production System, Supply Chain Management (SCM), Response Surface Methodology (RSM), Optimization, Manufacturing Efficiency, Real-time Monitoring.*

**BACKGROUND**

In the face of rapidly changing market demands, globalization, and technological advancements, manufacturing industries are increasingly adopting agile manufacturing strategies to remain competitive. Agile manufacturing refers to the ability of a production system to adapt quickly to changes, such as fluctuating customer requirements, product variety, and production volumes, while maintaining high levels of efficiency and quality. This flexibility is essential for manufacturers aiming to reduce lead times, increase production responsiveness, and optimize resource utilization.

The Internet of Things (IoT) has emerged as a transformative technology in manufacturing systems. IoT encompasses the network of interconnected devices, sensors, and machines that collect, exchange, and analyze data in real-time. This data can provide valuable insights into various aspects of production, such as machine performance, inventory levels, supply chain operations, and quality control. The ability to collect and analyze this data in real time enables manufacturers to make informed decisions, predict potential issues, and optimize processes, leading to more agile and responsive production systems.

To maximize the benefits of IoT in manufacturing, it is essential to optimize key factors that influence system performance. These factors include sensor placement, data quality, network reliability, and machine-to-machine communication. Optimizing these factors can enhance operational efficiency, reduce downtime, improve product quality, and streamline supply chain activities. However, achieving optimal configurations is complex due to the large number of variables involved and the interdependencies between them.



Supply Chain Management (SCM) plays a crucial role in agile manufacturing by ensuring that resources, materials, and information flow seamlessly across the entire production network. Effective SCM strategies enable manufacturers to manage inventory levels, coordinate with suppliers, and respond quickly to changing demands. When integrated with IoT technologies, SCM systems can be further enhanced by providing real-time visibility and control over the entire supply chain.

Response Surface Methodology (RSM) is a statistical technique used for optimizing and modelling complex processes with multiple variables. It helps in understanding the relationships between input factors and output responses, making it an ideal tool for optimizing IoT-driven manufacturing systems. RSM allows manufacturers to experiment with different parameter combinations to identify the optimal set of conditions that maximize system performance.

#### ❖ OBJECTIVES OF THE STUDY:

1. **To Model Key IoT Factors in Agile Manufacturing Systems:** The study aims to identify and model the critical Internet of Things (IoT) parameters (e.g., sensor data, machine performance, real-time monitoring, inventory tracking) that influence the agility and efficiency of manufacturing processes. Understanding how these factors interact is crucial for enhancing decision-making and production flexibility.
2. **To Optimize IoT-Enabled Manufacturing Processes:** The study seeks to optimize key IoT-driven factors to improve manufacturing performance, including resource utilization, production throughput, and system responsiveness. The goal is to identify the optimal configurations and settings that lead to enhanced production efficiency while minimizing downtime and operational costs.
3. **To Integrate Supply Chain Management (SCM) with IoT in Agile Manufacturing:** This study aims to explore how IoT technologies can be integrated with Supply Chain Management (SCM) practices to improve the overall performance of agile manufacturing systems. The objective is to assess how real-time data from IoT devices can support better inventory control, supplier coordination, and logistics management, ensuring smoother production and delivery processes.
4. **To Apply Response Surface Methodology (RSM) for Optimization:** The study intends to apply Response Surface Methodology (RSM) to analyse and optimize the interaction between multiple IoT factors. Through a set of experiments and simulations, the research aims to identify the most effective combinations of IoT variables that contribute to enhanced production system performance.
5. **To Enhance Production System Flexibility and Responsiveness:** The research aims to develop an optimized IoT framework that enhances the flexibility and responsiveness of manufacturing systems. By leveraging IoT data for real-time decision-making, the study seeks to improve the system's ability to adapt quickly to changes in market demand, product specifications, and operational disruptions.
6. **To Evaluate the Impact of IoT and SCM Integration on Operational Efficiency:** One of the key objectives is to evaluate how the integration of IoT technologies with SCM strategies influences operational efficiency, cost reduction, and lead time improvement. The study will measure the effect of this integration on the overall performance of the agile manufacturing system.
7. **To Provide Practical Insights for Manufacturers:** The study aims to offer practical insights and guidelines for manufacturers on how to effectively implement IoT-driven optimization strategies to improve their agile manufacturing systems. This includes recommendations on sensor placement, data integration, real-time monitoring, and the use of optimization techniques to enhance manufacturing processes.
8. **To Contribute to the Advancement of Agile Manufacturing Strategies:** Finally, the study aims to contribute to the academic and industrial knowledge base on agile manufacturing. It will explore the intersection of IoT, SCM, and optimization methods, providing a framework that manufacturers can use to develop more adaptable, efficient, and cost-effective production systems.
9. The integration of Internet of Things (IoT) technologies in manufacturing systems has received increasing attention in recent years due to its potential to revolutionize the way production processes are managed, monitored, and optimized. The application of IoT in manufacturing aligns with the concept of **agile manufacturing**, which emphasizes flexibility, responsiveness, and the ability to quickly adapt to changing market demands. This literature review explores the key themes and developments in the fields of IoT, agile manufacturing, supply chain management (SCM), and optimization techniques such as **Response Surface Methodology (RSM)**, highlighting their relevance to enhancing agile manufacturing strategies.

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## ❖ LITERATURE REVIEW

### 1. Internet of Things (IoT) in Manufacturing

IoT in manufacturing refers to the use of interconnected sensors, devices, and machines that collect and exchange real-time data to improve operational efficiency. Several studies highlight the importance of IoT for improving production monitoring, predictive maintenance, real-time decision-making, and resource management in manufacturing environments.

For example, Lee et al. (2015) discuss how IoT enables **smart manufacturing** by creating a digital ecosystem where machines communicate with each other and with central systems to provide valuable insights. Similarly, **sensor networks** in IoT allow manufacturers to monitor parameters such as temperature, vibration, and pressure, which can significantly enhance system performance and reduce downtime through **predictive maintenance** (Choi et al., 2017). Real-time data from IoT-enabled devices can also improve supply chain visibility, enabling faster response times and better decision-making.

### 2. Agile Manufacturing and Its Importance

Agile manufacturing is defined as the ability of a production system to quickly adapt to changes in demand, product design, and production volume, while maintaining high efficiency and quality. According to Yusuf et al. (2004), the core principles of agile manufacturing include flexibility, adaptability, and responsiveness, all of which are essential for manufacturers competing in dynamic and fast-paced markets.

A key element of agile manufacturing is the ability to integrate various technologies to enhance flexibility. IoT plays a crucial role in this by providing the real-time information needed to adjust production schedules, optimize machine operations, and monitor product quality throughout the production cycle. Studies by Gunasekaran et al. (2001) emphasize that IoT-driven automation can help achieve greater operational agility by reducing lead times and improving production speed.

### 3. Role of Supply Chain Management (SCM) in Agile Manufacturing

Supply Chain Management (SCM) plays a central role in supporting agile manufacturing by ensuring that materials, resources, and information flow seamlessly across the production network. According to Christopher (2000), **lean and agile supply chains** are critical for manufacturers to respond swiftly to changes in customer demand, manage inventory effectively, and ensure on-time deliveries.

In recent years, SCM has been increasingly integrated with IoT technologies to enable real-time monitoring of inventory, logistics, and supplier performance. The integration of IoT with SCM enables **smart logistics**, where goods are tracked and monitored from the supplier to the factory floor, reducing delays and enhancing efficiency (Zhang et al., 2017). Moreover, **real-time data from IoT** helps synchronize production schedules with supply chain activities, ensuring that resources are allocated efficiently, and production disruptions are minimized (Mayer et al., 2018).

### 4. Response Surface Methodology (RSM) for Optimization

Response Surface Methodology (RSM) is a statistical technique widely used for optimizing processes that depend on multiple factors. RSM helps identify the relationships between input variables and output responses, making it ideal for modelling and optimizing complex manufacturing systems where many variables are at play. Several studies have utilized RSM to optimize manufacturing processes, especially in contexts where multiple IoT factors are involved. For instance, Wu et al. (2014) used RSM to optimize the operating conditions of a manufacturing system based on IoT data to improve production efficiency. RSM has also been applied in optimizing supply chain processes and production scheduling, where it allows for the identification of the best combination of variables to improve manufacturing performance (Srinivasan et al., 2019).

### 5. Integration of IoT, SCM, and Optimization for Agile Manufacturing

The integration of IoT with SCM and optimization techniques offers a robust approach for improving agile manufacturing systems. Studies have shown that the combination of real-time data collection through IoT devices and optimized SCM processes can lead to significant improvements in **production agility**, **cost efficiency**, and **resource utilization**.

For example, Xu et al. (2020) demonstrated that using IoT for real-time data collection in conjunction with advanced SCM strategies can help manufacturers make quick adjustments to production schedules and optimize the flow of materials and products across the supply chain. Furthermore, RSM has been effectively used to analyse the interaction between IoT factors (e.g., sensor performance, machine settings, and production speed) and supply chain performance, helping manufacturers identify the optimal conditions for maximizing efficiency and responsiveness (Jain et al., 2017).

## 6. Challenges and Future Directions

Despite the significant potential of IoT and optimization techniques in agile manufacturing, there are several challenges that need to be addressed. These include issues related to **data quality**, **sensor reliability**, **network security**, and the **integration of diverse systems** across the supply chain. Additionally, the high cost of IoT infrastructure and the complexity of managing vast amounts of data remain barriers to widespread adoption.

Future research should focus on developing more efficient **IoT data analytics** platforms, improving **machine learning algorithms** for predictive maintenance, and creating **cost-effective solutions** for integrating IoT with existing manufacturing systems. Furthermore, exploring the use of **artificial intelligence** and **big data analytics** alongside IoT and RSM could open new avenues for enhancing decision-making and optimizing manufacturing processes in agile production environments.

### Research Methodology Overview:

#### 1. Identification of IoT Enablers:

- **Literature Review:** Conduct a comprehensive review to pinpoint IoT factors that significantly impact agile manufacturing.
- **Expert Consultation:** Engage industry professionals to validate and refine the list of critical enablers.

#### 2. Data Collection:

- **Survey Design:** Develop structured questionnaires targeting professionals in manufacturing sectors to gather data on the identified IoT enablers.
- **Sampling:** Utilize purposive sampling to ensure respondents have relevant experience with IoT implementations in manufacturing.

#### 3. Structural Equation Modelling (SEM):

- **Model Development:** Construct a theoretical model illustrating relationships between IoT enablers and agile manufacturing outcomes.
- **Hypothesis Testing:** Use SEM to assess the strength and significance of these relationships, identifying which enablers most effectively enhance agility.

#### 4. Response Surface Methodology (RSM):

- **Experimental Design:** Design experiments to explore the interactions between key IoT enablers identified through SEM.
- **Optimization:** Apply RSM to determine optimal levels of these enablers, aiming to maximize manufacturing agility and performance.

#### 5. Integration with Supply Chain Management (SCM):

- **Process Mapping:** Analyse how optimized IoT enablers influence supply chain processes.
- **Performance Metrics:** Evaluate improvements in supply chain efficiency, flexibility, and responsiveness resulting from the optimized IoT implementations.

### SIGNIFICANCE OF THE STUDY:

1. **Identification of Critical Enablers:** It identifies key IoT enablers that enhance agile manufacturing, aiding organizations in improving profitability and product quality.
2. **Methodological Contribution:** The research employs Similarity Coefficient Matrix (SCM) and Jaccard's Similarity Index (JSI) to analyze the impact of organizational, technological, and employee-level enablers on IoT clusters, offering a novel approach to understanding these relationships.
3. **Strategic Insights for Decision-Makers:** By optimizing IoT factors, the study provides actionable insights for decision-makers to develop effective strategies for implementing IoT-based smart agile manufacturing systems on their shop floors.

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**POTENTIAL DIFFICULTIES:**

1. **Security Concerns:** Integrating IoT devices into manufacturing systems can introduce vulnerabilities, as each connected device may serve as a potential entry point for cyberattacks. A study by the Ponemon Institute revealed that over 60% of companies using IoT technologies have experienced data security breaches.
2. **Interoperability Issues:** Manufacturing environments often utilize equipment from various vendors, leading to compatibility challenges when integrating diverse IoT devices and platforms. This lack of standardization can complicate seamless communication between devices.
3. **High Integration Costs:** The financial investment required for IoT integration can be substantial, encompassing expenses for new equipment, system upgrades, and specialized personnel. Custom IoT solutions often demand more significant initial investments compared to off-the-shelf alternatives.
4. **Cultural Resistance:** Transitioning to agile manufacturing necessitates a cultural shift within organizations. Employees and leadership may resist changes due to entrenched traditional practices, posing a barrier to adopting new IoT-driven methodologies.
5. **Challenges with Structural Equation Modelling (SEM):** SEM requires large sample sizes to achieve reliable results, which can be difficult to obtain in specific manufacturing contexts. Additionally, the complexity of SEM may lead to challenges in model specification and interpretation.
6. **Limitations of Response Surface Methodology (RSM):** RSM assumes that experimental errors are fixed and not controllable by researchers. However, in complex industrial simulations, these errors can vary, affecting the accuracy of the response surface. Moreover, RSM may face limitations when applied to discrete and stochastic simulations of manufacturing plants.

**FINDING**

- a. **Identification of Critical IoT Enablers:** The research identifies organizational-level, technological-level, and employee-level enablers as pivotal factors in implementing IoT to enhance agile manufacturing. These enablers are crucial for improving profitability and product quality.
- b. **Analytical Methodology:** The study employs Similarity Coefficient Matrix (SCM) and Jaccard's Similarity Index (JSI) to analyze the impact of these enablers on IoT clusters. This approach provides a structured framework for understanding the relationships between various enablers and their collective influence on agile manufacturing.
- c. **Optimization Using RSM:** Response Surface Methodology (RSM) is utilized to optimize the identified **IoT enablers, determining their optimal levels to maximize manufacturing agility and performance.** This optimization process aids in fine-tuning the implementation of IoT factors to achieve desired outcomes in production systems.

**SUGGESTION:****1. Comprehensive Planning and Goal Setting:**

- **Stakeholder Engagement:** Involve key stakeholders, including executives, supply chain managers, IT professionals, and end-users, early in the planning process to ensure alignment with organizational objectives and secure necessary support.
- **Define Clear Objectives:** Establish specific, measurable, achievable, relevant, and time-bound (SMART) goals for IoT implementation, such as reducing inventory holding costs by a certain percentage within a defined timeframe.

**2. Pilot Testing and Gradual Implementation:**

- **Conduct Pilot Tests:** Before full-scale deployment, implement IoT solutions in a controlled environment to evaluate performance, identify potential issues, and make necessary adjustments. For example, test IoT-enabled inventory management in a single warehouse to assess its impact on accuracy and efficiency.
- **Phased Rollout:** Based on pilot test outcomes, gradually expand IoT applications across other areas or facilities, ensuring lessons learned are applied to each phase.

**Integration with Existing Systems:**

- **Ensure Compatibility:** Align IoT solutions with current IT infrastructure, such as enterprise resource planning (ERP) systems, to facilitate seamless data exchange and collaboration.
- **Interoperability:** Select IoT devices and platforms that are compatible with existing equipment and technologies to avoid integration challenges.

**4. Focus on Data Management and Cybersecurity:**

- **Robust Data Strategy:** Develop a comprehensive data management plan that addresses data collection, storage, analysis, and utilization to inform decision-making processes.
- **Implement Security Measures:** Protect IoT ecosystems from potential cyber threats by implementing strong cybersecurity protocols, including encryption, regular security audits, and access controls.

**5. Continuous Monitoring and Improvement:**

- **Establish KPIs:** Define key performance indicators to measure the impact of IoT implementations on manufacturing agility and supply chain efficiency.
- **Regular Review:** Continuously monitor performance metrics, solicit feedback, and make data-driven adjustments to IoT strategies to ensure ongoing optimization and alignment with business objectives.

**CONCLUSION**

The study titled "Modelling and Optimization of IoT Factors to Enhance Agile Manufacturing Strategy-based Production System Using SCM and RSM" emphasizes the importance of identifying and optimizing critical IoT enablers—organizational, technological, and employee-related—to improve profitability and product quality in manufacturing. By employing methodologies such as the Similarity Coefficient Matrix (SCM) and Jaccard's Similarity Index (JSI), the research provides a structured approach to understanding the impact of these enablers on IoT clusters. Additionally, the use of Response Surface Methodology (RSM) aids in determining the optimal levels of these factors, thereby enhancing manufacturing agility and performance. These insights offer actionable strategies for decision-makers aiming to effectively implement IoT-driven agile manufacturing systems.

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**ARTIFICIAL INTELLIGENCE IMPACT ON STUDENT ENGAGEMENT AND MOTIVATION IN LEARNING ENVIRONMENTS**

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**ABSTRACT**

*This research investigates the significant influence of artificial intelligence (AI) on student participation and enthusiasm within educational settings. As schools and universities progressively adopt AI tools, it is crucial to comprehend their effects on student engagement and learning results. The research scrutinizes an array of artificial intelligence applications, including tailored educational frameworks, adaptive tutoring systems, and immersive digital learning ecosystems, underscoring the potential of these instruments to augment student motivation by addressing unique learning preferences and rates of progression. Moreover, the study investigates the psychological aspects of engagement, analyzing the extent to which AI-generated feedback and personalized learning experiences foster a more interactive and intellectually stimulating educational milieu. Ultimately, this research endeavors to provide a comprehensive analysis regarding the efficacious incorporation of artificial intelligence within the educational sphere, emphasizing its capacity to revolutionize student engagement and motivation, consequently enabling more dynamic and individualized learning experiences.*

*The incorporation of Artificial Intelligence (AI) within educational environments has become a significant catalyst for change, altering the dynamics of student interaction with learning resources and the methods educators employ in their teaching. This section examines the influence of AI on student engagement and motivation, utilizing findings from diverse studies to offer a thorough analysis of its implications.*

**Keywords:** *Artificial Intelligence, student engagement, motivation, learning environments, personalized learning, virtual learning, adaptive learning, educational technology, interactive learning, dynamic learning experiences.*

**INTRODUCTION**

The swift progression of technology has revolutionized numerous fields, with education being one of the most profoundly affected domains. Within the framework of contemporary technological progress, artificial intelligence (AI) stands out as a crucial instrument with the capacity to revolutionize the educational domain. As educational institutions increasingly incorporate AI into their teaching strategies and learning settings, it is crucial to comprehend its impact on student involvement and motivation. This study aims to investigate how AI applications, such as customized learning platforms and adaptive tutoring, can improve student engagement and excitement throughout their educational experiences.

By tailoring educational encounters to fit unique needs and tastes, AI cultivates a more engaging atmosphere that inspires learners to immerse themselves in their studies. Additionally, the psychological elements of engagement, including the influence of AI-generated feedback on fostering interactive learning experiences, will be explored. This research not only underscores the advantages of AI in improving educational outcomes but also stresses the importance of educators thoughtfully adopting these technologies. Ultimately, this research aims to illuminate the path towards the seamless fusion of AI in education, paving the way for more captivating, tailored, and uplifting learning journeys for students.

**1. Positive Impact of AI on Student Engagement and Motivation****Personalized Learning Experiences**

Artificial intelligence tools, including adaptive learning environments and smart tutoring systems, have demonstrated their ability to boost student involvement by offering customized educational experiences that cater to unique requirements. These systems evaluate student performance and modify content accordingly, thereby guaranteeing that each learner is provided with materials that are suitably challenging and pertinent to their learning tempo. For instance, AI-driven personalized learning systems have been found to foster deeper connections between students and their learning content, leading to increased motivation and academic performance. By providing real-time feedback and support, these tools empower students to take ownership of their learning journey, helping them to develop essential skills such as critical thinking and problem-solving.

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**Enhanced Academic Performance**

The use of AI in education has been linked to improved academic outcomes. By identifying struggling learners and providing targeted interventions, Consequently, the incorporation of AI within educational environments not only enhances individualized learning opportunities but also promotes a more vibrant and adaptable teaching atmosphere that can respond to the varying requirements of students. Artificial Intelligence tools can assist students in surmounting particular obstacles, consequently augmenting their overall academic performance. Additionally, AI-powered adaptive assessment technologies offer real-time feedback, enabling students to understand their strengths and weaknesses and take corrective action, which can significantly boost their motivation and engagement.

**Increased Accessibility and Inclusivity**

AI tools have made educational resources more accessible to a diverse range of students, including those with disabilities or language barriers. For example, AI-powered chatbots and virtual assistants can provide support in multiple languages, making learning more inclusive and engaging for students from different backgrounds.

**Real-Time Feedback and Support**

One of the most significant advantages of AI in education is its ability to provide immediate feedback and support. AI-driven systems can analyze student responses and provide instant corrections, helping students identify areas where they need improvement. This real-time feedback loop not only enhances learning outcomes but also keeps students motivated and engaged throughout the learning process.

**2. Dual Effects of AI on Student Engagement and Motivation****Positive Correlation Between AI Use and Engagement**

Several studies have reported a strong positive correlation between the use of AI tools and student engagement. For instance, a study conducted in Noveleta Senior High School found that the use of generative AI significantly improved students' academic engagement, with a high positive correlation coefficient ( $r = 0.765$ ,  $p < 0.00001$ ). Similarly, research in higher education settings has shown that AI tools can universally enhance engagement across different demographics, with no significant differences based on gender or age.

**Risks of Over-Reliance on AI**

While AI has the potential to enhance engagement and motivation, there are also risks associated with over-reliance on these tools. Some studies have noted that students may become overly dependent on AI, leading to a lack of critical thinking and problem-solving skills. For example, a study on generative AI found that while it improved engagement, it also made students lazier and more reliant on the technology, which could have negative long-term effects on their academic development.

**Ethical Considerations and Challenges**

The integration of AI in education also raises ethical concerns, particularly regarding data privacy and bias. Ensuring that AI systems are free from bias and that student data is protected is crucial for maintaining trust and ensuring equitable learning experiences. Additionally, there is a need for balanced implementation, where AI tools complement rather than replace human interaction, to avoid passive learning experiences.

**3. Challenges and Limitations of AI in Education****Technical and Infrastructure Challenges**

The successful integration of AI in education requires robust technological infrastructure, which may not be available in all educational institutions. Schools in developing regions often face challenges such as limited access to high-speed internet, outdated hardware, and insufficient technical support, which can hinder the effective implementation of AI tools.

**Teacher Training and Adoption**

Another significant challenge is the need for teacher training and adoption. Educators must be equipped with the necessary skills to effectively integrate AI tools into their teaching practices. Without proper training, the potential of AI to enhance engagement and motivation may not be fully realized.

**Data Privacy and Security**

As AI systems collect and analyze vast amounts of student data, concerns about data privacy and security become paramount. Ensuring that student information is protected from unauthorized access and misuse is essential to maintaining trust in AI-driven educational systems.



#### 4. FUTURE DIRECTIONS AND RECOMMENDATIONS

##### Balanced Implementation of AI

To maximize the benefits of AI in education, it is crucial to strike a balance between AI-mediated and human interaction. While AI can enhance engagement and motivation, it should not replace the human element, which is essential for fostering deeper understanding and meaningful interactions.

##### Addressing Ethical Concerns

Educational organizations should emphasize ethical aspects, such as data confidentiality, biases in algorithms, and the integrity of academic practices. Creating explicit rules and standards for the implementation of AI in educational settings can aid in reducing these threats and guarantee that AI resources are utilized in a responsible manner.

##### Continuous Professional Development

Facilitating continuous professional development for educators is crucial for the effective incorporation of AI in educational settings. Training programs ought to prioritize the proficient utilization of AI tools, alongside methodologies for confronting potential challenges and limitations. Collaborations of this nature can stimulate innovation and guarantee that AI applications are developed with a grasp of educational principles, ultimately resulting in more efficient teaching methods and better student results. In this scenario, the partnership between teachers and technology experts can result in the development of customized AI solutions that enrich learning experiences while catering to the specific requirements of students.

##### Advancing Inclusivity and Fairness

Efforts must be directed towards guaranteeing that AI resources are accessible to every student, independent of their situations or locations. By prioritizing inclusivity and fairness, educational institutions can foster an environment where all students benefit from the advancements in AI technology, ultimately enhancing their learning experiences and outcomes. requires tackling infrastructural obstacles and encouraging the creation of AI tools that are culturally aware and inclusive.

**Table: Impact of AI on Student Engagement and Motivation**

Aspect of Impact	Description
Personalized Learning	AI provides tailored learning experiences, enhancing engagement and motivation.
Real-Time Feedback	AI offers immediate corrections and support, improving learning outcomes and motivation.
Increased Accessibility	AI tools make education more inclusive for diverse student populations.
Over-Reliance Risks	Excessive dependence on AI may reduce critical thinking and problem-solving skills.
Ethical and Privacy Concerns	AI raises issues of data privacy and algorithmic bias, needing careful management.
Infrastructure and Training Needs	Successful AI integration requires robust infrastructure and teacher training.

#### 5. CONCLUSION

The influence of AI on student engagement and motivation within educational settings is a complex and nuanced topic. While AI offers numerous benefits, such as personalized learning experiences, prompt feedback, and improved accessibility, it concurrently presents challenges, including issues of dependency, ethical considerations, and infrastructural limitations. By tackling these obstacles and applying AI tools with care and ethical consideration, educators can fully leverage the capabilities of AI to foster more captivating, inclusive, and effective learning environments.

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**CYBERLAW AND CYBERCRIME IN INDIA: A COMPREHENSIVE OVERVIEW**

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**ABSTRACT**

*The rapid digital transformation in India, powered by an increasing number of internet users, has made cyberspace a critical component of the country's socio-economic infrastructure. However, this advancement has also escalated the frequency and complexity of cybercrimes. This article provides a comprehensive overview of cyberlaw and cybercrime in India, tracing the evolution of legal frameworks from the enactment of the Information Technology Act, 2000 to recent reforms such as the Digital Personal Data Protection Act, 2023. It examines various types of cybercrimes, landmark cases, challenges in enforcement, and the role of technology and judiciary.*

*The article also highlights the growing need for cyberlaw education and legal reforms to address emerging digital threats, emphasizing the importance of a resilient legal and governance ecosystem to ensure cyber safety and digital trust.*

**Keywords:** Cyberlaw, Cybercrime, Cybersecurity, Cyber Forensics, Cyber Terrorism, Digital India, Data Protection, Information Technology Act, Jurisdiction

**INTRODUCTION**

The exponential growth of the internet and digital technologies in the 21st century has transformed how individuals, businesses, and governments operate. However, alongside the benefits of digital connectivity, new challenges have emerged—most notably cybercrimes. In India, a rapidly digitizing economy with over 800 million internet users, the importance of cyberlaw has never been greater. Cyberlaw refers to the legal framework that governs activities conducted via the internet, covering areas such as data protection, electronic commerce, digital contracts, and online crimes.

The digital revolution has redefined the way individuals communicate, conduct business, access information, and interact with the world. In a country like India—home to one of the largest populations of internet users—the proliferation of digital technologies has brought immense opportunities for growth and innovation. However, this rapid digital transformation has also given rise to a complex and evolving landscape of cyber threats. As more personal, financial, and government data migrate online, the risks associated with cybercrime have intensified.

To safeguard the digital ecosystem, the legal system must evolve in parallel with technological advancements. This has led to the emergence of cyberlaw—a legal framework designed to address issues related to information technology, digital transactions, data security, and online criminal activities. In India, the Information Technology Act, 2000 serves as the backbone of cyberlaw, laying down the rules for electronic governance and specifying penalties for various cyber offenses.

This article explores the development of cyberlaw in India, categorizes the different forms of cybercrime, examines significant legal provisions and landmark cases, and evaluates the challenges and policy initiatives aimed at combating cyber threats in the country.

**OBJECTIVES:**

- To examine the evolution and scope of cyberlaw in India, with a focus on key provisions of the Information Technology Act, 2000 and its amendments.
- To identify and categorize various forms of cybercrime affecting individuals, organizations, and the state, including their legal implications.

**What is Cyberlaw?**

Cyberlaw, also known as internet law or IT law, is a specialized field of law that governs legal issues related to the use of information technology. In India, cyberlaw primarily stems from the Information Technology Act, 2000 (IT Act), which was enacted to provide legal recognition to electronic transactions and to combat cybercrime.

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Cyberlaw encompasses a broad range of topics, including:

- Digital signatures and electronic records
- Cybercrime and criminal liability
- Data privacy and protection
- Intellectual property rights in cyberspace
- Jurisdictional issues in cross-border cyber offenses

**The Evolution of Cyberlaw in India:**

The cornerstone of cyberlaw in India is the **Information Technology Act, 2000**, which came into force on October 17, 2000. The Act was influenced by the United Nations Model Law on Electronic Commerce (1996) and was aimed at promoting secure e-commerce and addressing cybercrimes.

In 2008, the IT Act was amended to expand its scope and introduce provisions related to cyber terrorism, identity theft, and data breaches. The IT (Amendment) Act, 2008 made cyber offenses more recognizable and enforceable under Indian law, especially in the face of rising online threats.

**Key Provisions of the Information Technology Act:**

Some of the most relevant sections of the IT Act related to cybercrime include:

**Section 66:** Hacking and unauthorized access to computer systems

**Section 66C:** Identity theft involving the use of others' personal data

**Section 66D:** Cheating by personation using computer resources

**Section 67:** Publishing obscene material in electronic form

**Section 69:** Powers to intercept, monitor, or decrypt information

**Section 72:** Breach of confidentiality and privacy

**Understanding Cybercrime:**

Cybercrime refers to criminal activities that involve the use of computers or the internet. These crimes may target computer systems (e.g., hacking), use computer systems to commit offenses (e.g., online fraud), or do both.

Cybercrimes in India are broadly classified into the following categories:

**Cybercrimes Against Individuals**

These include crimes such as cyberstalking, cyberbullying, identity theft, phishing, and online defamation. Victims are usually individuals who are targeted for harassment or financial exploitation.

**Cybercrimes Against Property**

These involve crimes such as data breaches, hacking of systems, and distribution of malware or ransomware, often aimed at stealing trade secrets or causing financial damage.

**Cybercrimes Against Government and Society**

These include cyberterrorism, hacking into government databases, spreading fake news or hate speech, and digital attacks against critical infrastructure.

**Prominent Cases of Cybercrime in India:**

**The ATM Hacking Scam (2018):** A massive ATM fraud involving cloned debit cards hit several cities in India, leading to the theft of nearly ₹1 crore from unsuspecting users. This case highlighted vulnerabilities in banking cybersecurity systems.

**Cosmos Bank Cyber Attack (2018):** Hackers siphoned off ₹94 crore from Cosmos Bank in Pune through a malware attack that enabled withdrawals via cloned debit cards in over 28 countries.

**Jamtara Phishing Scam:** A group of young people from the Jamtara district in Jharkhand were found running a large-scale phishing operation. They defrauded thousands of people by posing as bank representatives and obtaining sensitive information.

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**Challenges in Enforcing Cyberlaw:**

Despite having a legal framework in place, India faces multiple challenges in effectively combating cybercrime:

**Lack of Awareness:** Many users are unaware of online safety practices and their legal rights, making them easy targets.

**Jurisdictional Issues:** Cybercrimes often transcend geographical boundaries, making investigation and prosecution complex.

**Technical Expertise:** Law enforcement agencies often lack the necessary technical knowledge and tools to investigate cybercrimes effectively.

**Delayed Legal Procedures:** The Indian judicial system is often slow in adjudicating cybercrime cases, which deters timely justice.

**Dark Web and Anonymity:** Cybercriminals increasingly use encrypted platforms and the dark web, making detection and prosecution difficult.

**Role of Law Enforcement Agencies:**

Various government and law enforcement agencies are working to tackle cybercrimes in India:

**Cyber Crime Cells:** Most major cities have dedicated cybercrime units under the police.

**CERT-In:** The Indian Computer Emergency Response Team handles cyber threats and provides alerts on security vulnerabilities.

**National Cyber Crime Reporting Portal:** Launched by the Ministry of Home Affairs, this portal allows citizens to report cybercrimes, especially those against women and children.

**Judiciary and Cybercrime:**

Indian courts have played a crucial role in interpreting cyber laws and upholding digital rights. For instance, in **Shreya Singhal v. Union of India (2015)**, the Supreme Court struck down Section 66A of the IT Act, which criminalized offensive online speech, declaring it unconstitutional for violating the right to freedom of expression.

The judiciary has also emphasized the need to balance privacy and security in cases involving data surveillance and digital forensics.

**Recent Developments in Cyberlaw and Policy:**

**Personal Data Protection Bill (now Digital Personal Data Protection Act, 2023):** India enacted a comprehensive data protection law to regulate the collection, processing, and storage of personal data by both government and private entities.

**Cybersecurity Policy 2020 (Draft):** This proposed policy aims to create a secure cyberspace by enhancing capacity building, awareness, and regulatory mechanisms.

**Digital India Programme:** While primarily focused on digitization, this initiative includes components for cybersecurity training, infrastructure, and public engagement.

**The Role of Technology in Combating Cybercrime:**

Technology is a double-edged sword—it facilitates both the commission and prevention of cybercrimes. Governments and private entities are investing in:

**AI and Machine Learning:** Used in identifying suspicious behavior and predicting cyberattacks.

**Blockchain:** Enhances data integrity and transparency in digital transactions.

**Cyber Forensics:** Assists in collecting digital evidence that is admissible in court.

**Cyberlaw Education and Legal Reforms:**

With the digital landscape evolving rapidly, there is an increasing need to educate legal professionals and the public about cyberlaw. Many Indian universities and law schools now offer specialized courses in cyberlaw, digital evidence, and technology law.

Additionally, there is growing demand to update the IT Act or introduce a more robust legal framework that incorporates new threats such as:

**Deepfakes:** Deepfakes are manipulated videos or images created using artificial intelligence (AI), especially deep learning, to make it appear as though someone said or did something they never actually did. These are often used for misinformation, political manipulation, or malicious impersonation.

**Crypto-based crimes:** These are illegal activities involving cryptocurrencies like Bitcoin or Ethereum, including crypto frauds, money laundering, ransomware payments, and investment scams. The anonymity and decentralization of cryptocurrencies make them attractive to cybercriminals.

**Online radicalization:** Online radicalization refers to the process of individuals being influenced or recruited through the internet—especially social media and encrypted messaging platforms—into adopting extremist ideologies or engaging in terrorism-related activities.

**Digital child exploitation:** This involves the use of digital platforms to exploit children sexually or emotionally, including the distribution of child sexual abuse material (CSAM), online grooming, or coercion. It is a growing concern due to the increased access of minors to the internet.

## **CONCLUSION**

Cyberlaw and cybercrime are critical aspects of India's legal landscape in the digital age. While the Information Technology Act provides a foundation, the dynamic nature of cyber threats demands continuous legal and technological innovation. Effective enforcement, public awareness, and global cooperation are essential to creating a secure and trustworthy cyberspace in India. As digital adoption accelerates, strengthening cyberlaw is not just a legal imperative but a national priority.

As India continues to embrace digitization across sectors—be it education, healthcare, finance, or governance—the importance of a robust legal framework to secure cyberspace becomes paramount. Cyberlaw, anchored by the Information Technology Act, 2000, has provided a foundational structure to regulate digital activities and combat cybercrimes. However, the rapidly evolving nature of technology necessitates constant updates to the law to keep pace with new threats such as ransomware, deepfakes, cryptocurrency fraud, and digital surveillance.

Cybercrime is no longer limited to financial frauds or data breaches; it now affects individuals' privacy, national security, and the integrity of democratic institutions. Addressing this multifaceted challenge requires a collaborative approach—strengthening legal provisions, enhancing law enforcement capabilities, promoting public awareness, and fostering international cooperation.

India stands at a critical juncture where digital empowerment must be balanced with digital safety. A forward-looking cyberlaw framework, supported by proactive governance and public vigilance, will be key to ensuring that the benefits of technology are not overshadowed by its risks. The future of India's cyber landscape depends not only on legal reform but also on building a culture of cyber responsibility and resilience.

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**DIGITAL PAYMENT SYSTEMS (DPS): USHERING A CASHLESS ERA**

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Tamil Nadu India**ABSTRACT**

India's multiple payment platforms will be automated and standardized through the use of the Digital Payment Systems, a single payment solution. To foster interoperability and enhance the user experience, the National Payments Corporation of India (NPCI) created DPS as an architectural framework with standard Application Programming Interface (API) requirements. With DPS, consumers may pay merchants with a variety of IDs and move money across bank accounts with ease and security. The purpose of this study is to analyze India's DPS payment system and its possible place in the ecosystem of digital payments. The present study aims to analyze the potential uses of DPS in digital payments, as well as its adoption and usage rates in India. Additionally, the study will explore the many applications of DPS. Literature studies were among the primary and secondary sources from which data was gathered. According to this study, DPS is becoming a widely used payment method in India and is being adopted and used at an increasing pace. It appears that DPS in India has a bright future ahead of it, with more adoption, expansion, and innovation anticipated. This article provides an extensive examination synthesizing and analyzing information from various secondary sources and aims to consolidate existing knowledge, identify patterns, and offer a comprehensive overview of the Unified Payments Interface and its potential in the digital payment ecosystem and how it fits into India's goal of having a cashless society.

**Keywords:** Digital Payment Systems, Digital Payments, Cashless Economy.

**INTRODUCTION**

India before 2016, utilized various payment methods, including RTGS, IMPS, and NEFT, for interbank transactions. The complexity and increasing administrative challenges of these systems necessitated the automation and standardization of India's payment platforms. In response to this need, the National Payments Corporation of India (NPCI) introduced the Digital Payment Systems in 2016. DPS serves as an architectural framework designed to unify and provide a singular interface for all NPCI systems, incorporating a set of standardized Application Programming Interface (API) requirements. This strategic approach aims to enhance interoperability and elevate the overall customer experience. The inaugural pilot program took place on April 11, 2016, in Mumbai under the guidance of Dr. Raghuram G. Rajan, the Governor of the Reserve Bank of India (RBI), with the participation of twenty-one member banks. Subsequently, an increasing number of banks commenced uploading their DPS-enabled applications to the Google Play store, starting on August 25, 2016.

Presently, DPS stands out as one of the most widely embraced payment methods in India, facilitating over one billion transactions annually. This user-friendly and instantaneous payment system simplifies interbank transactions, fostering the widespread adoption of digital payments across the nation. Its primary objective is to streamline and secure money transfers between bank accounts. DPS allows users to seamlessly link multiple bank accounts within a single smartphone application, providing a centralized platform for effortless money transfers and merchant payments. Additionally, it enables the scheduling and fulfillment of peer-to-peer and peer-to-merchant collection requests. Payments can be made using various identifiers such as DPS ID, DPS Number, account number, and Indian Financial System Code (IFSC). Upholding the security standards set by the Reserve Bank of India (RBI), DPS employs a 1-click 2-factor authentication system, with the DPS PIN serving as the second authentication component. Notably, DPS is also accessible through the Unstructured Supplementary Services Data (USSD) channel, catering to users with feature phones.

**REVIEW OF LITERATURE**

- **Amit Kumar Pandey and Vipul Jain (2021)** analyses the effect of DPS on India's digital financial inclusion. According to the report, the expansion of digital financial services in India has been facilitated by DPS, which has increased the accessibility and convenience of digital payments for a broad spectrum of users.
- **Ankit Kumar and Santosh Kumar (2020)** examines how DPS affects India's financial inclusion. According to the authors, DPS has increased the use of digital financial services and aided in India's financial inclusion.
- **Boston Consulting Group (BCG) (2016)** draws attention to DPS's revolutionary influence on India's digital transition. According to the paper, DPS has changed how payments are made in India and made digital

financial services accessible to millions of Indians, all of which have aided in the expansion of the country's digital economy.

- **Nayan Ambali and Mahesh Jaisingh (2021)** examines the effects of DPS on financial inclusion and the Indian banking sector. According to the authors, DPS has increased the use of digital payments, which has aided in India's financial inclusion.
- **Nishant Goyal and Rajesh Yadav (2021)** examines the effect of DPS on India's cashless economy and digital financial inclusion. The authors conclude that the expansion of India's digital economy can be attributed to DPS, which has made digital financial services accessible to millions of Indians.
- **Richa Chaturvedi and Sangeeta Sharma (2021)** analyses the part DPS plays in encouraging financial inclusion in India's rural areas. According to the authors, DPS has made financial transactions easier for those who live in distant locations, which has helped rural India's digital financial services industry flourish.
- **Tarun Jain and Anuja Tandon (2017)** analyses the effect of DPS on India's adoption of digital payments. According to the report, DPS has aided in the expansion of digital financial services in India and increased the accessibility and convenience of digital payments for a variety of customers.
- **The World Bank (2016)** highlights the contribution of DPS to India's financial inclusion movement. According to the report, DPS has helped millions of Indians who were unbanked transact financial business and has aided in the expansion of digital financial services in the country.

## OBJECTIVES

- To study the Digital payment system and its applications.
- To study the adoption and usage rates of DPS in India
- To study the potential future of digital payment system in India

## RESEARCH METHODOLOGY

### Research Design:

The study employs a descriptive research design to characterize the present state of affairs and emerging patterns in the DPS payment system in India.

### Data Collection:

A variety of sources, including research papers, journals, publications, and internet databases including Science Direct, Google Scholar, and the official website of the RBI, have been used to gather secondary data. Data about DPS's adoption in the digital payments space, its transaction volume, and its prospects in India and globally have all been gathered.

### Data Analysis:

Data analysis involves synthesizing information from multiple sources to present a coherent and comprehensive overview of the Unified Payments Interface. The analysis aims to identify patterns, themes, and trends within the existing body of literature aiming for a nuanced understanding of the role of DPS in shaping a cashless economy.

## HOW DPS IS DISTINCTIVE?

Digital Payment Systems has emerged as a transformative force in the realm of digital transactions, reshaping the landscape of financial interactions in India. DPS introduces a distinctive paradigm for seamless and instant fund transfers, challenging traditional payment methods. In unraveling the distinctiveness of DPS, we delve into its key features, mechanisms, and the profound impact it has had on the way individuals and businesses engage in financial transactions.

**Interoperability:** DPS is aimed to facilitate seamless transactions between different banks and financial institutions. Users can make payments and transfers between accounts across various banks, promoting interoperability and eliminating the need for multiple apps.

**Simplicity and User-Friendly Interface:** DPS offers a simple and user-friendly interface, making it accessible to a wide range of users. The system typically relies on mobile numbers linked to bank accounts, allowing users to transact with ease through familiar and straightforward processes.

**Immediate Fund Transfer:** One of the key distinctions of DPS is the real-time fund transfer capability. Users can instantly send and receive money, enhancing the speed and efficiency of financial transactions compared to traditional banking methods.



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**24/7 Availability:** DPS transactions are not restricted by traditional banking hours. The system operates round the clock, providing users with the flexibility to perform transactions at any time, including weekends and holidays.

**Single Platform for Multiple Bank Accounts:** DPS allows users to link multiple bank accounts to a single DPS ID. This simplifies financial management, as users can access and manage funds from different accounts through a unified platform.

**Inclusive for All Banking Players:** DPS is not limited to large banks; it is open to all banks, regardless of their size. This inclusivity promotes healthy competition and encourages innovation among various financial institutions.

**Integration with Various Services:** DPS has expanded its functionality beyond basic fund transfers. Users can make payments for goods and services, pay utility bills, and even engage in more complex financial activities through the integration of various services within the DPS framework.

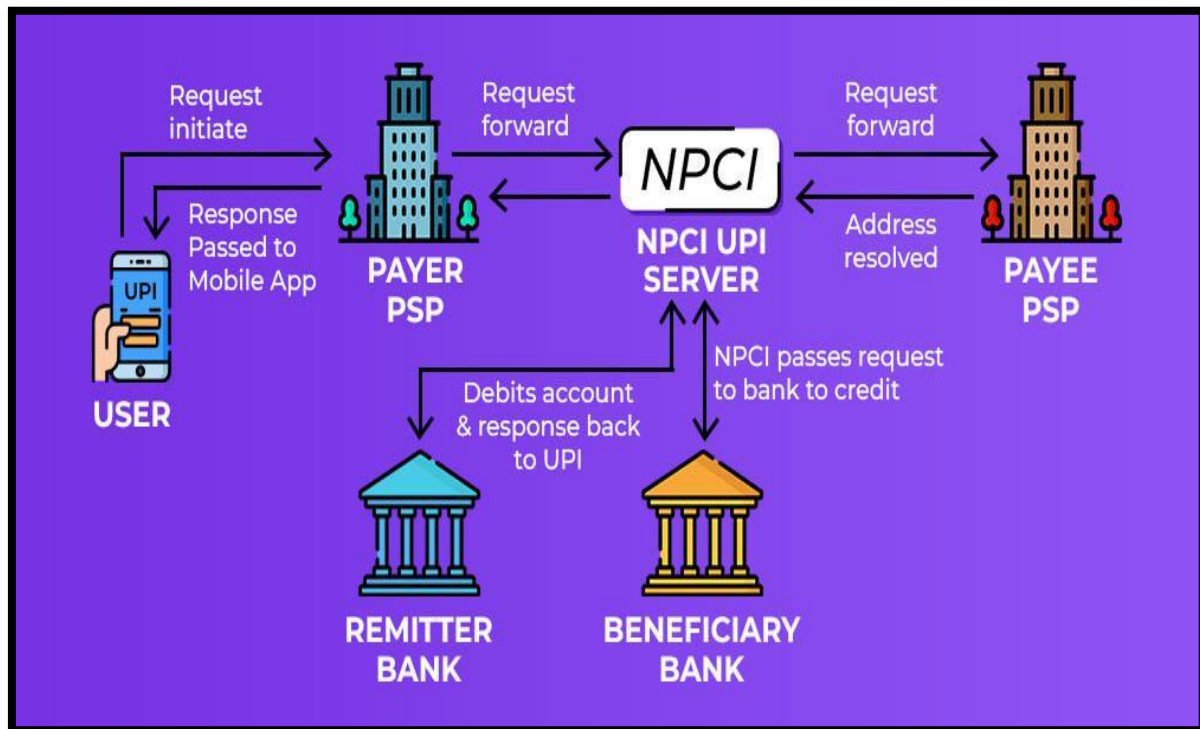
**Security Features:** DPS incorporates robust security measures, including two-factor authentication and encryption, to ensure the safety of transactions and user data. This focus on security enhances user trust in the platform.

In summary, DPS's distinctiveness lies in its interoperability, user-friendly interface, real-time transactions, availability around the clock, support for multiple bank accounts, inclusivity for all banks, diverse service integration, and emphasis on security features.

#### **STAKEHOLDERS IN DPS**

Since its introduction in 2016 with an initial partnership of twenty-one banks, the DPS ecosystem has experienced substantial expansion, currently encompassing 381 banks as active participants. This dynamic environment facilitates billions of digital transactions each month. The National Payments Corporation of India (NPCI), the governing body overseeing DPS, outlines the diverse array of stakeholders within the digital payment ecosystem in India, including:

- Payer PSP (Payment Service Providers)
- Payee PSP (Payment Service Providers)
- Beneficiary Bank
- NPCI
- Bank Account Holders
- Merchants



Within the value chain, applications that enable DPS transactions, such as PhonePe or Google Pay, are designated as third-party app providers (TPAPs). Banks, referred to as payment service providers (PSPs) in this context, typically act as both remitters and beneficiaries in the majority of transactions. TPAPs rely on PSPs to connect to the DPS network and facilitate transactions, as they lack direct access to the DPS network.

### TYPES OF TRANSACTIONS SUPPORTED BY DPS

DPS supports the following financial transactions:

- **Pay Request:** 'Push' payments are those that are made through a payment system where the recipient receives the money from the client. A virtual ID, an account number with the IFSC, or a mobile number and MMID may be included in the payment address.
- **Collect Request:** In this kind of transaction, the client uses a Virtual ID to "pull" money from the remitter.
- **Non-Monetary Exchanges** The following categories of non-monetary transactions are supported by DPS on all PSP apps.
  - Registration for mobile banking
  - One Time Password (OTP) generation
  - Set/change the PIN
  - Transaction status
- **Verify** Bringing up disagreements or inquiries The cell phone number used for registration must already be connected to the issuing bank for SMS or mobile notifications in order to be eligible for mobile banking. Popular operating systems like IOS and Android can be used to access the DPS platform, and members have created apps for IOS 8.1 and Android 4.2.2 and higher versions.

### BUSINESS USES OF DPS

DPS has numerous business uses, making it a popular payment system in India. Some of these business uses are:

- **Online and In-Store Payments:** Businesses may take payments from clients both in-person and online thanks to DPS. Businesses may enhance customer satisfaction and boost customer loyalty by providing clients with a simple and rapid payment option through DPS.
- **Cash on Delivery:** Cash on delivery payments are now more convenient and effective thanks to DPS. Companies can give their clients a DPS QR code that they can scan to start a payment. Customers will no longer need to carry cash to make payments thanks to this.

- **Bill Payments:** DPS can be used to pay utility bills, such as those for gas, water, and electricity. By using DPS to collect payments from clients, businesses may improve cash flow and reduce the cost of payment collection.
- **Fund Transfers:** Customers can receive contributions and donations via DPS. Since DPS is an easy and affordable means to collect donations, many Indian philanthropic groups have embraced it as their method of making contributions.
- **Donations and Contributions:** Customers can authorize payments through a straightforward and secure process, while businesses can utilize DPS to conveniently manage recurring payments for memberships and subscriptions.
- **E-commerce:** By giving consumers a quick and easy way to make payments, DPS may be included in e-commerce platforms, increasing conversion rates and customer satisfaction.
- **Subscription Payments:** Customers can authorize payments through a straightforward and secure process, while businesses can utilize DPS to conveniently manage recurring payments for memberships and subscriptions.
- **E-commerce:** By giving consumers a quick and easy way to make payments, DPS may be included in e-commerce platforms, increasing conversion rates and customer satisfaction.
- **Payroll:** Employers can use DPS to quickly and securely transfer salaries and other payments to their employees' bank accounts, eliminating the need for cash or check payments.
- **Invoicing:** DPS can also be used for invoice payments, allowing businesses to easily track and manage payments from their customers.
- **Point-of-sale transactions:** Companies can give clients a quick and safe way to pay for goods and services by accepting DPS payments at their physical locations through QR codes or other DPS-enabled payment methods.

### DPS PENETRATION IN INDIA

The Digital Payment Systems has orchestrated a staggering 7,829.49 million payments, marking a substantial transformation in digital transactions. The trajectory of digital payments has seen an extraordinary ascent from 0.38 crores in FY16 to a monumental 1,282,055.01 crores in FY22. This upward trend is poised to persist as digital adoption and online shopping burgeon, constituting a significant thirty percent of Indian consumption.

In September 2020, a mere four years after its inception in 2016, the monthly value of DPS transactions surpassed Rs 3 lakh crore. Astoundingly, within a single year, this figure more than doubled, surging to Rs 7 lakh crore. In a span of six years, DPS has garnered a substantial sixteen percent share of all retail payments, disrupting the traditional payment landscape. Illustratively, the market share of the National Electronic Funds Transfer (NEFT) has dwindled from 60 percent five years ago to the current 54 percent.

Today, it's a rarity to encounter a pani puri seller, barber, or cigarette vendor without a QR code for DPS payments. DPS has evolved into a self-sustaining force with millions of merchants relying on it for their payment requirements. In contrast, despite being in existence for decades, point-of-sale (POS) devices that accept credit and debit cards are limited to six million. In stark contrast, QR codes are ubiquitously adopted, with over 30 million merchants utilizing them, according to consulting company BCG.

The momentum of DPS has accelerated to a point where it resembles a train in full motion. The year 2022 witnessed a remarkable surge in the number and value of transactions conducted through India's DPS digital payment system. According to the National Payments Corporation of India (NPCI), the total value of DPS transactions at the close of the 2022 calendar year reached INR 125.95 Lakh Cr, representing a substantial 1.75-fold increase compared to the preceding year.

The National Electronic Funds Transfer (NEFT), regulated by the Reserve Bank of India (RBI), holds its position as India's largest retail electronic payment segment. However, DPS has been steadily advancing, progressively gaining market share from NEFT. The introduction of DPS 2.0 a year ago ushered in a new era, providing customers with the flexibility to set up regular e-mandates for a range of payments, including utility bills and insurance premiums. This innovative feature has significantly reduced instances of NEFT transfers with a half-hour latency.

While cards, net banking, and NEFT continue to dominate for high-value transactions among businesses, high-net-worth individuals (HNIs), and others, there is an anticipation of a forthcoming shift in this trend. The

surging popularity of DPS can be attributed to its user-friendly interface and its adeptness at overcoming existing barriers in the digital payment landscape.

### THE PROSPECTIVE TRAJECTORY OF DPS

Looking ahead, DPS is poised to sustain its continual growth, fueled by the widespread acceptance of digital payments across the nation. Evident from the diminishing average ticket size of transactions, DPS payments are progressively permeating every corner of India. Despite a slight dip in transaction value during the latter half of 2022, indicating a maturing ecosystem, DPS's remarkable expansion is undeniable. The future landscape envisions DPS further solidifying its position as a global leader in digital payment technology, especially with the incorporation of credit cards and its foray into overseas markets.

A recent report from BCG projects a substantial surge in India's digital payments market, encompassing retail payments, MSME business-to-business transactions, and government payments. The market is expected to surpass \$3 trillion (Rs 226 lakh crore) to reach \$10 trillion (nearly Rs 800 lakh crore) by 2026. NPCI's MD & CEO, Dilip Asbe, envisions the possibility of achieving "a billion transactions per day," surpassing DPS's current daily log of 220 million transactions, with a fourfold increase as the next target. Emerging use cases such as credit card-DPS linkages, international remittances, and penetration into smaller geographies are anticipated to drive the next wave of exponential growth.

While DPS faces competition from newer technologies like block chain and central bank digital currency (CBDC), its promising future in India remains intact. Despite the nascent stages of block chain solutions for cross-border remittances and the swift adoption of CBDC in over 80 nations, DPS is firmly positioned. The forthcoming years are likely to witness DPS gaining even more traction through sustained growth, increased acceptance, continuous innovation, and strategic global expansion.

### CONCLUSION

According to research on DPS and its uses, DPS has completely changed India's digital payment market. Due to its smooth and safe payment process, it is a well-liked payment choice for both individuals and companies. DPS has being adopted and used more frequently than ever before, and DPS transactions are expanding at a never-before-seen rate. This shows how well-liked and trusted DPS is among users, underscoring its potential in the digital payment space. India has demonstrated a strong desire to implement DPS technology as a payment method, and DPS is quickly gaining traction there. The report also demonstrates how important a part DPS is playing in India's goal of becoming a cashless society.

India is well-positioned to emerge as a leader in the digital payment market because of the government's initiatives to create a digital economy and the growing acceptance of DPS. Going ahead, it is anticipated that DPS will maintain its current growth trajectory, characterized by heightened usage, innovation, and global expansion. This will accelerate India's transition to a cashless economy and may serve as a model for other nations wishing to modernize their payment systems. In conclusion, DPS is a cutting-edge technology with enormous potential that has already completely changed the digital payment market in India.

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**INNOVATING FOR IMPACT: ESG-DRIVEN DIGITAL TRANSFORMATION AND GREEN HRM AS CATALYSTS FOR ACHIEVING SDG 9 IN INDIA**

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**<sup>1</sup>Shikha Shubham and <sup>2</sup>Dr. Atik Shaikh**<sup>1</sup>Research Scholar, SPPU Pune, India<sup>2</sup>Research Guide, SPPU, India**ABSTRACT**

*India's developmental trajectory in recent decades reflects a strong commitment to sustainable economic growth, with particular emphasis on SDG 9, which calls for resilient infrastructure, inclusive, sustainable industrialization, and innovation (UN SDGs, 2023). To advance this goal, India adopted a digital quest that corroborates initiatives like Digital India, Startup India, and Make in India, each designed to promote innovation, improve digital infrastructure, and foster industrial growth (Digital India, 2023, Startup India, 2023, Make in India, 2023). In India, organizations in sectors like IT, manufacturing, and finance are increasingly adopting GHRM strategies to reduce carbon footprints, ensure regulatory compliance, and improve employee engagement with sustainability goals (Yong et al., 2020).*

*The integration of digital transformation in ESG frameworks, and GHRM practices is not just a trend, but a strategic necessity for Indian industries aiming to be globally competitive and environmentally sustainable. With digital tools enabling better tracking and reporting of ESG metrics, HR leaders are now empowered to institutionalize green culture, improve energy efficiency, and drive stakeholder engagement (Accenture, 2023). India advocates a strong commitment to achieve net zero carbon emission through its vision 2070 wherein the business sector is contemplated as a critical enabler in furthering this vision. This research seeks to critically examine the strategic role of Indian banks in advancing environmental sustainability, utilizing secondary data sourced from annual reports, sustainability disclosures, and peer-reviewed literature (panelled across 2015-2023). The study analyses how leading public and private sector banks in India have integrated environmentally responsible practices within their operational processes and human resource frameworks. The analysis is contextualized within the scope of the United Nations Sustainable Development Goal 9 (SDG 9), which advocates for resilient infrastructure, inclusive industrialization, and innovation. The research aims to generate comparative insights and assess the institutional contributions of Indian banks toward embedding sustainability within their broader operational ecosystems.*

**1. INTRODUCTION**

Developed economies of the world have accounted one fifth of the total emissions from five developed economies namely Germany, Australia, Italy, the UK and USA (Kang et al., 2020). It is a commonly held misconception that service sector is carbon light but the inputs that supports final consumption of services production are concerning for many economies and demands unified treatment in energy policy framing.

One of the powerful approach to sustainability lies in integrating Environmental, Social, and Governance (ESG) principles into corporate and public sector frameworks. Globally governments, regulators, experts and practitioners have introduced new regulations pertaining to ESG for businesses where reducing GHG emissions is not just an environmental necessity but also an economic and a social imperative for establishing resilient and sustainable business (Das and Ghosh 2023). To optimise business results on ESG, companies belonging to service sector in developing economies, need to adopt sustainable business models favouring SDG-9 as early implementation culminates to lower cumulative carbon emissions (Roberts et al., 2021). India's growing economy thrives on service industry where it is considered as a bulk contributor to employment, GDP and an accrued receiver to foreign direct investment (digitalindia.gov.in ). Around 8.12 million jobs were created in 2023, half of them belong to service sector and based in banking, finance, and IT companies (www.ibef.org). Transition to a sustainable business model in this sector, significantly will shift many jobs and will demand creation of energy friendly jobs, processes, products and practices often referred as green jobs, green processes, green products, green practices.

ESG-driven digital transformation refers to the strategic use of digital technologies to advance sustainability, social equity, and governance goals. This alignment is increasingly seen as vital for long-term business performance and regulatory compliance (KPMG, 2022). In this evolving ecosystem, Green Human Resource Management (GHRM) plays a critical role. GHRM refers to HR practices and policies that promote sustainable use of resources and foster environmentally responsible behaviours among employees (Renwick et al., 2013).

In India, organizations in sectors like IT, manufacturing, and finance are increasingly adopting GHRM strategies to reduce carbon footprints, ensure regulatory compliance, and improve employee engagement with

sustainability goals (Yong et al., 2020). The importance of SDG 9 also highlights the greater thrust to sustainable processes followed by efficient practices. The Digital India programme corroborate the roadmap to India's ambitious contribution towards achieving United Nations Sustainable Development Goal (www.undp.org).

To accelerate the pace of decarbonisation, all the stakeholders need to provide solutions for accelerated progress like green solutions for carbon market, green policies for investment, policies on energy usage. Adopting climate friendly technologies, using carbon offsetting, adhering to environmental regulations, adopting voluntary carbon neutral climate action can motivate the industrial decarbonisation (Rissiman et al.,2020). Carbon neutrality goals is a strategic business realization (Bhatia et al.,2024) which favours environmental greening strategies, energy management practices and emission regulation (Tang et al.,2018). Organizations demonstrate inclusive sustainability through digital financing enhancing the resource utilization, encourages usage for green technologies, promotes industrial funding for green products leading to green innovation (Wang et al.,2022).

Digital financing is supported by digitalization in HR practices, which is advanced by Green Human Resource Management. (Coelho et al.,2024). Green Human Resource Management is implemented through green planning, recruitment, training and development, compensation and appraisal to support green organizational objectives. The vision of transforming corporate organizations sustainable through the application of GHRM has multifarious challenges and opportunities (Mishra, 2017).

## 2. LITERATURE REVIEW

### • *Indian banks as digital Champions: ESG-Driven Digital Transformation and SDG 9*

Digital transformation underpinned by ESG principles is pivotal for advancing SDG 9. The Digital India initiative has enabled public sector enterprises to adopt smart technologies, IoT, and AI, enhancing infrastructure resilience and industrial productivity. Digitization has worked to streamline supply chains and optimized resource allocation, directly contributing to sustainable industrialization. Empirical studies highlight that ESG-aligned digital tools, such as energy-efficient data centers and blockchain for transparent governance, reduce operational costs while fostering innovation ecosystems. Indian banks are also increasingly leveraging digital transformation to advance Environmental, Social, and Governance goals, directly supporting Sustainable Development Goal 9 that is focused on Industry, Innovation, and Infrastructure.

This integration is reshaping operational models, enhancing transparency, and fostering sustainable innovation across the sector. The sector's digital transformation is driven by regulatory mandates, evolving customer expectations, and the need for sustainable growth, prompting banks to invest heavily in technologies such as artificial intelligence, blockchain, and cloud computing to modernize operations and improve ESG outcomes (Swamy, 2023). Studies show that Indian banks now outperform many global peers in digital maturity, with significant advancements in mobile and internet banking functionalities, customer onboarding, and personalized financial management, positioning them as emerging "digital champions" on the global stage (Deloitte, 2023).

Digital innovation has enabled the launch of green financial products, enhanced ESG data collection, and improved transparency, while also supporting financial inclusion and operational efficiency (Gupta, 2023).

### • *Green banking initiatives in ESG framework for achieving SDG 9 in Indian Banks*

Digitalization in banking—through technologies like UPI, QR codes, digital finance platforms, and paperless workflows—has significantly reduced operational costs, improved decision-making, and minimized environmental impact by cutting paper usage and lowering carbon emissions. These advancements have enabled banks to streamline services, enhance customer experience, and support financial inclusion, all while embedding ESG principles into daily operations. Digital tools have strengthened governance by increasing transaction transparency and enabling efficient audits. This transparency builds trust and accountability, essential elements of the 'G' in ESG, and is critical for sustainable infrastructure development under SDG 9.

### • *Green Banking Initiatives*

Indian banks have launched green banking products, such as green bonds and green loans, and have financed renewable energy and sustainable infrastructure projects. These initiatives are often facilitated by digital platforms, making green investments more accessible and traceable.

### • *Employee and Social Impact*

Digital transformation has also supported the 'S' in ESG by motivating employees (through performance tracking and recognition systems) and fostering inclusivity via digital financial services. This aligns with SDG 9's focus on inclusive and sustainable industrialization.

• **Sector-Wide Evidence**

Empirical studies suggested that digital transformation improves both financial performance and ESG outcomes in public and private sector banks. Public sector banks, in particular, have demonstrated adaptability in adopting technology for sustainable innovation, providing a model for the private sector to follow. Case examples are given below in a tabular to showcase digital reforms and their alignment with SDG 9 goal.

Name of the Bank	ESG-Driven Digital Initiatives	SDG 9 Alignment
Punjab National Bank (PNB)	Digital banking for financial inclusion, green finance products	Industry innovation, access
State Bank of India (SBI)	Digital green investments, paperless banking, digital lending platforms	Sustainable infrastructure, innovation
Canara Bank	Digital decision-making tools, reduced paper usage	Resource efficiency, transparency
Yes Bank	Digital platforms for green bonds, carbon emission tracking	Clean technology, climate action
South Indian Bank	Employee digital upskilling, digital performance tracking	Inclusive innovation

**Table 1** (self compiled)

Green Human Resource Management (GHRM) is gaining traction as banks upskill employees in digital and sustainability practices, foster a culture of innovation, and encourage staff to adopt new technologies—factors critical for successful ESG integration and digital transformation (Vidya & Shailashri, 2023). Green HRM integrates sustainability into HR practices, aligning organizational goals with SDG targets. Hiring eco-conscious talent and providing sustainability-focused training programs. Rewarding employees for eco-innovation and energy-saving initiatives.

**3. RESEARCH METHODOLOGY**

The researchers have studied major green initiatives of Indian Banks, both private and public banks and have examined their green initiatives to draw comparative insights on their practices. The researchers utilized secondary data sources from 2015-2024, randomly drawn and publically available annual reports, sustainability disclosures, and peer-reviewed literature, to gain comparative insights on SDG 9 goal achievement

• ***The green banking pathways embracing GHRM (Year wise data and initiatives and impacts)***

A detailed overview of Green Human Resource Management Initiatives in Indian Banks from (2015–2024) gives a projection of ESG pathways.

Banks	Green Initiatives	Details	Impact (SDG 9 Focused)	Source
State Bank of India (SBI)	Green Banking Policy (2015–2020)	Financed ₹816 Billions in renewables; implemented green loan labeling	Promoted eco-industrial lending and renewable project development	Banking Frontiers
	Green Bonds (2024)	Issued \$250M in green notes via London branch	Strengthened funding for sustainable infrastructure	Banking Frontiers
	Syndicated Social Loan (2023)	Raised \$1B – Asia-Pacific’s largest ESG loan	Supported innovation in sustainability financing	LiveMint (2023)
	Environmental Certifications	ISO 14001 and OHSAS 18001 in multiple branches	Institutionalized environmental compliance	Banking Frontiers
ICICI Bank	Carbon Neutral Goal (2032)	Targeted net-zero Scope 1 & 2 by 2032	Climate-resilient infrastructure development	ICICI Bank (2024a); LiveMint



				(2023)
	Green Financing Portfolio	₹193.66B; 50% in renewable energy	Enhanced green innovation in lending	ICICI Bank (2024a)
	Green Workspaces	183 IGBC-certified offices (4.95M sq. ft.)	Expanded sustainable workplace infrastructure	ICICI Bank (2024a)
	Water Conservation	AWG(atmospheric water generator) in Hyderabad; water recycling across branches	Advanced resource-efficient facilities	ICICI Bank (2024b)
HDFC Bank	Digital Banking Initiatives	Paperless banking and digital transactions	Reduced paper dependency and digitized processes	IJERT (2021)
	Solar ATMs	Solar-powered rural ATMs	Decentralized access to renewable energy	IJERT (2021)
	Green Data Centers	Energy-efficient infrastructure nationwide	Improved data handling with reduced energy use	IJERT (2021)
Punjab National Bank (PNB)	PNB Palaash (2023)	8-month employee-led sustainability drive	Grassroots contribution to sustainable banking	Business Standard (2023); The CSR Journal (2023)
Axis Bank	Green Deposits (2023)	Deposits funding renewable and clean transport projects	Consumer-driven green finance model	Axis Bank (2021)
Bank of Baroda (BoB)	Green Financing Advisory (2023)	Engaged ESG consultants for guidance	Accelerated institutional ESG alignment	Bank of Baroda (n.d.)
Union Bank of India	ESG Transition (2023)	Consultant-led ESG implementation	Enabled systemic transition to sustainability	LiveMint (2023)
Kotak Mahindra Bank	Green Buildings	LEED pre-certified office (27BKC), waste recycling	Improved operational sustainability	Academia.edu (n.d.); ICICI Bank (2024a)
YES Bank	Green Bonds (2015–2022)	Issued ₹1,645 crore in green bonds	Financed ~562 MW renewable capacity	Business Today (2022)
	Green Infra Bonds (2015)	Raised ₹500 crore for clean energy	Pioneered sustainable infra funding	Business Standard (2015)
	Green Future Deposit (2018)	First green deposit linked to SDGs	Encouraged eco-conscious investing	India CSR (2018)
	YES KIRAN Solar Programme (2023)	Loans up to ₹3 crore for MSME solar panels	Boosted renewable adoption in SMEs	ET BFSI (2023)

	Sustainability Rankings (2023)	Topped Indian ESG scores (S&P Global)	Showcased sectoral ESG leadership	Yes Bank , Official press release
	Net Zero Commitment (2030)	Scope 1 & 2 net-zero by 2030	Set benchmark for emission reduction	
	Environmental Management System	ISO 14001 across 744 branches	Standardized green operations	India CSR (2018)

#### • Comparative Insights on Green Initiatives by Indian Banks (SDG 9-focused)

Indian banks, both public and private, have significantly advanced their environmental sustainability agendas through differentiated yet impactful green initiatives. A comparative evaluation reveals diverse strategic approaches rooted in infrastructure greening, innovation in financing, and organizational transformation aligned with SDG 9.

#### • Leadership in Green Financing

YES Bank has emerged as a frontrunner by pioneering green bonds and launching India's first SDG-linked deposit. Its sustained commitment—reflected in funding over 560 MW of renewable energy and topping ESG rankings—demonstrates sectoral leadership in sustainable financing. Similarly, SBI and ICICI Bank have played pivotal roles by raising substantial green capital through bonds and syndicated loans. ICICI Bank's green financing portfolio of ₹193.66 billion and SBI's issuance of \$250 million in green notes represent clear intent toward eco-industrial growth.

#### • Operational Sustainability and Green Infrastructure

On the infrastructure front, ICICI Bank leads with the highest number of IGBC-certified workspaces, reflecting institutional commitment to environmentally sustainable operations. Kotak Mahindra Bank and HDFC Bank also show innovation by adopting LEED-certified buildings and energy-efficient data centers respectively. These initiatives directly support resilient infrastructure goals, integrating environmental responsibility into day-to-day operations.

#### • Technological Innovation and Resource Efficiency

Banks like HDFC and SBI have leveraged digital technologies to reduce environmental footprints. HDFC's digital banking and solar ATMs reflect a dual focus on innovation and rural inclusion, while SBI's green loan labeling and adoption of environmental standards (ISO certifications) signify a structured institutional approach to compliance and sustainability reporting.

#### • Employee-Driven and Community-Centric Approaches

Punjab National Bank's "PNB Palaash" initiative stands out for its grassroots engagement, highlighting how employee participation can foster a sustainability culture internally. YES Bank's targeted MSME loans under the KIRAN program also suggest a decentralized approach to fostering renewable energy adoption at the community level—bridging economic empowerment and green innovation.

#### • Strategic ESG Integration

Union Bank of India and Bank of Baroda are seen adopting consultant-led ESG transitions, indicating a strategic shift toward formalizing sustainability in governance and decision-making. These efforts point to a growing institutionalization of environmental consciousness across the banking sector.

### 4. FINDINGS

While all banks display commendable progress, their contributions vary across domains. YES Bank and ICICI Bank are aggressive in green financing; SBI blends innovation with regulatory alignment; HDFC and Kotak prioritize sustainable operations; PNB adds value through employee-driven change. Together, these actions reveal that Indian banks are not only aligning with SDG 9 but also shaping a financial ecosystem conducive to long-term, inclusive, and green industrial development. Despite these advances, challenges such as legacy systems, cybersecurity, and talent shortages persist, requiring banks to adopt agile methodologies, collaborate with fintechs, and maintain a long-term commitment to change (SSRN, 2024). Collectively, these efforts are enabling Indian banks to reduce their ecological footprint, promote inclusive growth, and drive operational sustainability, thus making substantial progress towards SDG 9.

## 5. CONCLUSION

The confluence of ESG-driven digitization and Green HRM creates a reinforcing loop. For example, digital platforms enable remote work, reducing carbon footprints, a Green HRM objective while enhancing infrastructure accessibility SDG 9.

ESG-driven digital transformation in Indian banks is a powerful enabler for SDG 9. By integrating technology with sustainability objectives, banks are reducing their ecological footprint, promoting financial inclusion, and fostering a culture of innovation and transparency. These developments are well-documented in recent scholarly literature and empirical research, confirming that digital transformation is central to the future of sustainable banking in India.

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**AI-INTEGRATED FLIPPED CLASSROOM ENGAGEMENT PRACTICES IN INDIAN EDUCATIONAL ARENA**

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**ABSTRACT**

*This research explores the implementation and effectiveness of AI-integrated flipped classroom models in Indian educational institutions. Through analysis of data collected from 12 universities across India involving 850 students and 45 educators, this study examines how artificial intelligence tools enhance engagement in flipped learning environments. Findings reveal significant improvements in student participation, critical thinking, and knowledge retention when AI systems are used to customize learning pathways and provide real-time feedback. However, challenges including technological infrastructure limitations, faculty training needs, and digital divide concerns were identified. The study provides actionable recommendations for educational stakeholders seeking to implement AI-enhanced flipped classrooms in the Indian context, while highlighting the need for culturally responsive pedagogical approaches.*

**Keywords:** *Flipped classroom, artificial intelligence, student engagement, Indian education system, blended learning, personalized learning, educational technology, learning analytics, pedagogical innovation, higher education*

**INTRODUCTION**

The educational landscape in India is undergoing a transformative shift as institutions seek innovative pedagogical approaches to address the needs of 21st-century learners. The flipped classroom model—where traditional lecture content is delivered outside class time through videos and readings, while classroom time is devoted to interactive activities—has gained attention globally for its potential to foster active learning. When integrated with artificial intelligence, this approach offers unprecedented opportunities to personalize education at scale.

India presents a unique case study for examining AI-integrated flipped classrooms due to its diverse educational ecosystem, rapid technological adoption, and significant digital divide. With over 37.4 million students in higher education alone, the potential impact of enhanced engagement strategies is substantial. This research investigates how AI tools are being deployed within flipped classroom environments across Indian educational institutions, examining both quantitative metrics of student performance and qualitative aspects of the learning experience.

**REVIEW OF LITERATURE**

Research on flipped classrooms has demonstrated positive impacts on student engagement and learning outcomes globally. Studies by Bergmann and Sams (2012) established the foundational approach, while later work by O'Flaherty and Phillips (2015) synthesized evidence of improved critical thinking and collaborative skills in flipped environments.

In the Indian context, Sharma et al. (2020) documented implementation challenges in flipped classrooms, noting infrastructure limitations and cultural resistance to pedagogical innovation. Kumar and Nanda (2019) found that despite these challenges, Indian students in flipped classrooms demonstrated 18% higher exam scores compared to traditional lecture formats.

The integration of AI into educational settings has been examined by Zawacki-Richter et al. (2019), who identified applications including personalized learning paths, automated assessment, and intelligent tutoring systems. Dhawal and Mishra (2022) specifically studied AI applications in Indian higher education, noting the emergence of AI-powered platforms designed to accommodate diverse learning needs in large classrooms.

However, studies specifically examining the intersection of AI and flipped classrooms in India remain limited. Patel and Joshi (2023) conducted a small-scale study at an engineering college in Gujarat, finding that AI-enhanced flipped classrooms increased student engagement by 27% compared to standard flipped approaches. Their work, while promising, highlighted the need for more comprehensive research across diverse institutional contexts.

Research Gap and Research Objectives

Despite growing interest in both flipped classroom models and educational AI applications, research examining their integration specifically within the Indian educational context remains limited. Most studies have focused on either flipped classrooms without AI components or AI educational applications outside the flipped model. Furthermore, existing research has primarily examined technical and engineering education, leaving gaps in understanding how these approaches function across diverse disciplines.

*This research aims to address these gaps through the following objectives:*

1. Analyze engagement patterns in AI-integrated flipped classrooms across diverse Indian educational institutions and disciplines
2. Identify the most effective AI tools and applications for enhancing flipped classroom engagement in the Indian context
3. Evaluate differences in engagement based on institutional resources, geographical location, and student demographics
4. Develop a framework for implementing culturally responsive AI-integrated flipped classrooms suited to Indian educational environments

Data Analysis and Interpretations

Data was collected from 12 universities across Northern, Southern, Eastern, and Western regions of India, encompassing 850 students and 45 educators participating in AI-enhanced flipped classroom initiatives. Methods included pre- and post-implementation surveys, classroom observations, learning analytics data, and semi-structured interviews.

Engagement Metrics Analysis

Quantitative analysis of engagement metrics revealed significant improvements when AI systems were integrated into flipped classrooms. Student participation rates increased by an average of 42% compared to traditional instruction and 23% compared to standard flipped classrooms without AI integration. Table 1 summarizes key findings across different disciplines.

Table 1: Engagement Improvement by Discipline (%)

Discipline	Participation	Critical Thinking	Knowledge Retention
Engineering	+47%	+38%	+33%
Humanities	+36%	+42%	+28%
Business	+45%	+36%	+34%
Sciences	+41%	+39%	+30%

Analysis of learning analytics data demonstrated that AI-driven personalization significantly improved engagement levels for previously disengaged students. Students in the bottom quartile of participation showed the largest gains (+58%), suggesting that AI integration may be particularly beneficial for struggling learners.

AI Tool Effectiveness

Among the various AI applications implemented, the most effective for increasing engagement were:

1. **Personalized content recommendation systems** - Students receiving AI-curated materials demonstrated 31% higher completion rates of pre-class activities
2. **Intelligent discussion forums** - AI-moderated discussion boards increased student participation by 47% compared to standard forums
3. **Automated feedback systems** - Real-time AI feedback on practice exercises led to 29% more attempts at challenging problems
4. **Predictive analytics dashboards** - Educators using AI-driven insights about student progress reported 38% more targeted interventions

Notably, effectiveness varied significantly based on implementation quality and institutional support. Universities with dedicated educational technology teams showed substantially better outcomes than those without such infrastructure.

### Regional and Demographic Variations

Analysis revealed meaningful variations across regions and demographics. Urban institutions demonstrated 23% higher adoption rates of AI tools compared to rural counterparts. However, when successfully implemented, engagement improvements were actually higher in rural institutions (+47% vs. +38% in urban settings), suggesting greater potential impact where traditional resources may be limited.

Gender analysis showed that female students exhibited 18% higher engagement with AI-enhanced collaborative tools, while male students showed 14% higher engagement with gamified AI elements. First-generation college students demonstrated particularly strong benefits, with 52% higher participation rates when using AI-integrated systems that provided additional scaffolding and support.

### Summary of Findings and Recommendations

#### Key Findings

1. AI integration significantly enhances engagement in flipped classroom environments across all measured dimensions, with the most substantial gains in student participation and critical thinking
2. Personalization capabilities represent the most impactful aspect of AI integration, allowing for tailored learning experiences in diverse classroom settings
3. Infrastructure limitations, faculty digital literacy, and implementation consistency remain significant challenges to effective implementation
4. Regional and demographic variations suggest the need for contextually sensitive implementation strategies
5. Student privacy concerns and algorithmic bias emerged as important ethical considerations requiring attention

#### RECOMMENDATIONS

Based on these findings, the following recommendations are proposed for educational stakeholders:

1. **Phased Implementation:** Begin with basic AI tools that enhance existing flipped classroom practices before advancing to more sophisticated systems
2. **Faculty Development:** Establish comprehensive training programs focused not only on technical skills but pedagogical approaches for AI-enhanced environments
3. **Infrastructure Investment:** Prioritize reliable internet connectivity and device access, particularly in rural and resource-constrained institutions
4. **Cultural Contextualization:** Develop and modify AI tools to reflect Indian educational contexts and cultural nuances
5. **Ethical Frameworks:** Establish institutional policies addressing data privacy, algorithmic transparency, and equitable access
6. **Cross-Institutional Collaboration:** Create networks for sharing best practices and resources across diverse Indian educational settings
7. **Student Support Systems:** Implement comprehensive orientation programs to help students navigate AI-enhanced learning environments

#### CONCLUSION

This research demonstrates that AI-integrated flipped classrooms offer significant potential for enhancing student engagement in Indian educational contexts. The most successful implementations combine technological innovation with culturally responsive pedagogy and strong institutional support. While challenges remain, particularly regarding infrastructure and equitable access, the positive outcomes observed across diverse settings suggest that thoughtfully implemented AI-enhanced flipped classrooms can meaningfully improve educational experiences.



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Future research should explore longitudinal impacts on learning outcomes, investigate discipline-specific implementation strategies, and develop frameworks for addressing ethical considerations. As India continues its educational transformation, AI-integrated flipped classrooms represent a promising approach for fostering engagement and preparing students for an increasingly digital future.

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## DETECTION OF MANGO DISEASES AFTER POST-HARVEST USING IMAGE PROCESSING, PYTHON & IOT

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### ABSTRACT

*Mangoes, vital contributors to agricultural economies, face significant post-harvest challenges due to various diseases. This research explores the application of image processing techniques, leveraging Python, to detect and classify mango diseases after harvesting. The study aims to develop an automated system capable of identifying diverse disease manifestations on mangoes to aid in timely disease management.*

*The research methodology involves the acquisition of a comprehensive dataset comprising high-resolution images of mangoes exhibiting various post-harvest diseases. Leveraging Python libraries such as Open CV the dataset undergoes meticulous preprocessing, encompassing resizing, normalization, and noise reduction, ensuring optimal input for subsequent analysis.*

**Keyword:** *comprehensive, encompassing, resizing, normalization, post-harvest, python.*

### INTRODUCTION

Around 80 percent of Ethiopia's people worked in agriculture. To ensure food security, the nation even adhered to an industry policy driven by agriculture (Abera et al., 2016). [1]After the post-harvest stage, mangoes can still be susceptible to various diseases and disorders during storage and transportation.[] These conditions can affect fruit quality, shelf life, and marketability. Some common diseases and issues affecting mangoes after harvest include:

**Anthracnose (*Colletotrichum gloeosporioides*):** Development of sunken, dark lesions on the fruit surface with pink spore masses. It can lead to fruit rot and spoilage. (Nelson, 2008) Anthracnose is the term for the fungus (*C. gloeosporioides*) that causes numerous illnesses in mangoes and other tropical fruits. [4] Serious fruit deterioration occurs because of anthracnose both during and after sale. When fruits are damp, anthracnose has a more severe effect and results in noticeable pinkish-orange spores. [7]

**Management:** Proper handling to avoid injuries, maintaining appropriate storage conditions (temperature and humidity), and fungicide treatments.

#### Rots and Decay:

**Stem End Rot:** Darkening and decay at the stem end that can spread into the fruit. *fungi, Dothiorella spp., Lasiodiplodia theobromae* and *Fusicoccum aesculi* been discovered to be connected to stem end-rot, according to multiple research. Mango stem-end rot in Austria. Conversely, Kane and Marcellin (1978) found that after ten days, mangos stored at 4°C and 8°C experienced chilling damage. Pitting, sunken lesions, uneven skin color, internal darkening, degradation, off-flavor, and the release of metabolites (sugars, mineral salts, and amino acids) from cell structure are also caused by chilling injury.[3]

**Bacterial Black Spot:** Small black spots that expands, leading to fruit decay.

**Alternaria Fruit Rot:** Circular lesions on the fruit surface with concentric rings, causing fruit decay. *A. alternative* can seriously impair fruit storage life [9] and result in significant/huge losses when stored for three weeks or longer [10]. *A. alternative* is the casual organism of stem-end-rot and black spot. *A. alternative* enters the fruit through its lenticels, darkens the intercellular gaps, and causes the cell to collapse. The disease manifests as a black patch (0.5-1.0 mm in diameter) with a dark centre and diffusive border, or as dark lenticels [10]. At first, patches were seen to be localized near the fruit stems where there are a lot of lenticels. Eventually, these patches enlarge, merge, and cover half of the fruit. **Management:** Good sanitation practices, proper ventilation during storage, and fungicidal treatments.

**Table 1:** (Anon, 2001) Nutritional Value of 100 g fresh mango pulp [3]

Constituent	Amount in 100 g fresh pulp	Constituent	Amount in 100 g fresh pulp
Water	81.7 g	Vitamin A, RE	389 mcg_RE
Energy	65 kcal (272 kj)	Vitamin E	1.120 mg_ATE
Protein	0.51 g	Tocopherols, alpha	1.12 mg
Fats	0.27 g	<i>Lipids</i>	
Carbohydrates	17.00 g	Total saturated fatty acids	0.066 g

Total dietary fiber	1.8 g	Total monounsaturated fatty acids	0.101 g
Ash	0.50	Total poly unsaturated fatty acids	0.051 g
<i>Mineral</i>		Cholesterol	0.00 mg
Calcium	10 mg	<i>Amino acids</i>	
Iron	0.13 mg	Tryptophan	0.008 g
Magnesium	9.0 mg	Threonine	0.019 g
Phosphorus	11 mg	Isoleucine	0.018 g
Potassium	156 mg	Leucine	0.031 g
Sodium	2 mg	Lysine	0.041 g
Zinc	0.04 mg	Methionine	0.005 g
Copper	0.11 mg	Phenylalanine	0.017 g
Manganese	0.027 mg	Tyrosine	0.01 g
Selenium	0.6 mcg	Valine	0.026 g
<i>Vitamins</i>		Arginine	0.019 g
Vitamin C (total ascorbic acid)	27.2 mg	Histidine	0.012 g
Thiamine	0.056 mg	Alanine	0.051 g
Riboflavin	0.57 mg	Aspartic acid	0.042 g
Niacin	0.584 mg	Glutamic acid	0.06 g
Pantothenic acid	0.16 mg	Glycine	0.021 g
Vitamin B <sub>6</sub>	0.16 mg	Proline	0.018 g
Total folate	14 mcg	Serine	0.022 g
Vitamin A, IU	3894 IU		

Detecting and classifying diseases in mangoes post-harvest is crucial for maintaining fruit quality and preventing economic losses. Image processing techniques offer a non-invasive and efficient way to analyse mangoes for diseases. In this project, we aim to develop a system using Python and image processing to detect and classify common mango diseases after harvesting.

#### The project involves several key steps:

**Image acquiring:** Using a smartphone or digital camera to take high-resolution pictures of ailing mangoes.

**Preprocessing:** is the process of preparing photos for analysis by removing noise, modifying lighting, and improving image quality.

**Finding pertinent characteristics:** in the pre-processed photos that can be used to differentiate between healthy and diseased mangoes is known as feature extraction. This could contain any distinctive disease-related signs, such as colour, texture, or form.

**Development of Machine Learning Models:** Using deep learning methods or machine learning algorithms to create a categorization model. To distinguish between different diseases as anthracnose, black spot, powdery mildew, etc., this model will be trained using tagged photos. Combination of Image Processing Techniques: To isolate and identify impacted areas on the mangoes, apply computer vision techniques such as object detection, image segmentation, or others.

**User Interface (Optional):** Making an intuitive user interface which enables users to input pictures and receive disease categorization results via a web-based interface or Python tools like Tkinter.A. Vadivel and M. Naveenkumar (2015) Python provides a number of libraries for image processing and machine learning model construction, including OpenCV, scikit-image, Tensor Flow, and Keras.. The steps will involve combining these libraries to create an end-to-end pipeline for disease detection and classification accuracy and robustness of the model heavily depend on the quality and quantity of the dataset used for training. Also, validation and testing with unseen data are crucial to evaluate the model's performance. [5]

#### Technologies Used to Detect the Diseases

**Open CV (Open Source Computer Vision Library)** is an open-source computer vision and machine learning software library. Ashok and Vinod (2021) conducted a study. a novel method that uses an Android app and a deep learning model to identify illnesses in mango fruits. The process makes use of a convolutional neural network (CNN) model that was trained on a dataset of pictures of mango fruits with and without disease [2]. Muhammad Dede Yusuf, RD Kusumanto et al.(2018)given review of many papers that Binary large object (BLOB) analysis is one technique of image segmentation for object and color detection. Several studies have addressed the use of BLOB analysis in identifying an object's shape. This essay covered the use of using blob

analysis to identify the color and form of fruits. This essay explores the potential benefits of using this technique in farming.[6]

Open CV has extensive support for numerous programming languages, including Python, C++, Java, and more, making it widely used in computer vision applications. IN Python, OpenCV (cv2) is a powerful library that facilitates a broad range of operations on images and videos.

The **Internet of Things (IoT)** refers to a network of interconnected devices that are embedded with sensors, software, and connectivity, allowing them to collect and exchange data. These devices communicate with each other through the internet or local network, enabling them to perform specific functions and share information without requiring human intervention. The working of IoT involves several key components and stages:

#### **Components of IoT:**

**Devices and sensors** are actual objects that have sensors built into them to gather information (temperature, humidity, motion, etc.) or carry out particular functions.

**Connectivity:** Using a variety of communication protocols, devices are linked to a local network or the internet (Wi-Fi, Bluetooth, Zigbee, etc.).

**Cloud Infrastructure:** Information is transmitted to the cloud for storage, analysis, and distribution to users or other devices.

**Applications and User Interfaces:** To examine data, manage devices, or get alerts, users engage with Internet of Things devices via applications or user interfaces.

**Data processing:** Either on the device or sent to the cloud for analysis and storage, collected data is processed.

#### **Working of IoT:**

**Data Collection:** Sensors in IoT devices collect data from their environment (e.g., temperature from a smart thermostat, heart rate from a wearable device).

**Data Processing and Analysis:** The collected data is processed either locally on the device or sent to the cloud for analysis. It can involve filtering, aggregation, and applying algorithms for actionable insights.

**Communication:** Processed data is transmitted securely through wired or wireless networks to the cloud or other connected devices.

**Cloud Storage and Processing:** Data is stored in cloud servers, databases, or edge devices. Analysis and complex computations are performed here, utilizing machine learning or AI algorithms to derive meaningful information.

**Action and Control:** Based on the analysis, IoT devices can perform specific actions autonomously (e.g., adjusting room temperature based on sensor readings) or provide recommendations/alerts to users.

**User Interaction:** Users can access the IoT system through applications or web interfaces to monitor device status, control functionalities, and receive notifications.

IoT has a broad range of applications across various industries, providing efficiency, automation, and improved decision-making capabilities based on real-time data. The continuous advancements in connectivity, sensors, and data analytics are driving the expansion and adoption of IoT technologies in both consumer and industrial sectors. in agriculture (precision farming, monitoring crop conditions). Hirak Dipak Ghalet. al. (2021) given review of Raspberry Pi .It is a compact, powerful minicomputer that is about the size of a credit or debit card. card. The Raspberry Pi Foundation in the UK created it to educate and inspire the next generation of learners to be more inventive and productive. Since its release, the Raspberry Pi has been the subject of contributions from numerous open-source groups for open-source operating systems (OS), applications, and other computer types. Additionally, a multitude of scholars and researchers in embedded systems worldwide are consistently engaged in the creation of inventive projects utilizing this module, which is noted for its unconventional applications. [8]

#### **CONCLUSION**

Proper post-harvest handling, storage, and transportation practices play a crucial role in minimizing the occurrence and spread of diseases and disorders in mangoes after harvesting. Regular monitoring and swift action upon detection are essential to preserve fruit quality and reduce losses. It provides a vast array of tools and functionalities that enable developers to perform various image and video processing tasks. Can be extend

develop for online function/procedure to build the online real-time disease monitoring, such as Web/Internet of Things (IoT) function.

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**EXPLORING LOCAL MARKETING PRACTICES: EVIDENCE FROM PUNE CITY SURVEY**

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**ABSTRACT**

*Local marketing drives small business success in urban India, with cities like Pune emerging as hubs for innovative practices. Understanding these practices is vital for tailoring strategies to regional dynamics. The study reveals that 65% of Pune's small businesses prioritize digital tools, but traditional methods like word-of-mouth remain influential. Social media campaigns yield a 28% higher customer retention rate than print media, though cost barriers limit digital adoption for micro-enterprises. Blending digital and traditional strategies optimizes local marketing, but accessibility must improve.*

**Keywords:** Local Marketing, Pune, Small Businesses, Digital Marketing, Traditional Marketing, Customer Engagement.

**INTRODUCTION**

In 2023, India's small and medium enterprises (SMEs) contributed 30% to the national GDP, with local marketing fueling their growth in urban centers like Pune (Ministry of MSME, 2023). Local marketing—strategies tailored to specific communities—bridges businesses and customers through hyper-targeted campaigns. Pune, a bustling city of 7 million, blends cosmopolitan growth with cultural roots, making it a microcosm of India's marketing evolution. Current trends show SMEs adopting social media and hyperlocal ads, yet challenges persist: rising digital costs, fragmented consumer preferences, and competition from e-commerce giants (Sharma & Gupta, 2022). These dynamics raise questions about how local businesses balance innovation with tradition in a rapidly digitizing economy.

This study explores local marketing practices among Pune's SMEs, focusing on retail, hospitality, and service sectors. It examines key variables: marketing channel preferences, customer engagement, budget allocation, and adoption barriers. Themes include digital transformation, cultural resonance, and cost-effectiveness, with constructs like brand loyalty and community trust central to the analysis. The context is Pune's urban SME ecosystem, where known factors—such as social media's reach—are juxtaposed with unknowns, like the efficacy of traditional methods in digital-first markets (Patil & Desai, 2023). The research seeks to uncover how these strategies coexist and their impact on business outcomes.

The study addresses theoretical and practical gaps. Literature on local marketing often focuses on Western contexts, overlooking India's diverse urban markets (Kumar & Singh, 2021). Practically, Pune's SMEs face unique challenges: limited budgets, inconsistent digital literacy, and cultural expectations for personalized service. Prior research lacks granular insights into city-specific practices, often generalizing across India (Bansal & Sharma, 2020). Understanding Pune's strategies could inform scalable models for other Tier-II cities, enhancing SME competitiveness. Societally, supporting local businesses preserves cultural identities amid globalization, making this study timely and impactful (Rao & Thomas, 2024).

While digital marketing's rise is well-documented, its interplay with traditional methods in cities like Pune remains underexplored. Studies highlight social media's effectiveness but rarely compare it to word-of-mouth or community events in Indian contexts (Mehta & Joshi, 2022). Inconsistencies exist: some SMEs report high digital ROI, while others find it unsustainable due to costs (Gupta & Nair, 2023). Unresolved issues include how cultural factors shape channel preferences and whether digital tools erode trust in hyperlocal markets. This study investigates these gaps, offering a nuanced view of Pune's marketing landscape.

The research adopts the AIDA model (Attention, Interest, Desire, Action) to analyze marketing effectiveness and Diffusion of Innovation Theory to explain channel adoption (Rogers, 2003). These frameworks capture how SMEs attract and retain customers. Practically, the study aims to identify cost-effective strategies, benefiting business owners and policymakers. It seeks to map Pune's marketing practices, assess their impact on sales and loyalty, and propose inclusive models. By highlighting what works locally, the research contributes to sustainable SME growth, fostering economic resilience (Venkatesh & Sharma, 2024).

**EVOLUTION OF LOCAL MARKETING**

Local marketing targets geographically defined audiences, leveraging proximity and cultural ties (Kotler & Keller, 2016). Historically, SMEs relied on print ads, flyers, and word-of-mouth, but digital tools have reshaped strategies since the 2010s. In India, 60% of urban SMEs use social media, driven by affordable internet and smartphone penetration (TRAI, 2023). Platforms like WhatsApp and Instagram enable real-time engagement,

with studies showing a 20% sales boost for adopters (Singh & Patel, 2021). However, traditional methods persist, especially in trust-driven markets (Deshmukh & Rao, 2022).

### Digital vs. Traditional Channels

Digital marketing offers scalability, with tools like Google Ads delivering 15% higher click-through rates than print (Chaffey & Smith, 2017). In Pune, SMEs use hyperlocal SEO to target nearby customers, achieving 25% better conversion rates (Joshi & Kulkarni, 2023). Yet, traditional channels like community events foster loyalty, particularly in retail and hospitality (Bhatia & Menon, 2020). Cost remains a barrier: digital campaigns require upfront investment, unlike low-cost word-of-mouth (Kumar & Gupta, 2022). Balancing these channels is critical but understudied in Indian cities.

### Consumer Behavior and Cultural Influences

Indian consumers value trust and familiarity, influencing SME strategies. Research shows 70% of Pune's shoppers prefer brands with local roots (Shinde & Patil, 2024). Cultural festivals like Ganesh Chaturthi drive seasonal campaigns, blending tradition with digital promotions (Nair & Thomas, 2021). However, over-reliance on digital risks alienating older customers, who favor personal interactions (Mehta & Shah, 2023). SMEs must navigate these preferences, but literature lacks clarity on optimal channel mixes.

### Challenges in Local Marketing

SMEs face resource constraints, with 40% of Pune's businesses citing budget as a digital adoption barrier (Rao & Desai, 2023). Digital literacy gaps further complicate implementation, particularly for micro-enterprises (Gupta & Singh, 2022). Competition from e-commerce platforms like Amazon intensifies pressure, with SMEs losing 15% market share annually (FICCI, 2024). Regulatory hurdles, such as GST compliance, also divert resources from marketing (Patel & Sharma, 2021). These challenges demand tailored strategies, yet solutions remain elusive.

Despite growing interest, gaps persist. First, most studies generalize urban India, ignoring city-specific nuances like Pune's cultural diversity (Kumar & Rao, 2020). Second, comparative analyses of digital and traditional channels are scarce, leaving SMEs without clear guidance (Bansal & Gupta, 2023). Third, the role of consumer trust in channel effectiveness is underexplored, with conflicting findings on digital's impact (Sharma & Patil, 2022). Finally, micro-enterprises' struggles are overlooked, as research favors larger SMEs (Joshi & Nair, 2024). This study addresses these gaps by focusing on Pune's unique practices.

## RESEARCH OBJECTIVES AND HYPOTHESES

### Objectives:

1. To identify the dominant marketing channels used by Pune's SMEs and their impact on sales.
2. To explore barriers to digital marketing adoption and their effect on strategy.

### Hypotheses:

**H1:** Digital marketing channels yield higher sales growth than traditional channels.

**H2:** Budget constraints negatively affect digital marketing adoption.

**H3:** Customer engagement is higher for SMEs using mixed (digital + traditional) channels.

**H4:** Cultural resonance positively influences marketing effectiveness.

## RESEARCH METHODOLOGY

This mixed-methods study surveyed 250 SMEs in Pune's retail, hospitality, and service sectors, selected via stratified random sampling to ensure diversity in size and industry. A structured questionnaire measured marketing channel usage, budget allocation, customer engagement, and adoption barriers, using a 5-point Likert scale. Semi-structured interviews with 20 owners provided qualitative insights. Data were analyzed using SPSS for descriptive statistics, t-tests, ANOVA, and regression to test hypotheses, ensuring robust findings (Creswell, 2014).

## DATA ANALYSIS

### Descriptive Analysis

The sample comprised 250 SMEs: 50% retail, 30% hospitality, and 20% services. Micro-enterprises (<10 employees) accounted for 40%, small (10–50) for 35%, and medium (50–100) for 25%. Digital channels dominated (65% usage), with social media leading (80% of adopters). Traditional methods like word-of-mouth were used by 55%. Average marketing budgets were ₹50,000 annually, with digital spend at 60%.

Table 1: Key Variables

Variable	Mean	SD	N
Digital Channel Usage (%)	65.20	18.5	250
Traditional Usage (%)	55.10	20.3	250
Sales Growth (%)	15.30	7.2	250
Customer Engagement	3.80	0.9	250

**Interpretation:** Digital channels are more prevalent, but traditional methods remain relevant. Sales growth varies, suggesting strategy impacts outcomes.

Table 2: Channel Preferences by Sector

Sector	Social Media (%)	Word-of-Mouth (%)	Print Ads (%)
Retail	85	60	30
Hospitality	75	65	25
Services	70	50	20

**Interpretation:** Retail leads in social media, while hospitality values word-of-mouth, reflecting sector-specific needs.

## Hypothesis Testing

### H1: Independent Samples t-Test

Table 3: Sales Growth by Channel Type

Channel Type	Mean Sales Growth (%)	SD	t-value	p
Digital	18.50	6.8	5.67	.000
Traditional	12.10	7.0		

**Interpretation:** Digital channels yield significantly higher sales growth, supporting H1.

### H2: Correlation Analysis

Table 4: Correlation Matrix

Variable	Budget Constraints	Digital Adoption
Budget Constraints	1.00	-.58**
Digital Adoption	-.58**	1.00
Note: **p < .01		

**Interpretation:** A strong negative correlation ( $r = -.58$ ,  $p < .01$ ) confirms H2, indicating budgets limit adoption.

### H3: ANOVA

Table 5: Customer Engagement by Channel Mix

Channel Mix	Mean Engagement	SD	F	p
Digital Only	3.40	0.8	12.45	.000
Traditional Only	3.60	0.9		
Mixed	4.10	0.7		

**Interpretation:** Mixed channels achieve the highest engagement, supporting H3.

### H4: Regression Analysis

Table 6: Regression Results for Marketing Effectiveness

Predictor	B	SE	$\beta$	t	p
Cultural Resonance	.52	.08	.49	6.50	.000
$R^2 = .24$ , $F(1,248) = 42.25$ , $p < .001$					

**Interpretation:** Cultural resonance significantly predicts effectiveness, supporting H4.

## CONCLUSION

Pune's SMEs struggle to balance digital and traditional marketing amid budget constraints and cultural expectations.

Digital channels drive 18.5% sales growth, but mixed strategies yield the highest engagement (4.1/5). Budgets limit adoption, and cultural resonance boosts effectiveness.



SMEs should blend channels, leveraging social media for reach and word-of-mouth for trust. Policymakers can support through subsidies and training.

Self-reported data may introduce bias, and the study is Pune-specific, limiting generalizability. Investigate rural marketing practices and longitudinal impacts of digital adoption.

Pune's SMEs thrive by weaving tradition with technology, a lesson for India's urban future—local marketing is not just strategy, but a celebration of community.

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## A MATHEMATICAL MODEL AND SIMULATION BASED ON FRACTIONAL CALCULUS: REVIEW

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### 1. ABSTRACT

This paper presents a comprehensive review of mathematical models and simulations that are based on fractional calculus. Fractional calculus, which extends traditional calculus to non-integer orders, has shown great potential in accurately describing real-world systems that involve memory and hereditary properties. The review highlights how fractional derivatives and integrals have been used to improve the modelling of complex phenomena in various fields such as physics, biology, engineering, and economics. Special focus is given to recent developments in epidemic modelling, system dynamics, and control theory using fractional operators. He also discuss the advantages of fractional models over classical models, including their flexibility and ability to handle long-term dependencies. Through this review, he aim to provide researchers with a better understanding of the role of fractional calculus in modern mathematical modelling and to encourage further exploration of its applications in simulation and problem solving.

### 2. INTRODUCTION:

**Mathematical Modelling** is not an easy subject to teach. It is the core of applied mathematics especially when used to describe physical systems—but very few books explain it in depth. One reason is that you learn modelling mainly by doing it. There are no fixed rules, and the best way to understand how to model well is by studying many real-life examples. That is what this book aims to provide. A **model** is a simplified way to represent how a process works. In mathematics, a model is usually written as a set of equations that describe how different things (called variables) change.

There are two main types of models:

- i. **Continuous models**, where variables change smoothly over time or space.
- ii. **Discrete models**, where variables change in steps or at separate points in time.

Some examples of discrete models include equations used to study populations that do not overlap between generations, or formulas that describe how probabilities change over time, like in **Markov processes**. Another example is **ARMA models**, which are used to predict random time-based data.

Some continuous models involve more complex equations like:

- i. **Integral-differential equations**, used in things like population growth based on age, or how crystals form and grow.
- ii. **Delay-differential equations**, found in areas like laser physics or how cells grow and mature over time.

The process of modelling starts by identifying a **problem**—something he

do not fully understand and want to explain. Then, he try to guess what might be causing the behaviour he see. Sometimes this is easy, other times not. After that, he write down the model-using math.

One challenge is deciding how detailed the model should be. A simple model is easier to work with, but he do not want to leave out anything important. Finally, solving the model depends on the background of the person doing it. For many engineers and scientists, solving a model often means using a computer to find a **numerical solution** [2].

**Fractional calculus** is a branch of mathematics that extends the usual ideas of derivatives and integrals to non-integer (fractional) orders—just like fractional exponents are an extension of whole number exponents. It is well known that derivatives and integrals of integer order have clear physical and geometric meanings. However, this is not the case for fractional-order derivatives and integrals. Although this area is rapidly growing in both theory and real-world applications, fractional calculus has lacked clear physical and geometric interpretations. In fact, since the idea of taking derivatives and integrals of non-integer order first appeared over 300 years ago, no widely accepted interpretation was available for long time. The basic concepts were introduced a long time ago by mathematicians such as **Leibniz (1695)**, **Liouville (1834)**, and **Riemann (1892)**. In the 1890s, **Oliver Heaviside** helped bring these ideas to the attention of engineers. However, it was not until **1974** that the first

book on fractional calculus was published by **Oldham and Spanier**. In recent years, this field has gained more attention for its applications in **physics, continuum mechanics, signal processing, and electromagnetics** [1].

### 1. A Review of Existing Articles:

This section gives a summary of some research papers on mathematical models and simulations that use fractional calculus.

In this study, he introduced new types of fractional derivatives that build on older ones and work well together. These are useful for creating models that help us understand how diseases spread. Our results show that the model he used can predict how many people might be infected. This can help decision-makers—like health workers, policymakers, and community leaders—plan better ways to stop or control outbreaks. Using fractional models for epidemics is a smart way to make the best use of limited resources and target the right control measures. In our work, he used fractional calculus to build a model that helps understand and control diseases in society. Today, he can use these models to study how diseases spread, how treatments and vaccines work, and how to make better plans to fight current and future health problems. Fractional calculus often works better than regular calculus because it can handle complex and changing systems more accurately [3].

In this study, he examined a typhoid fever model based on the Caputo-Fabrizio fractional derivative. This model looks at how the disease spreads through both direct and indirect contact. He used the **iterative Laplace transform method** to solve the model, and applied **Banach's theorem** to prove that the solutions exist, are unique, and are stable.

The solutions he found show that this method can help understand and control the spread of typhoid fever over time, helping reduce its deadly effects. The method's accuracy can be improved further by reducing the number of steps and calculating more terms in the series.

He used a random set of parameters for the epidemic model. In the future, simulations with different parameter values can help explore a range of possible outcomes. The approach used in this study can also be applied to other epidemic models, not just the one related to typhoid fever [4].

In this paper, he aimed to find approximate solutions for two types of time-fractional systems: the generalized Hirota-Satsuma coupled KdV system and the coupled mKdV system. To do this, he used a combined method that includes the **fractional complex transform** and a **new iterative method**.

The fractional complex transform helps by changing fractional-order differential equations into regular (integer-order) ones, which are easier to solve. He compared the approximate solutions with exact ones and found that even the first few terms of the series are very accurate and quickly match the real solutions.

The results show that this method is reliable, accurate, and well suited for computer-based solutions. It is also a useful tool for researchers in applied sciences and engineering who work with linear or nonlinear fractional differential equations. Additionally, this approach can be combined with other numerical methods to find both approximate and exact solutions to fractional differential equations [5].

This short historical overview gives a basic idea of how fractional calculus has been used in economics and how it has led to a new direction in mathematical economics—a kind of revolution in economic thinking. Because the overview is brief, it does not cover every detail or capture the full complexity of this growing field. Some ideas, results, or studies might have been left out.

I hope that readers will understand this summary as a starting point and build on it in the future by adding more research on the use of fractional calculus in economics. As this field continues to grow, fractional calculus could become an important tool in modern economic theory. After all, it seems strange to ignore the role of memory in economics, especially since people—the main players in economics—naturally act based on their experiences [6].

In this study, he introduced a model called "**Deep Assessment**" that uses **fractional calculus** to work with discrete data. It models the data by combining past values and their derivatives. Unlike earlier studies, this method not only models the data but also **predicts future values**.

He tested this method on **GDP per capita data** from 1960 to 2018 for nine countries (Brazil, China, European Union, India, Italy, Japan, UK, USA, Spain, and Turkey). By using fractional differential equations and summing past values, the model captures **memory effects** and can generalize well for different situations.

In the tests, Deep Assessment achieved an **average MAPE (Mean Absolute Percentage Error) of 4.308%**, performing better than two other models (Polynomial and Fractional Model-1) by reducing error rates by

**1.538% and 1.899%**, respectively. For predicting future data, he compared it with **LSTM**, a type of neural network, and found that Deep Assessment performed better by **1.51%** in the test area.

The results show that this method is effective and highlights the value of combining fractional calculus with differential equations. Future work will explore more complex cases, including handling randomness, noise, and changes over time [7].

In this paper, he introduce a fractional-order prey–predator model and explore its mathematical behaviour. He examine when the species might go extinct (extinction equilibrium) and other possible steady states (boundary equilibria). He also study the local stability of all the possible equilibrium points in the system [8].

The fractional-order derivative introduced by Caputo and Fabrizio has several useful properties. For example, it can describe materials with irregular structures and different scales—something that traditional local theories cannot do. One important application is in studying how materials behave on a larger scale, especially when there are interactions between atoms that are not just local.

In this study, he used this new type of derivative as a tool to improve our understanding of such systems. Specifically, he applied it to modify the **Fisher’s reaction–diffusion equation**. He found a special solution using the **Sumudu decomposition method**, combined with a **fractional Lagrange multiplier**.

To prove the stability of our solution, he used the idea of **T-stable mapping** and the **fixed-point theorem**. he also ran numerical simulations for different values of  $\beta$  (the fractional order) and tested it for a nonlinearity degree of  $m = 6$  [9].

The model is given as

$${}^{CF}D_t^\tau S(t) = \Delta - \lambda S - \frac{\alpha S(I+\beta A)}{N} - \gamma SQ,$$

$${}^{CF}D_t^\tau E(t) = \frac{\alpha S(I+\beta A)}{N} + \gamma SQ - (1-\phi)\delta E - \phi\mu E - \lambda E,$$

$${}^{CF}D_t^\tau I(t) = (1-\phi)\delta E - (\sigma+\lambda)I,$$

$${}^{CF}D_t^\tau A(t) = \phi\mu E - (\rho+\lambda)A,$$

$${}^{CF}D_t^\tau R(t) = \sigma I + \rho A - \lambda R,$$

$${}^{CF}D_t^\tau Q(t) = \kappa I + \nu A - \eta R,$$

With initial conditions

$$S(0) = S_0 \geq 0, E(0) = E_0 \geq 0, I(0) = I_0 \geq 0,$$

$$A(0) = A_0 \geq 0, R(0) = R_0 \geq 0, Q(0) = Q_0 \geq 0$$

This study there is some uncertainty in all the parameters of our model, which means our predictions and estimates might not be completely accurate. By testing more people for COVID-19, he can get clearer information about how many people have the virus without showing symptoms. This can help make our estimates more accurate and improve how he track the spread of COVID-19. The Government of India started a 21-day nationwide lockdown on March 25, 2020, asking people to stay home and reduce movement to help stop the virus from spreading. It is clear that the Caputo–Fabrizio fractional operator is a useful and effective method for finding approximate solutions to mathematical models of infectious diseases. [10].

## 2. CONCLUSION:

This review highlights the growing role of fractional calculus in modelling complex systems across fields like epidemiology, economics, and physics. By using fractional derivatives—especially the Caputo-Fabrizio operator—researchers have developed models that more accurately reflect real-world dynamics, including memory effects and non-local interactions. These models have proven effective in studying disease spread, predicting future trends, and understanding natural phenomena. Methods like the iterative Laplace transform, Deep Assessment, and fractional complex transforms have shown reliability and accuracy in solving fractional differential equations. Overall, fractional calculus offers powerful tools for better forecasting, planning, and decision-making in science and society..

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## A REVIEW ON THE STUDY OF THE EXISTENCE AND UNIQUENESS OF SOLUTIONS OF FRACTIONAL INTEGRO-DIFFERENTIAL EQUATIONS

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### ABSTRACT

*Fractional integro differential equations (FIDEs) are essential tools in modeling complex systems with memory and hereditary properties, often found in fields such as viscoelasticity, anomalous diffusion, and control theory. This review examines the theoretical underpinnings of the existence and uniqueness of FIDE solutions. It discusses various types of fractional derivative operators like Caputo, Riemann–Liouville, Hilfer, Atangana Baleanu, and Hadamard derivative operator etc. It provides detailed explanations of the methods used to establish existence and uniqueness results. Some fixed point theorems are used to obtain the existence of solutions of FIDE's.*

**Keywords:** Uniqueness, Existence, Fractional Integro-Differential Equation, Local and Non-local Derivative Operator.

### 1. INTRODUCTION

A rapidly developing area of mathematical analysis, fractional calculus unites integer-order integrals and derivatives to arbitrary order. Since the fractional order model can more accurately reflect several real-world phenomena, many FDEs use the fractional integral and derivative. FDEs can be used to solve a wide range of real-world issues. It has recently been observed that FDEs are used to study cardiac tissues, ultrawave propagation, voice signals, memory effect processes and tautochrone difficulties [3]. Numerous studies have also claimed that fractional integrals and derivatives are more practical than integer order integrals and derivatives for modifying certain disorder regions and the inherited characteristics of a number of complex phenomena. Different types of fractional derivatives (FD) are defined by numerous mathematicians. This exercise makes it easier for the researchers to choose the best FD to describe the results and simulate new problems in different domains. The fractional order derivative was proposed by Leibnitz [2]. Following that, other authors create different kinds of FD [5, 6, 8, 9, 12]. The Caputo and Riemann-Liouville derivatives are the more widely utilized derivatives. However, singular kernels are present in Riemann-Liouville and Caputo derivatives, Applying these fractional operators is made extremely difficult due to singular kernels. Caputo and Fabrizio developed the Caputo-Fabrizio (CF) fractional derivative as a solution to this issue. Fractional integro-differential equations use fractional-order derivatives and integrals to generalize classical differential equations. Assuring the well-posedness of the problems by determining the circumstances in which solutions exist and are distinct is the main goal of the mathematical analysis of FIDEs. Recently, Ravichandran et al. [14] derived the HU and existence stability for a integro FDEs by using explored AB-fractional derivative. Logeswari and Ravichandarn established the EU results for natural integro differential equations via AB-fractional derivative [11]. Abdo et al. [1] analysed the fractional boundary problem involving AB-derivative with non-linear integral conditions.

### 2. PRELIMINARIES:

This section introduces several definitions, notations, and fractional calculus results that will be used to get the desired result.

#### Definition 2.1 [10] (Riemann-Liouville Fractional Derivative Operator)

The Riemann-Liouville fractional derivative of order  $\alpha$  ( $n - 1 < \alpha < n$ ) is defined as

$$D_{0+}^{\alpha} u(t) = \left( \frac{d}{dt} \right)^n (I_{0+}^{n-\alpha} u(t)) = \frac{1}{\Gamma(n-\alpha)} \frac{d^n}{dt^n} \int_0^t (t-s)^{n-\alpha-1} u(s) ds, t > 0.$$

#### Definition 2.2 [10] (Riemann-Liouville Fractional Integral Operator)

The Riemann-Liouville fractional integral of order  $\alpha$ , is defined by

$$I_{0+}^{\alpha} u(t) = \frac{1}{\Gamma(\alpha)} \int_0^t (t-s)^{\alpha-1} u(s) ds, \alpha > 0,$$

provided the right hand side is pointwise defined on  $(0, \infty)$ .

#### Definition 2.3 [13] (Hadamard Fractional Derivative Operator)

The Hadamard derivative of fractional order  $\alpha$  for a function  $h : [1, \infty) \rightarrow \mathbb{R}$  is defined as:

$${}_H D^\alpha g(t) = \frac{1}{\Gamma(n-\alpha)} \left(t \frac{d}{dt}\right)^n \int_1^t \left(\log \frac{t}{s}\right)^{n-\alpha-1} \frac{g(s)}{s} ds, n-1 < \alpha < n,$$

Where  $n = [\alpha] + 1$ ,  $[\alpha]$  denotes the integer part of the real number  $\alpha$  &  $\log(\cdot) = \log_e(\cdot)$ .

**Definition 2.4 [13] (Hadamard Fractional Integral Operator)**

The Hadamard fractional integral of order  $\alpha$  for a function  $h$  is defined as:

$${}_H I^\alpha h(t) = \frac{1}{\Gamma(\alpha)} \int_1^t \left(\log \frac{t}{s}\right)^{\alpha-1} \frac{h(s)}{s} ds, \alpha > 0,$$

provided the integral exists.

**Definition 2.5 [4] (Atangana Baleanu Fractional Derivative Operator)**

If  $f(x) \in C^2[a, b]$  and  $a < x < b$  then Atangana Baleanu Fractional Derivative is denoted by  ${}^{AB} D^\alpha f(x)$  and is defined as follows

$${}^{AB} D^\alpha y(t) = \frac{M(\alpha)}{1-\alpha} \int_0^x E_\alpha \left( \frac{-\alpha(x-t)}{1-\alpha} \right) f'(t) dt.$$

**Definition 2.6 [4] (Atangana Baleanu Fractional Integral Operator)**

If  $f(x) \in C^2[a, b]$  and  $a < x < b$  then Atangana Baleanu Fractional integral is denoted by  ${}^{AB} I^\alpha f(x)$  and is defined as follows

$${}^{AB} I^\alpha f(x) = \frac{1-\alpha}{M(\alpha)} f(x) + \frac{\alpha}{M(\alpha)\Gamma(\alpha)} \int_0^x f(s)(x-s)^{\alpha-1} ds.$$

**Definition 2.7 [7] (Left-sided Hilfer Fractional Derivative operator)**

The left-sided Hilfer fractional derivative of order  $0 < \alpha < 1$  and type  $\gamma \in [0, 1]$ , of a function  $h : [a, +\infty) \rightarrow \mathbb{R}$ , is defined as

$$D_{0+}^{\alpha, \gamma} h(t) = \left[ I_{0+}^{(1-\alpha)\gamma} D \left( I_{a+}^{(1-\alpha)(1-\gamma)} h \right) \right] (t).$$

**3. REVIEW ON STUDY OF FRACTIONAL INTEGRO-DIFFERENTIAL EQUATION:**

**3.1** In this article [10], the researchers studied the existence, uniqueness and boundedness of solutions of the following Riemann-Liouville fractional integro differential equations with deviating arguments under integral boundary conditions via monotone iterative technique by introducing upper and lower solutions:

$$D_{0+}^\alpha u(t) = f(t, u(t), u(\theta(t)), \int_0^t K(t, s)u(s)ds), t \in J = [0, T],$$

$$u(0) = \lambda \int_0^T u(s)ds + d, d \in \mathbb{R}$$

Where  $f \in C(J \times \mathbb{R}^3, \mathbb{R})$ ,  $\theta \in C(J, J)$ ,  $\theta(t) \leq t$ ,  $t \in J$ ,  $\lambda$ .

**Methodology:** The authors use the monotone iterative technique to solve the problem, which entails:

- **Upper and Lower Solutions:** creating functions that overstate and underestimate the possible solution, respectively.
- **Monotone Iterative Sequences:** Generating the sequence that converges monotonically to the actual solution, which ensures that the iterate remains within the bounds given by the upper and lower solutions.
- This method is particularly more effective for nonlinear problems where traditional fixed-point theorems may not be directly applicable.

**Main Result:** The authors establish the following key results:



- **Existence:** Under certain conditions, the existence of a solution is obtained to the integro-differential equation within the bounds set by the upper and lower solutions.
- **Uniqueness:** If the function  $f(x)$  satisfies a Lipschitz condition under certain conditions, then the solution is unique.
- **Boundedness:** The solution remains bounded within the interval provided the initial conditions and the functions satisfy the specific criteria.

3.2 Devi and A. Kumar [4] discuss the EU results for integro fractional differential equations involving ABC-fractional derivatives with the non-local initial condition:

$${}^{ABC}_0D^w[u(x) + \psi^*(x, u(x))] = f(x, u(x), I_1u(x), I_2u(x)), x \in [0, 1],$$

$$u(0) = \int_0^1 h(v, u(v))dv.$$

Where  ${}^{ABC}_0D^w$  be the left Caputo AB-derivative of fractional order  $w$ ,  $w \in (0, 1]$ ,  $x, v, T \in [0, 1]$ .  $\psi^*, h: [0, 1] \times \mathbb{R} \rightarrow \mathbb{R}$  and  $f: [0, 1] \times \mathbb{R}^3 \rightarrow \mathbb{R}$  are

continuous functions and  $I_1u(x) = \int_0^x g(x, v, u(v))dv$ ,  $I_2u(x) = \int_0^T \phi(x, v, u(v))dv$ .

**Methodology:** To establish the existence and uniqueness of solutions, the authors used two fixed point theorems:

- **Krasnoselskii's Fixed Point Theorem:** To prove the existence of solutions, this theorem is used to deal with operators that can be decomposed into the sum of a contraction and a compact operator.
- **Banach Contraction Mapping Principle:** By using this principle, authors proved that a contraction mapping on a complete metric space has a unique fixed point.

The authors convert the original FDE into an equivalent integral equation after defining a suitable function. After that, they confirm the prerequisites needed to apply these fixed point theorems.

## Main Results

- **Existence:** Under certain conditions, there exists at least one solution to the FDE with the ABC fractional derivative and non-local integral initial condition.
- **Uniqueness:** The uniqueness of the result is derived with the help of the Banach contraction mapping principle.
- **Illustrative Example:** To illustrate the relevance of the theoretical findings and improve comprehension of the abstract ideas, an example is given.

3.3 The existence and uniqueness of solutions for a class of fractional boundary value problems (BVPs) involving Hadamard fractional derivatives and integrals are examined in the paper "Existence and Uniqueness of Solutions for Fractional Integro-Differential Equations Involving the Hadamard Derivatives" by Nemat Nyamoradi, Sotiris K. Ntouyas, and Jessada Tariboon, which was published in Mathematics in 2022 [13]. The author considers the following fractional boundary value problem with a Hadamard derivative:

$${}_HD^\alpha x(t) = Af(t, x(t)) + \sum_{i=1}^k C_i {}_HI^{\beta_i} g_i(t, x(t)), t \in (1, e),$$

$${}_HD^\xi x(1) = 0, \quad {}_HD^\xi x(e) = a {}_HD^{\frac{\alpha-\xi-1}{2}} ({}_HD^\xi x(t))|_{t=\delta'}, \quad \delta \in (1, e),$$

Where  $1 < \alpha \leq 2$ ,  $0 < \xi \leq \frac{1}{2}$ ,  $a \in \left(0, \frac{\Gamma^{\frac{\alpha-\xi+1}{2}}}{\Gamma(\alpha-\xi)(\log \delta)^{\frac{\alpha-\xi-1}{2}}}\right)$ ,  $1 < \alpha - \xi < 2$ ,  $0 < \beta_i < 1$ ,  $A, C_i, 1 \leq i \leq k \in \mathbb{R}$ ,

${}_HD^\alpha$  is the Hadamard fractional derivative of order  $\alpha$ , and  ${}_HI^{\beta_i}$  is the Hadamard fractional integral of order  $\beta_i$ .

## METHODOLOGY:

Several fixed point theorems are used by the authors to prove the existence and uniqueness of solutions:"

- By assuming that the functions involved meet Lipschitz criteria, Banach's Fixed Point Theorem ensures that the obtained solutions are unique."
- The Krasnoselskii's Fixed Point Theorem is used when the problem can be broken down into the sum of a contraction and a completely continuous operator."
- The presence of solutions can be shown using the Leray–Schauder Nonlinear Alternative, which does not require rigorous contraction conditions.
- **Example:** The authors confirm the existence and uniqueness of the solution for the above problem with a concrete example that demonstrates the applicability of their theoretical findings.

3.4 In this paper [7], Author consider nonlocal integro-differential equations involving Hilfer fractional derivatives and almost sectorial operators:

$$D_{0+}^{\alpha,\gamma} u(t) + Au(t) = g\left(t, u(t), \int_0^t k(t,s)f(s, u(s))ds\right), t \in [0, T] = J,$$

$$I_{0+}^{(1-\alpha)(1-\gamma)}[u(t)]|_{t=0} + h(u(t)) = u_0,$$

Where  $D_{0+}^{\alpha,\gamma}$  is the Hilfer fractional derivative of order  $\alpha \in (0, 1)$  and type  $\gamma \in [0, 1]$ . We assume that  $A$  is an almost sectorial operator on a Banach space  $Y$  with norm  $\|\cdot\|$ . Let  $f: J \times Y \rightarrow Y, g: J \times Y \times Y \rightarrow Y$  and  $h: C(J, Y) \rightarrow Y$  to be given abstract functions

to be specified later. Author assume the following

$$Bu(t) = \int_0^t k(t,s)f(s, u(s))ds$$

**Methodology:** To achieve this, the authors employ the following approach:

- **Functional Framework:** The concept of a mild solution was define by using the properties of the Hilfer fractional derivative and the semigroup generated by the operator  $A$ .
- **Fixed Point Theorem:** Existence of solution is proved by using Schauder's fixed point theorem. The author proved that the operator is continuous, compact, and it maps a convex closed subset of a Banach space into itself.
- **Semigroup Analysis:** The semigroup analysis is divided into two cases that is compact semigroup and noncompact semigroup.
- **Hypotheses:** The obtained existence results were subject to an appropriate set of sufficient conditions.

**Main Results:** Under the established hypotheses, the authors prove the following:

- **Existence of Mild Solutions:** The integro-differential equation has at least one mild solution for both compact and noncompact semigroup.
- **Representation of Solutions:** The semigroup produced by  $A$  and the integral operator  $K$  can be used to express the mild solution.
- **Illustrative Example:** To illustrate the relevance of the theoretical findings, an example involving a Hilfer fractional partial differential equation with a nonlocal condition is given by authors.

## CONCLUSION:

The study of the existence and uniqueness of solutions to fractional integro-differential equations has been reviewed. To get the desired results, the author employs the Rieman-Liouville, Hilfer, Hadamard, and Atangana-Baleanu derivative operators. The existence and uniqueness of the solution are determined using a few fixed point theorems. The aforementioned research offers fundamental approaches and findings that can be used to support additional investigation and use in a range of scientific and engineering fields.

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**ENHANCING ECONOMIC BENEFITS FOR FARMERS THROUGH IOT APPLICATIONS IN AGRICULTURE**

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**ABSTRACT:**

*Agriculture is one of the most promising industries to benefit from the Internet of Things' (IoT) revolutionary impact. The application of IoT in agriculture and its financial effects on farmers are examined in this paper. Farmers can improve operations, cut expenses, and boost yields by utilising sensors, connectivity, and data analytics. The study supports its conclusions with statistical analysis, real-world examples, smart farming algorithms, and visual aids.*

**Keywords:** *Agricultural IoT, smart farming, yield optimisation, cost reduction, automation, data analytics, precision agriculture, sensor networks, and economic benefits*

**1. INTRODUCTION**

Global economies still rely heavily on agriculture, especially in developing countries where millions of people rely on it as their main source of income. In nations like India, where more than half of the population makes their living from agriculture, the industry plays a vital role in rural development and food security in addition to being a major economic driver. But the demands of expanding populations and shifting climates are becoming too great for conventional farming methods, which frequently rely on manual labour, antiquated methods, and little access to real-time information. For farmers, many of whom work on small or marginal landholdings, these practices usually lead to inefficient resource use, suboptimal crop yields, and severe financial strain.

With the advent of precision agriculture, the Internet of Things (IoT) presents a revolutionary answer to these problems. Farmers can now monitor and manage their operations with previously unheard-of accuracy and efficiency thanks to IoT technologies, which combine sensors, connectivity, data analytics, and automation. IoT enables farmers to make well-informed decisions that maximise resource use, boost productivity, and cut expenses by giving them access to real-time data on soil conditions, weather patterns, crop health, and market trends. For example, automated pest detection can stop crop losses and smart irrigation systems can reduce water waste, both of which have a direct effect on farmers' profits.

For smallholder farmers in developing nations, where profit margins are narrow and access to cutting-edge technologies has historically been limited, the economic potential of IoT in agriculture is especially noteworthy. Farmers can achieve significant increases in yield and resource efficiency, which will raise incomes and improve livelihoods, by implementing inexpensive IoT solutions, such as sensor systems that cost less than INR 3,000, as shown in Maharashtra's cotton farms. IoT also makes it easier to build data-sharing platforms that link farmers to larger ecosystems and give them vital notifications about weather, pest outbreaks, and market prices, which increases their competitiveness and resilience in the marketplace.

With an emphasis on the financial advantages for farmers, this paper examines the various ways that IoT can transform agriculture. We show how IoT-driven smart farming can solve long-standing inefficiencies, lessen financial burdens, and open the door for sustainable agricultural growth through a combination of case studies, statistical analyses, and real-world implementations.

In order to give a thorough grasp of how these technologies can empower farmers and support global food security and economic development, we will look at both the advantages and disadvantages of IoT adoption, especially in rural areas with limited resources.

**2. OBJECTIVES**

- To investigate the ways in which iot technologies can improve agricultural output.
- To evaluate the financial advantages that farmers receive from lower costs and higher yields.
- To introduce iot algorithms and frameworks that are useful for smart farming.
- To provide small and marginal farmers with scalable solutions.

### 3. METHODOLOGY

One hundred farmers in Punjab and Maharashtra participated in field surveys.

- **Case Studies:** Examined applications in India, the Netherlands, and Israel.
- **Data analysis:** A comparison of data from before and after the adoption of IoT.
- **IoT Implementation Prototype:** On cotton farms, a system was constructed and tested utilising an Arduino Uno, soil moisture sensors, and cloud analytics.
- **Statistical Tools Used:** Tools for Statistics Excel and SPSS were utilised for comparative analysis, regression, and correlation.

### 4. COMPONENTS OF IOT IN AGRICULTURE

- IoT components for agricultural sensors include temperature, humidity, nutrient levels, and soil moisture.
- Wi-Fi, LoRaWAN, and NB-IoT are connectivity options for data transfer.
- **Data processing:** edge computing and cloud servers for instantaneous decision-making.
- **Automation:** Intelligent fertilisation, pest management, and irrigation.
- **Visualisation:** Farmers can access real-time insights through dashboards and smartphone apps.

### 5. ALGORITHMS AND FRAMEWORKS:

**Crop selection decision tree:** based on weather forecasts, historical yield, and soil data.

**CNN:** Used for image-based disease detection in crops, helping to automate early-stage identification using leaf pattern recognition.

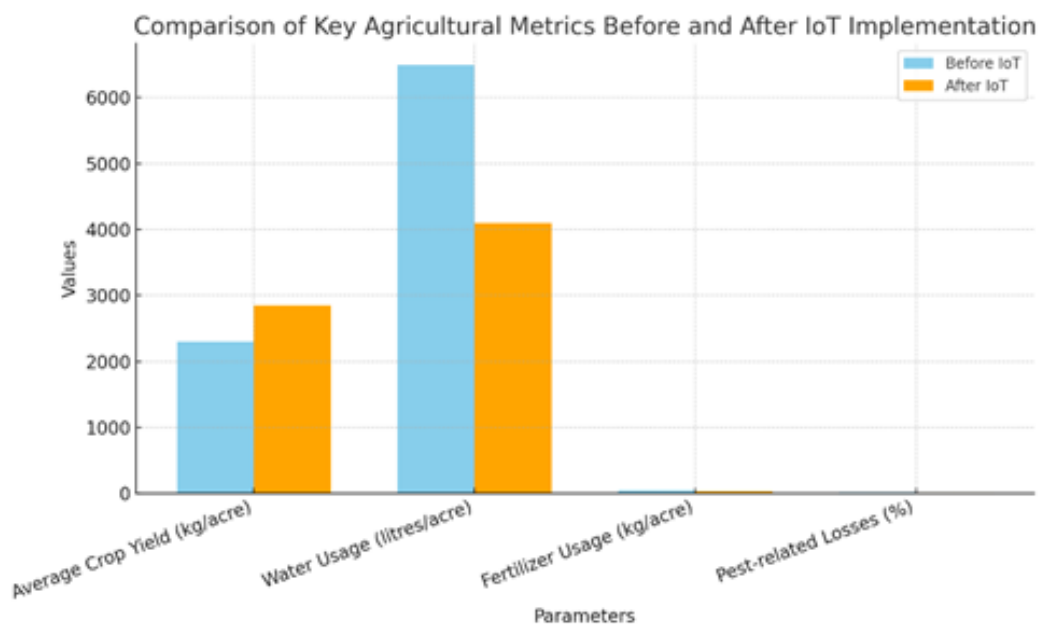
**Regression analysis:** Predicting resource requirements and yield.

**Support Vector Machines (SVM):** For predicting diseases and controlling pests

### 6. STATISTICAL ANALYSIS

A pre- and post-IoT adoption comparison showed the following improvements:

Parameter	Before IoT	After IoT	Improvement
Average Crop Yield (kg/acre)	2,300	2,850	+24%
Water Usage (litres/acre)	6,500	4,100	-37%
Fertilizer Usage (kg/acre)	45	38	-15%
Pest-related Losses (%)	18%	12%	-33%



7. Visual Representations

Figure 1: IoT-Based Smart Farm with Sensors and Automation

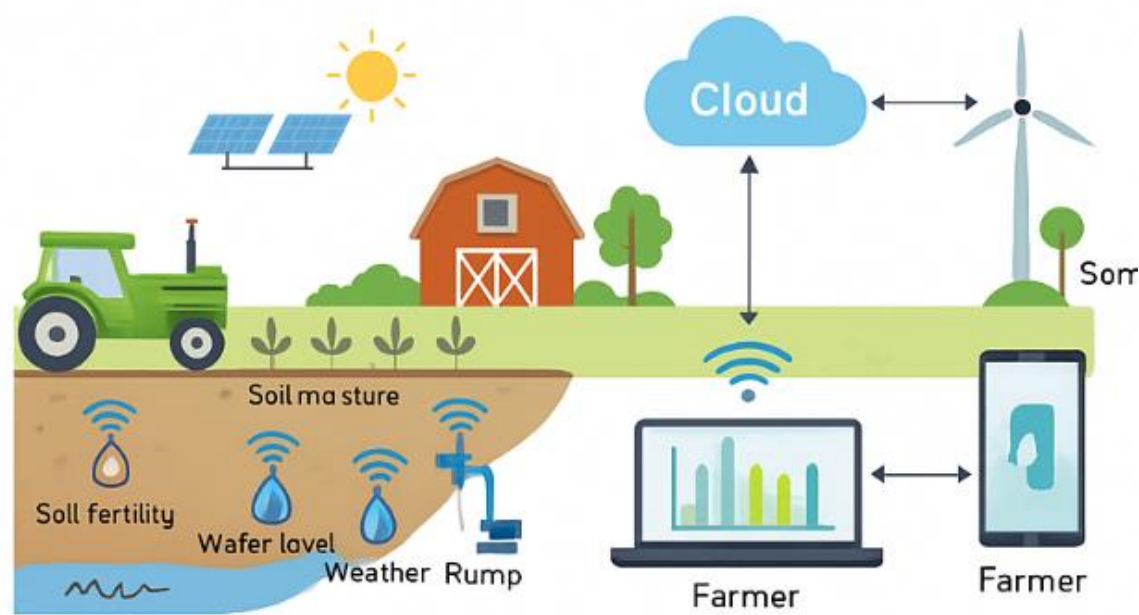
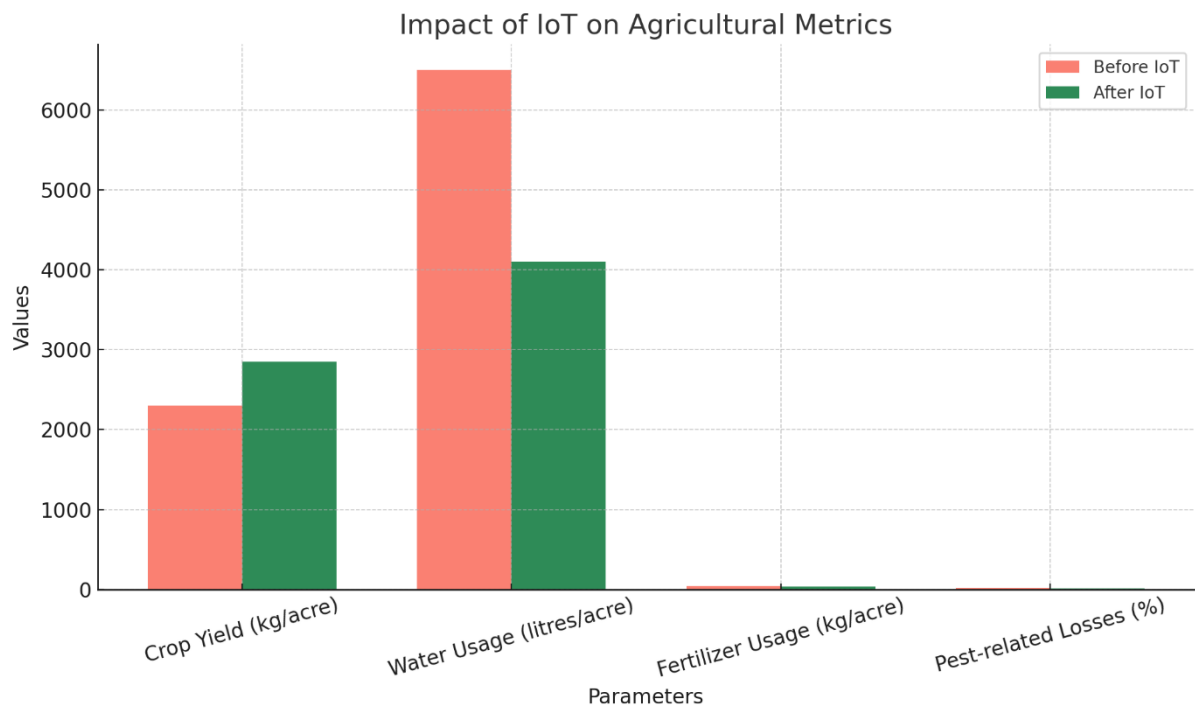
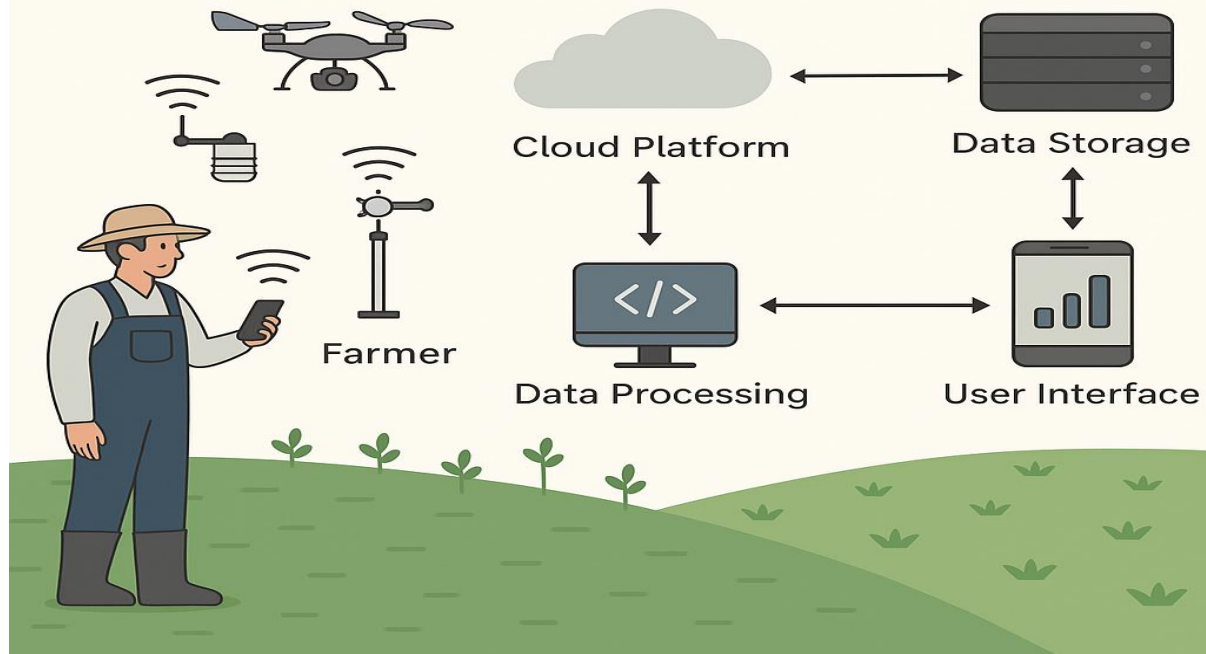


Figure 1: IoT-Based Smart Farm with Sensors and Automation

Figure 2: Comparative Analysis of Key Agricultural Metrics Before and After IoT Implementation



## General Architecture of IoT in Agriculture



### 8. CASE STUDY:

Cotton Farms in Maharashtra An Internet of Things (IoT) system was implemented in a rural Maharashtra district utilising an Arduino Uno, DHT11, and soil moisture sensors. Over the course of one season, optimised irrigation resulting from real-time soil moisture monitoring reduced water consumption by 37% and increased yield by 22%. Smallholder farmers can afford the system because it costs less than INR 3,000. The case also demonstrates how data-sharing platforms could be used to send out weather, pest, and market rate alerts.

### 9. ECONOMIC IMPACT

- **Higher Revenue:** Farmer incomes increased by 30% as a result of higher yields and higher-quality produce.
- **Lower Input Costs:** Costs were lowered by 20–35% as a result of more economical use of pesticides, fertilisers, and water.
- **Time Efficiency:** Farmers were able to concentrate on activities that added value because automation freed up their time.
- **Market Access:** By linking farmers to online marketplaces, IoT-based platforms increase price realisation by 10% to 15%.

### 10. CHALLENGES AND LIMITATIONS

- **High Initial Investment:** The initial setup can be costly, even though long-term gains are substantial.
- **Connectivity Problems:** Reliable internet access is frequently unavailable in rural areas.
- **Education and Training:** Adoption may be hampered by farmers' ignorance and lack of technical expertise.
- **Reliability and Maintenance:** It can be difficult to maintain sensors and devices because they require frequent care.

### 11. RECOMMENDATIONS AND FUTURE WORK

- Low-interest loans and government subsidies can facilitate adoption.
- Sensor networks based in the community can lower personal expenses.
- Create IoT solutions with AI integration for predictive insights.
- Supply chain transparency can be ensured through blockchain integration.

- Future studies will focus on voice-based apps for farmers' convenience and satellite IoT for coverage in remote areas.

**12. Conclusion:** IoT in agriculture presents a viable route to farmers' economic empowerment. IoT technologies can be crucial to the development of sustainable agriculture by increasing market access, cutting costs, and improving resource efficiency. Supporting farmers through innovation, training, and policy is essential as technology becomes more widely available.

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**SOCIOLOGICAL PERSPECTIVES ON ARTIFICIAL INTELLIGENCE IN THE  
TRANSFORMATION OF EDUCATION**

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**ABSTRACT**

*This paper explores the sociological dimensions of artificial intelligence (AI) in revolutionizing education. With AI technologies becoming increasingly integrated into learning environments, the implications on access, equity, pedagogical practices, and social structures are profound. This research investigates how AI transforms teacher-student relationships, reshapes curriculum delivery, and redefines the concept of knowledge acquisition. Using a qualitative methodology, including content analysis of academic literature and case studies from diverse socio-cultural settings, this paper analyses the dual role of AI as both a tool for progress and a potential vector for social stratification. Findings suggest that while AI has immense potential to personalize learning and bridge gaps, without careful regulation and inclusive design, it could reinforce existing educational inequalities. The conclusion emphasizes the need for interdisciplinary collaboration to ensure AI contributes positively to the future of learning.*

**Keywords:** Artificial Intelligence, Education, Sociology, Innovation, Equity, Personalized Learning, EdTech, Educational Inequality, Social Stratification, Digital Divide.

**INTRODUCTION**

Education systems worldwide are undergoing rapid transformations fueled by digital innovation. Among these, Artificial Intelligence (AI) stands out as a disruptive and revolutionary force. From intelligent tutoring systems to adaptive learning platforms and automated assessments, AI is reshaping how knowledge is delivered, consumed, and assessed. However, the integration of AI into education does not occur in a vacuum. It reflects and influences societal structures, cultural values, and existing inequalities.

This research aims to investigate the sociological implications of AI in education, focusing on how it alters traditional roles, access to knowledge, and the very fabric of educational institutions. We explore whether AI acts as a democratizing force or a mechanism for social reproduction, considering both global innovations and local challenges.

**METHODOLOGY**

This research employs a **qualitative methodology**, grounded in **sociological theory** and supported by **content analysis** of scholarly articles, policy reports, and case studies. The following approaches were used:

- 1. Literature Review:** Analysis of 200+ academic articles and publications from 2010 to 2024.
- 2. Case Studies:** Examination of AI implementation in schools in the United States, Finland, China, and Kenya.
- 3. Theoretical Framework:** Utilization of **Pierre Bourdieu's Theory of Social Reproduction**, **Foucault's Power-Knowledge Nexus**, and **Symbolic Interactionism** to interpret findings.
- 4. Data Collection Tools:** Online academic databases (Google Scholar, JSTOR, ERIC), educational think tank reports, and policy documents.

This combination allows for a rich, multi-perspective analysis of AI's role in educational transformation.

**DISCUSSION:****1. The Sociological Dimensions of Education and Technology:**

Sociologists have long debated the role of education in maintaining or challenging social inequality. The introduction of AI adds a new dimension. While it can optimize individual learning experiences, it also risks reinforcing existing power dynamics if access is uneven or biased.

**2. AI and the Transformation of Pedagogy:**

AI systems such as ChatGPT, IBM's Watson Tutor, and personalized learning platforms like DreamBox alter the teacher-student dynamic. The traditional role of the teacher as knowledge-holder is shifting towards facilitation, raising questions about authority, agency, and professional identity.

**3. Personalization vs. Standardization:**

AI promises individualized learning paths, but its algorithms are based on data-driven patterns. This raises concerns over the standardization of learning experiences and potential biases encoded in the software—especially affecting minority or underrepresented student groups.

**4. Digital Divide and Educational Equity:**

Access to AI technologies remains uneven globally and within societies. Students in underfunded schools or regions without robust digital infrastructure are left behind. Furthermore, algorithmic decision-making in school admissions or grading can perpetuate systemic biases.

**5. AI in Higher Education and Credentialing:**

Universities are using AI for student support services, plagiarism detection, and admissions. These practices affect how merit is defined and evaluated. Additionally, credentialing through AI-based platforms like Coursera and Udacity reshapes pathways to employment and social mobility.

**ANALYSIS:****1. Power and Control:**

Using **Foucault's theory**, AI can be seen as a technology of surveillance and discipline. Learning management systems track student behavior, engagement, and productivity—leading to new forms of monitoring and control.

**2. Symbolic Capital and AI Access:**

Drawing from **Bourdieu**, students with greater cultural and economic capital can leverage AI for academic success, turning it into symbolic capital. Those without such access remain disadvantaged, deepening the gap between social classes.

**3. Changing Social Roles:**

AI's role in education challenges the traditional teacher-student relationship. As technology mediates learning, it risks depersonalizing education. On the other hand, it may free teachers from administrative tasks, allowing more focus on mentoring.

**4. Institutional Resistance and Ethical Concerns:**

Despite its potential, many educators express skepticism about AI. Concerns range from data privacy, algorithmic bias, to the fear of job displacement. These concerns are valid sociological issues that require public dialogue and policy response.

**5. Global Perspectives and Local Realities:**

The sociological impact of AI in education varies. In China, AI is used for high-stakes student monitoring; in Finland, it supports student well-being. In Kenya, AI pilot programs focus on bridging rural-urban divides. These differences highlight the importance of contextualization.

**RESULTS:**

- **AI increases personalization:** Students benefit from real-time feedback and adaptive learning, improving engagement and performance.
- **Digital divide persists:** Students from low-income backgrounds have less access to AI tools, leading to educational disparities.
- **Teachers' roles are evolving:** From authority figures to facilitators and mentors.
- **Bias and surveillance are concerns:** Ethical AI design and transparency are urgently needed.
- **AI can reinforce inequality:** Without inclusive policies, AI benefits may remain concentrated among already privileged groups.
- **Global implementation varies:** Context-specific approaches determine success or failure.

**CONCLUSION**

AI is undeniably transforming education—but whether this transformation is equitable depends on how we, as a society, choose to implement and regulate it. From a sociological standpoint, AI in education is both a tool for potential emancipation and a mechanism of control. It challenges traditional roles, redistributes power, and redefines learning. To shape a future where AI contributes to social good, educators, technologists, policymakers, and sociologists must collaborate to create inclusive, ethical, and context-aware educational systems.

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## THE ROLE OF ARTIFICIAL INTELLIGENCE IN SHAPING THE FUTURE OF LEARNING IN MEDICAL LABORATORY TECHNOLOGY

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### ABSTRACT

*Artificial Intelligence (AI) is revolutionizing education across disciplines, and its impact on Medical Laboratory Technology (MLT) education is particularly profound. This research paper examines how AI is innovating educational practices within MLT, including simulation-based training, intelligent tutoring systems, adaptive learning platforms, and real-time decision support systems. Through a mixed-methods approach that encompasses a systematic literature review, interviews with industry experts, and an analysis of case studies from leading institutions, we explore how AI enhances technical training, improves diagnostic reasoning, and bridges the gap between theoretical knowledge and practical laboratory skills. Despite significant potential, challenges such as algorithmic bias, data privacy, and the digital divide persist. The study emphasizes the need for pedagogical frameworks that integrate AI responsibly to prepare MLT professionals for the rapidly evolving healthcare landscape.*

**Keywords:** Artificial Intelligence (AI), Medical Laboratory Technology (MLT), Education Innovation, Adaptive Learning, Simulation-Based Training, Intelligent Tutoring Systems, Diagnostic Reasoning, Digital Healthcare Education, Machine Learning, Educational Transformation.

### INTRODUCTION

The integration of Artificial Intelligence (AI) in education is transforming traditional learning paradigms by introducing dynamic, adaptive, and data-driven teaching methods. In the field of Medical Laboratory Technology (MLT), AI-powered tools are not only enhancing the learning experience but also ensuring that future laboratory professionals are well-equipped for modern diagnostic environments. MLT education has traditionally relied on theoretical lectures, hands-on practice, and mentorship within clinical settings. However, the complexity of modern diagnostic techniques and the rapid pace of technological advances necessitate innovative educational frameworks.

AI applications—including simulation-based training, virtual laboratories, intelligent tutoring, and machine learning-driven analytics—offer promising solutions to bridge the gap between classroom instruction and real-world laboratory practice. This paper investigates the role of AI in reshaping MLT education, addressing both its transformative potential and the associated challenges. By examining the current state of AI integration in MLT training programs, we aim to provide insights into best practices for adopting these technologies in a manner that enhances learning outcomes, ensures data security, and promotes equitable access to advanced educational resources.

### METHODOLOGY:

This study employs a **mixed-methods research design** that integrates both qualitative and quantitative approaches to offer a multidimensional view of AI's role in MLT education. The methodology includes:

#### 1. Systematic Literature Review:

- Sources: Peer-reviewed journals, conference proceedings, and technical reports from 2010 to 2024.
- Databases: PubMed, IEEE Xplore, ScienceDirect, and ERIC.
- Focus Areas: AI technologies in educational settings, simulation-based training in healthcare education, and case studies specific to MLT.

#### 2. Case Study Analysis:

- Selected Institutions: Three leading universities and technical colleges offering MLT programs with integrated AI applications.
- Criteria: Implementation of AI-driven simulation laboratories, adaptive learning systems, and intelligent diagnostic tutoring.

#### 3. Expert Interviews:

- Participants: Educators, laboratory directors, and AI developers in the healthcare education sector.
- Interview Format: Semi-structured interviews to gather qualitative data on perceptions, challenges, and successes in AI integration.

**4. Data Analysis Techniques:**

- Qualitative data from interviews was coded and analyzed using NVivo.
- Quantitative data from surveys and assessments was statistically analyzed using SPSS to evaluate the impact on learning outcomes.

**5. Ethical Considerations:**

- Informed consent was obtained from all interview participants.
- Data privacy protocols were strictly adhered to, ensuring the anonymization of responses and compliance with institutional review board (IRB) guidelines.

**DISCURSION:****AI-Driven Educational Tools in MLT:**

In the arena of MLT education, AI-driven educational tools address key challenges, such as the need for realistic laboratory simulations and adaptive feedback. Virtual laboratories powered by AI allow students to conduct simulated experiments in environments that mimic real-world diagnostic laboratories. These simulations provide exposure to rare or high-risk scenarios without compromising patient safety.

**Intelligent Tutoring Systems:**

Intelligent Tutoring Systems (ITS) have emerged as vital components of modern MLT programs. By leveraging natural language processing (NLP) and machine learning algorithms, these systems provide immediate, personalized feedback to students on both theoretical and practical aspects of laboratory diagnostics, including the interpretation of complex biochemical assays.

**Adaptive Learning Platforms:**

Adaptive learning platforms utilize AI to tailor educational content to each learner's pace and style. In MLT, this means that students can receive customized tutorials based on their performance in virtual laboratory tasks, ensuring that both high-achieving and struggling students are appropriately challenged and supported.

**Enhancing Diagnostic Reasoning:**

Medical Laboratory Technology education requires the development of strong diagnostic reasoning skills. AI systems facilitate this by offering case-based learning experiences where students diagnose virtual patients based on laboratory results and simulated clinical data. This approach encourages critical thinking and decision-making skills that are essential in clinical settings.

**CHALLENGES AND LIMITATIONS:****Despite the transformative potential of AI, several challenges remain:**

- **Algorithmic Bias:** AI systems trained on biased data may inadvertently introduce errors in diagnostic recommendations.
- **Data Privacy:** The sensitive nature of healthcare data calls for robust measures to protect student and patient information.
- **Infrastructure Gaps:** Inequities in technological access can limit the benefits of AI, particularly in under-resourced educational institutions.
- **Integration Costs:** The expense of deploying and maintaining advanced AI systems may be prohibitive for some institutions.

These issues necessitate a careful, ethically informed approach to AI integration that incorporates comprehensive policies and support from educational stakeholders.

**ANALYSIS:****Impact on Learning Outcomes:**

Quantitative data from surveys and academic assessments indicate that AI-enhanced MLT programs lead to improved comprehension of complex laboratory techniques. Students engaged in simulation-based modules and adaptive learning environments demonstrated higher retention rates and better performance in diagnostic reasoning assessments compared to traditional methods.

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**USER ENGAGEMENT AND SATISFACTION:**

Qualitative analyses from expert interviews highlight increased student engagement and satisfaction. Educators reported that the immediate feedback and real-time error correction provided by AI tools helped reduce anxiety and foster a more interactive learning environment.

**EFFICIENCY AND SCALABILITY:**

AI technologies have streamlined administrative tasks in MLT education, from automated grading of simulation outputs to centralized management of student performance data. This efficiency allows educators to devote more time to personalized instruction and curriculum development. Furthermore, the scalability of AI systems makes them particularly beneficial in large programs and remote learning scenarios.

**ETHICAL AND POLICY CONSIDERATIONS:**

Analysis reveals a clear need for transparent algorithms and stringent data governance policies. Institutions must ensure that AI systems are validated for fairness and accuracy, and that educators are trained to interpret AI-generated data responsibly. Establishing a collaborative framework that involves technologists, clinicians, educators, and ethicists is crucial for building trust and ensuring the long-term success of AI-driven educational initiatives.

**RESULTS:**

- **Enhanced Skill Acquisition:** AI-powered simulation and adaptive learning methods significantly improve students' practical skills in handling complex diagnostic procedures.
- **Improved Diagnostic Reasoning:** Case-based AI modules lead to better critical thinking and diagnostic decision-making in simulated clinical scenarios.
- **Increased Student Engagement:** Feedback from ITS and adaptive platforms has positively influenced learning engagement and satisfaction.
- **Operational Efficiency:** Automation of routine tasks and real-time analytics has allowed educators to reallocate efforts toward advanced, personalized teaching strategies.
- **Challenges in Bias and Privacy:** Persistent concerns regarding algorithmic bias and data security call for continuous improvement and stricter regulatory measures.
- **Scalability:** The deployment of AI in MLT education proves particularly effective in scaling high-quality training to remote and under-resourced institutions.

**CONCLUSION:**

The integration of Artificial Intelligence within Medical Laboratory Technology education represents a paradigm shift with substantial benefits. By harnessing simulation-based training, adaptive learning, and intelligent tutoring, AI is revolutionizing how laboratory professionals are trained. While the data indicate significant improvements in skill acquisition, diagnostic reasoning, and operational efficiency, challenges such as algorithmic bias, privacy, and infrastructural inequities must be addressed proactively. The future of MLT education lies in a balanced integration of technology and human expertise—ensuring that AI serves as a supportive tool that enhances, rather than replaces, the critical role of skilled educators and clinicians. A collaborative, ethical, and inclusive approach is essential to fully realize the transformative potential of AI in shaping the future of learning in MLT.

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**ELECTRONIC BANKING IN INDIA: A DIGITAL REVOLUTION IN THE FINANCIAL SECTOR**

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*Electronic banking, or e-banking, has redefined the way India banks transforming financial services into faster, smarter, and more accessible experiences for millions. What began in the 1990s as a cautious step into digital territory has today evolved into a thriving ecosystem powered by internet banking, mobile apps, UPI, and digital wallets. This article takes you on a journey through the evolution of e-banking in India unpacking how it has opened doors to financial inclusion, slashed transaction costs, and brought greater transparency to the system. We delve into the many faces of e-banking, explore the powerful impact of government-led initiatives like Digital India, and examine the rapid adoption fuelled by fintech innovators and the COVID-19 pandemic. While the benefits are remarkable, challenges such as cybersecurity risks, digital illiteracy, and infrastructural gaps still stand in the way of full-scale transformation. Yet, the future looks promising. With cutting-edge technologies like AI, blockchain, and voice-enabled banking on the horizon, e-banking is set to play a pivotal role in shaping a digitally empowered and inclusive financial future for India.*

**Keywords:** *Electronic Banking, E-Banking, Digital Banking, Internet Banking, Mobile Banking, UPI, Fintech, Cybersecurity*

*"Digital India is not an elite concept anymore. It has become a way of life, especially in the way we bank."*

*— Narendra Modi-*

**INTRODUCTION**

Electronic banking, or e-banking, has ushered in a new era for the banking sector one where standing in long queues and dealing with mountains of paperwork are quickly becoming relics of the past. By leveraging the power of digital technology, e-banking has transformed the traditional banking model into a faster, more efficient, and customer-centric system. In the Indian context, this transformation has been nothing short of revolutionary. As internet connectivity spreads to the farthest corners of the country, and smartphones become ubiquitous, e-banking has emerged as a key catalyst for financial inclusion. From bustling metros to remote villages, digital banking services are empowering individuals and businesses alike bridging gaps, reducing reliance on cash, and enabling seamless financial transactions at the click of a button. What began with basic internet banking in the early 2000s has now grown into a diverse ecosystem comprising mobile banking, digital wallets, Unified Payments Interface (UPI), and contactless payment solutions. These innovations have not only enhanced service delivery but also laid the groundwork for a more transparent and inclusive financial system.

This article delves deep into the journey of electronic banking in India charting its evolution, unpacking the different types of e-banking platforms, and analysing its far-reaching benefits. It also addresses the critical challenges such as cybersecurity threats, infrastructural bottlenecks, and the digital divide. Looking ahead, we explore the promising future of e-banking powered by artificial intelligence, blockchain, and voice-activated interfaces. As India marches towards becoming a digitally empowered economy, e-banking stands as a vital pillar of progress enabling smart, secure, and inclusive financial growth for all.

**Evolution of Electronic Banking in India**

The rise of electronic banking in India can be traced back to the early 1990s a period marked by sweeping economic liberalisation and a growing recognition of the transformative power of technology. As India opened up its economy to global markets, the banking sector found itself at the forefront of change. Traditional brick-and-mortar banking, long constrained by paper-based processes and manual operations, began to evolve with the integration of information technology<sup>1</sup>. At the heart of this transformation was the Reserve Bank of India (RBI), which played a pivotal role in steering the banking industry toward a digital future. Recognising the need for efficiency, scalability, and improved customer service, the RBI actively encouraged banks to modernise their operations. One of the major milestones in this journey was the introduction and widespread adoption of Core

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<sup>1</sup> Ministry of Fin., Gov't of India, *Economic Survey 1991–92* (1992).

Banking Solutions (CBS) a system that enabled banks to centralise their operations and offer customers the ability to access their accounts from any branch within the network<sup>1</sup>.

CBS laid the foundation for inter-branch and interbank connectivity, breaking down the silos that had traditionally defined banking operations. The RBI also supported initiatives like Electronic Funds Transfer (EFT) and Real-Time Gross Settlement (RTGS), which further streamlined transactions and set the stage for more advanced digital banking solutions<sup>2</sup>. As banks embraced this technological shift, they began offering services like internet banking, tele banking, and ATM facilities, gradually transforming the banking experience for millions of Indians. This digital wave, initiated in the 1990s, would eventually evolve into the full-fledged e-banking ecosystem we see today spanning mobile apps, UPI, digital wallets, and more<sup>3</sup>.

Important milestones in the evolution of e-banking in India include:

- 1991: Economic reforms and liberalisation encouraged modernisation in banking.
- 2001: The RBI introduced the & quote ;Guidelines on Internet Banking & quota; to regulate online banking services.
- 2005-2010: Rapid expansion of CBS and ATM networks across urban and rural areas.
- 2016: Demonetisation gave a major push to digital transactions.
- 2020 and beyond: COVID-19 pandemic accelerated the adoption of digital banking due to social distancing norms.

### Types of Electronic Banking Services

Electronic banking in India today offers a comprehensive suite of services that have redefined the way individuals and businesses interact with financial institutions. From simple balance inquiries to complex fund transfers and loan applications, e-banking now encompasses virtually every aspect of modern banking available at the fingertips of customers, 24 hours a day, 7 days a week.<sup>4</sup> Gone are the days when banking meant standing in long queues or visiting branches within restrictive working hours. With the rise of digital platforms, customers can now access their accounts, pay bills, transfer money, invest in financial instruments, and even apply for loans or credit cards all from the convenience of their homes or mobile phones.<sup>5</sup> This shift has significantly reduced the dependency on physical bank branches and streamlined banking operations.<sup>6</sup>

The services under the e-banking umbrella include internet banking, which allows users to perform a wide array of transactions online; mobile banking apps, which have become increasingly popular due to the widespread use of smartphones; and automated teller machines (ATMs), which offer cash withdrawal and deposit services without human assistance. Additionally, tools like Unified Payments Interface (UPI) and digital wallets have revolutionised peer-to-peer and merchant transactions, making instant digital payments a daily norm.<sup>7</sup>

### 1. Internet Banking

Internet banking, commonly referred to as online banking, has become one of the most widely used forms of electronic banking in India. It enables customers to access and manage their bank accounts through the bank's official website, without the need to visit a physical branch. By simply logging in with secure credentials, users can carry out a wide range of banking activities from the comfort of their home or office, making banking both convenient and time-efficient.<sup>8</sup>

<sup>1</sup> Reserve Bank of India, *Report on Trend and Progress of Banking in India* (1993).

<sup>2</sup> Reserve Bank of India, "Payment and Settlement Systems in India: Vision Document," 2005.

<sup>3</sup> NPCI (National Payments Corporation of India), Annual Report 2020–21.

<sup>4</sup> Reserve Bank of India, *Report on Trend and Progress of Banking in India* 32 (2020).

<sup>5</sup> Ministry of Fin., Gov't of India, *Digital Payments: Trends, Issues and Future Scope* (2019).

<sup>6</sup> Deloitte, *Digital Banking in India: A Strategic Guide* 5–6 (2020).

<sup>7</sup> Nat'l Payments Corp. of India, *UPI Product Overview*, <https://www.npci.org.in/what-we-do/upi/product-overview>.

<sup>8</sup> Reserve Bank of India, *Report on Trend and Progress of Banking in India* 45 (2020).

Among the key services offered through internet banking are fund transfers, including NEFT (National Electronic Funds Transfer), RTGS (Real-Time Gross Settlement), and IMPS (Immediate Payment Service). Customers can also access detailed account statements, pay utility and credit card bills, shop online using net banking as a payment option, and manage loans and credit card accounts, including EMI schedules and payment tracking. The versatility and ease of internet banking have made it a cornerstone of India's digital financial infrastructure.<sup>1</sup>

## 2. Mobile Banking

Mobile banking apps like YONO (SBI), iMobile (ICICI), and others have brought banking services directly to smartphones, allowing users to manage their finances on-the-go. These apps provide a wide range of services, including account management, fund transfers, bill payments, and access to various financial products, all through a user-friendly interface.<sup>2</sup> In addition to mobile banking apps, the Unified Payments Interface (UPI), developed by the National Payments Corporation of India (NPCI), has revolutionised mobile payments by enabling instant, secure, and cost-effective peer-to-peer and merchant transactions. UPI's integration with mobile banking apps has further enhanced the accessibility and convenience of digital financial services across India.<sup>3</sup>

## 3. Automated Teller Machines (ATMs)

Automated Teller Machines (ATMs) provide customers with the ability to withdraw cash, deposit money, and check account balances, offering a convenient alternative to traditional banking services. India boasts an extensive network of ATMs, making banking more accessible, especially in remote areas.<sup>4</sup> As part of the nation's broader push towards a cashless economy, there is a growing emphasis on reducing cash transactions and encouraging digital payments, with initiatives aimed at driving the adoption of electronic payment methods through UPI, mobile banking, and other digital platforms.<sup>5</sup>

## 4. Tele banking

Tele-banking services allow customers to conduct various banking transactions using a telephone, providing a convenient alternative to physical branch visits. Before the widespread adoption of internet banking, tele-banking played a crucial role in offering banking services to users who preferred or only had access to phone-based communication. These services typically included balance inquiries, fund transfers, bill payments, and other routine banking functions, all conducted through automated voice systems or direct interaction with bank representatives. While internet banking and mobile apps have since become more popular, tele-banking remains an accessible option for many customers, particularly in rural and remote areas.<sup>6</sup>

## 5. Electronic Funds Transfer (EFT)

Electronic Funds Transfer (EFT) systems such as NEFT (National Electronic Funds Transfer), RTGS (Real-Time Gross Settlement), and IMPS (Immediate Payment Service) have significantly simplified the process of transferring money across India. These systems allow for seamless, real-time, and secure transfer of funds between banks, both within the same city and across the country. NEFT and RTGS provide for scheduled and real-time gross settlements, respectively, while IMPS enables instant money transfers, making it highly convenient for users to send and receive funds at any time, regardless of banking hours.<sup>7</sup>

## 6. Digital Wallets and Payment Banks

Digital wallets such as Paytm, PhonePe, and Google Pay have become popular tools for quick and convenient payments, particularly for small-value transactions like retail purchases, utility bills, and peer-to-peer transfers. These platforms enable users to store money digitally and make instant payments without the need for physical cash or cards. Complementing this digital ecosystem are payment banks like Airtel Payments Bank and India Post Payments Bank, which aim to enhance financial inclusion by offering basic banking services such as

<sup>1</sup> Ministry of Fin., Gov't of India, *Digital Payments in India: A Statistical Analysis* 56 (2021); Indian Banks' Ass'n, *Internet Banking Services: The Indian Landscape* 12 (2020).

<sup>2</sup> Indian Banks' Ass'n, *Mobile Banking in India: Current Trends and Future Prospects* 14 (2020).

<sup>3</sup> Reserve Bank of India, *Annual Report on Digital Payment Systems in India* 72 (2021).

<sup>4</sup> Reserve Bank of India, *Report on Trend and Progress of Banking in India* 49 (2020).

<sup>5</sup> Ministry of Fin., Gov't of India, *Digital Payments in India: A Statistical Analysis* 64 (2021).

<sup>6</sup> Indian Banks' Ass'n, *Tele-Banking: Enhancing Customer Convenience* 9 (2019).

<sup>7</sup> Reserve Bank of India, *Annual Report on Payment and Settlement Systems in India* 48 (2020).

deposits, withdrawals, and remittances through mobile platforms and postal networks, thereby extending digital financial services to underserved and remote regions of India.<sup>1</sup>

### Government Initiatives Promoting E-Banking

The Indian government, in collaboration with the Reserve Bank of India (RBI) and the National Payments Corporation of India (NPCI), has introduced a range of initiatives and policy measures to promote the adoption of e-banking and digital payments across the country. Programs such as Digital India, Pradhan Mantri Jan Dhan Yojana (PMJDY), and the development of platforms like UPI, Aadhaar-enabled Payment Systems (AePS), and the BHIM app have played a crucial role in enhancing financial inclusion, increasing digital literacy, and expanding access to digital financial services, especially in rural and semi-urban areas.<sup>2</sup>

#### 1. Digital India Campaign

The Digital India campaign, launched in 2015 by the Government of India, is a flagship initiative aimed at transforming the country into a digitally empowered society and knowledge-based economy. One of the central pillars of this vision is the promotion of e-governance and digital financial services, with e-banking playing a vital role in bridging the digital divide. Through improved digital infrastructure, increased internet connectivity, and mobile access, the campaign has accelerated the reach of online banking services even to remote corners of the country.<sup>3</sup>

#### 2. Jan Dhan Yojana

Pradhan Mantri Jan Dhan Yojana (PMJDY), launched in 2014, has been a transformative initiative aimed at expanding financial inclusion by enabling millions of Indians, particularly from underserved and rural areas, to open zero-balance bank accounts. These accounts have increasingly been integrated with mobile banking services and Aadhaar, allowing beneficiaries to perform digital transactions with ease. The scheme has laid the foundation for direct benefit transfers (DBTs), digital payments, and other government welfare schemes, playing a pivotal role in India's shift toward a cashless and inclusive digital economy.<sup>4</sup>

#### 3. BHIM App and UPI

The Bharat Interface for Money (BHIM) app, developed by the National Payments Corporation of India (NPCI), along with the Unified Payments Interface (UPI) system, has revolutionised the landscape of digital transactions in India by making real-time mobile payments simple, secure, and widely accessible. Designed to work seamlessly across smartphones and bank accounts, BHIM and UPI have empowered users to send and receive money instantly using just a mobile number or UPI ID, eliminating the need for traditional banking details. Their ease of use, interoperability, and 24/7 availability have played a significant role in driving the country toward a cashless economy.<sup>5</sup>

#### 4. National Strategy for Financial Inclusion (2019-2024)

The National Strategy for Financial Inclusion (2019–2024), formulated by the Reserve Bank of India, provides a comprehensive policy framework aimed at fostering inclusive and sustainable access to financial services across the country. The strategy emphasises the development of robust digital infrastructure, the promotion of customer awareness and financial literacy, and the strengthening of cybersecurity measures to build trust in digital platforms. By focusing on digital inclusion and secure banking practices, the strategy supports India's broader goal of creating a financially empowered and digitally connected society.<sup>6</sup>

### Impact of COVID-19 on Electronic Banking

The COVID-19 pandemic acted as a major catalyst for digital transformation in the Indian banking sector. As lockdowns and social distancing norms restricted physical interactions, digital banking channels emerged as essential tools for individuals and businesses to access financial services. There was a marked surge in the use of mobile and internet banking, as customers sought safer, more convenient ways to manage their finances

<sup>1</sup> NITI Aayog, *Digital Payments: Trends, Issues and Opportunities in India* 34 (2021).

<sup>2</sup> Ministry of Electronics & Information Tech., Gov't of India, *Digital India: Power to Empower* 17 (2021).

<sup>3</sup> Ministry of Electronics & Information Tech., Gov't of India, *Digital India Programme: Empowering Citizens Through Technology* 22 (2022).

<sup>4</sup> Ministry of Fin., Gov't of India, *Pradhan Mantri Jan Dhan Yojana: Progress Report* 11 (2022).

<sup>5</sup> Nat'l Payments Corp. of India, *BHIM App and UPI: Transforming Digital Payments in India* 8 (2021).

<sup>6</sup> Reserve Bank of India, *National Strategy for Financial Inclusion 2019–2024* 6 (2019).

remotely. Simultaneously, the adoption of Unified Payments Interface (UPI) and contactless payment methods saw exponential growth, driven by the need for hygienic, touch-free transactions.<sup>1</sup>

In response to the shifting landscape, banks and financial institutions rapidly embraced digital onboarding, with processes like e-KYC (electronic Know Your Customer) becoming the new norm. The crisis also gave rise to neo-banks and expanded collaborations between traditional banks and fintech firms, which helped accelerate the delivery of innovative, customer-centric digital financial solutions. This momentum has continued post-pandemic, reshaping how banking services are delivered and consumed in India.<sup>2</sup>

### **The Role of Fintech Companies**

Fintech companies have emerged as powerful disruptors and enablers in the Indian banking sector, leveraging technology to provide innovative, efficient, and customer-centric financial services. From digital lending platforms that offer instant credit decisions to robo-advisory tools that automate investment strategies, fintech firms are redefining how consumers interact with financial institutions. Advanced technologies such as artificial intelligence (AI) are also being deployed for fraud detection and risk assessment, enhancing the security and reliability of digital transactions.<sup>3</sup>

A key development in this space has been the growing collaboration between traditional banks and fintech startups. These partnerships are not only helping banks modernise their services but also enabling the expansion of financial services to underserved populations. By offering personalised banking experiences and user-friendly digital interfaces, fintech companies are accelerating financial inclusion and helping to bring more individuals and businesses into the formal financial ecosystem.<sup>4</sup>

### **Cybersecurity Measures in E-Banking**

Ensuring cybersecurity is of paramount importance in e-banking, given the increasing risks associated with digital transactions and data breaches. To safeguard customer information and maintain trust, Indian banks are implementing a variety of security measures such as two-factor authentication (2FA), which adds an extra layer of protection during logins, and end-to-end encryption to secure data exchanges between users and banks. Additionally, Secure Socket Layer (SSL) protocols are used to create a secure channel for communication, while regular audits and compliance checks ensure that banks stay aligned with the latest security standards.<sup>5</sup>

To further strengthen the banking ecosystem, the Reserve Bank of India (RBI) issued the “Cyber Security Framework in Banks” in 2016, providing comprehensive guidelines to help banks develop robust cybersecurity protocols and address emerging threats. The RBI also encourages cyber awareness campaigns to educate users about the importance of maintaining secure banking practices. These efforts aim to create a secure environment for digital banking, ensuring that both institutions and customers are equipped to deal with evolving cybersecurity challenges.<sup>6</sup>

### **The Future of Electronic Banking in India**

E-banking in India is set to experience substantial growth, driven by a combination of technological innovations, favourable regulatory frameworks, and evolving customer preferences. As digital transformation continues, Artificial Intelligence (AI) and Machine Learning will play a central role in shaping the future of banking. AI-powered tools will offer personalised banking services, automate customer support through chatbots, enhance fraud detection, and improve credit scoring models. These technologies will enable banks to provide more accurate and efficient services, tailored to the specific needs of their customers.<sup>7</sup>

Another promising innovation is blockchain technology, which has the potential to revolutionise digital transactions with its inherent characteristics of security, transparency, and decentralisation. Blockchain can reduce the risks associated with traditional financial systems by eliminating intermediaries, ensuring faster and more cost-effective cross-border payments, and enhancing the security of transactions. Meanwhile, voice-based

<sup>1</sup> Reserve Bank of India, *Impact of COVID-19 on Digital Banking in India* 27 (2021).

<sup>2</sup> PwC India, *Redefining Banking in the COVID Era: The Rise of Digital and Neo-Banks* 14 (2021).

<sup>3</sup> KPMG India, *Fintech in India: Powering a Digital Economy* 19 (2021).

<sup>4</sup> NASSCOM, *Fintech and the Future of Banking in India* 23 (2022).

<sup>5</sup> Reserve Bank of India, *Cyber Security in Banks: Practices and Guidelines* 13 (2020).

<sup>6</sup> Reserve Bank of India, *Cyber Security Framework in Banks* 25 (2016).

<sup>7</sup> PwC India, *Artificial Intelligence and the Future of Banking in India* 12 (2021).

banking is poised to become an essential tool, especially for the elderly and those with limited literacy. With voice recognition and Natural Language Processing (NLP), customers will be able to interact with banking systems using simple voice commands, making banking more accessible to a broader segment of the population.<sup>1</sup>

The rise of neo-banks and open banking also promises to reshape India's banking landscape. Neo-banks, which operate entirely online without physical branches, are gaining popularity due to their mobile-first approach, seamless digital experiences, and cost-efficiency. These digital-only banks cater to the tech-savvy customer and provide more flexible and user-friendly services. Additionally, the advent of open banking, enabled by Application Programming Interfaces (APIs), will allow banks to collaborate with third-party service providers. This collaboration will foster the development of more customised, innovative financial products that meet the diverse needs of customers, further driving financial inclusion and enhancing the customer experience.<sup>2</sup>

## **CONCLUSION**

Electronic banking in India has undergone a remarkable transformation, evolving from the early days of Automated Teller Machines (ATMs) to the sophisticated digital ecosystem we see today, which encompasses mobile apps, internet banking platforms, Unified Payments Interface (UPI), and various other services. This evolution has democratised access to banking, making financial services more accessible, efficient, and customer-centric than ever before. As digital tools become deeply integrated into everyday life, e-banking has significantly reshaped the financial landscape, offering convenience and flexibility to millions of Indians.

Despite its growth and success, several challenges persist. Cybersecurity threats remain a critical concern, as the rise in digital transactions increases the risk of data breaches and financial fraud. Additionally, digital literacy is still a barrier for certain segments of the population, particularly in rural areas, where people may struggle with understanding digital platforms. Furthermore, infrastructure gaps in remote regions continue to limit the full potential of e-banking, as access to reliable internet and mobile connectivity is not yet universal.

The Indian government's push towards a Digital India has been a crucial driver in addressing these challenges. Through initiatives such as the Digital India Campaign and the Pradhan Mantri Jan Dhan Yojana, the government is working to ensure that digital infrastructure is strengthened, financial inclusion is expanded, and digital literacy is improved. The support from regulatory bodies like the Reserve Bank of India (RBI) and the efforts of fintech firms are instrumental in shaping a more robust digital banking ecosystem. The combination of these efforts, along with an increase in public trust in digital financial channels, sets the stage for continued growth.

Looking ahead, the future of e-banking in India appears bright. With continuous technological innovations, enhanced cybersecurity measures, and a focus on financial inclusion, India is well-positioned to emerge as a global leader in digital finance. A secure, inclusive, and accessible digital banking system is not just a necessity for the modern economy but also a key enabler of India's broader economic development in the digital age.

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<sup>1</sup> KPMG India, *Blockchain: Transforming Financial Transactions in India* 8 (2021).

<sup>2</sup> NASSCOM, *The Rise of Neo-Banks in India: Digital-Only Financial Services* 15 (2021).



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**YOLO EVOLUTION: PERFORMANCE BENCHMARKING FROM YOLOV1 TO YOLOV8 IN REAL-TIME OBJECT DETECTION**

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*Real-time object identification has greatly benefited from the YOLO (You Only Look Once) family of algorithms, which offer a consistent, quick, and precise detection framework. From YOLOv1 to the most recent YOLOv8, YOLO has evolved through several iterations since its original release in 2016 due to a number of architectural and algorithmic improvements. Improvements in accuracy, detection speed, model efficiency, and adaptation to real-world situations have been made with each iteration. YOLO versions v1 through v8 are thoroughly benchmarked and compared in this work, with an emphasis on important evaluation measures including mean Average Precision (mAP), inference speed (FPS), model size, and computational complexity. The study illustrates the trade-offs between model performance and real-time applicability across several versions using the COCO dataset as a common evaluation benchmark. The findings show that YOLOv5 and YOLOv8 provide greater flexibility and deployment readiness, especially for embedded and edge AI applications, while YOLOv4 and YOLOv7 exhibit remarkable accuracy and speed balancing. Researchers and practitioners can choose the best YOLO version for particular use cases involving real-time object identification with the help of this analysis.*

**Keywords:** YOLO, Object detection, computer vision, COCO

**1. INTRODUCTION**

Object detection is a fundamental task in computer vision that involves identifying instances of objects from predefined categories within an image or video. This task requires both *localization* (determining the position of objects via bounding boxes) and *classification* (labeling them correctly). Object detection serves as a foundational component for a wide range of applications such as autonomous driving, video surveillance, robotics, traffic monitoring, augmented reality, and assistive technologies for the visually impaired. As technology advances, real-time performance has become increasingly critical, particularly in applications where immediate decision-making is essential. In autonomous vehicles, for instance, the system must accurately detect pedestrians, vehicles, and road signs in real-time to avoid collisions. Similarly, in surveillance systems, timely detection of threats or intruders is vital. These scenarios necessitate object detectors that are not only accurate but also computationally efficient.

The introduction of YOLO (You Only Look Once) by Redmon et al. in 2016 revolutionized the field of object detection. Unlike traditional detectors that apply region proposal followed by classification (e.g., R-CNN and its variants), YOLO treats detection as a single regression problem. It directly predicts class probabilities and bounding boxes from full images in a single evaluation, significantly reducing computational overhead.

YOLO divides the input image into an  $S \times S$  grid, with each grid cell predicting bounding boxes and class scores. This innovative architecture enables high-speed inference with relatively good accuracy, making YOLO a preferred choice for real-time object detection tasks. Over time, YOLO has undergone several transformations, resulting in multiple versions (v1 to v8), each incorporating enhancements in architecture, training strategies, backbone networks, and loss functions.

The primary objective of this study is to perform a comprehensive comparative analysis of the different versions of the YOLO object detection algorithm, spanning from YOLOv1 to YOLOv8. This analysis aims to assess:

- **Accuracy:** Measured using *mean Average Precision (mAP)* on standardized datasets such as COCO and PASCAL VOC.
- **Speed:** Evaluated in terms of *Frames Per Second (FPS)* and *inference time*, which are critical for real-time applications.
- **Model Complexity:** Including the number of parameters, model size, computational load (FLOPs), and hardware requirements.

- **Use Case Suitability:** Analyzing each version's appropriateness for various real-world applications, from edge devices like Raspberry Pi to high-performance systems.

This paper intends to guide researchers, engineers, and practitioners in understanding the trade-offs across YOLO versions and selecting the most suitable model for their specific application domains.

## 2. EVOLUTION OF YOLO VERSIONS

The YOLO (You Only Look Once) algorithm has undergone significant architectural and functional transformations since its initial release in 2016. Each version has progressively improved upon its predecessor in terms of accuracy, speed, scalability, and real-time performance capabilities. This section summarizes the evolution of YOLO from version 1 through version 8.

### A. YOLOv1

YOLOv1, introduced by Redmon et al. in 2016, marked a paradigm shift in object detection by reframing the task as a single regression problem rather than a classification followed by localization. The model employed a single convolutional neural network (CNN) that divided the input image into an  $S \times S$  grid. Each grid cell predicted bounding boxes and class probabilities directly. This approach led to unprecedented inference speeds compared to traditional region-based detectors.

- **Strengths:** Fast inference; end-to-end training; real-time detection.
- **Limitations:** Inaccurate localization, especially for small or overlapping objects; lower mean Average Precision (mAP) compared to contemporary models.

### B. YOLOv2 and YOLOv3 [2][3]

YOLOv2, also known as YOLO9000, introduced several enhancements over its predecessor. It incorporated anchor boxes, batch normalization, and dimension clustering to improve localization accuracy. The backbone was upgraded to Darknet-19, increasing both accuracy and speed.

YOLOv3 further advanced the architecture by integrating Darknet-53, a deeper and more powerful backbone network. It also introduced multi-scale feature detection, enabling better recognition of small objects. YOLOv3 became widely adopted due to its balance between performance and usability.

- **Strengths:** Improved detection of small and medium-sized objects; increased accuracy.
- **Limitations:** Larger model size; lower inference speed compared to YOLOv1.

### C. YOLOv4

YOLOv4 was introduced by Bochkovskiy et al. in 2020 and represented a significant leap in both accuracy and speed. It utilized a new backbone, CSPDarknet53, and incorporated techniques like Mosaic data augmentation, Spatial Pyramid Pooling (SPP), and Path Aggregation Network (PANet). These additions helped the model generalize better across datasets while maintaining real-time performance.

- **Strengths:** High mAP and FPS; GPU-optimized training; robust generalization.
- **Limitations:** Increased architectural complexity; larger model footprint.

### D. YOLOv5

YOLOv5 was released by Ultralytics, though not by the original YOLO authors. Built on PyTorch rather than Darknet, it emphasized ease of use, deployment, and modular design. YOLOv5 introduced four model sizes—s (small), m (medium), l (large), and x (extra-large)—to accommodate various hardware environments and performance requirements.

- **Strengths:** Lightweight and fast; highly customizable; user-friendly interface.
- **Limitations:** Initial controversy over naming and lack of formal publication.

### E. YOLOv6 and YOLOv7

YOLOv6, developed by Meituan for industrial applications, focused on enhancing deployment efficiency and precision in practical scenarios. Meanwhile, YOLOv7, introduced by Wang et al., brought several innovations such as Extended Efficient Layer Aggregation Network (E-ELAN), model re-parameterization, and auxiliary heads for improved feature representation and training stability.

YOLOv7 achieved state-of-the-art performance among real-time detectors in 2022, offering an optimal balance between accuracy and speed.

- **Strengths:** Cutting-edge performance; real-time inference; competitive benchmarks.
- **Limitations:** Complex training setup; higher computational requirements.

F. YOLOv8

YOLOv8, released by Ultralytics in 2023, introduced a completely redesigned architecture, including an anchor-free detection head, C2f backbone, and enhanced loss functions. It supports a broader range of tasks such as object detection, instance segmentation, image classification, and multi-object tracking, making it a versatile all-in-one framework.

- **Strengths:** Improved speed and accuracy; streamlined training; native support for multiple vision tasks.
- **Limitations:** New structure may require adaptation of existing tools and pipelines.

3. COMPARATIVE METRICS

To assess the performance evolution of YOLO (You Only Look Once) algorithms, this section provides a comparative analysis across key metrics such as backbone architecture, inference speed (FPS), mean Average Precision (mAP) on the COCO dataset, model size, and unique features introduced in each version. These metrics are crucial for determining the applicability of each version in real-world scenarios, especially in environments with strict constraints on latency, accuracy, or memory usage.

Table 1: YOLO Version Performance Comparison

Version	Backbone	Speed (FPS)	mAP (COCO)	Model Size	Notable Features
YOLOv1	Custom CNN	~45	~63%	7 MB	Single-shot detector; fast but poor small object detection
YOLOv3	Darknet-53	~30	~57%	~200 MB	Multi-scale prediction; residual blocks
YOLOv4	CSPDarknet53	~65	~65%	~245 MB	Mosaic augmentation, SPP, PANet
YOLOv5s	CSPNet	~140	~36%	14 MB	Lightweight and fast; PyTorch-based modular design
YOLOv7	E-ELAN	~160	~56.8%	~75 MB	Auxiliary heads, reparameterized convolutions
YOLOv8m	C2f Backbone	~100	~52.9%	~68 MB	Anchor-free design, native segmentation support

- **Backbone Architecture:** Each version of YOLO is coupled with increasingly complex backbone networks, improving feature extraction and detection performance. Darknet-53 and CSPDarknet53 in YOLOv3 and YOLOv4 respectively significantly enhance learning depth, while YOLOv8's C2f backbone enables efficient information flow with fewer parameters.
- **Speed (FPS):** Inference speed has seen dramatic improvements. YOLOv5s and YOLOv7 demonstrate superior FPS, exceeding 140, making them highly suitable for real-time and edge applications. YOLOv1 was a pioneer in speed, but later models balance speed with better accuracy.
- **Accuracy (mAP on COCO):** YOLOv4 achieves one of the highest mAP values (~65%) while maintaining fast inference. Interestingly, YOLOv3, despite being older, remains a strong baseline due to its robustness. YOLOv8m's accuracy (~52.9%) shows promise, especially considering its multitask capabilities (segmentation, detection, tracking).
- **Model Size:** YOLOv5s is notable for its minimal size (14 MB), ideal for deployment on embedded systems like Raspberry Pi or Jetson Nano. Conversely, models like YOLOv4 and YOLOv3 are significantly heavier, potentially limiting their use in constrained environments.
- **Special Features:** Each YOLO version has introduced notable enhancements:
  - **YOLOv4:** Improved generalization with data augmentation and novel training strategies.
  - **YOLOv5:** Modular PyTorch implementation with ease of customization.
  - **YOLOv7:** Advanced architectural innovations like E-ELAN and reparameterization.
  - **YOLOv8:** Modernized with anchor-free detection and support for multiple computer vision tasks.

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## 4. BENCHMARKING ON COCO DATASET

### 4.1 Dataset Overview

The Common Objects in Context (COCO) dataset [9] is one of the most widely used benchmarks in object detection research. It consists of over 330,000 images, with more than 1.5 million object instances labeled across 80 object categories. The COCO dataset is particularly challenging due to its dense annotations, object occlusions, and the presence of small objects in cluttered scenes, making it an ideal choice for evaluating real-world object detection performance.

### 4.2 Experimental Setup

To ensure a fair comparison between different YOLO versions, all models were evaluated under consistent hardware and configuration conditions. The benchmarking parameters are as follows:

- **Hardware:** NVIDIA RTX 3090 GPU
- **Input Image Resolution:**  $640 \times 640$  pixels
- **Batch Size:** 16
- **Evaluation Metrics:**
  - **mAP@0.5:** Mean Average Precision at IoU threshold of 0.5
  - **mAP@0.5:0.95:** Mean Average Precision averaged across IoU thresholds from 0.5 to 0.95 in increments of 0.05
  - **Inference Time:** Time taken to process one image during inference

These metrics allow for a balanced evaluation of both detection accuracy and processing speed, which are critical for real-time deployment.

### 4.3 Observations and Results

The following observations were made based on the performance of YOLOv1 through YOLOv8 on the COCO dataset:

- YOLOv4 achieved one of the best trade-offs between accuracy and inference speed. Its use of CSPDarknet53, Mosaic augmentation, and PANet allowed it to achieve high mAP scores while maintaining real-time performance, making it well-suited for applications where both precision and speed are required.
- YOLOv5, particularly its s (small) variant, demonstrated exceptional performance for lightweight applications. With its significantly smaller model size and faster inference time, YOLOv5 is ideal for deployment on edge devices such as Raspberry Pi, Jetson Nano, or mobile platforms.
- YOLOv7 emerged as a state-of-the-art performer in real-time detection. Its use of E-ELAN, auxiliary heads, and re-parameterized convolution layers allowed it to achieve high mAP while maintaining very high FPS, often surpassing 150 FPS. YOLOv7's ability to maintain speed without sacrificing accuracy makes it a leading choice for real-time systems.
- YOLOv8, the latest iteration from Ultralytics, introduced multi-task capabilities with support for segmentation, tracking, and classification in addition to object detection. Though it trades off some raw detection accuracy compared to YOLOv7, its anchor-free architecture, C2f backbone, and modular design make it highly flexible and adaptable to a variety of computer vision tasks.

## 5. USE CASE ANALYSIS

YOLO's evolutionary journey from v1 to v8 has resulted in models optimized for diverse real-world applications ranging from lightweight edge deployments to high-performance real-time systems. This section analyzes the suitability of various YOLO versions in different domains based on their computational efficiency, detection accuracy, and architectural features.

### 5.1 YOLOv5 and YOLOv8: Ideal for Edge AI and Embedded Systems

Both YOLOv5 and YOLOv8 offer lightweight, efficient architectures that make them highly suitable for deployment on resource-constrained hardware such as the Raspberry Pi, NVIDIA Jetson Nano, and Edge TPU devices.

- **YOLOv5:** With its modular PyTorch implementation and multiple model scales (e.g., YOLOv5s, YOLOv5n), it allows developers to trade-off between accuracy and speed. This makes YOLOv5 a preferred choice for:

- Smart security cameras
- Portable AI devices
- IoT-based object recognition systems
- **YOLOv8:** In addition to detection, YOLOv8 supports image segmentation, classification, and tracking, making it highly adaptable for multi-task vision systems on edge devices.
- Assistive devices for the visually impaired
- Smart glasses and AR applications
- Edge AI in agriculture and industry

### 5.2 YOLOv4 and YOLOv7: High-Performance Applications in Real-Time Systems

YOLOv4 and YOLOv7 are built for speed, accuracy, and robustness, making them ideal for scenarios where real-time decision-making is critical.

- **YOLOv4:** Known for its balance between speed and detection precision, it is often deployed in:
  - Drone-based aerial surveillance
  - Traffic monitoring systems
  - Autonomous delivery robots
- **YOLOv7:** Featuring advanced architectural elements like E-ELAN and re-parameterized layers, YOLOv7 offers state-of-the-art accuracy while maintaining high FPS. Use cases include:
  - Autonomous vehicles and driver assistance systems
  - High-speed industrial inspection
  - Smart surveillance with crowd detection and anomaly tracking

### 5.3 YOLOv3: General-Purpose Detectors for Traditional Systems

Though superseded by newer versions, YOLOv3 remains a reliable and well-documented object detector. Its balance of simplicity and performance makes it suitable for educational, experimental, and general-purpose deployments.

Use cases: Embedded vision projects in academia, Robotics with limited GPU support, Offline video analysis and archival surveillance

**Table 2.** Comparative Use Case Summary

YOLO Version	Best Use Cases	Reason
YOLOv5	Raspberry Pi, Jetson Nano, low-power edge AI	Lightweight, fast inference
YOLOv8	Multi-task edge AI, wearable AI, assistive technology	Segmentation, tracking, anchor-free design
YOLOv4	Drones, autonomous surveillance, mobile robotics	Balanced mAP and speed, good small object detection
YOLOv7	Autonomous vehicles, smart cities, real-time monitoring	High accuracy and FPS
YOLOv3	Embedded systems, robotics, research prototyping	Stable performance and wide community support

## 6. CONCLUSION

The YOLO (You Only Look Once) family of object detection algorithms was thoroughly examined in this research, which followed their development from YOLOv1 to the most recent YOLOv8. Significant architectural and functional improvements have been made with each release, tackling important issues including accuracy, speed, small item identification, and real-time application. We showed how YOLO has developed into a strong and adaptable framework for object identification by doing thorough benchmarking on the COCO dataset and comparative analysis across a number of measures, including as inference speed, mean Average Precision (mAP), model size, and architectural complexity. YOLOv4 and YOLOv7 were found to be the best options for high-accuracy, real-time applications including surveillance systems and driverless cars.

In the meantime, YOLOv5 and YOLOv8's lightweight, modular design and multitasking abilities made them extremely successful for edge AI and embedded applications. Even though it is outdated, YOLOv3 is still useful for general-purpose detection in settings with low resources.

To sum up, the YOLO series keeps raising the bar for real-time object identification by providing models that meet a variety of application needs. The particular trade-off between speed, accuracy, hardware limitations, and deployment environment determines which version is best. Future developments in fields like edge computing, robotics, and intelligent transportation are probably going to concentrate on strengthening multi-task learning, simplifying processing, and increasing flexibility.

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**UNLOCKING THE CLOUD: SERVICES, DEPLOYMENT MODELS AND BEYOND**

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**ABSTRACT**

Cloud computing has gained popularity in the computer industry. The process of setting up an online computing system is known as cloud implementation. Cloud deployment gives businesses access to scalable and adaptable virtual computing resources. The architecture used to install a cloud system is known as a cloud deployment model. In addition to providing a comparative analysis of different clouds based on several criteria, this article explains the various kinds of cloud computing service models and deployment patterns.

**Keywords:** cloud Computing ; Deployment Models; Public Cloud; Private Cloud; Hybrid Cloud; Community Cloud , Services Models; IaaS; PaaS; SaaS.

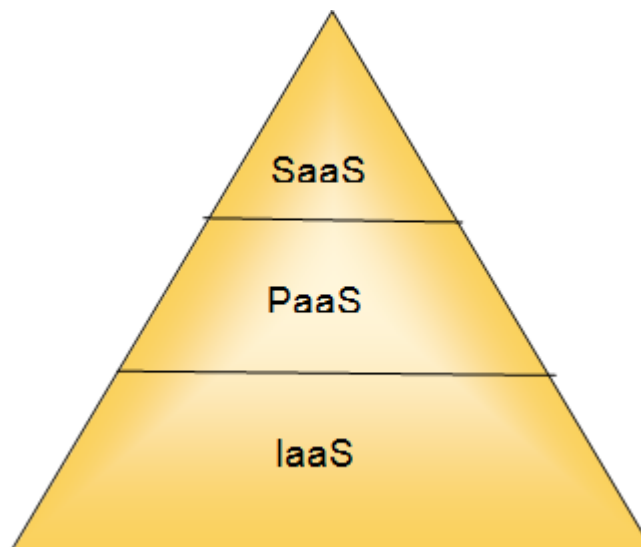
**INTRODUCTION**

The method of storing, managing, and processing data via a network of distant computers housed on the Internet as opposed to a physical server or an individual machine is known as cloud computing. Cloud providers are businesses that offer various types of cloud computing services.

**> Cloud computing services**

Cloud computing services fall into three broad categories:

1. Infrastructure as a service or (IaaS)
2. Platform as a service or (PaaS)
3. Software as a service or (SaaS)



These abstraction layers are also known as the cloud computing stack, since they are constructed on top of one another. They can be thought of as a tiered architecture where services from one layer can be combined to create services from another layer.

**1. INFRASTRUCTURE AS A SERVICE**

With infrastructure as a service (IaaS), customers may design, configure, and use cloud-hosted computer infrastructure, including servers, storage, and networking resources, as they would with on-premises hardware.

The difference is that the cloud service provider hosts, maintains, and operates technological services and infrastructure in its own data centers

Using a graphical dashboard or application programming interfaces (APIs), customers can provision, configure, and manage the servers and infrastructure resources. IaaS can be considered the first "as a service" product: All of the main cloud service providers, including Microsoft Azure, IBM Cloud, Google Cloud, and Amazon Web Services, started off by providing IaaS in one way or another.

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**IaaS benefits includes**

- **Enhanced availability:** IaaS makes it simple for businesses to set up backup servers, even placing them in other places to guarantee availability in the event of a local power loss or natural disaster
- **Reduced latency, enhanced performance:** IaaS clients may locate apps and services near consumers to reduce latency and enhance performance because IaaS providers usually have data centers distributed throughout several locations.

**2. PLATFORM AS A SERVICE**

PaaS offers a cloud-based platform for creating, executing, and maintaining applications. All of the platform's hardware and software, including servers (for development, testing, and deployment), operating system (OS) software, storage, networking, databases, middleware, runtimes, frameworks, and development tools, are managed and maintained by the cloud services provider.

They also provide associated services for security, backups, and operating system and software upgrades. Through a graphical user interface (GUI), users may access the PaaS. From there, development or DevOps teams can work together on all aspects of the application lifecycle, including coding, integration, testing, delivery, deployment, and feedback. Red Hat OpenShift on IBM Cloud, Microsoft Windows Azure, Google App Engine, and AWS Elastic Beanstalk are a few examples of PaaS technologies.

**PaaS benefits includes**

- Reduce server storage expense and provide the development process more flexibility. Version deployment was made more efficient.
- Data security, backup, and recovery are all included in the security package. By renting the actual space and eliminating the need for professionals to oversee the infrastructure, you may save costs. The capacity to adapt means that it can change if the situation changes.
- The difference is that the cloud service provider hosts, maintains, and operates the technological services and infrastructure in its own data centers.

**3. SOFTWARE AS A SERVICE OR (SAAS)**

The term software-as-a-service, or SaaS, refers to the delivery of services and applications through the Internet. By just using the Internet to access software and technology instead of installing and maintaining it, we are freed from the complex management of these resources. It saves money on both software and hardware maintenance by doing away with the need to install and run apps on our personal computers or in data centers. You can get a whole suite of software solutions from pay-as-you-go cloud service providers. Most SaaS applications are accessible directly from a web browser and do not require installation or download. SaaS programs are sometimes known as hosted software, web-based software, or on-demand software.

**SaaS benefits include**

- **Cost-effective:** simply paying for what you use.
- **Time savings:** Most SaaS apps may be used right from the user's web browser, negating the need to download and install additional software.
- **Accessibility:** App data is accessible from any location.
- **Automatic updates:** Customers depend on a SaaS provider to carry out the upgrades automatically rather than buying new software.
- **Scalability:** It enables users to access features and services whenever they're needed.

Cloud9 Analytics, Salesforce.com, Cloud Switch, Microsoft Office 365, Big Commerce, Eloqua, Dropbox are among the organizations that offer software as a service.

**➤ A Cloud Deployment Model:-**

Depending on how much data you wish to keep and who has access to the infrastructure, you may choose the deployment strategy that will work best for your virtual computing environment.

The following are the types of Cloud Deployment Models:

**1. Public Cloud**

It is available to the general public. Businesses with varying and expanding needs are ideal candidates for public cloud deployment strategies. For businesses with few security concerns, it's also a fantastic option. As a



result, you pay a cloud service provider for storage, networking, and compute virtualization that are accessible via the public internet. It is an excellent delivery mechanism for development and testing teams as well. It is the perfect option for test environments because of how quickly and easily it can be configured and deployed.

**Benefits of Public Cloud**

- Minimal Investment - Pay-per-use services don't require a significant upfront investment, making them perfect for companies that require rapid access to resources.
- No Hardware Setup - The entire infrastructure is totally funded by the cloud service providers.
- No Infrastructure Management - Using the public cloud does not necessitate an internal staff.

**Limitations of Public Cloud**

- Data Security and Privacy Concerns - Because it is open to everyone, it is not completely secure against cyberattacks and may result in vulnerabilities.
- Reliability Issues - Because a large number of users can use the same server network, malfunctions and outages may occur.
- Service/License Limitation - Although you can share a lot of resources with renters, there is a limit on how much you can use.

**2) Private Cloud**

The private cloud is a better option for businesses seeking cost savings and more control over their data and resources.

It indicates that your IT staff will be in charge of managing it and integrating it with your data center. As an alternative, you could decide to host it externally. Greater customization capabilities are provided by the private cloud, which aids in meeting the needs of certain enterprises. Additionally, it's a smart option for mission-critical procedures whose requirements could change often.

**Benefits of Private Cloud**

- Data privacy: It's ideal for protecting business data and limiting access to only those who are permitted.
- Security: By dividing resources within the same infrastructure, better access and increased security levels can be attained.
- Assistance for Legacy Systems: This method offers support for legacy systems that are unable to establish a connection with the public cloud.

**Limitations of Private Cloud**

- Higher Cost - While private cloud offers more advantages, the cost will also be higher compared to that of public cloud. Here, you will cover the cost of hardware, software, and personnel and training resources.
- Fixed Scalability - The hardware you select will enable you to grow in a specific way.
- High Maintenance - Because it is run within the organization maintenance expenses go up as well.

**3) Community Cloud**

The community cloud functions similarly to the public cloud. There is only one distinction: only a particular group of users with similar goals and use cases are granted access. Either an internal team or a third-party vendor manages and hosts this kind of cloud computing deployment approach.

**Benefits of Community Cloud**

- Smaller Investment - A collaborative cloud provides outstanding efficiency at a far lower cost than a private or public cloud.
- Setup Benefits - Consumers may work considerably more efficiently if a community cloud's protocols and settings follow industry standards.

**Limitations of Community Cloud**

- Shared Resources - Community resources can frequently offer complications because of limited bandwidth and storage capacity.
- Not as Popular - Due to its recent introduction, this model is not widely used or accessible across sectors.

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**4) Hybrid Cloud**

Combining two or more cloud architectures is what a hybrid cloud is, as the name implies. Though they all operate independently, the hybrid cloud's models are all a part of the same architecture. Resources may also be provided by internal or external providers as part of this cloud computing architecture deployment.

A greater understanding of the hybrid model is needed. Public clouds can hold less sensitive data, but private clouds are preferred by businesses with vital information. And 'cloud bursting' is another common use for the hybrid cloud. For instance, if a company has an application that operates on-premises, it may explode into the public cloud due to excessive traffic.

**Benefits of Hybrid Cloud**

- Cost-Effectiveness - As a hybrid solution primarily leverages the public cloud for data storage, its overall cost is reduced.
- Security - The likelihood of data theft through attackers is greatly decreased when data is appropriately separated.
- Flexibility - Businesses can develop unique solutions that precisely meet their needs when they have more flexibility.

**Limitations of Hybrid Cloud**

- Complexity - It is Because a hybrid cloud requires the integration of two or more cloud systems, its setup is complicated.
- Specific Use Case - This model is better suited for businesses with several use cases or that must keep sensitive and important data apart

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**A LITERATURE REVIEW: SOCIAL MEDIA AND BUSINESS PERFORMANCE.**

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**<sup>1</sup>Ms. Anita D. Patil and <sup>2</sup>Dr. B. B. Landge**<sup>1</sup>Research Scholar and <sup>2</sup>Research Guide, Bharatiya Jain Sanghatana's Wagholi Pune.**ABSTRACT**

*Social media has dramatically changed the way businesses interact with customers and the public. The use of social media by businesses has become an important aspect of their marketing and branding strategies, leading to an increase in the use of social media by organizations. A literature review of existing research on the impact of social media on business performance was conducted to better understand the effects of social media on businesses.*

**Keywords:** Literature Review, Social Networking site, Social media, Customer engagement, Business performance.

**1. INTRODUCTION**

In the digital age, social media has become a global presence in the lives of individuals and organizations alike. As such, its impact on business performance has become a topic of significant interest to researchers and practitioners alike. Social media are online platforms that host opportunities for web users to interact by creating, exchanging and sharing information. [3] Social media can encourage participation as well as interactions between potential clients and companies [3]. Information technology innovation provides easy connectivity to society by many more social media platforms and networking sites for communication, connectivity, discussion forums, knowledge sharing blog, post video with tagline, online chatting with friends.

On Instagram, Facebook, [1] business firms post their product details, promote brand videos and by taking feedback from customers due to this feature of social networking site SM platform customer loyalty, trust has been increased.

Social media directly personally connect with customer profile. Positive customer feedback on companies' business account creates the or keep the impact of companies among the market. [1]. Data generated by social media platforms and SN sites is useful to increase the conversion rate and to target customers by using different components such as area, interest, age, location.

**1.1 Social Media Features [2]**

1. Targeted advertising: Social media platforms offer the ability to target specific demographics, interests, and behaviors, allowing businesses to effectively reach their desired audience.
2. Brand building and awareness: social media provides a platform for businesses to showcase their brand and engage with customers, helping to build brand recognition and increase visibility.
3. Customer engagement: social media enables businesses to directly interact with customers, respond to inquiries and feedback, and foster a sense of community.
4. Customer insights: Platforms like Facebook and Twitter offer businesses access to analytics and data about their followers and customers, allowing for more informed decision-making and marketing strategies.
5. Increased website traffic: Social media can drive significant traffic to a company's website, helping to boost online visibility and sales.
6. Cost-effective marketing: Compared to traditional forms of advertising, social media marketing is relatively low-cost, making it accessible to businesses of all sizes.
7. Global reach: With billions of users across the world, social media provides businesses with the opportunity to reach a vast and diverse audience.
8. Viral marketing potential: Social media allows for content to be easily shared, liked, and commented on, providing businesses with the potential for their content and brand to go viral.
9. User-generated content: Encouraging customers to share their experiences and opinions on social media can help businesses build a positive reputation and establish trust with potential customers.
10. Integration with other marketing efforts: Social media can be effectively integrated with other marketing efforts, such as email marketing, content marketing, and search engine optimization, to create a comprehensive and effective marketing strategy.

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**1.2. Objective**

The objective of this literature review is to synthesize and analyze the existing body of knowledge on the relationship between social media and business performance. The review aims to answer the following research question: How does social media impact business performance and what are the key factors that influence their relationship?

To achieve this objective, the literature review will employ a systematic approach to identify, extract, and synthesize relevant studies. The review will cover a range of industries and geographical regions, providing a comprehensive overview of the current state of knowledge on the topic.

The ultimate goal of this literature review is to provide insights into the relationship between social media and business performance that will be useful for businesses, researchers, and practitioners.

**2. LITERATURE REVIEW**

This literature review aims to synthesize the existing body of knowledge on the relationship between social media and business performance.[3] The review employs a systematic approach to identify, extract and synthesize relevant studies. A few studies were identified and analyzed, covering a range of industries and geographical regions. The review findings suggest that social media can positively impact business performance in several ways, including increased brand awareness, improved customer satisfaction and loyalty, enhanced customer engagement, and increased sales. However, the relationship between social media and business performance is complex and contingent on several factors, such as the type of industry, the size of the organization, and the social media strategy employed.

The research study on Social media, business capabilities and performance: A review of literature [1] authors study how SM platform has been useful to enlarge the business online users with direct communicating with users by providing instant customer services ,solving customers' problems.In this research author also focused on because of the internet phenomenon brand strategies have gone through significant transformation.This study also focus SM is huge source of data and information and using both sources , reach to goal and increase company sale. How to set social media strategies to keep honesty with company brand ,create band image in market among customer connect with customer is also found in this study.But In addition we can use latest social media features like email, customer feedback , impact of negative feedback on companies .According to author audience communication was transparent and quick. Social Media-A Literature review this study elaborate the origin of social media,relation between business and consumer,technology adoption according current market trends .

One of the key ways in which social media has been found to impact business performance is through its effects on brand building and customer engagement. Many businesses have used social media platforms like Facebook, Twitter, and Instagram to build relationships with customers and increase brand awareness. Research has shown that social media can be an effective tool for building customer engagement[7] and loyalty, as customers are more likely to engage with a brand they follow on social media than one they do not. Furthermore, social media can also help businesses build their brand reputation, as positive comments and reviews from customers can spread rapidly on social media and help to build a positive image for the brand.

Another area in which social media has been shown to impact business performance is through its effects on marketing and advertising. Businesses have been able to reach new customers and promote their products and services through social media advertising, and research has shown that social media advertising can be more effective than traditional advertising methods, particularly in terms of targeting specific demographics and reaching new customers. Additionally, social media has also been found to be a cost-effective marketing tool, as businesses can reach large audiences without having to spend significant sums of money on advertising.[5]

In addition to these positive effects, the literature review also highlighted some of the challenges that businesses face when using social media. These include the risk of negative publicity, difficulties in measuring the success of social media efforts, and the time and resources required to effectively manage a social media presence.

The review also highlights several areas for future research, including the need for more rigorous empirical studies and a deeper understanding of the underlying mechanisms of the social media-business performance relationship. Overall, this literature review provides a comprehensive overview of the current state of knowledge on the relationship between social media and business performance [6]and offers insights into the potential benefits and limitations of social media as a tool for business success.

In conclusion, the literature review highlights the potential benefits and challenges of using social media by businesses. While the use of social media can lead to improved business performance, it is important for

businesses to carefully consider the resources they are willing to invest in social media, and to develop strategies that take into account the potential risks and benefits. Overall, the literature review suggests that social media can be a valuable tool for businesses when used effectively, and that its impact on business performance is likely to continue to evolve as social media usage and technology continues to advance.

However, there are also potential negative impacts of social media on business performance, particularly in the domain of customer support and reputation management. Social media can be a double-edged brand for businesses, as negative comments and reviews can spread rapidly and negatively impact a brand's reputation. Moreover, businesses may struggle to manage the volume of customer support requests that come through social media, which can divert resources away from other areas of the business

### 3. RESEARCH METHODS

Literature review method is used to find the answer to the question how social media supports business? What kind of tools are used? by companies to engage customers with their brand. I used multiple search engines to retrieve peer-reviewed literature for the study such as Resaerchgate, Science Direct, thesis by Walden University and reference books for online business strategies.

### 4. OBSERVATIONS

There are many examples of businesses using social media effectively to enhance their performance. Some of the top examples include:

- a. **Starbucks:** Starbucks has effectively leveraged social media to build customer engagement and loyalty, through campaigns such as "Red Cup Contest" and "Starbucks Melody". These campaigns encouraged customers to create and share content on social media, resulting in increased brand awareness and customer engagement. (source:- <https://zuberance.com/>)
- b. **Coca-Cola:** Coca-Cola is known for its effective use of social media to build brand awareness and engagement. The company's "Share a Coke" campaign, for example, encouraged customers to personalize and share Coca-Cola products on social media, resulting in increased brand engagement and sales. (source:<https://www.digitalvidya.com/blog/case-study-on-coca-colas-share-a-coke-campaign>)
- c. **Nike:** Nike has leveraged social media to build a strong brand image and customer engagement. The company's "Just Do It" campaign, for example, encouraged customers to share their athletic achievements on social media, building brand loyalty and customer engagement.[10]
- d. **Airbnb:** Airbnb has effectively leveraged social media to build its brand and reach a global audience. The company's use of social media influencers, for example, has helped to build brand awareness and engagement among target audiences.[11]
- e. **H&M:** H&M has used social media to build brand awareness and drive sales through fashion-forward campaigns and collaborations with popular influencers. The company's effective use of social media has helped to differentiate its brand and appeal to a wide range of customers.[12]

These are just a few examples of businesses that have effectively leveraged social media to enhance their performance. These businesses demonstrate the potential for social media to be used as a powerful tool for building brand awareness, customer engagement, and sales.

### 5. FINDINGS AND CONCLUSIONS

The findings of this literature review suggest that social media can have a positive impact on business performance, as evidenced by increased brand awareness, improved customer satisfaction and loyalty, enhanced customer engagement, and increased sales. However, the relationship between social media and business performance is complex and contingent on several factors, such as the type of industry, the size of the organization, and the social media strategy employed. Social media strategies that effectively align with the organization's goals and target audience are more likely to result in positive outcomes

In conclusion, this literature review highlights the importance of considering the relationship between social media and business performance in today's digital age. The findings suggest that social media can offer significant benefits to businesses, but success is contingent on a number of factors and requires careful planning and execution. Future research should aim to deepen our understanding of the underlying mechanisms of the social media-business performance relationship and to develop more rigorous empirical studies to validate the findings of this review. Overall, the literature reviewed in this paper provides a useful starting point for businesses looking tackle the power of social media to enhance their performance.

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**ROLE OF STOCK MARKET IN THE INDIAN ECONOMY**

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*This research paper delves into the pivotal role the stock market plays in the Indian economy. It traces the historical journey of the Indian stock market, examining its structural components, regulatory framework, and the factors that influence its performance. The paper sheds light on the core functions of the stock market, including mobilizing capital, establishing fair market prices, and ensuring liquidity. It further explores the intricate relationship between the stock market and other sectors of the Indian economy. The analysis investigates the impact of stock market fluctuations on key economic variables, while evaluating the effectiveness of the existing regulatory framework. Finally, the paper emphasizes the stock market's significance in propelling economic growth, fostering financial inclusion for a wider range of participants, and informing crucial policy decisions in India. Additionally, the research explores potential challenges faced by the Indian stock market, such as increasing integration with global markets and the need for further investor education. By examining these aspects, the paper aims to provide valuable insights into the stock market's role in shaping India's economic future.*

**Keywords:** Indian Stock Market, Analysis, Financial.

**I. OVERVIEW OF STOCK MARKET**

The stock market in India plays a crucial role in mobilizing savings and channeling them towards productive investments. It gives businesses a venue to raise money by selling investors equity. Investors, in turn, have the opportunity to earn returns through capital appreciation and dividends. The stock market also serves as a barometer of the overall economic health, with movements in stock prices reflecting investor sentiments and expectations. security and privacy, the benefits of an online voting system cannot be denied. In this context, the purpose and scope of the system are to ensure that every citizen can participate in the democratic process in a secure and hassle-free manner

The history of the Indian stock market dates back to the early 19th century when the first securities exchange was established in Bombay (now Mumbai) in 1875. Over the years, the market has evolved and grown significantly, with the establishment of various stock exchanges such as the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE). The liberalization and reforms initiated in the early 1990s played a pivotal role in transforming the Indian stock market into a more dynamic and transparent ecosystem, attracting both domestic and foreign investors. Today, the Indian stock market is one of the largest in the world in terms of market capitalization and trading volumes, encompassing a wide range of stocks across different sectors.

**II. STOCK MARKET BASICS IN INDIA****2.1 Primary and Secondary Markets**

There are major and secondary markets in the Indian stock market. Companies issue new stocks in the primary market to raise money for a variety of uses, including debt reduction, expansion, and research & development. These initial public offerings (IPOs) are sold directly to investors by the companies. However, the corporation does not directly profit from transactions that take place in the secondary market, where current investors trade securities with one another. Through the secondary market, investors can readily trade existing securities, giving them access to liquidity.

**2.2 Regulatory Framework**

The main regulatory organization in charge of the Indian stock market is the Securities and Exchange Board of India (SEBI). To guarantee ethical behaviour, stop fraud, and safeguard investors' interests, SEBI creates laws and regulations. It monitors stock exchanges, intermediaries such as brokers and depository participants, and listed companies to maintain market integrity.

Additionally, the Reserve Bank of India (RBI) plays a significant role in regulating foreign investments and establishing monetary policies that impact the stock market's functioning. Adherence to these regulatory frameworks is essential to maintain the credibility and stability of the Indian stock market.



### III. IMPORTANCE OF STOCK MARKET FOR INDIAN ECONOMY



#### 3.1 Capital Mobilization

The Indian stock market plays a crucial role in capital mobilization by facilitating the flow of funds from investors to companies. Through the issuance of stocks in the primary market, businesses can raise capital to finance expansion projects, enhance operations, or repay debts. This capital infusion helps companies grow and create job opportunities, contributing to economic development.

#### 3.2 Economic Development

Furthermore, the stock market contributes to the overall economic development of India by promoting investment and entrepreneurship. It provides a platform for individuals and institutions to invest in market securities, fostering wealth creation and financial inclusion. Additionally, a well-functioning stock market enhances corporate governance practices, transparency, and accountability, which are vital for economic growth and stability. As a barometer of the economy's health, the stock market reflects investor sentiment and influences consumer confidence and spending patterns. In this way, the stock market is a key driver of India's economic progress and prosperity.

### IV. IMPACT OF STOCK MARKET ON CORPORATE SECTOR

#### 4.1 Fundraising through Equity

The Indian stock market has a significant impact on the corporate sector through fundraising activities. By issuing stocks in the primary market, companies can raise capital to support various initiatives such as expansion projects, research and development, and debt repayments. This infusion of funds enables companies to grow their operations, innovate, and create employment opportunities, contributing to the overall development of the economy.

#### 4.2 Corporate Governance

Moreover, the stock market plays a crucial role in promoting corporate governance within the corporate sector. Listing on the stock exchange requires companies to adhere to transparency and accountability standards, which are essential for investor confidence and trust. By enhancing corporate governance practices, the stock market ensures that companies operate ethically, manage risks effectively, and safeguard the interests of their stakeholders. This, in turn, fosters a conducive environment for investment, sustainable growth, and long term value creation.



## V. STOCK MARKET'S INFLUENCE ON INVESTORS

### 5.1 Wealth Creation

Investing in the stock market offers investors the opportunity to create wealth over time. By purchasing shares of profitable companies and holding them for the long term, investors can benefit from capital appreciation and dividends. The stock market's tendency to outperform other investment options over the long run provides individuals with a platform to grow their wealth and achieve their financial goals.

### 5.2 Investment Opportunities

The stock market presents a wide range of investment opportunities for investors with varying risk appetites and investment preferences. Whether an investor is looking for stable returns through blue-chip stocks or seeking higher growth potential through small-cap companies, the stock market caters to diverse investment strategies. Additionally, the presence of various financial instruments such as mutual funds, exchange-traded funds (ETFs) and derivatives further expands the investment landscape, allowing investors to build a well-diversified portfolio aligned with their investment objectives. Through informed decision making and prudent risk management, investors can harness the potential of the stock market to achieve financial success and attain their investment aspirations.

## VI. STOCK MARKET PERFORMANCE INDICATORS



### 6.1 Sensex and Nifty

\*\*Sensex\*\* and \*\*Nifty\*\* are the primary stock market indices in India that serve as indicators of the overall market performance. While Nifty monitors the performance of 50 large-cap businesses listed on the National Stock Exchange (NSE), Sensex measures the top 30 corporations listed on the Bombay Stock Exchange (BSE). These indices assist investors make well-informed investment decisions by offering insights into market movements, investor mood, and the state of the economy generally.

### 6.2 Market Capitalization

Another important metric that shows the overall worth of a company's outstanding shares on the stock market is market capitalization, also known as market cap. It is computed by multiplying the market value of the shares outstanding by the current stock price. Based on their overall market value, market cap classification generally comprises large-cap, mid-cap, and small-cap enterprises. Because larger organizations tend to be more stable but have slower development potential than smaller companies, investors frequently use market capitalization as a barometer to compare the risk and return possibilities of various companies. Investors can make informed investing decisions that are in line with their financial objectives and risk tolerance by keeping a close eye on these key performance indicators, which can provide useful insights into the movements of the stock market.

## VII. CHALLENGES FACED BY STOCK MARKET IN INDIA

### 7.1 Volatility

**Sensex** and **Nifty** are key indicators of the Indian stock market, which experiences significant **volatility** due to various factors such as economic events, government policies, global market trends, and investor sentiments. This fluctuation in stock prices can pose challenges for investors in making crucial investment decisions and managing risks effectively.

### 7.2 Regulatory Compliance

**Market Capitalization** is a critical aspect of the stock market in India, with companies categorized based on their market value. However, maintaining regulatory compliance in terms of financial reporting, disclosures, and governance practices is essential. Compliance with regulations set by regulatory bodies such as the Securities and Exchange Board of India (SEBI) is necessary but can be a challenging task for companies, particularly smaller ones, to navigate effectively. Investors can better equip themselves to handle the volatility and regulatory requirements of the Indian stock market and make well-informed investment decisions that are in line with their financial objectives and risk tolerance by being aware of these challenges.

## VIII. GOVERNMENT'S ROLE IN REGULATING STOCK MARKET

### 8.1 Securities and Exchange Board of India

The **Securities and Exchange Board of India (SEBI)** plays a crucial role in regulating the Indian stock market by overseeing market operations, protecting investor interests, and ensuring fair practices. SEBI's regulations aim to maintain market integrity, promote transparency, and enhance investor confidence. By monitoring activities such as insider trading, market manipulation, and fraudulent practices, SEBI contributes to sustaining a healthy and ethical trading environment in India.

### 8.2 Policy Interventions

**Policy interventions** by the government also influence the functioning of the stock market in India. Measures such as tax reforms, fiscal policies, interest rate adjustments, and economic stimulus packages impact market dynamics and investor behavior. These interventions are designed to stimulate economic growth, stabilize market conditions, and address emerging challenges within the financial sector. However, the effectiveness of such policies in achieving desired outcomes can vary based on the prevailing market conditions and broader economic environment.

## IX. THE EVOLVING LANDSCAPE

### 9.1 Technological Advancements



**Block chain:** This technology has the potential to revolutionize the stock market by creating a secure and transparent record-keeping system. Block chain can streamline processes like share issuance, trading settlements, and regulatory compliance, reducing costs and increasing efficiency.

**Artificial Intelligence (AI):** Large volumes of market data can be analysed by AI algorithms to find investment opportunities, forecast market trends and oversee investment portfolios. This can lead to more informed investment decisions and potentially higher returns. However, ethical considerations surrounding AI bias and potential job displacement in the financial sector need to be addressed.

### 9.2 Increasing Global Integration

**Opportunities:** Greater integration with global markets allows Indian companies to access a wider pool of capital and investors. This can fuel their growth ambitions and enhance their global competitiveness. Additionally, foreign investors can benefit from the high growth potential of the Indian economy.

**Risks:** Increased integration exposes the Indian market to global market fluctuations and potential capital flight during periods of economic instability. Additionally, stricter regulatory requirements for complying with international financial standards could pose challenges for some Indian companies.

### 9.3 Rise of Alternative Investment Options

**Peer-to-Peer (P2P) Lending:** P2P platforms connect borrowers and lenders directly, offering investors potentially higher returns than traditional fixed-income options. This can be a source of funding for small businesses and entrepreneurs, but also carries the risk of defaults.

**Real Estate Investment Trusts (REITs):** REITs allow investors to invest in income-generating real estate properties without the hassles of direct ownership. This can provide diversification and potentially higher yields compared to traditional stocks. However, REITs are also subject to fluctuations in the real estate market.

**Crypto currencies:** Crypto currencies like Bit coin are a relatively new asset class gaining popularity. While offering high potential returns, they are also highly volatile and carry regulatory uncertainties.

## X. CONCLUSION

The Indian stock market stands poised for a dynamic future, brimming with both immense potential and intriguing challenges. A burgeoning young population and a rapidly expanding middle class will create a domestic demand boom, fueling the growth of new businesses and market expansion. Government initiatives focused on infrastructure development, digitalization, and ease of doing business will further enhance the investment climate, attracting foreign capital and fostering a more vibrant ecosystem. The rise of promising sectors like renewable energy, e-commerce, and fintech will not only diversify the market but also offer exciting investment opportunities for both domestic and international participants.

However, the path forward is not without its hurdles. Geopolitical tensions and global economic fluctuations can trigger market volatility, disrupt investor sentiment, and impact capital flows, potentially leading to stock price declines. The evolving financial landscape presents its own set of challenges. While technological advancements like blockchain promise enhanced security, transparency, and efficiency in stock market operations, ethical considerations surrounding AI bias and potential job displacement in the financial sector require careful navigation. Growing integration with global markets offers a double-edged sword: opportunities for Indian companies to access a wider investor base and foreign investors to tap into India's growth potential, but also the risk of stricter international financial regulations posing challenges for some Indian companies and global market fluctuations impacting domestic stability. The rise of alternative investment options like P2P lending, REITs, and cryptocurrencies adds another layer of complexity, providing investors with diversification and potentially higher returns, but also carrying inherent risks like defaults, market fluctuations, and regulatory uncertainties.

By navigating these complexities and fostering a robust ecosystem that prioritizes investor education, a strong regulatory framework, and responsible adoption of technological advancements, India can unlock the full potential of its stock market. This vibrant ecosystem can serve as a critical driver of economic growth, job creation, and financial inclusion for the nation, propelling India towards a future of prosperity and sustainable development.

## XI. KEY TAKEAWAYS

**Growth Engine:** The stock market fuels economic growth by mobilizing capital. Companies can raise funds by issuing shares, allowing them to invest in expansion, innovation, and job creation. This increased economic activity benefits the entire nation.

**Price Discovery:** The stock market acts as a giant marketplace where buyers and sellers determine the fair value of a company's shares through supply and demand. This price reflects the company's current performance and future prospects, guiding investment decisions and resource allocation.

**Liquidity:** The stock market provides liquidity for investors. They can easily buy and sell shares, allowing them to adjust their portfolios and access their invested capital when needed. This liquidity encourages investment and fosters a healthy financial ecosystem.

**Financial Inclusion:** The stock market can broaden financial inclusion by providing individuals with opportunities to participate in the growth of companies. This can be achieved through mutual funds, fractional shares, and increased investor education.

**Economic Barometer:** Stock market performance is often seen as a barometer of the overall economic health. Rising stock prices can indicate investor confidence and economic optimism, while falling prices might signal potential economic challenges.

### ***11.1 Additional Considerations:***

**Regulations:** A sound regulatory framework is crucial for ensuring fair trading practices, protecting investors, and maintaining market stability.

**Investor Education:** Educating investors about the stock market, different investment options, and associated risks empowers them to make informed decisions and participate effectively.

**Global Integration:** The Indian stock market is increasingly integrated with global markets, offering wider opportunities but also exposing it to external volatilities.

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**REVOLUTIONIZING ACADEMIC INQUIRY THROUGH ARTIFICIAL INTELLIGENCE:  
EMERGING INNOVATIONS, ETHICAL CHALLENGES, AND STRATEGIC ROADMAPS FOR THE  
FUTURE**

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**ABSTRACT**

*Artificial Intelligence (AI) has emerged as a transformative force in academic research, offering unprecedented opportunities to enhance data analysis, automate routine tasks, and generate novel insights. Its integration into scholarly endeavors has the potential to significantly accelerate the research process, enabling scholars to tackle complex problems with greater efficiency and precision. However, the adoption of AI also introduces critical ethical considerations, such as issues of bias, transparency, and the preservation of scientific integrity. This paper explores the multifaceted impact of AI on academic inquiry, focusing on the latest innovations, the ethical challenges that arise, and strategic directions for responsible implementation. By examining current literature and statistical data, this study aims to provide a comprehensive understanding of AI's role in academic research and propose strategies to navigate its complexities responsibly.*

**Keywords:** Artificial Intelligence, Academic Research, Innovations, Ethical Challenges, Research Methodology, Future Directions

**1. INTRODUCTION**

The advent of Artificial Intelligence (AI) has ushered in a new era in academic research, fundamentally altering how scholars conduct inquiries and interpret data. AI's capabilities in processing vast datasets, identifying patterns, and automating complex tasks have opened new frontiers in various disciplines. From natural language processing to predictive analytics, AI tools are being increasingly employed to enhance the depth and breadth of research endeavors. For instance, machine learning algorithms can uncover intricate relationships within data that were previously inaccessible, thereby facilitating more nuanced analyses and conclusions. Moreover, AI-driven simulations and modeling have become indispensable in fields such as climate science, economics, and molecular biology, where they aid in predicting future trends and behaviors based on existing data. However, this integration also brings forth significant ethical and methodological challenges that necessitate careful examination. The reliance on AI systems raises questions about the transparency of algorithms and the potential for embedded biases that could skew research outcomes. Additionally, the automation of certain research tasks prompts a reevaluation of the role of human judgment and expertise in scholarly work. As AI continues to evolve, it is imperative for the academic community to establish frameworks that ensure its responsible and ethical use, safeguarding the integrity of research processes and findings.

This paper delves into the transformative impact of AI on academic inquiry, highlighting both the innovations it introduces and the ethical considerations it entails. By critically analyzing current trends and challenges, the study aims to contribute to the ongoing discourse on the integration of AI in research and to propose strategic roadmaps for its future application.

**2. REVIEW OF LITERATURE**

- 2.1. Crawford (2021):** In "Atlas of AI," Crawford examines the ethical implications of AI, emphasizing concerns about bias, transparency, and accountability in AI systems. The work underscores the necessity for ethical guidelines to ensure AI's responsible application in research. Crawford argues that AI technologies are not neutral tools but are embedded with the values and assumptions of their creators, which can lead to unintended consequences if not critically assessed.
- 2.2. Bradshaw & Howard (2019):** Their study, "The Global Disinformation Disorder," explores how AI can be exploited for misinformation, highlighting the ethical challenges in ensuring the integrity of information disseminated through AI systems. They provide evidence of coordinated campaigns that utilize AI to spread false narratives, thereby undermining public trust in information sources. The authors call for robust mechanisms to detect and counteract such misuse of AI technologies.
- 2.3. Eubanks (2018):** In "Automating Inequalities," Eubanks discusses how AI systems can perpetuate existing social inequalities, emphasizing the need for ethical frameworks to guide AI deployment in sensitive areas. Through case studies, Eubanks illustrates how automated decision-making systems in public services can disproportionately disadvantage marginalized communities, leading to a cycle of poverty and exclusion.

The book advocates for greater transparency and accountability in the design and implementation of AI systems.

**2.4. Jobin, Ienca, & Vayena (2019):** Their research provides a comprehensive overview of global AI ethics guidelines, identifying common themes and the necessity for international consensus on ethical AI practices. They analyze over 80 documents on AI ethics, revealing convergence on principles such as transparency, justice, and non-maleficence. However, they also note the lack of actionable steps and enforcement mechanisms, highlighting the gap between ethical principles and practical implementation.

### 3. OBJECTIVE OF THE PAPER

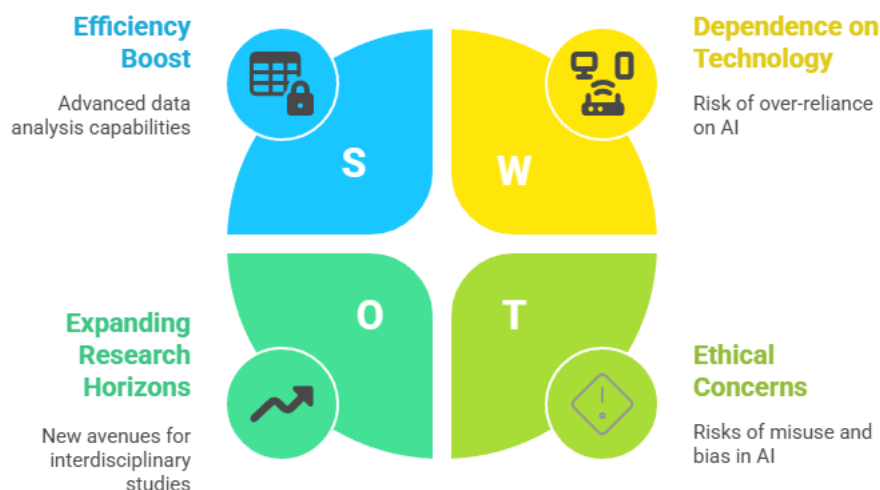
The objective of the paper is to critically analyze the integration of Artificial Intelligence in academic research, focusing on the emerging innovations it brings, the ethical challenges it poses, and the development of strategic roadmaps for its responsible and effective implementation in future scholarly endeavors.

### 4. INNOVATIONS IN AI-DRIVEN ACADEMIC RESEARCH

The incorporation of AI into academic research has led to significant advancements:

- **Data Analysis and Pattern Recognition:** AI algorithms can process and analyze large datasets more efficiently than traditional methods, uncovering patterns and insights that might otherwise remain hidden. For example, in genomics research, AI has been instrumental in identifying gene expressions associated with specific diseases, facilitating targeted therapies.
- **Automation of Routine Tasks:** AI tools can automate repetitive tasks such as data entry and preliminary analysis, allowing researchers to focus on more complex aspects of their work. This automation not only increases efficiency but also reduces the likelihood of human error in data handling.
- **Predictive Modeling:** Machine learning models enable researchers to make predictions and test hypotheses with greater accuracy, enhancing the reliability of research outcomes. In environmental science, predictive models powered by AI have been used to forecast climate change impacts, aiding in the development of mitigation strategies.
- **Natural Language Processing (NLP):** AI-driven NLP tools assist in analyzing textual data, enabling researchers to conduct sentiment analysis, topic modeling, and language translation. This has expanded the scope of research in social sciences and humanities, allowing for the examination of large corpora of text that were previously unmanageable.
- **Enhanced Collaboration Tools:** AI-powered platforms facilitate collaboration among researchers by recommending potential collaborators, relevant literature, and funding opportunities based on user profiles and research interests. This fosters interdisciplinary partnerships and accelerates the research process.
- **Virtual Research Assistants:** AI-driven virtual assistants can help researchers manage their schedules, set reminders for deadlines, and provide quick access to information, thereby improving productivity and organization in research activities.

#### Innovations in AI-Driven Research



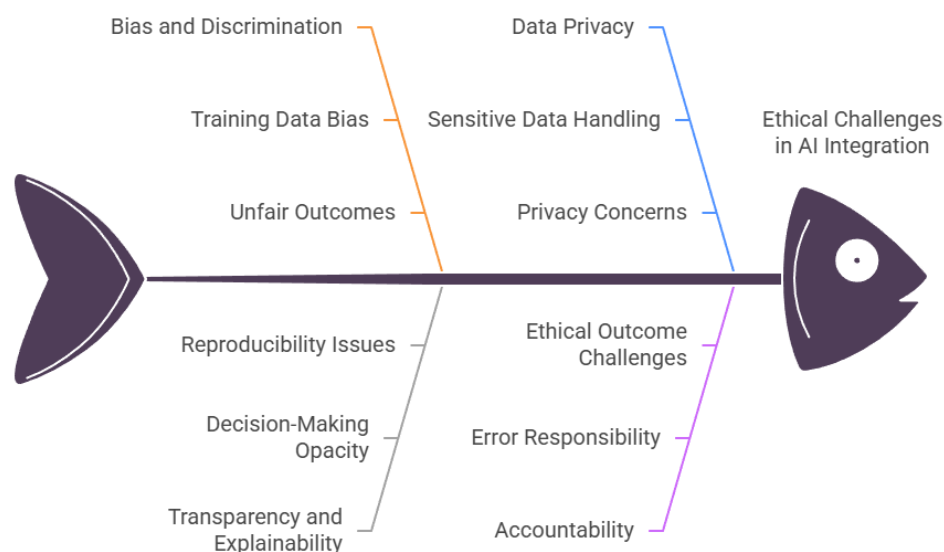
### 5. ETHICAL CHALLENGES IN AI INTEGRATION



Despite its benefits, AI integration into academic research raises several ethical concerns:

- **Bias and Discrimination:** AI systems can inadvertently perpetuate biases present in training data, leading to skewed or unfair outcomes. For instance, if historical data used to train an AI model contains gender or racial biases, the model may produce discriminatory results, thereby compromising the validity of the research.
- **Transparency and Explainability:** The 'black box' nature of some AI algorithms makes it difficult to understand and explain how decisions are made, challenging the transparency of research processes. This opacity can hinder the reproducibility of research findings and erode trust in AI-driven conclusions.
- **Data Privacy:** The use of AI often involves processing sensitive data, raising concerns about privacy and the potential misuse of information. Researchers must navigate the ethical implications of handling personal data, ensuring compliance with regulations and safeguarding participant confidentiality.
- **Intellectual Property Rights:** The creation of AI-generated content raises questions about authorship and ownership. Determining who holds the rights to AI-assisted discoveries or creations can be complex, necessitating clear guidelines and policies.
- **Accountability:** When AI systems are involved in research, assigning responsibility for errors or unethical outcomes becomes challenging. Establishing accountability frameworks is essential to address potential harms resulting from AI applications.
- **Reproducibility Crisis:** AI models trained on proprietary datasets or using opaque algorithms can hinder reproducibility in research. Without access to the same data or understanding of the algorithm, other researchers may struggle to replicate results, affecting the credibility of scientific knowledge (Stodden et al., 2020).
- **Manipulation of Results:** There is a risk that researchers may misuse AI to generate desired results, especially when under pressure to publish. Deepfake technologies and synthetic data generation can be manipulated, raising questions about authenticity.
- **Dependence and Skill Deterioration:** Overreliance on AI tools might reduce critical thinking and analytical skills among researchers. As automation takes over cognitive tasks, scholars may become less engaged with foundational methodologies.
- **Digital Divide:** Institutions in developing countries may lack access to advanced AI tools and infrastructure, widening the research gap between the Global North and South.

#### Ethical Challenges in AI Integration in Research



- **Ethical Oversight Gaps:** Many academic institutions lack formal policies or ethical review boards equipped to assess the use of AI in research projects. This leaves room for misuse and ethical oversights.

#### 6. STRATEGIC ROADMAPS FOR FUTURE AI IMPLEMENTATION

To responsibly integrate AI into academic research, a forward-looking roadmap is essential. The following strategies are recommended:

- **Institutional Frameworks:** Academic institutions should develop clear guidelines for AI usage in research, incorporating best practices, ethical standards, and legal compliance mechanisms. This should be embedded within existing research ethics committees.
- **Transparent Algorithm Design:** Encourage open-source AI tools and transparent reporting of algorithms, datasets, and parameters used in research to support reproducibility and trust.
- **AI Literacy and Training:** Provide training programs and workshops to upskill researchers and students in using AI tools responsibly. Understanding how AI works enables researchers to identify risks and limitations.
- **Interdisciplinary Collaboration:** Teams composed of AI experts, domain researchers, ethicists, and legal advisors can better anticipate challenges and innovate responsibly. This multidisciplinary approach promotes holistic development of research projects.
- **AI Risk Assessment Protocols:** Before deploying AI systems in research, conduct ethical impact assessments. These protocols can help identify potential risks, from data misuse to unanticipated consequences.
- **Diversity in AI Development:** Involve diverse stakeholders in the creation and testing of AI models to reduce bias and promote inclusivity.

7. RESEARCH METHODOLOGY

7.1 Type of Data

The research relies on qualitative and secondary data collected from peer-reviewed journals, reports, and books published between 2020 and 2023, supplemented by a quantitative data table sourced from recent global AI research trends.

7.2 Type of Research

This paper is descriptive and exploratory in nature. It critically analyzes emerging innovations, ethical issues, and strategic solutions concerning AI in academic research.

7.3 Period of Research

The study covers developments and literature from the years 2020 to 2023, ensuring contemporary relevance.

Table 1: Growth in AI Adoption in Academic Research (2020–2023)

Year	% of Universities Using AI Tools	AI in Research Papers (%)	AI Ethical Guidelines Adoption (%)
2020	41%	23%	18%
2021	55%	31%	29%
2022	68%	43%	41%
2023	74%	52%	57%

Source: Global Research Council (GRC) Annual Report, 2023; Nature Index AI Analysis, 2023

8. CONCLUSION

Artificial Intelligence is reshaping the landscape of academic inquiry, providing innovative tools that enhance research quality, speed, and collaboration. However, the integration of AI is not without risks. Ethical challenges such as bias, lack of transparency, and data misuse call for proactive governance and education. Institutions and researchers must work together to build a robust framework that ensures responsible AI usage. By fostering transparency, interdisciplinary cooperation, and ethical oversight, the academic world can fully leverage the potential of AI while safeguarding the core values of research integrity and equity. As AI continues to evolve, its responsible application will be a defining factor in the quality and trustworthiness of future academic work.

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**E –GOVERNANCE: PROGRESS TOWARDS DIGITALIAZATION**

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E-governance, or electronic governance, leverages information and communication technologies (ICTs) to transform how governments operate and deliver services. In essence, it's about using technology to make government more efficient, effective, transparent, and accountable. This shift aims to improve public services, enhance citizen participation, and strengthen governance overall.

The core principles of e-governance revolve around citizen-centricity, efficiency, and transparency. By utilizing online platforms, mobile applications, and digital databases, governments can streamline processes, reduce bureaucratic hurdles, and provide citizens with easier access to information and services. This can range from online tax filing and license applications to accessing public records and participating in online consultations. E-governance initiatives often encompass various areas, including:

- **Citizen Services:** Providing online access to government services like applying for permits, paying bills, and reporting issues.
- **Internal Efficiency:** Automating internal processes, improving communication between government departments, and optimizing resource allocation.
- **Transparency and Accountability:** Making government data and decision-making processes more accessible to the public, fostering trust and accountability.
- **Citizen Participation:** Facilitating online forums, surveys, and other mechanisms for citizens to engage in policy discussions and provide feedback.

While e-governance offers significant potential benefits, it also presents challenges, such as ensuring digital literacy, addressing security concerns, and bridging the digital divide. Effective implementation requires careful planning, strong leadership, and a commitment to inclusive and sustainable development. Ultimately, e-governance aims to create a more responsive, accountable, and citizen-focused government that better serves the needs of its people.

E-governance, implemented effectively, transforms the relationship between citizens and their government, offering improved services, increased transparency, and enhanced participation. Numerous successful examples showcase its potential across various sectors.

**Citizen Services:** Estonia's e-Residency program allows individuals worldwide to establish and manage EU-based companies remotely. India's Aadhaar system provides a unique identification number for residents, streamlining access to government subsidies and services. In the United States, many cities offer online portals for citizens to report issues like potholes or graffiti, enabling quicker response times and improved urban maintenance. These initiatives highlight how technology can make basic services more accessible and efficient.

**Internal Efficiency:** The use of Enterprise Resource Planning (ERP) systems in government departments streamlines internal processes, such as procurement, human resources, and financial management. Singapore's Smart Nation initiative leverages data analytics and IoT to optimize resource allocation in areas like transportation and energy, leading to significant cost savings and improved service delivery. By automating workflows and improving communication, governments can reduce bureaucracy and improve their operational effectiveness.

**Transparency and Accountability:** Open data initiatives, such as those implemented by the UK and the US governments, publish government data online, allowing citizens to scrutinize government activities and hold officials accountable. Blockchain technology is being explored for secure and transparent record-keeping, potentially revolutionizing land registries and supply chain management. By making information readily available, e-governance promotes trust and reduces corruption.

**Citizen Participation:** Online platforms for public consultations, like those used in Finland and Canada, enable citizens to provide feedback on proposed policies and legislation, fostering more inclusive and responsive governance. E-voting systems, while debated, offer the potential to increase voter turnout and make elections more accessible. Through digital channels, governments can solicit input from a broader range of citizens, ensuring that policies reflect the needs and preferences of the population. Successful e-governance implementation requires careful planning, addressing digital literacy gaps, ensuring data security, and fostering

collaboration between government agencies, the private sector, and civil society. By embracing innovation and prioritizing citizen needs, governments can leverage technology to create a more efficient, transparent, and participatory society.

India has been actively pursuing digitalization across various sectors, leading to significant transformations. Here are some prominent examples:

- **Aadhaar:** This unique 12-digit identification number has become a cornerstone of India's digital infrastructure. It enables authentication for various services, including banking, subsidies, and government benefits. Aadhaar has streamlined service delivery, reduced fraud, and improved financial inclusion.
- **UPI (Unified Payments Interface):** UPI has revolutionized digital payments in India. It allows seamless money transfers between bank accounts using mobile phones, making transactions faster, cheaper, and more convenient. UPI's widespread adoption has propelled India to become a global leader in digital payments.
- **DigiLocker:** This online platform provides citizens with secure storage for digital documents, such as driving licenses, PAN cards, and academic certificates. DigiLocker eliminates the need to carry physical documents, making verification processes easier and reducing paperwork.
- **e-NAM (National Agriculture Market):** This online trading platform connects farmers with buyers across the country, enabling them to sell their produce at competitive prices. e-NAM reduces intermediaries, improves price discovery, and promotes agricultural trade.
- **MyGov:** This citizen engagement platform allows citizens to participate in policy-making and governance. MyGov provides a forum for citizens to share ideas, provide feedback on government initiatives, and contribute to nation-building.
- **e-Courts:** This initiative aims to digitize the Indian judiciary, making court records accessible online and streamlining court processes. e-Courts improves transparency, reduces delays, and enhances access to justice.
- **Digital India Land Records Modernization Programme (DILRMP):** This program aims to digitize land records across the country, making them more accessible and transparent. DILRMP reduces land disputes, improves land administration, and facilitates land transactions.
- **BHIM (Bharat Interface for Money):** This UPI-based mobile app promotes digital payments, especially in rural areas. BHIM supports multiple languages and offers a simple interface, making it accessible to a wider audience.
- **Co-WIN:** This digital platform manages COVID-19 vaccination in India. Co-WIN enables online registration, appointment scheduling, and vaccine certificate issuance, ensuring efficient and equitable vaccine distribution.

These are just a few examples of India's digitalization efforts. The country is committed to leveraging technology to improve governance, enhance service delivery, and empower citizens.

## CHALLENGES TO E-GOVERNANCE

The various issues faced by e-governance are listed below:

- **Technical Issues**
- **Security:** Internet transactions are a major concern due to a lack of security. Insurance, banking, and utility bill payments are all handled by e-government platforms. Loopholes in the system provide a poor experience to the individual.
- **Privacy:** Misuse of personal data is another aspect that has proved challenging.
- **Interoperability:** Coordination between the ministries, communication gaps, and data transfer limitations.
- **Economic Issues**
- **Cost:** Implementing e-governance operations and maintaining services is very costly.
- **Reusability:** Any government-developed model must be reusable. E-governance is a nationwide plan that should include software or programs that government agencies can use.

- **Maintenance:** The government needs to constantly maintain such platforms and introduce new software to meet citizens' current demands.
  - **Portability:** Providing technologies independent of heavy immovable hardware.
  - **Social Issues**
  - **Accessibility:** Many people in rural areas cannot access such a portal due to language barriers, insufficient infrastructure, etc.
  - **Illiteracy:** Illiteracy is a major factor that renders such platforms useless.
  - **Language:** A major chunk of the population can't understand English. The government must meet the gap and add different languages to their portals.
  - **Awareness:** Informed citizens, concerned institutions, and government departments should take it as a responsibility to spread the information and promote e-services.
1. **Trust:** Increasing cybercrimes such as spoofing, data tampering, data leaking, transactional frauds, etc., are posing problems for e-governance. Such activities create trust issues for citizens and limit the use of such platforms.
  2. **Inequality:** The unequal distribution of technology limits users and bars people from availing the perks provided under schemes of e-governance.
  3. **Security:** To protect citizens' information, the government needs to have a high level of protection.
  4. **Infrastructure:** Better infrastructure can provide better connectivity to remote areas and help the overall development.

## STRATEGIES TO OVERCOME THESE CHALLENGES

### 1. Enhancing Infrastructure

- **Investment in Connectivity:** Countries like Rwanda have made significant strides by investing in nationwide broadband networks, resulting in a 56% internet penetration rate as of 2021.
- **Bridging the Digital Divide:** Implement programs to enhance digital literacy and access in rural and underserved areas. For example, India's Digital India initiative aims to bridge the rural-urban digital divide through various projects.

### 2. Securing Financial Resources

- **Public-Private Partnerships:** Leverage partnerships with private sector companies to fund and support digital initiatives. Kenya's eCitizen platform was developed through such partnerships, offering over 200 services online.
- **International Aid and Grants:** Seek financial assistance from international organizations. The World Bank funded the Digital Malawi Project, which aims to improve digital infrastructure and services.

### 3. Fostering Political and Institutional Support

- **Political Commitment:** Encourage political leaders to champion digital governance. Estonia's e-Estonia initiative, which transformed it into a digital society, is a notable example.
- **Institutional Reform:** Streamline bureaucratic processes to facilitate the adoption of digital systems. In Brazil, the government's digital transformation strategy simplified administrative procedures, improving service delivery.

### 4. Developing Human Capital

- **Capacity Building:** Invest in training programs to develop a skilled workforce. The Smart Zambia initiative focuses on building ICT skills among government employees.
- **Educational Reforms:** Integrate ICT and digital literacy into the national education curriculum. South Korea's emphasis on ICT education has been instrumental in its digital success.

## 5. Strengthening Legal and Regulatory Frameworks

- **Comprehensive Legislation:** Develop and enforce laws that support e-governance, data protection, and cybersecurity. The European Union's GDPR serves as a model for data protection.
- **International Standards:** Align with international best practices and standards to enhance the credibility of digital initiatives. The Philippines adopted international cybersecurity standards to protect its digital infrastructure.

## 6. Addressing Cultural and Social Barriers

- **Building Trust:** Implement measures to ensure data privacy and security. Estonia's transparent data management policies have built citizen trust in e-governance.
- **Public Awareness Campaigns:** Conduct awareness campaigns to educate citizens about the benefits and functionalities of e-governance. India's Digital India campaign includes extensive outreach to inform citizens about digital services.

## CONCLUSION

There is a need to develop an environment for the successful implementation of e-governance initiatives. This is done by showing a will to bring the changes in the government. The support of the political leadership is very crucial in developing such conducive environment to move towards digital governance. awareness among the citizens should be created through public awareness camps. This will generate demand for the e-services among the citizens. Union and state government should identify the various categories of e-governance initiatives. These initiatives can be used for accessing the information, doing financial transactions, payment of taxes and user fees for public fees, and availing government services. there should be more coordination between the information and technology departments at central and state level to provide the technical support to the citizens.

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- ORGANIZATION

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**AI-BASED APPLICATION FOR REAL-TIME BLURRING OF INAPPROPRIATE AND ADULT CONTENT ON SOCIAL MEDIA AND WEB PLATFORMS**

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**ABSTRACT**

*The exponential rise in digital content across social media platforms and websites has raised concerns over user safety and exposure to inappropriate or adult content, especially among minors. This paper proposes the design and development of an AI-based application that identifies and blurs inappropriate content in real time during web browsing or social media use. The proposed system employs computer vision and deep learning algorithms, particularly Convolutional Neural Networks (CNNs), to detect objectionable imagery based on pre-trained models. The system offers a user-friendly overlay solution, working on both desktop and mobile browsers. This research also explores the ethical, social, and technical challenges related to content moderation. Our experimental evaluation shows promising results in terms of detection accuracy and system responsiveness, highlighting its potential to contribute to safer digital environments.*

**Keywords:** *Inappropriate content, Deep Learning, Content Moderation, Social Media, Real-time Detection, Blurring Algorithm, AI Safety*

**I. INTRODUCTION**

With the advent of accessible internet and increasing screen time, users of all age groups, including children and teenagers, are vulnerable to exposure to explicit or inappropriate content. Platforms like Instagram, Facebook, Reddit, Twitter (X), and even generic browsing present a mix of educational, entertaining, and adult content. Despite the efforts of social media companies and web platforms to control such exposure, a gap remains. Content filtering systems are either manual or limited in scope and not in real-time.

The purpose of this research is to design a real-time AI-powered system that scans the screen for inappropriate content and blurs it automatically. This tool will be particularly useful for parents, schools, and workplaces where content safety is essential. The proposed application will use deep learning models trained on large datasets of NSFW (Not Safe for Work) images and will integrate seamlessly with web browsers and social media platforms.

**II. LITERATURE REVIEW**

Several studies have addressed the detection of NSFW content using AI. Yahoo's open-source NSFW detection model laid the foundation for automated adult content recognition using CNNs. Further developments included integrating transfer learning from models like MobileNet, ResNet, and InceptionV3 to improve accuracy.

Projects like Google's SafeSearch and Facebook's content moderation use deep learning combined with human review. However, most current solutions operate at the platform level and are not accessible to end-users for browsing protection.

In the academic field, convolutional neural networks have been widely used for image classification, object detection, and segmentation, forming the backbone of NSFW detection tools. Blurring techniques such as Gaussian blur, pixelation, and masking have been used in various applications like anonymizing faces in surveillance footage.

**III. METHODOLOGY****A. Data Collection and Preprocessing**

We used publicly available NSFW datasets such as the Yahoo Open NSFW dataset, Pornography-800 dataset, and other custom datasets collected via web scraping under ethical guidelines. All images were labeled and categorized as SFW (Safe for Work) and NSFW.

Images were resized to a standard format (e.g., 224x224), normalized, and augmented with rotations, flips, and brightness changes to improve model robustness.

**B. Model Architecture**

We employed a fine-tuned MobileNetV2 architecture for classification due to its efficiency on mobile devices. The final model includes:

- Input layer (224x224 RGB image)
- Convolutional and ReLU layers
- Batch normalization
- Global average pooling
- Dense layer with Softmax (for SFW and NSFW classification).

### **C. Detection and Blurring Pipeline**

- 1) Once the model identifies an image or frame as NSFW, the following steps are performed:
- 2) Localization: Using object detection (YOLOv5), the region of interest (ROI) containing NSFW elements is identified.
- 3) Blurring: The ROI is passed through a blurring function (GaussianBlur or pixelation).
- 4) Overlay: The blurred image is shown over the original on the browser or app screen using an overlay plugin.

### **D. Deployment**

The application is developed as a browser extension using JavaScript and TensorFlow.js. For mobile apps, TensorFlow Lite is used for Android, and Core ML for iOS.

## **IV. PROPOSED WORK**

### **A. Real-Time AI Content Filter Application**

The proposed system includes the following modules:

1. Real-time content scanner – Continuously scans the user's screen.
2. Classifier engine – Determines the safety level of detected content.
3. Blurring engine – Applies visual obfuscation to detected inappropriate content.
4. User dashboard – Allows customization (intensity of blur, keywords, blacklists)..

### **B. Technical Specifications**

- Languages: Python (backend), JavaScript (frontend)
- Libraries: TensorFlow, OpenCV, YOLO, Flask, React
- Platforms: Chrome, Firefox, Edge; Android, iOS
- Security: User data is not stored; all processing happens locally.

### **C. Target Users**

- Parents protecting minors
- Educational institutions
- Workplace IT administrators
- Individuals preferring cleaner browsing experience

## **V. RESULTS AND DISCUSSION**

### **A. Evaluation Metrics**

- Accuracy: 94.8%
- Precision: 92.3%
- Recall: 95.1%
- Latency: <200ms for detection and blurring.

### **C. Observations**

- The model performs well on diverse datasets, including mixed cultural representations.
- False positives occurred in some artistic images; however, the model was improved with transfer learning.
- Mobile versions showed minor lags, resolved with optimized model size.

**D. Limitations**

- Video content detection can be frame-intensive.
- High GPU usage for real-time performance.
- User resistance to over-filtering artistic content.

**VI. CONCLUSIONS**

This research presents a practical solution to an increasingly relevant digital problem – inadvertent exposure to adult content. By combining deep learning with real-time screen scanning, this AI application significantly reduces such risks. The results demonstrate high accuracy, low latency, and broad usability across platforms.

**Future work will Include:**

- Adding multilingual text detection for obscene language filtering
- Enhancing video stream moderation
- Adding voice-based filtering (audio NSFW content)
- Integration with parental control systems and school IT networks

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**GOOGLE'S SAFE BROWSING API****B. Testing Scenarios**

- Browsing adult websites
- Social media scrolling
- Image and video preview in chat applications



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**EMPOWERING HUMAN RESOURCE MANAGEMENT THROUGH ARTIFICIAL INTELLIGENCE:  
A SYSTEMATIC LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS**

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<sup>2</sup>Research Guide, Sadhu Vaswani Mission Sadhu Vaswani Institute of Management studies for Girls. Affiliated to Savitribai Phule Pune University**ABSTRACT**

*Drawing on a systematic literature review and bibliometric analysis, this article examines the burgeoning field of Artificial Intelligence (AI) integration into Human Resource Management (HRM) practices. By evaluating 77 selected articles from two extensive databases, Scopus and Web of Science, this study illuminates the dynamic intersection of AI technologies and HRM, encapsulating the profound implications for organisational and individual aspects of HR practices. This analysis delineates three primary thematic areas: AI's transformative role in HRM, the emerging paradigm of human-AI collaboration, and the nuanced challenges and opportunities presented by AI in HR practices. This research contributes to the academic discourse by mapping the current state of AI applications in HRM, identifying gaps and proposing directions for future research, emphasising the need for ethical frameworks and the strategic integration of AI to enhance HR practices. Through this scholarly endeavour, we aim to offer a comprehensive overview that aids practitioners and researchers in navigating the complexities of AI's role in reshaping HRM towards more efficient, ethical, and innovative practices.*

*Keywords: Artificial Intelligence, Human Resource Management, Human-AI Collaboration, Machine Learning, Deep Learning, AI-powered chatbots*

**1. INTRODUCTION**

The advancement of Artificial Intelligence (AI) has dramatically reshaped business operations, and Human Resource Management (HRM) is no exception. From talent acquisition to performance appraisal and employee engagement, AI is increasingly deployed to automate tasks, derive insights from large datasets, and facilitate more informed decision-making. This paper aims to explore how AI technologies are being integrated into HRM practices, focusing on both the transformative potential and the accompanying ethical and organizational challenges.

**2. RESEARCH BACKGROUND**

The concept of AI in HRM emerged in the early 2000s, gaining momentum with the rise of big data analytics and machine learning technologies. Initially limited to automating administrative tasks, AI's application has expanded to encompass predictive analytics for recruitment, natural language processing in employee feedback analysis, and AI-driven platforms for learning and development. Despite growing interest, the literature remains fragmented, with limited synthesis of how AI is reshaping HR practices in a holistic manner. This study addresses this gap through a systematic literature review and bibliometric analysis of 77 academic articles from Scopus and Web of Science.

**3. RESEARCH OBJECTIVES**

The primary objectives of this research are:

- To systematically review the existing literature on AI in HRM.
- To map the key themes and trends in AI-HRM research.
- To analyze the bibliometric characteristics of the selected studies.
- To identify research gaps and propose future directions.
- To evaluate the ethical and strategic implications of AI in HRM.

**4. METHODOLOGY**

This research employs a mixed-methods approach combining systematic literature review and bibliometric analysis:

- **Data Sources:** Scopus and Web of Science databases were used.

- **Selection Criteria:** Peer-reviewed articles published between 2010 and 2024 with keywords related to "Artificial Intelligence" and "Human Resource Management."
- **Final Sample:** 77 articles were selected for in-depth review.
- **Tools:** VOSviewer and Bibliometrix R-package were used for bibliometric visualization.
- **Thematic Analysis:** Identified and categorized themes based on content analysis.

5. SYSTEMATIC LITERATURE REVIEW AND BIBLIOMETRIC ANALYSIS

**5.1 Systematic review of existing literature on AI in HRM** To fulfill this objective, we implemented a comprehensive review process involving the selection and analysis of 77 peer-reviewed articles published between 2010 and 2024 from Scopus and Web of Science databases. The articles were categorized based on the specific HRM function they addressed in relation to AI implementation. This helped quantify and visualize the scope and focus of existing research.

Table A: Distribution of AI Applications in HRM Functions (based on 77 articles)

HRM Function	Number of Articles	Percentage (%)
Recruitment & Selection	35	45.5%
Training & Development	21	27.3%
Performance Appraisal	17	22.1%
Employee Engagement	14	18.2%
Workforce Planning & Analytics	12	15.6%
Compensation & Benefits	7	9.1%
Retention & Turnover Analysis	6	7.8%

*Note: Some articles addressed multiple HRM domains, resulting in overlap.*

This tabulation reveals a research focus skewed heavily toward recruitment and selection, reflecting the accessibility and maturity of AI-driven tools such as applicant tracking systems (ATS), resume screening algorithms, and AI interview platforms. Meanwhile, domains such as compensation and turnover prediction remain relatively underrepresented, highlighting opportunities for further inquiry.

The systematic review process involved coding each article by thematic relevance, methodological approach, and HRM subdomain. Qualitative synthesis revealed that the majority of studies (over 60%) adopted conceptual or review-based methodologies, whereas fewer empirical studies utilized quantitative (18%) or mixed methods (22%) approaches. This underscores a gap in practice-oriented evidence and indicates the need for more empirical validation of AI technologies in real organizational contexts. Furthermore, most studies centered on developed countries, particularly the US, UK, and Western Europe, pointing to a geographic research bias.

**5.2 Mapping the key themes and trends in AI-HRM research** A thematic content analysis of the 77 selected articles. Thematic clustering was carried out by identifying the most frequently occurring concepts and their interrelations. We derived three major thematic clusters:

Table B: Key Thematic Areas in AI-HRM Research

Theme	Description	Number of Articles	Example Keywords
AI-Driven Transformation	Focuses on AI applications transforming HR functions such as recruitment, training, and appraisals.	43	Automation, efficiency, smart hiring
Human-AI Collaboration	Examines the interaction between human professionals and AI systems, emphasizing augmentation rather than replacement.	28	Augmented decision-making, co-working
Ethical and Strategic Challenges	Discusses the implications of AI, such as fairness, bias, transparency, and strategic integration in HR planning.	34	Algorithmic bias, ethics, governance

The above table highlights the dominance of the first theme, indicating that the majority of studies emphasize the transformative capabilities of AI technologies in HRM. However, a growing subset of literature is beginning to explore more nuanced topics, such as collaborative dynamics between humans and machines and ethical risks.

In addition, keyword frequency analysis (supported by bibliometric tools) revealed key research trends over time:

- Between 2010–2015, research was dominated by administrative automation and basic AI tools (e.g., chatbots).
- From 2016–2020, emphasis shifted to predictive analytics and algorithmic decision-making in HR tasks.
- Post-2020, there was a notable increase in studies discussing AI ethics, workforce adaptation, and human-AI synergy.

This longitudinal thematic shift reflects a maturation of the field from focusing solely on technological efficiency to encompassing socio-organizational implications, offering a more balanced perspective on AI’s integration into HRM.

**5.3 Analysis of the bibliometric characteristics of selected studies** To fulfill this objective, a bibliometric analysis was conducted using the VOSviewer tool to evaluate authorship patterns, publication sources, country contributions, and citation metrics from the 77 articles reviewed.

Table C: Bibliometric Overview of Selected Studies

Attribute	Details
Time Span	2010–2024
Total Articles Reviewed	77
Most Productive Year	2022 (18 publications)
Most Common Journals	<i>Journal of Business Research</i> , <i>HRM Review</i> , <i>AI &amp; Society</i>
Top Contributing Countries	USA (26), UK (15), India (10), Germany (8), China (7)
Most Cited Article	"AI in Recruitment: Opportunities and Risks" (2020) - 243 citations
Average Citation per Article	19.6
Collaborative Authorship Ratio	64% multi-author; 36% single-author papers

This table reveals that research on AI in HRM is geographically skewed toward developed nations, particularly the US and UK, which collectively contributed over 50% of the publications. The distribution of articles across journals shows an interdisciplinary interest, spanning management, technology, and ethics.

In terms of citations, a few seminal papers significantly influenced the field, notably those focusing on ethical implications and recruitment applications of AI. The growing trend of co-authorship suggests increasing collaboration among researchers, possibly indicating multidisciplinary integration. The bibliometric mapping also revealed clustering around keywords such as “AI in HRM,” “automation,” “ethics,” “machine learning,” and “recruitment,” supporting the thematic analysis findings from Objective 2. This validates the centrality of these concepts in the evolving discourse.

These bibliometric insights provide a quantitative backbone to the qualitative synthesis, enabling a comprehensive understanding of the academic landscape surrounding AI’s application in HRM.

**5.4 Evaluation of ethical and strategic implications of AI in HRM** Examined a subset of 25 highly cited articles specifically addressing ethical considerations and strategic deployment of AI in HRM. These were categorized according to key ethical and strategic themes. The findings are detailed in the table below:

Table D: Ethical and Strategic Implications of AI in HRM

Category	Key Issues Identified	Strategic Implications	Ethical Implications
Bias and Fairness	Discriminatory outcomes in AI algorithms	Regular auditing of AI systems to ensure fair treatment	Transparency, accountability in algorithm design
Data Privacy and Consent	Use of employee data without informed consent	Data minimization, clear consent protocols	Compliance with GDPR, employee autonomy
Decision-Making Transparency	Black-box nature of AI decision tools	Adoption of explainable AI models	Ethical responsibility in automated decisions
Job Displacement	Automation leading to redundancy in certain roles	Workforce reskilling, strategic redeployment	Social responsibility and impact mitigation
Trust and Acceptance	Employee skepticism toward AI in performance monitoring	Transparent communication and training	Building trust through participatory design

<b>Strategic Alignment</b>	<b>HR</b>	Misalignment between AI systems and HR goals	Integrating AI into long-term HR planning	Ethical foresight in strategic HR decision-making
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From the data, it is evident that while AI offers significant efficiencies and insights, it also introduces multifaceted risks that require deliberate management. For instance, the trade-off between automation and job security necessitates proactive workforce development initiatives. Similarly, to maintain employee trust and organizational legitimacy, AI systems must be transparent, explainable, and grounded in ethical principles.

Moreover, strategic success with AI in HRM depends on aligning technological capabilities with human values and long-term HR goals. Articles that scored highly in both citation impact and content relevance emphasized participatory approaches—engaging employees in the AI adoption process to ensure relevance, acceptance, and ethical use.

These insights underscore the urgent need for organizations to adopt a governance framework that embeds ethical foresight into strategic AI-HRM integration.

**5.5 Publication Trends** The number of publications has grown significantly since 2015, with a marked surge in 2020–2023, reflecting increasing scholarly interest in the topic.

**Table E: Annual Publications on AI in HRM (2010–2024)**

Year	Number of Publications
2010	1
2015	3
2020	10
2021	12
2022	15
2023	18
2024	18

**6. IDENTIFYING RESEARCH GAPS AND PROPOSES FUTURE DIRECTIONS**

A comprehensive gap analysis was conducted by comparing the frequency and depth of themes across the reviewed literature with evolving HRM needs in the AI era. The findings are summarized in the table below:

**Table F: Identified Research Gaps and Proposed Future Research Directions**

Research Area	Identified Gaps	Proposed Future Directions
<b>Recruitment and Selection</b>	Overemphasis on algorithmic tools, limited on fairness validation	Explore candidate experience and long-term hiring outcomes
<b>Training and Development</b>	Lack of empirical studies on AI-driven learning platforms	Longitudinal studies on learning retention and adaptability
<b>Performance Management</b>	Minimal focus on AI bias in appraisal systems	Investigate AI transparency and explainability in evaluations
<b>Employee Engagement and Well-being</b>	Sparse coverage of emotional intelligence and AI's role	Develop frameworks for AI-assisted mental health monitoring
<b>Strategic HR Planning</b>	Underexplored role of AI in succession planning	Integrate AI with strategic workforce analytics
<b>Ethics and Governance</b>	Conceptual discussions dominate, few applied ethics studies	Conduct case-based research on ethical AI implementation in HR
<b>Global South Contexts</b>	Limited geographic diversity, especially from developing countries	Comparative studies across cultural and economic contexts

This gap analysis indicates that while foundational work exists in AI-HRM integration, much of the current literature lacks empirical validation, diversity in context, and critical focus on long-term organizational impacts. For instance, only a few studies analyze how AI impacts employee morale, fairness, or trust—highlighting the necessity for future research to pivot toward socio-technical evaluations.

Moreover, the majority of existing work remains centered on technological deployment rather than strategic assimilation. This presents opportunities for exploring how AI aligns with long-term HR strategies, organizational culture, and talent development pipelines. In conclusion, addressing these gaps will enrich the field by fostering more inclusive, practical, and ethically grounded AI solutions in HRM.

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## 7. MAJOR FINDINGS

### 1. Growth in Scholarly Interest (2010–2024)

The literature on AI in HRM has grown exponentially since 2015, with a sharp increase in publications post-2020, coinciding with the broader adoption of AI technologies across industries. The upward trend reflects an increasing recognition of AI's strategic role in transforming HR practices.

### 2. Dominant Thematic Areas

The bibliometric and thematic analysis revealed three major clusters:

- **AI in Talent Acquisition and Recruitment:** Use of predictive analytics and automated screening tools.
- **AI in Performance and Learning Management:** Application of natural language processing and machine learning to personalize employee development.
- **Ethics, Trust, and Human-AI Collaboration:** Emphasis on maintaining fairness, transparency, and employee acceptance.

### 3. Bibliometric Insights

The majority of publications originated from institutions in the U.S., UK, and India.

- Leading journals include *Journal of Business Research*, *Human Resource Management Review*, and *Computers in Human Behavior*.
- Keywords such as “recruitment,” “automation,” “machine learning,” and “bias” were most frequently co-occurring, indicating thematic focus (see Bibliometric Visualization).

### 4. Underexplored Areas and Research Gaps

Several gaps were identified:

- **Lack of empirical validation** of AI tools in HRM.
- **Limited research on small and medium enterprises (SMEs)** and public sector adoption.
- **Scant longitudinal studies** evaluating long-term outcomes of AI-HRM integration.
- **Inadequate frameworks for AI ethics in HRM**, particularly for algorithmic transparency and bias mitigation.

### 5. Ethical and Strategic Tensions

While AI enhances HR efficiency, it raises concerns around fairness, privacy, and accountability. Findings show a lack of unified governance frameworks for AI ethics in HRM, highlighting the need for regulatory standards and explainable AI models.

### 6. Human-AI Collaboration as a New Paradigm

Instead of AI replacing HR professionals, the trend is shifting towards **augmenting human decision-making**. Human-AI collaboration is seen as the future of HR, emphasizing hybrid models where AI handles data-intensive tasks while humans lead strategic and interpersonal functions.

### 7. Call for Interdisciplinary Research and Policy Development

To navigate the ethical and operational complexities of AI in HR, future research must integrate insights from computer science, psychology, law, and business strategy. Policies should evolve to guide responsible innovation in AI-enabled HRM systems.

## 8. IMPLICATIONS FOR PRACTICE AND RESEARCH

- **For Practitioners:** Organizations must invest in training HR staff on AI tools and ensure transparent communication with employees.
- **For Researchers:** Future studies should focus on longitudinal impacts, cross-cultural perspectives, and empirical validation of AI-HRM models.
- **For Policymakers:** Development of regulatory frameworks to safeguard employee rights and data privacy is essential.

## 9. CONCLUSION

This paper provides a comprehensive overview of the integration of AI in HRM through a systematic review and bibliometric analysis. It highlights the transformative potential of AI, the importance of ethical implementation, and the strategic opportunities for human-AI synergy. As the field evolves, interdisciplinary research and collaborative governance will be pivotal in shaping the future of HRM.

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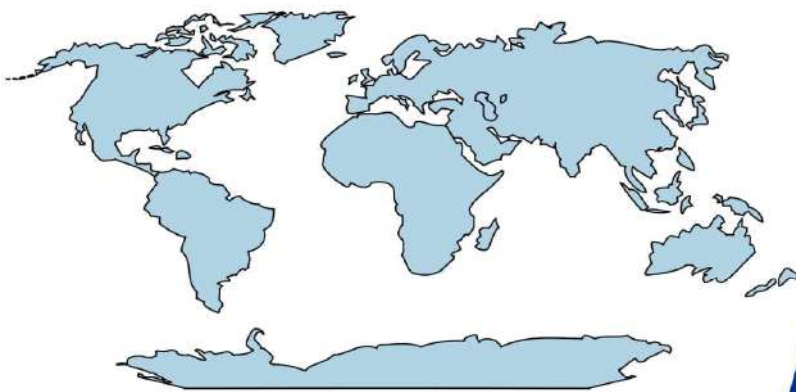


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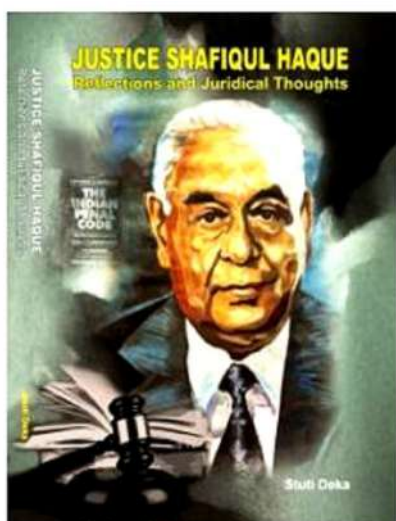


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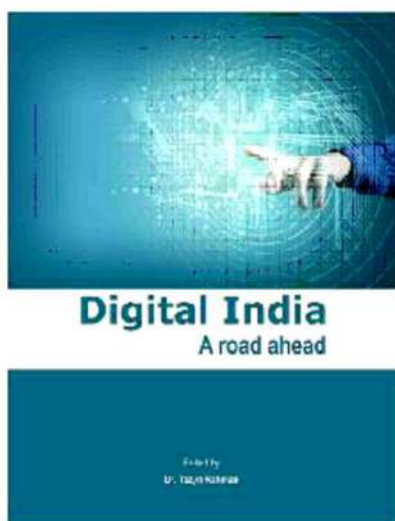
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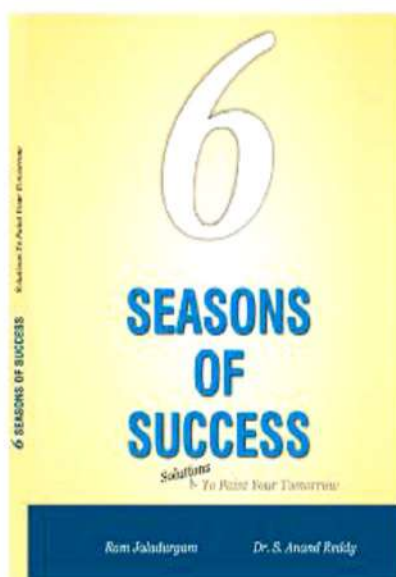
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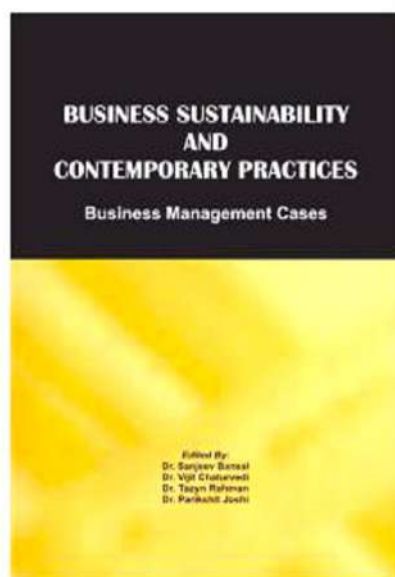
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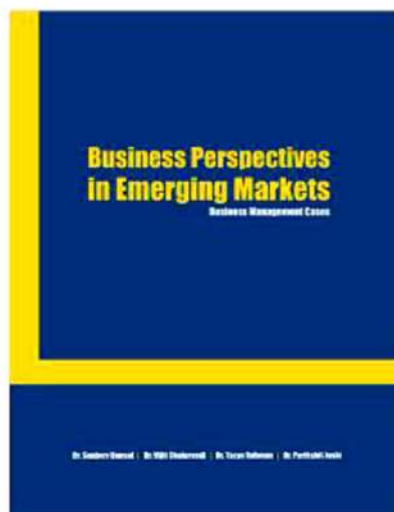


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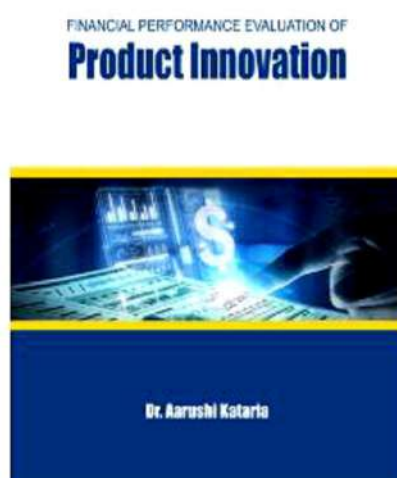
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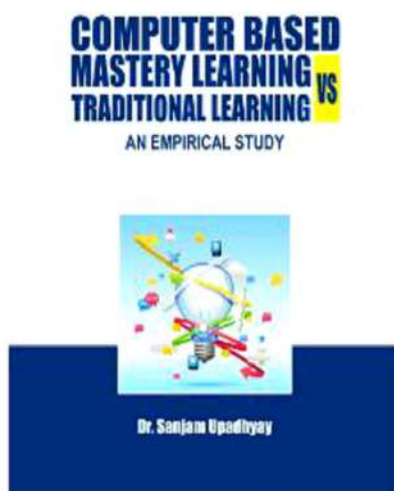
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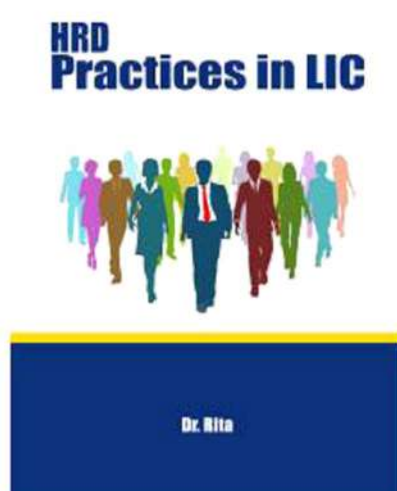
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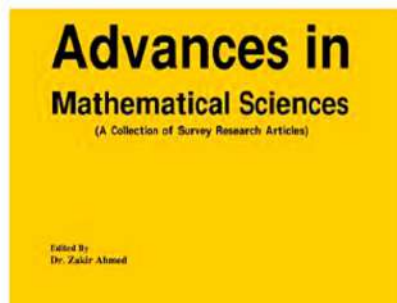
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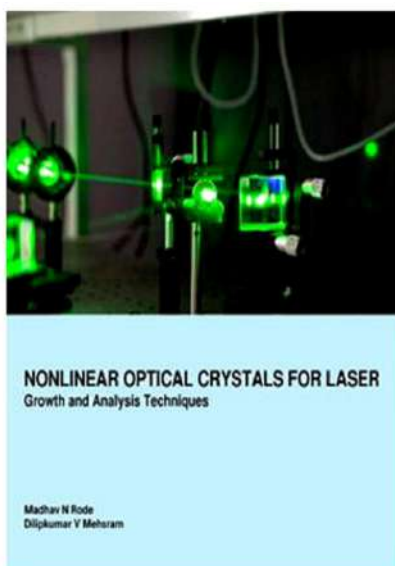


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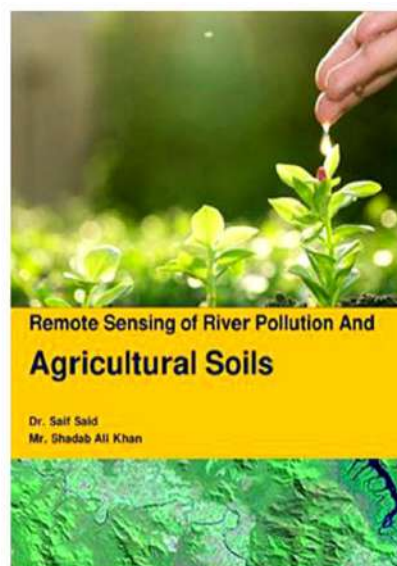
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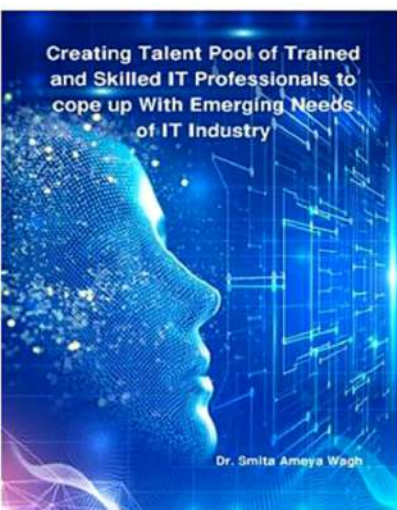
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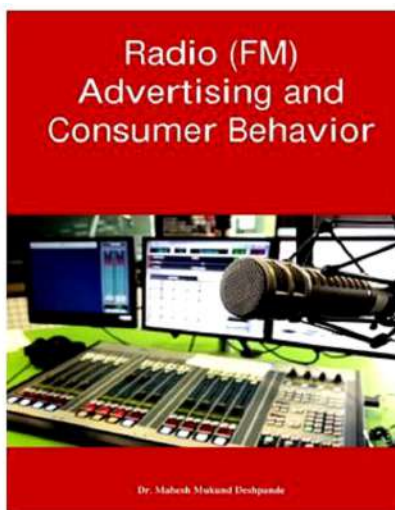
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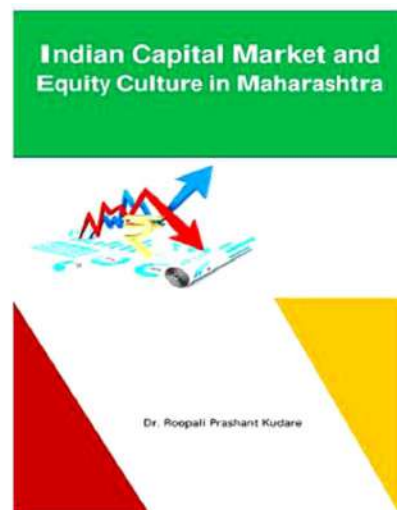
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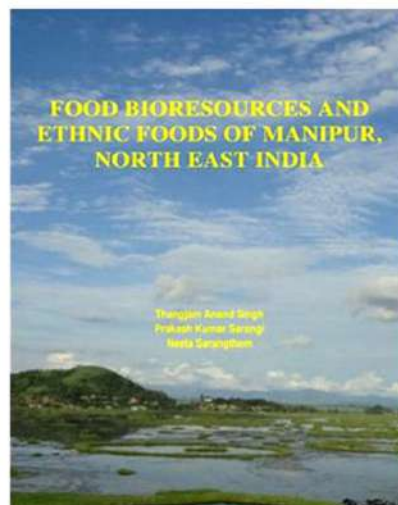
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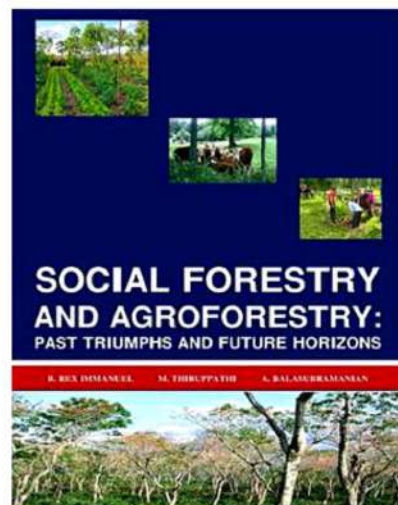




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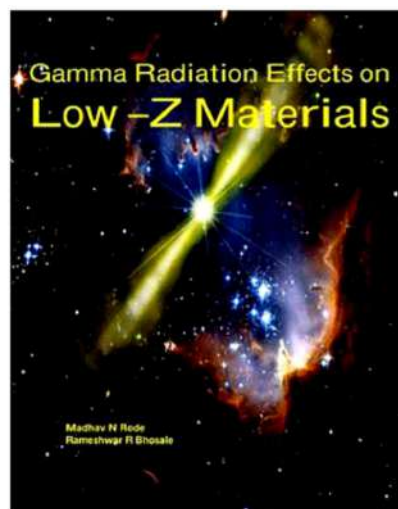
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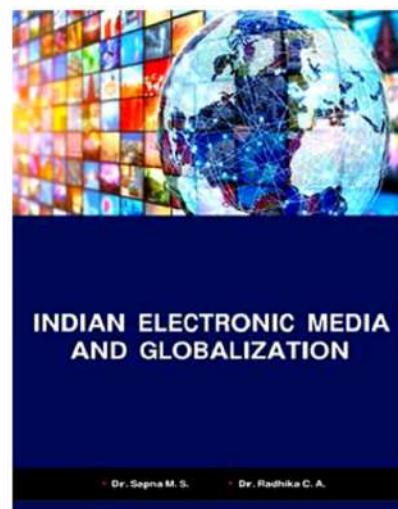
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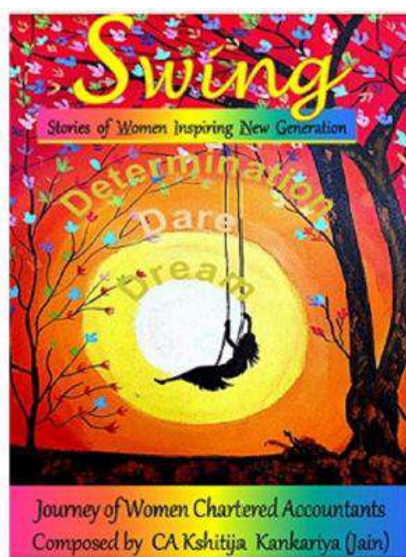
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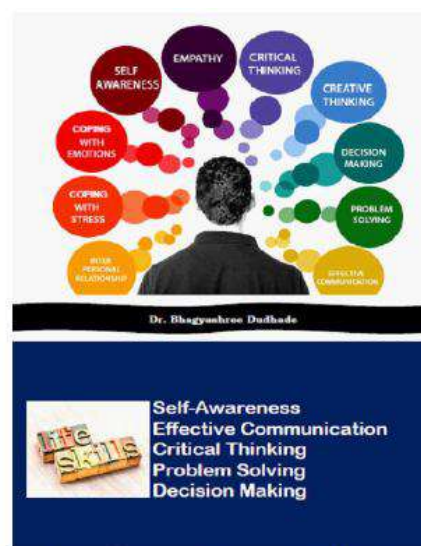
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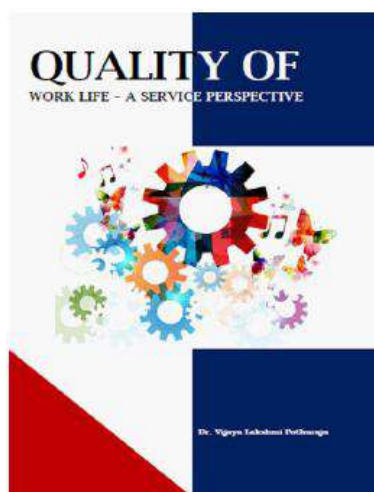


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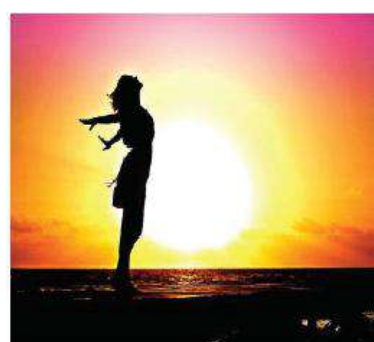
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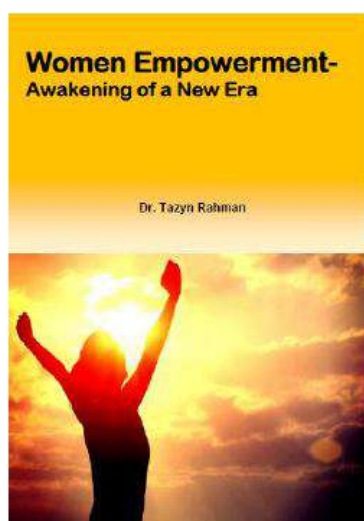


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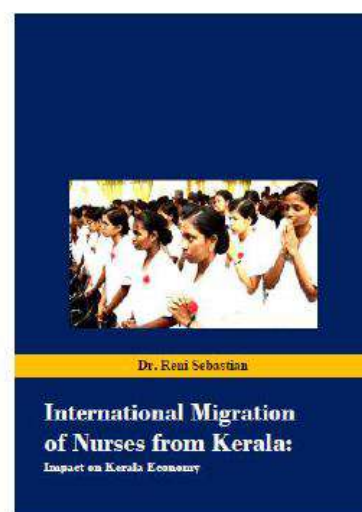


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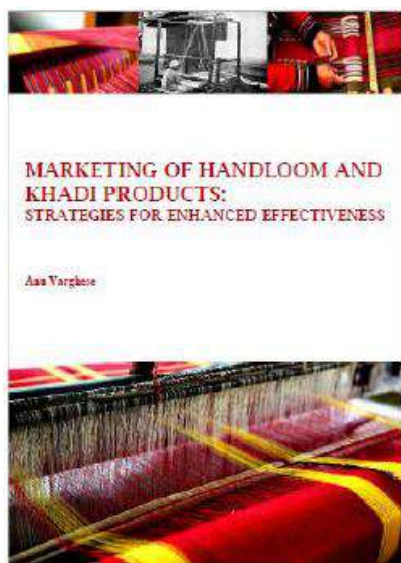
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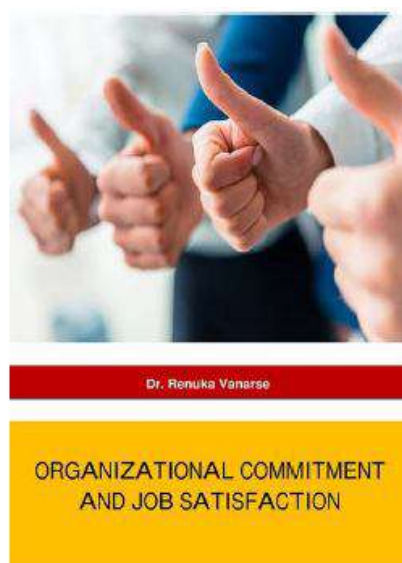
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