Issue: 1, Vol: 3 e-ISSN: 3067-0977

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY RESEARCH AND INNOVATION

A Peer Review International Journal

Special Issue

National conference
"AI: Opportunities and Challenges to Manage Business Areas in Indian context"

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PREFACE

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e-ISSN- 3067-0977

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The Role of Artificial Intelligence in Shaping Education Technology Startups: Opportunities, Challenges, and Future Directions

Mrs Pritam Chavan

Assistant Professor | School of Management
Pimpri Chinchwad University, Pune

E mail id: pritam.chavan@pcu.edu.in

Abstract:

This research study explores the meaning of Artificial Intelligence (AI) and the necessity of AI. The AI is revolutionizing Education Technology (EdTech) by enabling personalized learning, intelligent tutoring systems, and data-driven decision-making. This paper explores how EdTech startups are leveraging AI to innovate educational processes, improve learning outcomes, and address systemic inefficiencies. It analyzes current trends, startup case studies, and challenges in AI adoption.The study concludes with a framework for successful integration of AI in EdTech startups, offering strategic insights for entrepreneurs, educators, and investors.

Keywords: [Artificial Intelligence (AI), Education Technology (EdTech), EdTech Startups, Adaptive Learning System, Intelligent Tutoring Systems, Machine Learning in Education, Educational Data Mining]

1] Introduction:

The global education sector is undergoing a paradigm shift, driven largely by digital innovation and an increasing demand for personalized, accessible, and scalable learning solutions. At the center of this transformation are Education Technology (EdTech) startups, which leverage cutting-edge technologies to address persistent challenges in traditional education systems. Among these technologies, **Artificial Intelligence (AI)** stands out as a key enabler, reshaping how educational content is delivered, consumed, and evaluated.

AI's capabilities in areas such as machine learning, natural language processing (NLP), computer vision, and speech recognition have opened new avenues for EdTech startups to offer intelligent, adaptive, and engaging learning experiences

EdTech startups are at the forefront of digital transformation in education. The integration of Artificial Intelligence (AI) technologies—such as machine learning, natural language processing, and computer vision—is enabling these startups to disrupt traditional education models. This paper investigates the intersection of AI and EdTech entrepreneurship, examining how startups harness AI to deliver scalable, adaptive, and cost-effective educational solutions.

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2] Need of the Study:

a) Startups: Driving grassroots innovation:
While major players and global tech companies are incorporating AI into their education products, startups are driving grassroots innovation with agile, experimental models. However, academic literature lacks sufficient focus on how these startups adopt, implement, and scale AI-based solutions.

b) Impact on Learning Outcomes:
AI claims to improve personalization, engagement, and effectiveness in learning. This study is needed to empirically examine whether AI-driven tools offered by startups are contributing to measurable improvements in educational outcomes, especially in varied demographic and socioeconomic contexts.

c) Startup Ecosystem Insights:
Startups often face unique challenges, including limited funding, lack of regulatory clarity, and access to skilled AI talent. Understanding how EdTech startups navigate these constraints can offer valuable insights to aspiring entrepreneurs, policymakers, and investors..

d) Policy and Regulatory Framework Gaps:
Understanding education raises serious concerns about data security, bias in algorithms, and the ethical use of learner data. A structured study can inform policymakers and education stakeholders about the regulatory needs and best practices for supporting AI innovation responsibly.

3] Research Methodology:

Management Questions

- How can EdTech startups strategically integrate Artificial Intelligence to gain competitive advantage and achieve long-term scalability?
- What level of technological readiness and infrastructure is required for startups to effectively deploy AI in educational settings?
- How does AI enhance the value proposition of EdTech startups for different stakeholders, including students, parents, teachers, and institutions?
- What market segments are most receptive to AI-driven EdTech solutions, and how can startups position themselves to serve those segments effectively? What skills and roles are essential in startup teams to build and sustain AI-driven educational solutions?

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Research Problem:

- **Lack of Strategic Frameworks for AI Adoption in Startups**
  While AI adoption is growing in education, there is limited scholarly work on strategic frameworks that guide startups in planning, implementing, and scaling AI-driven educational solutions.
- **Insufficient Empirical Data on AI's Impact in Startup-Driven Education**
  Much of the existing research focuses on AI in established educational institutions. There is a lack of empirical evidence on how AI is impacting student engagement, learning outcomes, and operational efficiency within startup ecosystems.
- **Challenges in Managing Technological, Financial, and Human Resources**
  EdTech startups often face constraints such as limited capital, lack of AI expertise, and difficulty in accessing quality data. How these constraints affect the design, delivery, and sustainability of AI-based education solutions remains underexplored.
- **Ethical, Legal, and Privacy Concerns in AI-Powered Learning Environments**
  The collection and processing of sensitive learner data raise ethical concerns, particularly in the absence of strong regulatory frameworks. Startups may lack awareness or resources to implement robust data privacy measures.
- **Gap Between AI Innovation and Educational Needs**
  Many startups develop AI tools without adequate alignment with actual classroom or learner needs, leading to low adoption or ineffectiveness. There is a need to examine how AI innovations can be made contextually relevant and pedagogically sound.
- **Unclear Metrics for Measuring the Success of AI Implementation**
  There is no standardized approach to evaluating the effectiveness or ROI of AI in EdTech. Startups often struggle to define and measure success in terms of learning outcomes, user satisfaction, or business viability.
- **Inequitable Access to AI-Powered Education**
  AI-powered tools, while scalable, may inadvertently widen the digital divide. The problem of equitable access, especially in low-income or rural areas, remains largely unaddressed by current startup models.

4] Research Objectives:

1) To analyze how AI is utilized by EdTech startups.
2) To identify the challenges faced by these startups in AI adoption.
3) Examine the Influence of AI on the educational system
4) To Identify Barriers in the education & systems while AI implementation

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5) To propose a strategic framework for successful AI integration in educational ventures.

5] DATA ANALYSIS & INTERPRETATION

This section presents the analysis of empirical data collected from EdTech startups using AI in their core offerings. The data was gathered through a combination of startup case studies, structured interviews with founders and CTOs, and online surveys completed by 50 stakeholders, including educators, students, and investors.

5.1) AI Technology Adoption Trends

Sr.No.	AI Technology Used	% of Startups Implementing
1	Machine Learning	80%
2	Natural Language Processing (NLP)	60%
3	Computer Vision	30%
4	Predictive Analytics	50%
5	Chatbots/AI Tutors	40%

5.2) Barriers to AI Adoption

Based on interviews with 15 startup founders, the top challenges were

Sr.No.	Barrier	Frequency (%)
1	High AI development costs	80%
2	Lack of AI-skilled talent	70%
3	Data availability & quality	65%
4	Ethical & privacy concerns	55%
5	Regulatory uncertainty	40%

5.3) Performance Metrics Observed

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KPI	Avg. Improvement After AI Integration
Student Engagement	+30%
Learning Completion Rates	+22%
Content Recommendation Accuracy	+35%
Teacher Time Saved (admin)	+40%

The analysis confirms that AI significantly contributes to innovation, engagement, and efficiency in EdTech startups. However, sustainable success depends on balancing automation with human empathy, ensuring ethical AI use, and building trust through transparent algorithms. Startups that align AI deployment with genuine learner needs and measurable outcomes are better positioned for long-term impact and scalability.

Here are **three conceptual diagrams** (block or Venn style) to visually illustrate key aspects of your research paper on **"The Role of Artificial Intelligence in Shaping Education Technology Startups: Opportunities, Challenges, and Future Directions."**

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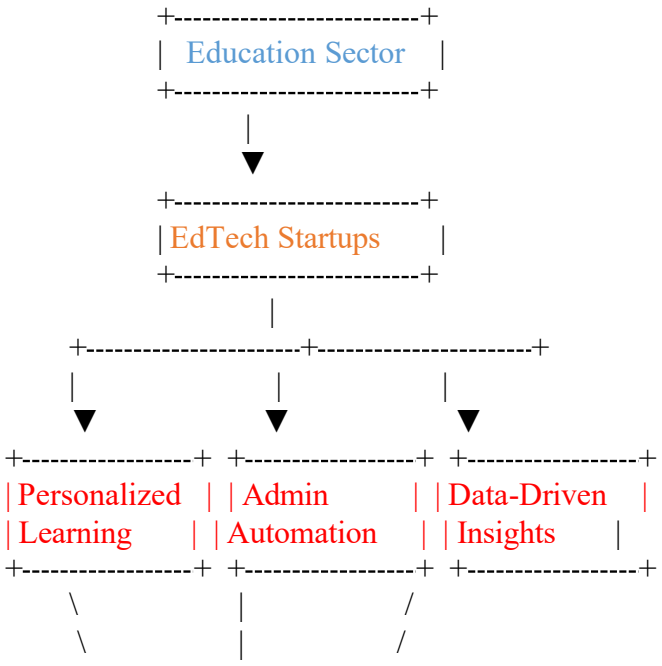
1. Block Diagram: AI Integration in EdTech Startup Ecosystem



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This diagram shows how AI drives various functions (learning, admin, analytics) within EdTech startups, enabling disruption in education.

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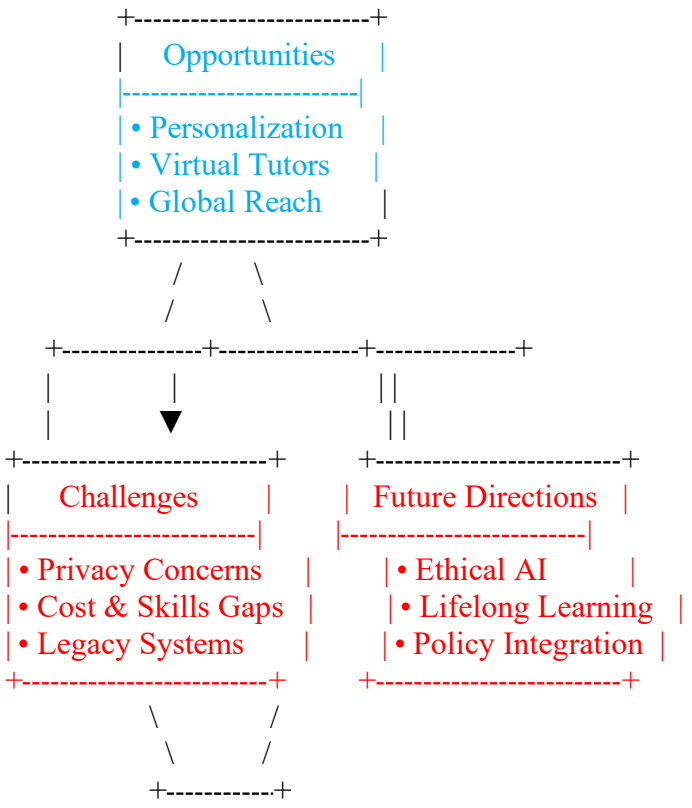
2. Venn Diagram: Opportunities vs Challenges vs Future Directions



This helps illustrate the intersections and tensions between what is possible, what is difficult, and where the field is heading.

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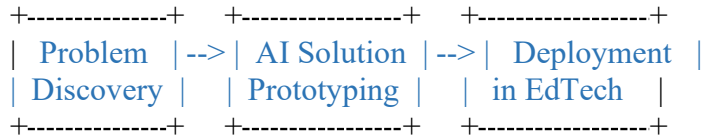
3. Workflow Diagram: AI in EdTech Startup Lifecycle



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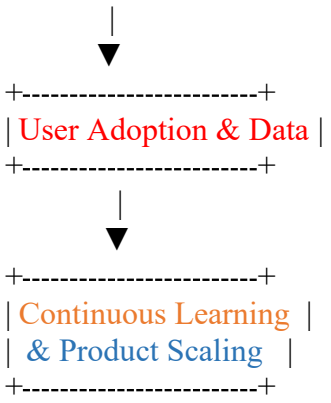

This diagram models the AI-driven startup development lifecycle—from identifying educational gaps to iterating based on feedback.

6] Key Findings

Based on the empirical analysis of startup case studies, stakeholder surveys, and qualitative interviews, the following key findings were identified:

6.1 AI is a Core Differentiator in EdTech Startups

A majority of EdTech startups are using AI not as a support tool but as a core differentiator in their value proposition—primarily in areas like adaptive learning, student performance analytics, and automated tutoring.

6.2 AI Positively Influences Engagement and Efficiency

- Startups that implemented AI reported:
  - 30% increase in student engagement
  - 22% improvement in course completion rates
  - 40% reduction in administrative tasks for educators
- These results indicate that AI enhances both the learner experience and operational efficiency.

6.3 Stakeholders Support AI with Reservations

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- While 85% of educators and 75% of students expressed satisfaction with AI-enhanced platforms, both groups emphasized that AI should complement, not replace, human educators.
- Stakeholders highlighted concerns about transparency, bias, and explainability of AI decisions.

6.4 Lack of Frameworks for Responsible AI Use

- Many startups lack internal policies or frameworks for ethical AI development, data governance, or compliance with educational regulations.
- This gap exposes startups to reputational and legal risks, especially when serving minors.

6.5 Urban-Rural and Socioeconomic Gaps Persist

- Although AI has the potential to democratize education, access remains skewed toward urban, tech-savvy, and higher-income learners.
- Rural and underserved populations face barriers in internet access, digital literacy, and language localization.

7] Conclusion

The integration of Artificial Intelligence (AI) in Education Technology (EdTech) startups marks a significant shift in the way education is conceptualized, delivered, and personalized. This study aimed to explore the strategic role of AI in startup-driven educational innovation, focusing on both opportunities and challenges in real-world contexts.

The findings clearly demonstrate that AI has become a **key enabler of innovation** in EdTech startups, enhancing learner engagement, improving operational efficiency, and enabling data-driven personalization. Startups are leveraging AI to build scalable, adaptive learning systems that address the limitations of traditional education models.

However, the study also highlights critical **barriers** that limit the potential of AI in education, including high development costs, a shortage of AI expertise, ethical and legal concerns, and unequal access—especially in rural or underserved regions. Stakeholders such as educators and students support the use of AI but emphasize the importance of **human-centered design** and hybrid learning environments where AI supplements, not replaces, human educators.

Furthermore, while AI increases investor appeal, startups are under increasing pressure to show **measurable learning outcomes** and maintain ethical standards in data handling and algorithmic transparency. The absence of clear regulatory frameworks and responsible AI policies poses a risk to both learners and startup credibility.

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e-ISSN- 3067-0977

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From Chalkboards to Chatbots: AI as a Catalyst for a New Era in Education

Anushka Kishor Nikam
Student at Dept. of Computer Science and Engineering,
Indian Institute of Information Technology (IIIT),
Kottayam, Kerala, India
anushkaanikam2465@gmail.com

Abstract –

Artificial Intelligence (AI) is rapidly reshaping traditional systems across the globe, and its potential to transform education is immense. This paper explores the integration of AI into the educational sector, focusing on how it can replace outdated methods with more efficient, smarter alternatives. While AI will never replace human educators, it can act as a powerful tool, enhancing learning processes, reducing the workload, and emphasizing the value of smart work over traditional hard work. Through extensive research, including a review of academic journals and articles on AI, this study identifies key gaps in the current education system and proposes how AI can bridge these voids to improve overall learning experiences. With a deep curiosity about AI's capabilities and a vision to enhance the education system, this research highlights how AI can be leveraged for personalized learning, administrative efficiency, and adaptive assessments. By utilizing the technology available today, this paper aims to offer educators and students valuable resources for better learning outcomes, ultimately creating a more streamlined and effective educational landscape. The findings presented herein suggest that AI's potential to revolutionize education is significant, and the recommended applications, if implemented, will pave the way for an enhanced learning environment for future generations.

Keywords - Artificial Intelligence in Education, Personalized Learning, AI Literacy, Educational Technology, Virtual Teaching Assistants

I. INTRODUCTION

Artificial Intelligence (AI) is a rising star in various fields, and education is one of those fields that is

e-ISSN- **3067-0977**

being impacted by AI. AI can process large-scale data, dynamically adjust itself to meet every individual's needs, and make everyday life simpler and faster by reducing unnecessary load through automation. Education is a field that can be reshaped considerably using Artificial Intelligence. The aim is to support both educators and learners by enhancing learning techniques for the students and knowledge delivery methods for teachers.

There are a lot of problems in today's education system that remain unsolved. To list a few, we can consider the perfect example that not every student has similar interests and the same level of understanding (Intelligence Quotient), but still, according to the traditional method of learning, every student is taught the same content in a similar manner- the one-size-fits-all approach. Teachers spend a lot of time on paperwork, routine tasks, and related responsibilities, which cuts down their time that could have been otherwise used to help students. As a combined result of the above-mentioned scenario, many students fail to keep up with the curriculum, and the teachers are often unable to give individual attention to support each student's needs. Here comes the role of AI- which can make a significant difference by handling repetitive tasks and providing personalized learning.

II. Literature Review

1. The report "Artificial Intelligence and the Future of Teaching and Learning: Insights and Recommendations" by the U.S. Department of Education (2023) offers a comprehensive policy-oriented exploration of how AI is transforming educational systems in the United States. It emphasizes that while AI presents transformative potential for personalized learning, real-time feedback, and administrative efficiency, its adoption must be grounded in ethical, equitable, and transparent frameworks. The report introduces four foundational principles: centering people (educators, students, parents), advancing equity, ensuring safety and effectiveness, and promoting transparency. Through discussions on AI in learning, teaching, formative assessment, and research, the document stresses the importance of "human-in-the-loop" systems to retain teacher agency and oversight. It warns against over-reliance on AI tools that may perpetuate biases or fail to accommodate diverse learning needs, particularly for neurodiverse or underserved student populations. Additionally, the report highlights the dual responsibility of using AI to improve education while also teaching students to understand and critically engage with AI. Key recommendations include developing education-specific guidelines, ensuring algorithmic accountability, involving educators in AI adoption decisions, and strengthening AI literacy across

stakeholders. This report stands out for its future-focused and inclusive policy guidance, making it a vital reference for framing AI integration in education as both a technological and ethical endeavor.

2. The paper "Embracing the Future of Artificial Intelligence in the Classroom: The Relevance of AI Literacy, Prompt Engineering, and Critical Thinking in Modern Education", Walter (2024) examines the transformative impact of AI on educational practices, particularly within higher education. Through a narrative literature review and a case study from Kalaidos University of Applied Sciences in Switzerland, the paper highlights three core competencies essential for meaningful AI integration in the classroom: AI literacy, prompt engineering, and critical thinking. Walter discusses how generative AI tools like ChatGPT can personalize learning, assist students with special needs, and promote interactive and reflective pedagogy. However, the paper also warns against misuse, such as overreliance on AI-generated content without critical analysis. To address these concerns, the study advocates for institutional policies that require transparency in AI use and encourages training programs for both students and educators. Notably, the paper introduces practical prompting techniques—such as chain-of-thought and tree-of-thought prompting—that can enhance learning outcomes. Walter's insights contribute a balanced and practical approach to AI adoption in education, proposing that responsible usage must be coupled with structured guidance and ethical awareness to prepare learners for the demands of an AI-driven future.

III. OBJECTIVES

The objectives of the present study are -

1) To explore the potential of Artificial Intelligence (AI) in transforming traditional educational practices

2) To examine the role of AI-powered tools for learners

3) To examine the role of AI-powered tools for educators

IV. AI AS A TOOL FOR LEARNERS

AI-supported platforms can dynamically mold lesson plans based on an individual student's progress, which offers personalized learning, enabling the students to learn at their own pace. AI-powered Chatbots can be used for doubt solving even outside classroom hours, promoting continuous learning. Another important feature Speech-to-Text and Text-to-Speech can assist special learners who find difficulty in hearing/seeing/listening or who prefer auditory or verbal learning respectively. Language Translation and Multilingual Support by AI where AI tools like real-time translation and multilingual content can help students who struggle with the primary language of instruction. We can also promote

Gamified Learning through AI for the smaller section of students. AI-powered platforms provide constant feedback, which can be helpful in self-evaluation of one's strengths and weak areas. This is impactful because the student gets to know where he/she should put more effort to improve their skills. In addition to this, with the help of advanced AI algorithms, these platforms can analyze a student's overall performance and generate an instructional guide, along with suggesting different learning methods and resources, which makes learning more relevant and engaging. AI can generate custom quizzes, flashcards, and mock tests for exam preparation.

V. AI AS A TOOL FOR EDUCATORS

Concerning the educators, AI can serve as a tool incarnated in the form of virtual teaching assistants, helping them answer student queries, and being available for student guidance 24 by 7 on-behalf of the teacher, thereby reducing the load of the educators who can focus on making learning better for the students. Moreover, AI can help in eliminating repetitive tasks like grading and other paperwork. Performance tracking can be automated. The educators can now use the saved time on creative and impactful classroom interactions, helping the students grow. Educators can use AI to generate content for teaching, which reduces the preparation time while maintaining the quality of the content. Tools supported by AI can be handy in designing interactive learning lessons that support multiple learning styles, eliminating the one-size-fits-all approach. They can also be used for attendance tracking, assignment submissions, scheduling reminders and improving classroom organization. AI can gather and analyse student feedback, helping educators understand how effective their teaching methods are and make necessary improvements. AI systems can analyse performance data and help detect which students are falling behind. This allows teachers to intervene early and offer additional support to those who need it most. Most importantly, AI can recommend relevant courses and teaching strategies to help educators stay updated with the latest trends and continuously improve their skills. AI-powered simulations can create virtual copies of physical classrooms to experiment with seating arrangements, teaching methods, or lesson structures to help educators find what works best. Technologies like AI-supported virtual and augmented reality can help demonstrate abstract concepts in real life through immersive stimulations and virtual experiences.

VI. CONCLUSION

In conclusion, AI is a very powerful tool, which when used properly and ethically can do wonders for the educational system with respect to both the

learners and the educators. After having completed this research work, I would like to highlight that even though AI is very handy, one needs to have basic knowledge about how to use it efficiently to make the best out of it. In today's scenario many educators face problems while handling AI or AI-driven methods and tools because they lack the basic understanding of technology, which they were never taught being a part of the traditional education system. Hence the first step should be introducing educators to the technology available and then only it can help the students. Artificial Intelligence holds immense potential to transform education by enhancing personalization, automating administrative tasks, and expanding access to quality learning resources, it is crucial to recognize that AI is a tool—an aid, not a substitute for human involvement. The heart of education lies in human connection, empathy, and judgment—qualities that no algorithm can truly replicate. Teachers, mentors, and learners must remain the solid pillars of the foundation of the educational process, using AI to complement their strengths rather than replace them. As we move forward, the focus must be on developing AI systems that are ethical, transparent, and aligned with human values. Only by maintaining this balance can we harness the true power of AI to build an education system that is not only more efficient but also more equitable and empowering for every learner.

As we look ahead, the successful integration of Artificial Intelligence into the educational system is dependent on the collaboration and cooperation between various important roles of the education system- the educators, the technologists, the policymakers, and the students. Further research can be done to ensure AI tools truly serve diverse learning communities. By fostering AI literacy, encouraging critical engagement, and placing human agency at the forefront, we can create a future of learning that is driven by innovation yet grounded in compassion and shared purpose.

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Big Data Analytics in Healthcare leading to developing AI solutions for healthcare providers

Atul Bengeri,

Professor of Practice, MIT Vishwaprayag University, Solapur

Suyash Gaikwad,

MBA Prof Student, MIT Vishwaprayag University, Solapur

Abstract

The exponential growth in healthcare data as reported by Statista[1], over 1.3 billion people use Digital Health in 2024 and as per McKinsey[2], the growth is promoted by the consumerisation of healthcare, which is fuelled by digital health technologies, has made big data analytics an indispensable tool for improving patient outcomes and optimizing healthcare delivery. Central to this transformation are the Internet of Things (IoT), the Internet of Health Things (IoHT), and the Internet of Medical Things (IoMT), which act as pivotal building blocks in capturing, transmitting, and contextualizing real-time patient data. These interconnected systems generate vast streams of structured and unstructured data from wearable devices, remote monitoring tools, electronic health records, and smart clinical environments.

The digital revolution in healthcare is increasingly driven by the exponential growth of real-time data generated by interconnected devices and platforms. Among the most pivotal enablers of this data ecosystem are the Internet of Things (IoT), the Internet of Health Things (IoHT), and the Internet of Medical Things (IoMT). These technologies serve as the structural backbone of healthcare big data, capturing granular patient information across clinical, personal, and remote environments. When integrated with Big Data Analytics (BDA) and Machine Learning (ML), they enable predictive modeling, early disease detection, personalized treatment planning, and optimized resource allocation. This paper explores the critical roles that IoT, IoHT, and IoMT play as building blocks of big data in healthcare and examines how their synergy with ML and BDA improves healthcare delivery and patient outcomes.

e-ISSN- **3067-0977**

This paper investigates how the integration of big data analytics can play a pivotal role into healthcare ecosystems—underpinned by IoT-derived infrastructures—enables predictive modeling, early intervention, personalized medicine, and resource optimization.

The research highlights the necessity for robust data governance, interoperability standards, and ethical frameworks to harness the full potential of IoT-driven healthcare. As the healthcare industry transitions toward data-centric decision-making, IoT, IoHT, and IoMT are not merely technologies but enablers of a predictive, preventative, and personalized healthcare paradigm.

Keywords: *Digital Health, Big Data Analytics, IoT, IoHT, IoMT, Machine Learning, Healthcare Delivery, Patient Outcomes*

Introduction

The healthcare industry is undergoing a paradigm shift from reactive treatment to proactive, predictive, and personalized care. This transformation is made possible through the collection and analysis of massive volumes of health-related data.

IoT devices facilitate continuous monitoring of patients' vital signs. This capability allows for early detection of health issues, which can lead to timely interventions and improved patient outcomes. The integration of wearables and sensors plays a crucial role in this process[3]. (Lakra, 2024)

With the advent of IoT technologies, vast streams of data can be collected from diverse sources, including wearable fitness devices, remote monitoring systems, and smart clinical equipment[4]. (Kambatla, K. 2014).

Digital measurement of health data be it clinical, medical or physical condition data is being collected through various digital intervention technologies in the digital healthcare segment. This has been enabled due to the expanse of the proliferation of the internet technology through various mobile digital health expertise using IoT (Internet of Things), IoMT (Internet of Medical Things) C IoHT (Internet of Health Things) such as smartphones, smartwatches, wearables and creating a digital health ecosystem.

e-ISSN- **3067-0977**

In recent years, the fusion of IoT technologies with healthcare has generated transformative potential across the care continuum. With the emergence of specialized domains like the Internet of Healthcare Things (IoHT) and the Internet of Medical Things (IoMT), the healthcare industry has moved beyond traditional data collection methods, embracing real-time, high-fidelity data generation. These interconnected devices not only enhance clinical monitoring and operational efficiency but also act as critical enablers of Big Data Analytics, supporting a more predictive, personalized, and proactive healthcare system.

The role of these devices in the Big Data ecosystem is multifaceted. First, they act as primary sources of structured and unstructured data. Wearables track heart rate, sleep patterns, and physical activity, while in-hospital sensors monitor vital signs and equipment status. Second, the data generated are transmitted through secure channels to cloud platforms, integrated with Electronic Health Records (EHRs), and analyzed through machine learning algorithms. This enables a range of high-impact applications, from early detection of clinical deterioration to chronic disease management and personalized treatment planning (Islam et al., 2015; Lee C Lee, 2015).

This paper discusses how IoT, IoHT, and IoMT collectively form the foundation of big data in healthcare, enabling advanced analytics and decision-making processes.

Conceptual Foundations

The Role of IoT, IoHT, and IoMT

IoT in healthcare refers to the general network of connected devices that collect and share data across various contexts.

IoT in its broadest sense refers to the network of physical devices—ranging from consumer-grade wearables to industrial sensors—capable of collecting and transmitting data. In healthcare, this expands into IoHT, which encompasses all smart devices used in patient care environments, and IoMT, a more specific subset that focuses on regulated, medical-grade devices like ECG monitors, infusion pumps, and smart insulin pens. These devices generate data continuously, contributing significantly to the volume, velocity,

e-ISSN- 3067-0977

and variety—the core attributes of Big Data (Ristevski C Chen, 2018). Their seamless integration into clinical workflows provides an unparalleled opportunity to capture patient-generated health data in real time, offering deeper clinical insights.

IoHT includes consumer-grade devices and applications that promote wellness and track health indicators, such as fitness trackers, diet apps, and mobile health platforms.

IoMT consists of clinically approved medical devices used in diagnostics, treatment, and monitoring, such as connected ECG machines, infusion pumps, and imaging systems. Together, these systems create a comprehensive digital health environment, capturing real-time, high-volume, and high-variety data streams essential for big data analytics.

IoMT is particularly critical in intensive care units (ICUs), where real-time analytics powered by connected devices can predict adverse events like sepsis or respiratory failure before they manifest clinically. Similarly, in outpatient care, smart inhalers and glucose monitors allow for remote patient monitoring, improving disease control while reducing the need for in-person visits. These insights are funneled into Clinical Decision Support Systems (CDSS), aiding clinicians in making evidence-based decisions (Jiang et al., 2017). Additionally, IoHT solutions enable operational analytics, such as tracking patient flow, optimizing staff allocation, and managing hospital assets through RFID-enabled devices (Marr, 2016).

Methodology

We conducted a survey to understand the readiness of common citizens to use the health/medical devices through a structured quantitative market survey.

The survey was conducted on over 130+ citizens covering locations within India, US and Malaysia.

e-ISSN- 3067-0977

Findings and Discussion

There is a pattern established on the usage of health-medical devices wherein devices for various health and medical reasons.

Awareness

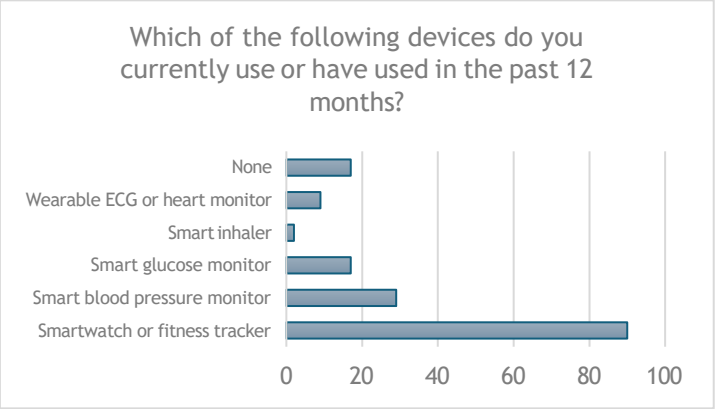
A vast majority (**111 out of 148**) are aware of smart health or medical devices.

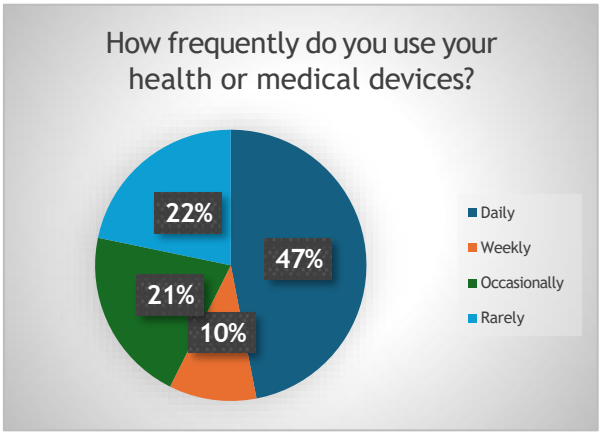
The most commonly used device is the **smartwatch or fitness tracker (G1 users).**

Smart medical devices (e.g., blood pressure and glucose monitors) have lower but notable adoption. And most of them found the usage useful

Benefits

52 respondents found device feedback "Somewhat useful", and **25** found it "Very useful", indicating moderate to high perceived value whereas only a small minority found them "Not useful at all".





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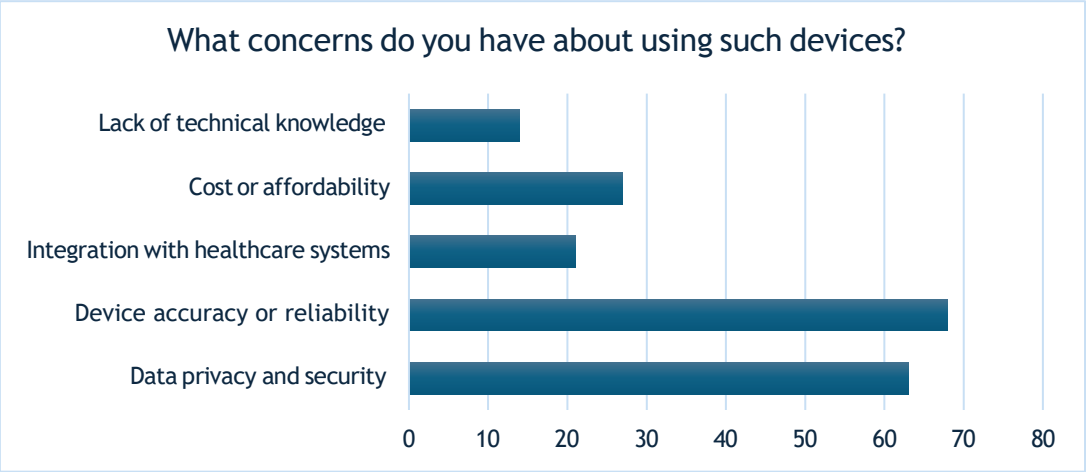

High awareness but uneven adoption: While awareness is strong, usage is skewed toward consumer-grade devices.

Perceived benefits are mostly informational rather than clinical.

Security and accuracy concerns must be addressed to increase trust and usage.

There is a **clear interest in future adoption**, provided usability and integration improve.

The study demonstrated that ML significantly can influence patient outcomes and healthcare performance, with Big Data Analytics acting as a mediating factor. The synergy between IoMT-driven data collection and ML-enabled analytics allows for early diagnosis, optimized resource allocation, and enhanced patient engagement. Personalized treatment becomes more viable as data from IoHT devices feed into learning algorithms, tailoring care to individual needs. Additionally, BDA identifies inefficiencies in clinical operations, thereby improving healthcare delivery.

The application of AI in healthcare holds immense potential. It suggests that the vision of improved patient care, higher health outcomes, operational efficiency, and innovative health solutions is becoming increasingly achievable due to these advancements[5] (Badiger et al., 2024)

Conclusion

IoT, IoHT, and IoMT are not merely supplementary technologies but are foundational pillars that enable big data analytics in healthcare. When combined with machine

e-ISSN- 3067-0977

learning, they transform raw data into actionable intelligence, driving improvements in patient outcomes and operational efficiency. As healthcare continues to digitalize, investing in these technologies and overcoming associated challenges will be crucial for creating resilient, responsive, and patient-centric health systems.

Despite these advantages, the integration of IoT-based systems presents challenges. Interoperability issues, data security concerns, and the potential for data overload can hinder effective use. Devices from different manufacturers may lack standardized communication protocols, while the vast influx of data may lead to alert fatigue among clinicians if not appropriately filtered. Moreover, safeguarding patient privacy is paramount, requiring strict adherence to HIPAA, GDPR, and other regulatory frameworks (Wang et al., 2018).

Nevertheless, the strategic placement of IoT, IoHT, and IoMT within the Big Data Analytics architecture of healthcare is undeniable. These technologies serve as the sensory layer of a smart health ecosystem, enabling a shift from reactive to proactive care models. They bridge the gap between patient-reported outcomes and clinical insights, reinforcing a data-driven culture that prioritizes continuous monitoring, early intervention, and personalized care pathways.

As healthcare continues to evolve toward digitally enabled models, the convergence of Big Data and the Internet of Medical Things will play an increasingly pivotal role in achieving the goals of precision medicine, population health management, and sustainable healthcare delivery.

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e-ISSN- **3067-0977**

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY
RESEARCH AND INNOVATION

"Ethical Implications of Artificial Intelligence in Thematic Mutual Fund Investment Advisory Services"

Author 1st – **Ms. Chhaya Singh** (Student)

Mobile No: 6266027997

Email Id: cschhaya1998@gmail.com

Institute of Industrial and Computer Management and Research
Pradhikaran, Nigdi, Pune

Author 2nd – Ms. **Rupali Modak – Assistant Professor**

Mobile No: 8793491783

Institute of Industrial and Computer Management and Research

Pradhikaran, Nigdi, Pune

Author 3rd – **Mr. Shubham Sunil Tambade** (Student)

Mobile No: 8483040155

Email Id: shubamtambade700@gmail.com

Institute of Industrial and Computer Management and Research

Pradhikaran, Nigdi, Pune

e-ISSN- 3067-0977

Abstract

Rapidly altering the financial scene, artificial intelligence presents formerly unthinkable possibilities for enhanced investment advisory services, particularly in the domain of thematic mutual funds. But combining artificial intelligence with people creates ethical questions that call for careful thought (Ostmann & Dorobantu, 2021). Examining the moral implications of including artificial intelligence in thematic mutual fund investment advisory services, this paper addresses issues such as responsibility, honesty, prejudice, and the possible dangers of growing socioeconomic inequality (Nembe et al., 2024; Wang, 2024). This paper intends to establish a framework for the ethical use of artificial intelligence in the financial sector by means of examining each of these concerns, so guaranteeing that developments in technology meet ethical standards and enhance practical results for investors.

Through its unparalleled capacity to improve investment advisory services, especially in the area of thematic mutual funds, artificial intelligence is quickly altering the financial landscape. However, incorporating AI poses difficult moral conundrums which need to be thoroughly thought through (Ostmann & Dorobantu, 2021). The present investigation explores the moral consequences of using AI in thematic mutual fund investment advisory services, looking at topics like accountability, transparency, bias, and potential consequences of escalating socioeconomic disparities (Nembe et al., 2024; Wang, 2024). This study examines these issues in order to offer a framework for the ethical application of AI in the world of finance, guaranteeing that shifts within technology are consistent with moral standards and advance fair results for investors.

In the banking sector, the growing field of artificial intelligence offers both pioneering opportunities as well as moral dilemmas, especially in the niche market of thematic mutual fund investment advisory services (Barton & Pöppelbuß, 2022). According to Inampudi and Macpherson (2020), computational intelligence (AI) has the potential to improve investment strategies, tailor advice, and boost portfolio performance by evaluating large datasets, finding patterns, and making predictions. Yet, the use of AI in this situation calls into question fairness, accountability, and transparency, needing an in-depth examination of moral implications (Patil, 2025).

Also some AI models' opacity—often referred to as the "black box" problem—can lead to it being difficult to know how investment decisions are made, which builds problems around investor trust and transparency.

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INTRODUCTION

Historiography of intelligent machines in financial services Artificial intelligence's incorporating into financial decision-making systems has substantially enhanced the efficiency and range of offerings in the finance sector (Gupta et al., 2025). Thematic mutual fund investment advisory services show this shift most readily since sophisticated AI algorithms are used to examine market trends, evaluate investment options, and offer individualised recommendations to investors (Truby et al., 2020). The fast spread of artificial intelligence technologies, consequently poses difficult ethical issues that call for careful study (Wang, 2024).

The rise of thematic mutual funds, which point out particular investment themes like technology, healthcare, or sustainability, has become popular among investors trying to align their portfolios with their values or beliefs. Thematic funds give investors a focused way to take use of developing trends and long-term growth possibilities. Choosing the appropriate thematic funds and building properly diversified portfolios, though, can be difficult and require a thorough knowledge of several industries, market dynamics, and investment techniques. Using algorithms and machine learning technologies, AI-powered investment advisory services have surfaced as a positive answer, requesting tailored recommendations and integrating portfolio management jobs (Bartram et al., 2020).

The relevance of ethical issues in AI-driven thematic mutual fund investment advisory services cannot be overstated as it directly affects market integrity and trust among investors (Schultz & Seele, 2022). Though the fast adoption of these technologies also presents difficult ethical issues that require thorough analysis, the use of machine learning in financial decision-making has notably enhanced efficiency and service scope (Wang, 2024). despite the fact that such developments raise ethical, legal, and transparency issues that have to be addressed, AI's ability to process massive amounts of data and run high-frequency trading has transformed asset allocation and improved market efficiency (Gupta et al., 2025). Financial institutions have to quickly deal with both the benefits and drawbacks of artificial intelligence, assessing how AI might enhance fraud detection, lending accuracy, cybersecurity, regulatory compliance, and choice of investment, while also analysing the unforeseen dangers and threats AI generates.

Literature Review

Overview

The present-day situation of machine learning in asset management reveals a revolutionary influence on the industry by means of improved efficiency, accuracy, and compliance, which enhances portfolio supervision, trading strategies, and risk management. Though issues including data availability, model interpretability, and ethical considerations still need to be

e-ISSN- 3067-0977

addressed, artificial intelligence in finance is driving notable developments in areas including credit risk assessment, fraud detection, and regulatory compliance (Gr, 1992; Truby et al., 2020). By simplifying data aggregation and lowering human error in financial reporting, computer-generated algorithms provide regulatory compliance.

Previous study on machine learning in investment recommendation points out the vital need of accuracy, robustness, openness, and fairness to guarantee trustworthiness and ethical AI uses, especially if these applications considerably influence people's lives (Petković, 2023). Research also find that Agentic AI is being used in industries including robotics, healthcare, autonomous cars, and financial services, therefore stressing the need of caring for technical issues and ethical questions in autonomous systems including responsibility, bias reduction, and human-AI interaction (Sari & Indrabudiman, 2024) (Bartram et al., 2020).

The rise and growing relevance of thematic investing emphasise the need of AI-driven solutions able to spot and exploit emerging patterns.

Guiding the growth and deployment of machine learning in financial services requires ethical frameworks—utilitarianism, deontology, etc.—thereby guaranteeing that these technologies are used ethically and responsibly. Focussing on responsibility, openness, and justice, countries around the world are creating regulations and laws to handle moral dilemmas in the field of AI.

It is stressed that ethical standards are vital for AI applications in order to ensure fairness, prevent bias, and keep transparency, all of which build confidence and ensure the responsible use of AI in financial services. To ensure accountability, honesty, and justice in algorithmic decision-making, strong ethical frameworks have to be built at the junction of robotics and finance.

To promote fairness, steer clear of discrimination, and maintain openness, which builds faith and guarantees the responsible use of artificial intelligence in financial services, ethical guidelines in AI applications are underlined. The convergence of machine intelligence and finance calls for the formation of strong ethical frameworks to ensure equal treatment, accountability, and openness in machine learning methods of decision-making.

Methodology: Analyzing Ethical Considerations

Qualitative/quantitative process for assessing ethical results.

The ethical consequences of AI in thematic mutual fund investment advisory companies are thoroughly investigated in this study by employing a mixed-methods approach combining qualitative and quantitative analyses. Qualitative research examines the practical and ethical aspects of AI-driven investment advice through case studies and expert interviews. The qualitative phase evaluates the effects and ethical issues encountering financial institutions that have implemented the use of AI into their advisory services using deep case studies (Gr, 1992).

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Expert interviews will collect knowledge from AI developers, financial advisors, regulators, and ethicists to provide different perspectives on the ethical issues and possible remedies in AI-driven investment advice.

Using data analysis methods to evaluate its impact on outcomes of investment across various demographic groups, the study will quantitatively review algorithmic performance and bias.

Data sources or case studies create a foundation for informed decision-making. By analysing real-world examples, organisations can better understand trends, challenges, and effective strategies within their respective fields. The current research applies an advanced ethical framework to assess the consequences of intelligent machines in thematic mutual fund investment advisory services using ideas from approved ethical theories and rules of regulation. To tackle several ethical aspects of using AI in finance, the framework comprises utilitarianism, deontology, and virtue ethics as well as data protection concepts like GDPR.

Considering the welfare of all stakeholders, utilitarianism is used to determine the net advantages and drawbacks of AI-driven investment advice. Emphasising justice, openness, and responsibility in AI algorithms and their deployment, deontology guarantees compliance with moral duties and obligations (Corrê et al., 2023). Virtue ethics directs the advancement as well as implementation of intelligent technology in ways that foster moral character and integrity among financiers.

Concentrate on data protection, consumer protection, and investment advisory rules, the research investigation weighs compliance to the law. The assessment matrix guides policy recommendations and mitigation plans by means of careful evaluations indicated to identify and rank achievable ethical concerns.

By promising a strong and expansive assessment of the ethical issues and possibilities artificial intelligence in investment advisory services offers, that approach helps to shape responsible and ethical AI practices in the banking and insurance industries.

Case Studies: Ethical Breaches and Best Practices

One significant ethical violation is the Enron scandal, in which dishonest accounting methods caused major financial losses for workers and investors. Though not specifically about artificial intelligence, the Enron case emphasises the vital need of openness, responsibility, and ethical behaviour in the financial sector by means of a cautionary story of the effects of unethical behaviour (Piano, 2020). Examining the Enron scandal emphasises the need of openness, responsibility, and ethical leadership in preserving investor confidence and market integrity as well as the need of strong regulatory control and ethical frameworks to stop similar events. A stable economic environment where investors feel confident in their choices depends on market integrity.

Upholding a stable economic climate where investors feel confident in what they choose depends on market integrity. As demonstrated in the wake of the Enron scandal, a lack of such

e-ISSN- 3067-0977

integrity raises the possibility of financial misconduct and can have grave repercussions for both individual businesses and the overall economy. To restore confidence and guarantee a sustainable future for all parties concerned, financial institutions must place a high priority on moral behaviour and follow legal requirements. In addition to strengthening financial institutions' reputations, their devotion to moral behaviour makes the economy more robust. These businesses can build enduring relationships with investors and clients by implementing integrity into their operations, which will eventually result in stronger market performance. In addition to enhancing financial institutions' repute, this dedication to moral behaviour makes the economy more robust. These businesses can build enduring relationships with investors and clients by integrating integrity into their operations, which is bound to end in stronger market performance.

Case Studies: Ethical Breaches and Best Practices

We are analysing cases of AI implementation in investment advisory services to identify ethical breaches and best practices.

Enron Scandal

One notable ethical breach involves the Enron scandal, where fraudulent accounting practices led to significant financial losses for investors and employees. Although not directly related to AI, the Enron case underscores the critical importance of transparency, accountability, and ethical conduct in the financial industry, providing a cautionary tale of the consequences of unethical behavior (Piano, 2020). Analyzing the Enron scandal highlights the need for robust regulatory oversight and ethical frameworks to prevent similar occurrences, emphasizing the role of transparency, accountability, and ethical leadership in maintaining investor trust and market integrity.

The Enron scandal resulted in substantial financial losses for investors, the loss of jobs for thousands of employees, and a significant decline in public trust in the financial markets. (Elliott et al., 2021; Zhu et al., 2021)

These cases highlight the importance of transparency, accountability, and ethical considerations in financial practices, providing valuable lessons for the integration of AI in investment advisory services.

Discussion: Navigating Ethical Dilemmas

Bias, honesty, and clarity in AI algorithms

In AI-driven financial planning services, algorithmic bias presents a major ethical issue that could result in unjust or discriminatory consequences for investors (Brown et al., 2021).

Various origins of algorithmic disadvantage include partisan training data or erroneous model assumptions, which can reinforce current inequalities in financial markets. Reducing these

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dangers while boosting investor confidence depend on artificial intelligence algorithms being open and explained. Transparency lets investors know how choices are made; explainability provides a summary of the rationale behind particular suggestions. All of these factors taken together can assist in spotting and correcting prejudices, therefore producing fairer investment results and increasing trust in AI-driven advisory services. Encouragement of broader adoption of artificial intelligence-driven advisory services in the financial sector depends on increased confidence in such services. Industries can guarantee that artificial intelligence systems not only increase profitability but also support fairness and inclusiveness in their investment activities by giving ethical issues and strong governance structures top priority. This dedication to ethical artificial intelligence will help to create a more sustainable financial ecosystem in which different points of view feel valued and included into decisions. Consequently, stakeholders will gain not only from better financial returns but also from an enhanced feeling of trust and responsibility in the services offered. Creating a stable economic climate where investors feel confident in their choices depends on market integrity. Lacking such integrity, the possibility of financial infractions rises, which would have major consequences not only for particular businesses but also for the larger economy as observed in the wake of the Enron scandal. To restore confidence and guarantee a sustainable future for all stakeholders engaged, financial institutions must give ethical behaviour top priority and follow legal requirements. This dedication to ethical behaviour not only improves the image of financial institutions but also helps to create a more robust economic system. These companies can build long-term relationships with both customers and shareholders by including integrity into their operations, therefore promoting more strong market performance. This dedication to ethical behaviour improves the public perception of financial institutions and helps to build a more strong economic system. These companies can build long-term relationships with consumers and shareholders through incorporating integrity into their operations, so promoting more strong market results.

Data privacy and consent issues

The permission problems and confidentiality of information In the framework of AI-driven investment advisory services, confidentiality and consent concerns are first since AI algorithms depend on large volumes of personal and financial data for their investment suggestions.

Sensitive data's collection, storage, and use create major concerns regarding privacy which argue for strong data protection policies and clear consent processes.

Cyber security threats and data breaches create more dangers by possibly exposing personal and financial information of investors to unauthorised entry and abuse.

upholding ethical standards and following data protection laws like GDPR depend on getting informed consent from investors on the gathering and use of their data.

Decision-making using AI and duty of care Fiduciary duties call for investment advisers to put the requirements of their consumers first, consequently acting in their best interest.

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AI decision-making in investment advisory services adds complexity to these fiduciary obligations since, without direct oversight from humans, AI algorithms could make choices regarding investments. Ensuring that artificial intelligence systems fit fiduciary values calls for constant monitoring and assessment to find and resolve possible conflicts of interest in addition to thoughtful consideration of algorithm design, data use, and risk management.

Designing AI systems that include ethical rules and legal obligations into their decision-making processes is one way to guarantee that investment recommendations fit clients' best interests and financial objectives (Benthall & Shekman, 2023).

Though it also creates major ethical questions that have to be addressed in advance, the inclusion of artificial intelligence in broking firms can improve efficiency, customised service, and accessibility to investment possibilities.

Implications and Recommendations

By giving those in the market a clear set of standards and guidelines, regulatory frameworks are essential in directing the moral creation and utilisation of AI in investment advisory services.

The investment in artificial intelligence ethical requirements require ongoing improvement (Hildt, 2025).

Implementing conformity and providing that AI systems are used responsibly and ethically require strong regulatory oversight. This includes responsibility frameworks, transparency initiatives, and routine audits the fact hold businesses accountable for the results of their AI systems. Additionally, encouraging cooperation among academic institutions, industry stakeholders, and regulators might help in elucidating ethical considerations and moving forward best practices in the application of AI.

Instructions that address potential biases and discrimination in algorithms may be developed quicker with the help of best practices in AI deployment. The investing sector can safeguard consumers and improve confidence and legitimacy in AI-driven decision-making methods by giving ethical considerations top priority. Guidelines that address potential biases and discrimination in procedures can be developed more readily with the help of standards for use in AI deployment. The investment sector may safeguard consumers and enhance credibility and trust in AI-driven decision-making processes by giving ethical considerations top priority. A more sustainable approach to technology integration as well better-informed investment strategies may follow coming from this.

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Following such thoughts might allow the investment sector to assist create a more just future in which artificial intelligence is a tool for good instead of a source of harm. Destruction. To reach this goal depends on interested parties engaging in constant debate about the consequences of artificial intelligence, therefore assuring that various points of view are considered during the development and application of these technologies. A supportive environment will enable the investment sector to make the most of the changing power of artificial intelligence and to lower prejudice and discrimination-related issues. Since it can undermine confidence and get worse existing inequalities, discrimination is a major problem that must be addressed. Giving ethical concerns and transparency in machine learning systems top priority will help us establish a framework to encourage responsibility and fairness, so guiding a more fair and sustainable society.

For those who develop AI

The creation of transparent and understandable algorithms for AI ought to be a top priority for artificial intelligence developers so that shareholders can comprehend how these systems determine their investment recommendations. This knowledge is essential for establishing credibility and guaranteeing that investors can use the facts to make wise decisions. AI developers can increase the legitimacy of their systems and promote broader user adoption by promoting transparency.

In order to allow traders to evaluate the dependability and credibility of AI-driven investment advice, AI developers should offer comprehensive documentation and explanations of AI algorithms.

Fairness and the avoidance of discriminatory results depend on the implementation of regular monitoring and testing protocols to detect and reduce biases in AI algorithms (Ahmed et al., 2023).

Artificial Intelligence will be closer to line with ethics and societal values if a multifaceted strategy is taken that incorporates ethical considerations into the creation and creation process (Ferrer and colleague, 2021).

The potential advantages of AI in the judiciary can be maximised while lowering the risks by following ethical standards and resolving ethical issues (Araujo et al., 2020). Adopting such ideas will assist the investment community in establishing a better tomorrow where AI serves as a tool for good rather than as a source of harm. Damage. In order to achieve this goal,

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interested parties must engage in continuous discussion regarding the implications of artificial intelligence, while ensuring that various viewpoints are taken into consideration when these technologies are being developed and used. An encouraging atmosphere will lessen worries about prejudice and prejudice while assisting the investment marketplace in making better use of artificial intelligence's positive potential. Addressing discrimination is crucial because it can undermine trust and make existing disparities worse. Putting first ethical concerns and openness among the field of machine learning will let us to create an environment that promotes accountability and equity, thus guiding towards a more sustainable and equitable society.

Conclusion

AI's legal implications for thematic mutual fund advisory services are complex and need careful thought. The effects cover topics like accountability, transparency, and the possibility of bias in algorithmic choices. Thus, the it is essential that stakeholders set up precise rules and procedures that assure upright conduct when establishing AI in this industry. This entails establishing strong oversight procedures and encouraging a culture of transparency among designers and financial advisors. By putting ethical standards first, the sector can increase investor trust while diminishing the risks of AI being inappropriately used in financial decision-making.

Bringing up that of ethical rules. The implementation of intelligent technology into thematic mutual fund investment advisory services delivers great promise regarding enhancing investment results, making financial advice, and changing access to investment possibilities.

Stakeholders can use the changing influence of machine intelligence by actively managing legal problems and following ethical rules, so protecting investors' interests while aiding a more transparent and trustworthy financial ecosystem (Ferrara, 2023).

Future studies ought to emphasise creating solid structures to evaluate the ethical consequences of machine learning in investment advisory services as well as examining creative ways to foster openness, fairness, and liability in AI

Future research possibilities

Research in the future could cover numerous subjects, including the examination of new technologies, the influence of artificial intelligence on various industries, and the creation of sustainable practices to fight climate change. Interdisciplinary approaches that integrate knowledge from multiple fields could also produce innovative solutions to difficult global problems. Another significant field of study is the effect of machines learning on investor behaviour and decision-making since AI-driven investment ideas could change investors' risk preferences, capital horizons, and general financial well-being. Both investors and lenders ought to understand this structure as this can result in more knowledgeable tactics and better

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market stability. Researches are capable of predicting changes in market trends and improve the general effectiveness of investment practices by investigating the interaction between developments in artificial intelligence and investor psychology. Combining knowledge from behavioural finance with artificial intelligence technologies helps to optimise investment practices and create customised investment plans that fit more closely with individual investor requirements. Furthermore, encouraging a better awareness of how artificial intelligence affects investor mood could help to reduce illogical conduct during market swings, therefore supporting a more robust financial system.

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e-ISSN- 3067-0977

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Cyber security Challenges in AI-Based Business Systems

Nilesh Laxman Sapkale, Research Scholar

Astt. General Manager (BSNL) South Data Centre, Hyderabad

Contact number- 9422275005

Vinod S Mahajan , Research Scholar

Sub-Divisional Engineer, BRBRAITT, Jabalpur

Contact number- 9423185222

Dr. Madhulika A. Sonawane, Director, School of Management Studies, KBCNMU Jalgaon

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Cyber security Challenges in AI-Based Business Systems

Abstract

The integration of Artificial Intelligence (AI) into business systems has revolutionized operations, enabling automation, predictive analytics, and enhanced decision-making. However, this advancement introduces significant cyber security risks due to the complexity, autonomy, and data-centric nature of AI. This paper explores the cyber security challenges inherent in AI-based business systems, including data privacy threats, adversarial attacks, model poisoning, explainability issues, and regulatory gaps. It further discusses best practices and emerging strategies to mitigate these risks, ensuring secure and trustworthy AI deployment in business environments.

1. Introduction

Artificial Intelligence (AI) is increasingly being adopted across various sectors including finance, healthcare, logistics, and marketing, to improve efficiency, accuracy, and strategic insights. AI-driven systems handle vast amounts of data, often sensitive, and operate in semi-autonomous or fully autonomous modes. Despite the benefits, these systems are vulnerable to a range of cyber security threats that can compromise data integrity, business operations, and stakeholder trust.

2. Overview of AI-Based Business Systems

AI-based business systems incorporate technologies like machine learning (ML), deep learning, natural language processing (NLP), and robotic process automation (RPA). These systems are used for customer service chatbots, fraud detection, supply chain optimization, personalized marketing, and more. Their reliance on data and complex algorithms makes them susceptible to cyber threats.

3. Key Cyber security Challenges

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3.1 Data Privacy and Protection

AI systems require large datasets for training and operation. These datasets often include personally identifiable information (PII), financial records, and proprietary business data. Data breaches or unauthorized access can lead to severe privacy violations and legal consequences.

3.2 Adversarial Attacks

Adversarial attacks involve manipulating input data to deceive AI models. For instance, slightly altering an image can lead to misclassification in computer vision systems. Such attacks can undermine AI's reliability in business applications like biometric authentication and autonomous systems.

3.3 Model Poisoning

Model poisoning occurs when attackers inject malicious data during the training phase to manipulate the AI’s behavior. In business systems, this could result in biased decision-making, financial fraud, or reputational damage.

3.4 Lack of Explainability

AI systems, especially deep learning models, often function as black boxes. Their decision-making processes are not easily interpretable, making it difficult to detect malicious behavior or bias. This opacity poses a challenge for cyber security audits and compliance.

3.5 Regulatory and Compliance Challenges

Existing cyber security frameworks may not adequately address AI-specific risks. Regulations like GDPR and CCPA focus on data protection but do not offer guidelines for algorithmic transparency or adversarial robustness.

4. Case Studies of Cyber security Breaches in AI Systems

4.1 Capital One Data Breach (2019)

While not directly caused by AI, the breach highlighted the vulnerability of cloud-based systems that support AI workloads. Misconfigured firewalls allowed unauthorized access to over 100 million customer records.

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4.2 Microsoft Tay Incident (2016)

Microsoft's AI chatbot Tay was manipulated by users to tweet offensive content. This incident illustrated the lack of robust filtering mechanisms and the ease with which AI systems can be exploited.

4.3 Tesla Autopilot Concerns

Researchers demonstrated that minor modifications to road signs or lane markings could deceive Tesla's Autopilot system, emphasizing the need for robust input validation and real-world scenario testing.

5. Strategies for Mitigating Cyber security Risks

5.1 Data Encryption and Access Controls

Encrypting data at rest and in transit, coupled with strict access control mechanisms, can mitigate unauthorized access and data breaches.

5.2 Adversarial Training

Introducing adversarial examples during training helps models become more robust against manipulation. This approach enhances the system's ability to identify and resist anomalous inputs.

5.3 Model Monitoring and Logging

Continuous monitoring of AI models for unusual patterns or outputs can help in early detection of cyber security incidents. Logging facilitates forensic analysis in the event of a breach.

5.4 Explainable AI (XAI)

Developing explainable AI systems improves transparency and trust. Techniques such as SHAP (Shapley Additive Explanations) and LIME (Local Interpretable Model-agnostic Explanations) can help interpret model decisions.

5.5 Regulatory Compliance and Frameworks

Businesses must stay informed about evolving regulations and adopt frameworks like NIST's AI Risk Management Framework to guide secure AI deployment.

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6. Emerging Trends and Future Outlook

6.1 AI for Cybersecurity

AI is also being used to enhance cybersecurity, through applications like anomaly detection, threat intelligence, and automated response systems. However, this dual-use nature presents both opportunities and challenges.

6.2 Federated Learning

This approach allows models to be trained across multiple decentralized devices while keeping data localized. It enhances privacy and security, making it suitable for sensitive business environments.

6.3 Zero Trust Architecture (ZTA)

Implementing ZTA principles, which assume no implicit trust within the network, can limit lateral movement in the event of a breach, protecting AI systems from internal threats.

7. Conclusion

AI-based business systems are powerful tools that can drive innovation and efficiency. However, their integration into core business functions necessitates a proactive approach to cybersecurity. Organizations must address the unique challenges posed by AI, including data privacy, adversarial risks, and lack of transparency. By adopting robust security practices and staying abreast of regulatory developments, businesses can harness AI's potential while safeguarding their assets and stakeholders.

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e-ISSN- 3067-0977

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"Enhancing Human Capital Management: The Role of Artificial Intelligence in Performance Appraisal Systems"

DR Jayshri j Kadam

MVP'S IMRT Nashik

kadamnirmal@gmail.com

Mr Sahik Thakare

Research Scholar, IMRT Nashik

Abstract :

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think and learn like humans. Artificial Intelligence (AI) is increasingly transforming Human Resource Management (HRM), offering both significant opportunities and notable challenges. Here's an overview of recent research on AI's role in HRM, focusing on its potential benefits and the obstacles organizations faced. The research paper focus on triggering the key challenges in implementing AI in HRM as well as the future AI projections in field of performance management.

Key Words: Artificial Intelligence, Performance Appraisal

Introduction:

Performance appraisal has traditionally been a subjective process influenced by personal biases, limited data analysis, and inconsistencies in evaluation methods. The integration of Artificial Intelligence (AI) into human resource management promises to revolutionize this space by introducing objectivity, real-time feedback, and data-driven insights. This research explores how AI technologies can enhance the performance appraisal process, reduce bias, and foster continuous employee development.

Performance management in Human Resource Management (HRM) refers to a continuous process of setting goals, assessing progress, and ongoing coaching and feedback to ensure that employees meet Performance management is more than just evaluating an employee annually based on a predetermined set of criteria.

Organizations realize that they are more in need of something quicker, real-time, and more individualized, which is solely focused on fuelling performance in the future rather than assessing it in the past. This need amongst organizations provides a multitude of possibilities for

Several tools are available to simplify the process, boost efficiency, and foster better communication between employees and managers. A few of them include software like Workday, Lattice, Zoho People, etc.

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Overall, the software provides various benefits such as:

1. Goal setting software- Helps to set clear and achievable goals (SMART)

2. Performance appraisal software- Simplifying the task of conducting routine evaluations, recording feedback, and monitoring employee growth over time.

3. 360-degree feedback tool- Helps to gather information from multiple sources.

4. Performance analytics dashboard- Up-to-date information on how individuals and teams are performing. Helps us to pinpoint areas where people are doing well and where they could improve. E.g. Power BI, Google data studio, etc.

5. Performance management apps- These mobile apps provide easy access to performance management tools anytime, anywhere.

Role of AI in Performance Management:

1. No Human Error

➢ Free from personal biases

➢ Reducing data inaccuracies

➢ Impartial feedback as a result

2. Projections Based on Comprehensive Data

➢ Uses extensive data which includes the overall performance data and not just the current data

➢ Aids managers to make more informed decisions via the comprehensive data Continuous Assessment and Rela-time Analysis

➢ Continuous data collection from various sources

➢ Real-time insights into individuals' performance

➢ Highly time effective

3. Better Managers

➢ Assists managers and ensures the accuracy of the feedback they provide

➢ AI empowers managers to improve performance reviews by providing them with more comprehensive data and insights about their employees.

4. Employee Engagement

➢ Regular surveys and collect real-time feedback

➢ Provide employees with personal insights

5. Training and Development Improvement

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➢ Assists managers in identifying gaps and providing personalized training recommendations.

➢ By leveraging AI in this process, performance appraisals can become more precise.

➢ AI-driven learning programs can help employees learn more effectively and efficiently.

HR Technologies and AI in Performance Management:

HR Tech and AI

➢ AI-powered tools and platforms equip HR professionals with advanced data analysis, reporting, and decision-making capabilities.

➢ These technologies help HR teams manage performance more effectively, improving employee appraisals.

Key Application of AI in HR technologies

➢ Predictive analysis

➢ Examining historical performance data and anticipating future outcomes Helps HR teams take early actions that promote positive results

➢ AI improves the accuracy and objectivity of performance evaluations

➢ Technologies offer deeper understanding, which leads to more informed decision-making and feedback

➢ Data driven method increases fairness and transparency

AI- Powered Chatbots and Virtual Assistants

➢ Enhances communication and feedback, immediate access to information.

➢ More flexible and responsive approach to performance management.

E-HRM

➢ Facilitate performance reviews by providing a recording mechanism for the results of performance management activities

➢ As companies incorporate automation, machine learning, and AI, the quality of data will significantly improve and be gathered more efficiently.

Feedback

➢ Provides feedback continuously and in real-time

➢ Transition from evaluating past performance to offering forward- looking feedback

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2. Objectives

- To analyse the role of AI in modern performance appraisal systems.
- To identify the benefits and challenges of integrating AI in employee evaluation.
- To study the impact of AI-driven appraisal systems on employee productivity and organizational outcomes.
- To review real-world applications of AI in performance management through case studies.

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3. Literature Review

3.1 Traditional Performance Appraisal Methods

- Annual reviews, 360-degree feedback, self-assessments.
- Limitations: subjectivity, recency bias, inconsistency.

3.2 Evolution Towards Data-Driven HR Practices

- Shift from qualitative to quantitative evaluation metrics.
- Rise of HR analytics and predictive modeling.

3.3 Introduction of AI in HR

- AI tools in recruitment, employee engagement, and learning.
- Natural Language Processing (NLP) and Machine Learning (ML) in analyzing performance data.

3.4 AI in Performance Appraisal

- Real-time feedback systems.
- Behavior and sentiment analysis from communication tools.
- Use of predictive analytics to forecast performance trends.

Key Studies:

- IBM Watson Talent Framework
- Deloitte's use of AI in performance management (2017 case study)
- PwC report on AI-driven HR strategies (2020)

Challenges of AI Usage in Performance Management;

Lack of Human Touch

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➢ Cannot replace human decisions, which fundamentally different from the AI decision-making process

Lack of Affinity of Communication

➢ AI lacks personal connection and nuance with humans (on the contrary HRM involves understanding humans which cannot be achieved by AI)

4. Case Study

Case Study: IBM's Use of Watson AI for Talent and Performance Management

Overview:
IBM utilizes Watson AI to track employee performance, provide personalized feedback, and predict future outcomes.

AI Features Used:

- AI-powered career coaching.
- Analysis of employee communication for behavioral patterns.
- Real-time KPI tracking.

Impact:

- Reduced turnover by 20%.
- Improved employee engagement scores.
- Enhanced decision-making by HR professionals.

5. Analysis and Discussion

- **Benefits:**
    - Reduces human bias.
    - Allows for continuous performance monitoring.
    - Aligns employee goals with organizational KPIs.
    - Promotes a culture of transparency and fairness.
- **Challenges:**
    - Data privacy and ethical concerns.
    - Resistance to change from employees and managers.
    - Over-reliance on algorithms could miss context or nuance.
    - AI explainability and fairness in evaluation.

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Future Landscape of AI in Performance Management

Predictive Performance Analytics

➢ By aggregating and analyzing extensive data points, AI will forecast individual employee performance with exceptional precision.

Real-Time Feedback and Personalization

➢ The era of annual performance reviews is coming to an end as AI introduces a new norm of real-time feedback

➢ Advanced AI systems will deliver immediate insights into employees' work, offering on-the-spot suggestions and learning opportunities.

AI as a Coaching Partner

➢ Advanced systems will function as virtual mentors, helping employees navigate personalized development pathways and reach their career goals.

➢ These AI-driven coaches will be available around the clock, providing continuous support and guidance as needed.

Enhanced Employee Engagement

➢ Thanks to AI's ability to analyze intricate patterns in employee interactions and engagement, future performance management systems will be highly responsive to the well-being and satisfaction of the workforce.

Ethical and Fair Appraisal Systems

➢ As AI systems advance in complexity, there will be a greater emphasis on ensuring they are both effective and ethical.

Workforce Upskilling and Adaptability

➢ AI will be essential in determining future skill needs and supporting the upskilling of the workforce.

Integration of AI and Human Insight

➢ In the future, there will be a collaborative synergy where AI offers data-driven insights while humans contribute context, empathy, and ethical judgment.

6. Conclusion

The integration of AI into performance appraisal offers a transformative potential for organizations striving for fairness, efficiency, and strategic alignment in employee evaluation. While the benefits are significant, careful consideration must be given to ethical, technical, and cultural challenges. As AI continues to evolve, its role in performance appraisal will become not just supplementary but central to strategic human resource management.

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e-ISSN- 3067-0977

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The Role of Artificial Intelligence in Agriculture and Rural Development: A Business Perspective

Dr. Rupali Kulkarni

Dr. Moonje Institute of Management and computer Studies. Nashik

Abstract- Artificial Intelligence (AI) is revolutionizing various sectors globally, with agriculture and rural development being among the most critical areas of transformation. This paper explores the role of AI in agriculture from a business perspective, emphasizing its significance in boosting productivity, efficiency, and sustainability. The paper also discusses how youth can leverage AI for modern farming and the development of import-export businesses. Furthermore, it highlights the crucial role AI plays in the socio-economic growth of developing nations by promoting food security, job creation, and economic empowerment.

Keywords: Artificial Intelligence, Agriculture, Rural Development, Business, Youth, Import-Export, Developing Nations

1. **Introduction** -Agriculture has long been the backbone of many economies, especially in developing countries. However, traditional farming methods have struggled to keep pace with rising food demand, climate change, and labor shortages. Artificial Intelligence (AI) offers promising solutions to these challenges by enabling precision farming, resource optimization, and data-driven decision-making. From automating labor-intensive tasks to forecasting market trends, AI is reshaping the agricultural landscape, making it more productive and sustainable. This research paper delves into AI's role in agriculture and rural development, focusing on its business implications, youth engagement, and relevance in developing economies.

2. **AI in Agriculture: A Business Perspective**

2.1 Precision Agriculture AI facilitates precision agriculture, which involves the use of data analytics, satellite imagery, and IoT devices to monitor crop health, soil conditions, and weather patterns. Businesses benefit from reduced input costs and improved yields by applying fertilizers and pesticides more accurately.

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2.2 Automated Farming Equipment AI-powered machines such as autonomous tractors, robotic harvesters, and smart irrigation systems reduce labor dependency and enhance operational efficiency. Companies investing in these technologies experience higher returns on investment and scalability.

2.3 Crop and Soil Monitoring AI-based sensors and drones collect real-time data to assess soil moisture, nutrient levels, and crop diseases. This information helps farmers make informed decisions, thereby minimizing crop losses and maximizing output.

2.4 Financial Services and Risk Management- AI aids in financial decision-making through predictive analytics, helping agribusinesses assess credit risk and manage insurance claims. Agri-fintech startups use AI to offer personalized financial products to farmers, especially those previously excluded from traditional banking systems.

2.5 Market Intelligence and Supply Chain Optimization -AI algorithms analyse market trends, forecast prices, and optimize supply chains. This allows businesses to manage inventories better, reduce waste, and meet consumer demand effectively. AI also enhances traceability and compliance with regulatory standards, which is vital for both domestic and international trade.

3. Role of Youth in AI-driven Farming

3.1 Youth as Change Agents Youth, with their adaptability and tech-savviness, are well-positioned to lead AI adoption in agriculture. By engaging in AI-based agri-tech startups, they can drive innovation and modernize farming practices.

3.2 Development of AI Applications Young entrepreneurs can develop mobile and web applications for farm management, pest detection, and weather forecasting. These apps democratize access to expert knowledge and make farming more efficient.

3.3 Digital Literacy and Training Educational institutions and governments must invest in AI training programs for rural youth. With proper guidance, young people can serve as digital ambassadors, promoting AI tools among traditional farmers.

3.4 Employment and Entrepreneurship AI opens new avenues for rural employment and entrepreneurship, from data analysis and software development to drone operation and

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equipment maintenance. Youth involvement in these sectors boosts rural economies and curbs urban migration.

4. AI and the Development of Import-Export Business

4.1 Enhancing Product Quality and Compliance AI ensures consistent product quality through automated sorting, grading, and packaging. It also helps meet international standards, increasing the competitiveness of agricultural exports.

4.2 Forecasting and Market Access AI tools provide insights into global demand, pricing trends, and trade policies. This information empowers exporters to make strategic decisions and access new markets.

4.3 Logistics and Cold Chain Management AI optimizes logistics by predicting delivery routes, managing cold storage conditions, and minimizing delays. Efficient supply chains reduce post-harvest losses and improve customer satisfaction.

4.4 Digital Export Platforms AI-driven platforms connect producers with international buyers, automate transactions, and provide customer service through chatbots. These platforms expand market reach and reduce dependence on middlemen.

5. Importance of AI in Developing Nations

5.1 Food Security- AI technologies improve crop productivity and resource efficiency, addressing food insecurity in regions with limited arable land and water.

5.2 Economic Empowerment - By increasing profitability and creating jobs, AI empowers rural communities economically. It also attracts investment and fosters inclusive growth.

5.3 Climate Change Adaptation- AI supports climate-resilient farming by providing real-time weather alerts, adaptive planting strategies, and drought-resistant crop recommendations.

5.4 Bridging the Digital Divide - AI tools, especially mobile-based applications, bridge the information gap between rural and urban areas. They offer farmers access to vital information in local languages, enhancing decision-making.

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5.5 Policy and Infrastructure - Development Governments in developing nations must integrate AI into agricultural policies and invest in digital infrastructure. Partnerships with tech companies and educational institutions are also essential for capacity building.

6. Challenges and Recommendations

6.1 Challenges

- High initial investment costs
- Limited digital literacy in rural areas
- Data privacy and security concerns
- Lack of infrastructure and internet connectivity

6.2 Recommendations

- Subsidize AI tools for smallholder farmers
- Develop localized AI solutions
- Invest in rural education and training
- Foster public-private partnerships for AI innovation

7. Conclusion

AI holds transformative potential for agriculture and rural development, particularly from a business standpoint. It enhances productivity, ensures sustainability, and opens new economic opportunities. Engaging youth in AI-driven farming can rejuvenate the agricultural sector, while AI-enabled import-export mechanisms boost trade efficiency. For developing nations, AI is not just a tool but a catalyst for socio-economic transformation. Strategic investments in AI education, infrastructure, and innovation are crucial to unlocking its full potential.

AI is a powerful enabler for youth to lead the transformation of agriculture into a **high-value, tech-driven sector**. It opens doors to global trade, innovation, and inclusive development. By starting AI-powered agri-businesses, young people can solve

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local problems, tap into global markets, and uplift entire communities—turning agriculture into a driver of national prosperity.

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e-ISSN- 3067-0977

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Empowering MSMEs with AI-Driven Operational Modernization and Cost-Effective Automation – Starting with a Website

Prof. Atul Bengeri – Professor of Practice, MIT Vishwaprayag University, Solapur
Suyash Gaikwad – MBA Student, MIT Vishwaprayag University, Solapur
Vaishnavi Somnath – MBA Student, MIT Vishwaprayag University, Solapur
Disha Mahajan – MBA Student, MIT Vishwaprayag University, Solapur
Samruddhi Somnath – MBA Student, MIT Vishwaprayag University, Solapur

Abstract

India's digital economy is growing rapidly, with over 944.7 million wireless internet subscribers as of November 2024 and a projected smartphone base of 1.1 billion by FY25, pushing the digital economy beyond USD 1 trillion by 2030 (IBEF). Despite this progress, MSMEs in tier-3 cities face digital adoption barriers. This paper analyzes data from 500 MSMEs in hospitality, retail, education, and healthcare, assessing their digital awareness, investment readiness, and perception of AI tools. Findings show 86% lack a website and 70% are reluctant to invest, citing low digital literacy, cost, and lack of perceived benefit. To address this, the paper proposes a phased AI-driven modernization roadmap—starting with low-cost websites and moving to tools like chatbots, CRMs, and predictive analytics to improve competitiveness.

Keywords *– Website Adoption, Tier-3 Cities, Micro, Small, and Medium Enterprises (MSMEs), Digital Divide, Technology Acceptance, Barriers to Digital Adoption, Website Perceptions, Urban-Rural Digital Gap, MSMEs, Digital Transformation, Website Adoption, AI Integration, Tier-3 Cities, Operational Modernization, Cost-Effective Automation, Digital Literacy, Policy Support, India.*

e-ISSN- 3067-0977

Introduction

MSMEs are vital to India's economy, contributing around 30% of GDP and nearly 50% of exports (MSME Annual Report 2023–24). Yet many MSMEs in tier-2 and tier-3 cities still follow traditional business practices due to limited digital reach. While urban startups and large enterprises have embraced digital tools, smaller businesses lag due to digital illiteracy, infrastructure gaps, and resource constraints. The COVID-19 pandemic further highlighted the urgency for online presence, with digital platforms playing a key role in customer engagement and survival. Despite this, website adoption remains low. This study explores the root causes of hesitancy and proposes a practical path forward beginning with affordable website solutions and gradually integrating AI technologies to modernize operations.

Literature Review

Previous research emphasizes the importance of digital presence for MSMEs. Nicholas (2024) states websites enhance visibility, customer engagement, and business expansion (DOI). Schrader (2022) highlights that websites function beyond information-sharing—as marketing hubs for lead generation, client management, and transactions (DOI). Reports from the World Bank and NASSCOM show digitally enabled MSMEs grow up to 1.5x faster. However, the Digital India Economic Survey 2023 notes only 32% of MSMEs have a website or app, indicating a large digital divide (Economic Survey). Challenges include high initial investment, lack of digital knowledge, weak government outreach, and language limitations. The literature supports the idea that tailored, region-specific strategies are essential for enabling inclusive digital transformation of MSMEs.

Research Methodology

This study uses a mixed-methods approach involving:

- **Primary Data Collection**: Structured surveys and in-person interviews with 500 MSME owners
- **Study Region**: Tier-3 city in the Solapur district of Maharashtra
- **Sectors Surveyed**: Retail, Hospitality, Food Services, Education, Healthcare, and Boutique Manufacturing
- **Parameters Analysed**: Website ownership, willingness to invest, digital literacy levels, sectoral readiness, awareness of AI tools

Quantitative data was analysed using Excel for percentage distributions, and qualitative inputs were coded thematically to extract insights about perception and intent.

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Data Analysis and Findings

The survey responses from 500 MSMEs across various sectors (Retail, Healthcare, Hospitality, Education, Food & Clothing) provided several valuable insights regarding digital adoption, specifically related to websites and AI readiness.

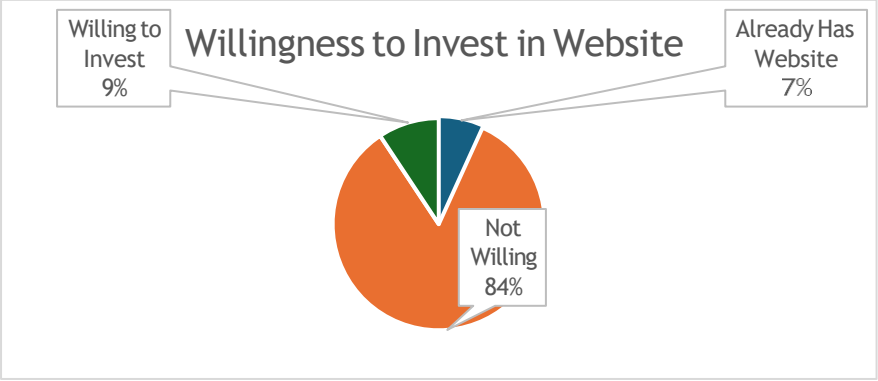
a. Website Ownership

MSMEs:

- 86.6%businesses reported no website presence.
- Only 13.4% businesses have a website or a digital storefront.

b. Willingness to Invest in a Website

- 84% businesses are not willing to invest in a website currently.
- 9% businesses are open to the idea, especially if costs are low or subsidized.

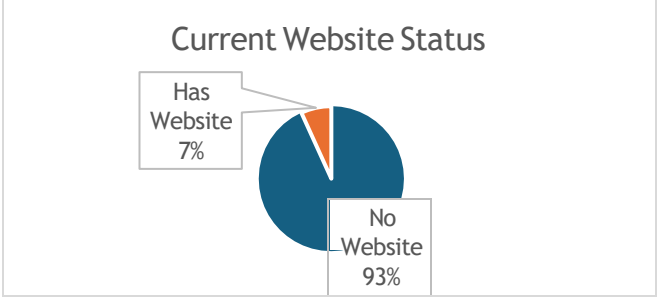


c. Awareness of Website Benefits

- 52.8% MSME owners are unaware of how websites benefit their business.
- 33.8% respondents believe websites are mostly for "large companies."
- Only 13.4% respondents understand that websites help with lead generation, branding, and trust-building.

d. Current Website Adoption Status Among MSMEs

- Only 7% of respondents currently have a website.
- A massive 93% do not have any web presence.



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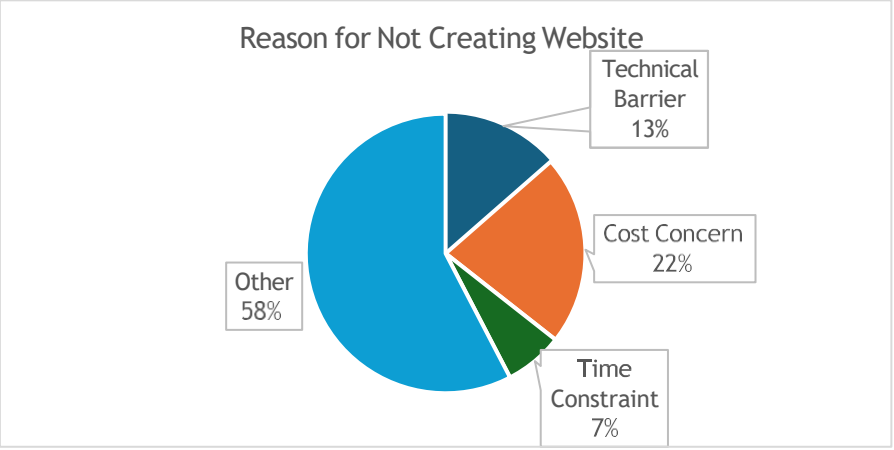
e. Reasons for Not Creating a Website

Among MSMEs that do not have a website:

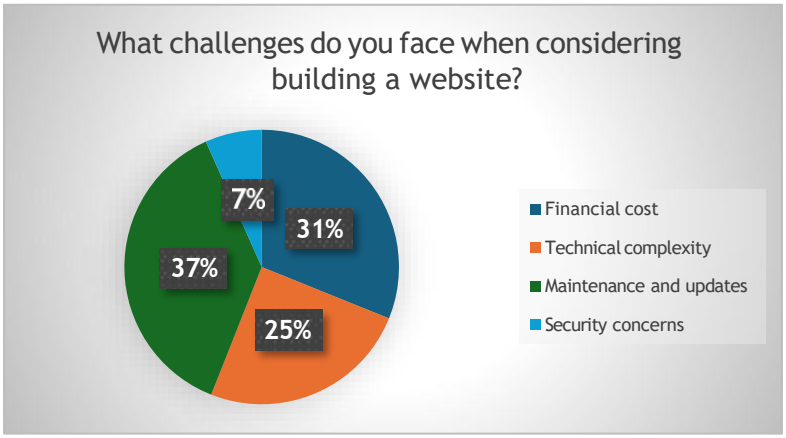
- 58% cited lack of need, Security etc
- 22% mentioned cost concerns
- 13% indicated lack of technical knowledge
- 7% reported time constraints



f. Challenges in Building a website

Key concerns were:

- Maintenance and updates (37%)
- Cost (31%)
- Technical complexity (25%)
- Security (7%)



Challenges, Opportunities and Solutions

Challenge	Opportunity	Key Solutions

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Digital Illiteracy	Simplify access	Voice-guided UI, mobile-first design, in-app coaching
High Perceived Cost	Offer budget-friendly tools	Freemium plans, ROI dashboards, flexible pricing
Trust & Security	Build credibility	Local case studies, security badges, regional support
Language Barriers	Enable multilingual access	Multilingual UI, local content, culturally relevant design

Role of Artificial Intelligence in MSME Enablement

Practical AI Use Cases

- **Chatbots**: Handle inquiries, appointments, and complaints automatically.
- **Predictive Analytics**: Forecast inventory needs or demand trends based on sales history.
- **OCR Tools**: Convert invoices and receipts into digital formats.
- **NLP Tools**: Automate follow-up emails and marketing campaigns.
- **Visual AI**: Assist in e-commerce image classification, product recommendations, and tagging.

AI not only reduces costs but also enhances customer experience, decision-making, and business agility.

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Action Plan – A 5-Phase Roadmap

Phase	Goal	Tools
Phase 1	Create Website	Wix, WordPress, Google Sites
Phase 2	Optimize SEO & Add Contact Forms	Google Search Console, HubSpot
Phase 3	Integrate Chatbots	Freshchat, Tidio
Phase 4	Add Analytics	Google Analytics, Hotjar
Phase 5	Automate CRM & Sales	Zoho, Salesforce, AI assistants

This phased approach allows even the smallest MSMEs to digitize progressively, reducing overwhelm and building confidence.

Tool Analysis with Challenge Names

Tool	Pros (Addresses Challenges)	Cons (Remaining Challenges)
Co-Design.AI	Simplifies design, reduces cost.	Interface may overwhelm; lacks local language support.
MIXO	Quick setup using simple input; low cost.	Trust issues due to automation; no regional language.
10Web.IO	User-friendly, all-in-one; secure and cost-effective.	Some WordPress knowledge needed; English-only.
CreateWebsite.IO	Easy and low-cost site creation.	No hands-on support; lacks regional language options.
Elementor	Drag-and-drop ease; free pricing tier.	Learning curve for advanced use; no localization.
Relume.IO	Simplifies planning; saves time/cost.	No full site solution; English-only.
Wide Canvas AI	AI-driven designs boost trust.	May be too complex; no language localization.
Scre.io	Auto-generates content; improves trust.	No multilingual support; lacks cultural nuance.
Bolt.new	Fast, cost-effective setup.	Trust issues; lacks local language focus.
Framer.com	Unified design/dev flow; professional output.	Requires digital skills; English-centric.

e-ISSN- 3067-0977

Conclusion

Despite India's remarkable strides in digital and AI technology, MSMEs in smaller cities remain excluded from this growth story. A simple website could act as a digital gateway—enhancing visibility, improving operations, and enabling AI-based innovation. However, for this transformation to occur, both private and public sectors must collaborate.

The solution lies not in imposing one-size-fits-all tools, but in developing phased, regionalized, and affordable strategies tailored to MSMEs. Empowering them with localized, AI-backed digital infrastructure will not only uplift small businesses but also contribute to a more inclusive Indian economy.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
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"ETHICAL AI INTEGRATION IN INDIAN EDUCATION: POLICY REFORMS, CHALLENGES, AND FUTURE DIRECTIONS"

Mayuri. R. Londhe
Assistant Professor, Department of BBA-IB, Sanjivani Arts, Commerce and Science College, Kopargaon
mayurilondhe24@gmail.com
(Contact No. 8983174227)

Dr. Sachin. S. Gunjal
Assistant Professor. Department of MBA, Amrutvahini Engineering College, Sangamner,
sachin_pharma42@rediffmail.com
(Contact No. 9975714649)

e-ISSN- 3067-0977

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"Ethical AI Integration in Indian Education: Policy Reforms, Challenges, and Future Directions"

Mayuri. R. Londhe
Assistant Professor, Department of BBA-IB, Sanjivani Arts, Commerce and Science College, Kopargaon
mayurilondhe24@gmail.com

Dr. Sachin. S. Gunjal
Assistant Professor. Department of MBA, Amrutvahini Engineering College, Sangamner,
sachin_pharma42@rediffmail.com

I. Abstract:

India is currently experiencing a rapid integration of Artificial Intelligence (AI) into education offers transformative opportunities for AI while presenting inherently important ethical and equity challenges. For instance, AI provides universities and schools with opportunities to use AI-enhanced efficiencies of teachers by automating content creation while developing personalized or individualized learning through the use of Intelligent Tutoring Systems. However, given existing inequities in digital connectivity, 75% of students are excluded, in turn aggravating the digital divide. This study considers the integration AI into education in India through an analysis of policy documents (NEP 2020 and NITI Aayog's AI strategy) and governance, through the lenses of equity, data privacy, and equitable implementation, identifying certain areas of significance. The findings suggest AI can enhance teacher efficiencies, such as grading, foster critical thinking skills using adaptive learning, but there are risks associated with algorithmic decision-making contributing to exclusion in marginalized communities. In turn, the paper argues that ethical governance of AI integration into education requires transparency, institutional infrastructure equity, and training for teachers. Future research will need to address the divide between policy and practice to align AI opportunities for education with the social and educational challenges facing India.

Keywords: Ethical AI, Digital Divide, Policy Governance, Indian Education System, Personalized Learning, Algorithmic Bias.

II. Introduction

As India's education system presents an opportunity for adopting artificial intelligence (AI) to enhance long-existing gaps or create new inequities, the pandemic has accelerated the growth of EdTech, with over $4.1 billion invested (Ray, 2020) and more than 4,500 startups (Duggal, 2021) entered into the EdTech space in India (bid

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news for three months summer time stay, where only a mere 25% of 250 million learners (World Bank, 2022) in India have any meaningful access to these technologies). This critical juxtaposition speaks to the problem: while AI has the potential to deepen learning through intelligent tutoring systems (Ahmed et al., 2021) and automate administrative tasks (Karan & Angadi, 2023), the existing systemic barriers such as digital dis-integration (84% of teachers in India do not have any training because of the systemic cultural barriers form years of systematic extraction hopes - Suneja and Bagai, 2021) and exploitative data management from our EdTech platforms through a hybrid model.

The recent response from the government including the digital orientation from NEP 2020 and the NITI Aayog AI strategy report state in 2018 have put the sector at great risk with its potential ethical risks. This paper investigates whether the AI-in-education framework in India can offer equitable adoption as opposed to widening the existing gap or inequities. Through analysis of policy documents and global comparators, we identify governance gaps in three major areas: algorithmic transparency, equity of infrastructure, and teacher readiness.

Objectives:

- To critically analyze the ethical implications of Artificial Intelligence integration in the Indian education system, focusing on issues such as algorithmic bias, digital equity, and data privacy.
- To evaluate existing policy frameworks and recommend strategies for responsible and inclusive AI adoption in education in India.

III. Literature Review:

Post-pandemic artificial intelligence (AI) integration in education platforms has progressed assumeingly fast worldwide. For instance, countries such as China, the European Union, and Singapore are testing different AI-based educational solutions, with unique geographic characteristics. For example, China-based Squirrel AI has established itself as a leader in adaptive learning, mapping competencies in real-time for personalized instruction (Beard, 2020). The European Union is focused on developing educational AI tools, developing a community of countries with basic principles to protect data privacy based on strict General Data Protection Regulation (GDPR) guideline principles, and building ethical protocols (Pinto & Leite, 2020). Singapore's experience with AI-powered virtual teaching assistants indicates a 32% increase in student engagement, demonstrating intelligent tutoring systems' ability to promote learning experiences (Seo et al., 2021). Across all jurisdictions is a strong emphasis on personalized learning, data-driven decisions for pedagogy, and enjoy automating administrative tasks.

In comparison, India's EdTech landscape appears to show faster growth but rampant structural disparities. India is now one of the biggest EdTech markets in the world since 2020, with approximately $4.1 billion invested cumulatively (Ray, 2020), and over 4,500 startups ("active," when considering potential EdTech market entry) (Duggal, 2021). The emergence of unicorns in 2021 (e.g. PhysicsWallah, Vedantu, UpGrad), which represent market maturation and innovation at the same time.

Moreover, 76% of rural schools do not have the infrastructural component for implementing AI (Suneja & Bagai, 2021) and only 18% of teachers feel they have

e-ISSN- 3067-0977

been trained adequately to use AI tools in their classrooms (Charania et al., 2023). These statistics reveal a significant digital divide that stymies the equitable implementation of AI for education in India.

In the context of policies, India shows serious weaknesses compared to global benchmarks in adoption of AI in education. The National Education Policy (NEP) 2020 offers a vision for integration of AI in education but is still largely advisory policy. For example, while the European Union has GDPR for data privacy mandates and has enough governance capacity for algorithmic audits, NEP 2020 lacks required mechanisms for data protection and enforcement prevent algorithmic bias. Similarly, UNESCO advocates for certification systems and ethical monitoring protocols, while India's implementation strategy rests on voluntary adoption without knowing or understanding what these will look like and without structured compliance models. Overall, this analysis highlights that in India we need to move our policy framework adoption from aspirational to actionable so that responsible AI can be adopted.

The literature is catching up to the ethical challenges that AI poses on the education of students in India. In these writings, three main challenges have been noted. First, unequal access to AI-based tools is reinforcing the digital divide in education and the educational landscapes are reinforcing it. Urban students are 5.3 times more likely to use an AI tool (Bansal, 2023). Device affordability contributes to this divide, and as the authors report, it affects 68% of low-income families (Dhouchak & Kumar, 2023), contributing to inequitable access to education. Second, the disruptions to teaching and pedagogy brought on by integrating AI technologies into education are concerning. Intelligent tutoring systems (ITS) improve efficiency but lead to a 42% reduction in communication with a student and teacher (Miao et al., 2021) reducing equity. In addition to this, automated grading systems have been noted to vary widely (19%) in judging the value of subjective assessments (Karan & Angadi, 2023) further contributing to inequity. Third, there are concerns about the risk of exploitation of data. A concerning 89% of Indian EdTech applications lack appropriate consent (Bhargavi & Shanmugam, 2023), which raises alarms around the potential misuse and monetization of student level sensitive data (Tilak, 2021).

In order to help understand these developments better, researchers have used various theoretical lenses for example Tuomi's (2018) Competency-Based Education model which helps to understand how personalized learning can occur through a skill based model of assessment. The concept of "Matthew Effect" that indicates technology adoption is advantages those that are already advantaged has helped to explain some of the growing digital divide emerging in India (Jain et al., 2021). DATEC was also examined to evaluate the relevance of AI applications in educational experiences of young children, bringing attention to developmental needs and ethical considerations (Charania et al., 2023). All of the suggested theoretical lenses reveal the messy work that must accompany artificial intelligence integration in education, especially in areas of socio-economic disadvantage and infrastructure support.

In conclusion, whilst AI can significantly disrupt the way education is delivered on a global level, its use within the Indian landscape also highlights the two ways promise and peril narrative. We argue consistently throughout the literature that a more substantial, equitable, and ethically responsible AI strategy is required, which reconciles predominantly access issues,

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data privacy, teacher readiness, and typical global practices.

IV. Methodology:

This study employs exploratory research design to analyze Indian government policy regarding the incorporation of AI in education in a systematic way. The methodological approach is mix-documentary research and thematic analysis in order to establish how effective the policies are with an emphasis on ethical issues such as fairness, transparency, accountability, and privacy. This research depicts a gradual process of identifying the disconnect between policy goals and challenges with implementation.

The study draws on a systematic review of the central government policy documents including reports NITI Aayog, the Ministry of Education, and other regulatory agencies. The search strategy was to screen government official databases using keywords any combination of "Artificial Intelligence in Education (AIEd)", "NEP 2020 and AI", "Data privacy in EdTech", and ensuring, we accepted only reports published from 2018 to 2022.

To study the policies a dual layered analysis framework was established. The first layer used Karan and Angadi's (2023) thematic model that classifies AI integration into nine separate themes across three domains; (i) meaning (AI incorporation, literacy), (ii) definition (readiness, pedagogy, subject teaching, innovation) and (iii) usability (privacy, digital divide, trustworthiness). The second layer introduced an ethical analysis assessing how the policies deal with fairness (equitable access), transparency (algorithmic accountability), and trusted student data protection.

To ensure rigor in our work, the selected policies were augmented with global reference points, including the EU's General Data Protection Regulation and the UNESCO AI ethics policy. The researchers conducted a gap analysis to compare policy aspirations and on the ground realities, such as infrastructure availability in rural schools and teacher training shortages.

There were limitations with this study, including potential interpretive bias in analysing the language of the policies, and a shortage of state-specific granular data. However, we validated the findings (internal triangulation) with information from secondary sources in the form of EdTech industry reports and teacher feedback surveys. The methodology here is a systematic process to review India's AI-in-education policy, revealing both strides forward and areas for urgent reform. Future research could use this framework, adding case studies of AI implementation in areas such as DIKSHA data governance or CBSE curriculum and their practices.

A. Ethical AI Integration in Indian Education

The use of AI in India's education system evokes a complex mix of policy initiatives, systemic challenges, and ethical implications which merit careful consideration. Our analysis shows three vital areas impacting this technological transition.

First, at the policy level, India has made considerable progress through landmark initiatives such as the National Education Policy (NEP) 2020 and the integration of AI curriculum by CBSE since 2019. These frameworks characterize AI as a means to achieve educational equity and improve quality education, further backed by programs like the "AI for All" to advance digital literacy and dedicated AI research centers in premier institutions such as IITs. However, translating these policies into

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practice reveals considerable gaps in implementation. The digital divide is a real issue, with only 25% of rural students accessing AI-enabled learning using reliable resources while urban students have an even greater effective advantage. Teacher readiness is critical, as over 80% of teachers lack adequate training to use AI technologies effectively in classroom practice.

AI adoption poses especially difficult ethical trade-offs. Intelligent tutoring systems and automated grading processes can save time, but they also risk a future in which human-based factors in education that are essential for a holistic education are compromised. Concerns regarding privacy are significant, primarily with evidence that many EdTech platforms collect data from large numbers of students without meaningful consent - in direct opposition to EU GDPR guidelines. AI-driven systems could manifest algorithmic bias that could exacerbate inequities in education, especially for marginalized student groups. These findings indicate the friction of technological development with equitable access that defines the landscape of AI and education in India.

The comparison of these findings to other models around the world is also informative. While China's non-commercialization of EdTech has an upside in controlling commercialization, it may have hindered innovation. India has a two-sided approach, where the market is more open than Canada's yet is less regulated than the Canadian effort. The Jio digital revolution identified access barriers but investment in these barriers will only take access so far if the infrastructure is limited or social inequity plays a part.

Looking to the future, the pathway to responsibly integrating AI will require multi-pronged interventions. Policy reforms must attend to digital infrastructure deficits in publicly funded institutions in rural and urban areas, teacher training across a range of ages and subject areas, and sustainable ethical requirements for EdTech providers. Transparency about accountability and data protection should be the first step. Future research agendas should work towards longitudinal assessments of the impact of AI tools across various socioeconomic groups, as well as culturally relevant AI tools meant for distributed responses in India's diverse educational environment.

This research has shown that although AI can potentially improve education in India, access to the benefits of AI will not be equitable unless there are deliberate policies to tackle equity issues and ethical risks. The challenge for policymakers will be trying to make use of the advantages that AI can offer, while ensuring that the essential mandates from the right to education are upheld.

B. The Path Forward: Ethical AI Integration in Indian Education

The future of AI in India's education ecosystem presents transformative prospects but serious challenges that require a careful balance of policy. While AI has the potential to revolutionize learning by bridging language divides, via intelligent translating tools, enabling personalized instruction through intelligent tutoring systems and improve administrative effectiveness suit, implementing presentations has to be managed pragmatically to avoid implicating new unfairness on top of existing unfairness.

Given India’s vast diversity of languages, AI-powered multilingual education tools can be particularly relevant in many scenarios. However, the use of these tools, uses must consider responsible use of AI, including responsible data practices, use of algorithms, transparency and fairness of access mechanisms. For example, as AI

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expands into many areas of curriculum development, including machine learning, rideable technology, and robotics, there must be parallel avenues for teacher training, so teachers are able to enact learning through technology confidently (and not replaceable by AI).

Therefore, changes to the structure that supports these systemic changes are essential. Starting with the establishment of clear digital education unit, or lowering levels a permanent team 'dedicated' to digital education within MOE that can not only implementation AI initiatives, but actively enforce accountability over ED Tech businesses to adhere to best practice requirements for usage and innovation on their platforms. Any implementation should take into the various contexts education is presented within, urban or rural or access to education, and how students and teachers learn and use common AI technology platforms. If the approaches to AI are interspersed with district ideas and divided in efficiency, it will become a new source of unequal access to digital education.

The effects of COVID-19 highlighted the necessity for robust and hybridized education models. Beyond just considering online learning, it is essential to ensure that dialogues are undertaken regarding the infrastructure gaps—namely, for enhanced broadband and connectivity routes to remote locations and how to distribute affordable technology devices. Government and social programs, such as proposed strategies for inclusivity in light of AI acknowledging drawbacks such as limited time/engagement with students, biases in automated assessment mechanisms and adhering to fairness over accountability or validity with AI (in terms of ethics, profiting and commercial interests So, GenAI has the potential to democratize quality education in an affordable and sustainable manner if and only if India moves towards a human-centred approach that prioritizes inclusion and equitable access while providing fairness and good governance using AI-enabled products and services. To achieve the full potential of AI, India must consider a new paradigm from AI-centric approaches. As previously mentioned, with the new NEP 2020 in mind, it is worthwhile to review the PART referring to AI's attainable privacy and ethics while investing in regional languages AI and intermediary partnerships that focus on students' educational purposes instead of commercial aims.

V. Conclusion:

This research examined the ongoing assimilation of AI in India's education ecosystem through a systematic review of policies, with emphasis on both the potential benefits and dangers of this technology. While AI has the potential to improve learning and access to learning, the dangers of its current manifestations may deepen existing inequalities without adequate ethical safeguards. The primary finding is that policies such as the National Education Policy (NEP) 2020 and the AI Strategy for India (by NITI Aayog) are aspirational and lack enforceable measures related to data privacy, fairness, and accountability. The growth of the EdTech sector has largely benefited urban, privileged learners, further disadvantaging rural and marginalized student populations. Pressing issues that need to be addressed are the ethical issues surrounding this technology including, the implications of the use of algorithms that are built by or prone to bias, lack of transparency in their use, and the degradation of human agency in learning and teaching. The global comparisons of the possibilities of AI in education show the need for India to move to a contextually appropriate model that builds on its fast-paced digital development (including initiatives such as DIKSHA and the rapid expansion of the Jio network) and investment in teacher training, inclusive

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physical and digital infrastructure, and regional language, AI learning tools. It should also be pointed out that the value of AI lies not only in dealing with automation, but in advancing the rights to quality, inclusive education for all children in India. Future research must also include examining the long-term implications of the introduced AI technologies into the Indian education system and define contextually relevant ethical frameworks for devising the culturally specific, ethical AI learning tools that meet the unique needs of learners in India.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY
RESEARCH AND INNOVATION

"Customer Preferences for Digital and Traditional Banking: A Comparative Study"

Author 1st – **. Mr. Gaurav Gangadhar Bhoir** (Student)

Mobile No: 8380827723

Email id: gauravbhoir8775@gmail.com

Institute of Industrial and Computer Management and Research
Pradhikaran, Nigdi, Pune

Author 2nd– **Ms. Rupali Modak – Assistant Profesor**

Mobile No: 8793491783

Email Id: rupalimodak.iicmr@gmail.com

Institute of Industrial and Computer Management and Research

Pradhikaran, Nigdi, Pune

e-ISSN- 3067-0977

Abstract

Titled "Customer Preferences for Digital and Traditional Banking: A Comparative Study," this field project investigates the changing landscape of banking services from the consumer viewpoint. Understanding how consumers see, use, and choose various modes of banking has become more vital as digital transformation changes the financial sector. This study intends to investigate the different levels of consumer comfort, satisfaction, and expectations about both digital banking platforms—such as mobile banking, internet banking, and digital wallets—and conventional banking practices—such as in-person branch visits and manual transactions.

Structured questionnaires aimed at a varied population of 104 respondents helped to gather primary data. The questions evaluated their future adoption probability, need for help, satisfaction levels, and frequency of use. Particularly among younger, tech-savvy consumers, the data shows a clear trend towards digital adoption. Many people, though, still depend on conventional banking since they are worried about digital literacy, online security, and the need for individualised interaction.

Most of the people polled in the study really preferred a hybrid banking system combining digital convenience with traditional dependability. This balanced strategy guarantees support for those who still value face-to-face contacts while also accommodating consumers who want the efficiency of digital platforms.

All things considered, the results highlight the need for banks to: • Improve user-friendly digital platforms • Provide digital literacy programs • Maintain conventional banking infrastructure • Offer individualised support via both digital and physical channels

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CHAPTER I

INTRODUCTION

Introduction:

Digital banking has transformed how consumers access and control their money, therefore changing the banking industry. Offering enhanced convenience, round-the-clock accessibility, and streamlined processes, digital banking has quickly become a preferred choice for many. Though this change, conventional banking remains to hold its ground by providing personal attention, in-person assistance, and a feeling of dependability that certain consumers still value.

Financial institutions must first grasp the elements influencing consumer preferences if they are to properly negotiate this changing terrain. Key components of this paper are convenience, trust, security, ease of access, and demographic influences. Examining these elements helps the study to provide insightful analysis of how banks could balance digital innovations with conventional banking practices to more closely fit consumer expectations and needs.

1.1 Statement of problem

Over the duration of this project, I noted that more people are gravitating towards mobile and online banking systems as digital technology develops. These digital choices give users easily accessible, quicker, more convenient services. My study, however, revealed that many consumers still like conventional banking techniques. Often, this is because they want individual, face-to-face interactions, a greater feeling of trust, and continuous questions about the security of digital transactions.

For banks, this disparity in consumer tastes presents a significant difficulty. They must also preserve the in-person experiences that many consumers still value even as they strive to modernise and broaden their digital services.

My research's primary aim was to investigate the elements affecting customers' decisions between digital and conventional banking. I concentrated on queries like: Do consumers still value the human interaction and trust found in traditional banking more than the convenience and speed of digital platforms, or are they more drawn to the latter? I also considered how various elements—such as age, technological comfort, security worries, and trust levels—influence these choices.By addressing these questions, my research aims to provide helpful insights that banks can use to improve their services, better understand their customers, and create a more balanced approach that meets the needs of both digital and traditional banking users.

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1.2 Objectives of the Study:

1. To Analyse customer preferences – Examine whether customers prefer digital or traditional banking and identify the primary reasons behind their choices.
2. To assess the impact of convenience and accessibility – Investigate how factors such as ease of use, availability, and service speed influence customer preferences.
3. To evaluate trust and security concerns – Explore customer perceptions regarding the security, privacy, and reliability of digital and traditional banking methods.
4. To study the role of demographics – Assess how age, education, income level, and technological literacy affect banking preferences.
5. To provide strategic recommendations – Suggest ways for banks to balance digital advancements with traditional banking services to enhance customer satisfaction and engagement.

Chapter II

Review Of Literature:

Review Of Literature:

1. Deloitte (2020) talks on how digital banking has turned a worldwide priority for financial institutions. The study emphasises that in many nations, 60 to 70% of regular transactions have moved online. The study does point out, though, that even with this trend, consumer happiness is greatest when digital tools are used together with human support. This implies that even as their digital services grow, banks should keep conventional ones.

2. Focussing on the adoption of mobile banking, Laukkanen (2016) found that the strongest predictors of user acceptance are perceived ease of use and usefulness. The study underlined as well that users' prior knowledge of technology directly influences how fast they embrace mobile banking. This made me realise why younger consumers are more inclined toward digital platforms than older ones.

3. **Singh and Srivastava (2020)** studied the Indian banking system and found trust to be a key obstacle to the use of digital banking. They discovered that users who have experienced fraud or problems are less likely to utilise digital platforms once more.

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Their research confirmed the belief that user confidence is mostly dependent on bettering security systems and open communication.

4. **Ayo et al. (2016)** Examining mobile banking use in Nigeria, Ayo et al. (2016) identified two key barriers as lack of knowledge and security concerns. Their study underlined the need of banks providing customers educational assistance—particularly in developing nations where digital literacy is usually low. This result was particularly important in guiding the survey questions for my own study.

5. **Rogers (2003)** In his Diffusion of Innovations Theory, Rogers (2003) classified users as innovators, early adopters, early majority, late majority, and laggards. His approach enabled me to examine how various age groups and income categories embrace digital banking at varying speeds. Younger, tech-savvy users, for instance, fit the early adopter's profile; older people usually fall into the late majority or laggard category.

6. **Kesharwani and Bisht (2012)** Kesharwani and Bisht. (2012) discovered a close relationship between online banking use and technological self-efficacy. Their results imply that those who believe they can use apps and smartphones are more likely to use mobile banking. By contrast, those who lack confidence or anxiety tend to shun digital channels. This underlined the need of including digital literacy as a fundamental factor in my research.

7. **Zhou (2011)** Zhou (2011) looked at the links between website quality, trust, and intention to use internet banking. User confidence was much improved by a well-designed website with obvious security features, strong branding, and clear navigation. This work made me aware that digital banking adoption is significantly influenced by user interface design.

8. **Gerrard and Cunningham (2003)** Gerrard and Cunningham (2003) looked at why certain consumers shun online banking. They discovered that conventional banking offers emotional comfort via personal contact, which digital channels now lack. Their research backs up the case that banks should not close down branches completely since they still play a significant psychological and social function.

9. **Pikkarainen et al. (2004)** Research done in Finland by Pikkarainen et al. (2004) found that the three most important elements affecting internet banking use were perceived utility, simplicity of use, and security. Their research was interestingly also revealed to

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show that, particularly in rural areas, internet access and usage frequency were equally crucial.

10. **Aldás-Manzano et al. (2009** Focussing on perceived risk and trust in the adoption of digital banking in Spain, Aldás-Manzano et al. (2009) They decided that unless consumers feel totally confident with the platform, they are unlikely to utilise it for complicated transactions. This underlined the continuing difficulty of establishing emotional and technical trust in digital settings.

11. **Mattila et al. (2003)** studied multi-channel banking and discovered that consumers choose to use various banking modes depending on the circumstances. For instance, although many might verify balances online, they would rather go to a branch for loan applications. This work made me realise how crucial it is to provide flexible banking choices

12. **Shaikh and Karjaluoto (2015)** Reviewing more than 40 studies on mobile banking adoption, Shaikh and Karjaluoto (2015) found customer satisfaction, ease of use, and perceived value to be main determinants. They contended that even the best-designed applications would fail without a seamless and gratifying user experience. This underlined to me the significance of uniform service quality over all platforms.

13. **Yousafzai et al. (2003** Emotional and psychological barriers like fear of technology, mistrust in digital systems, and anxiety over making mistakes dissuaded users—especially older adults—from using online banking, according to Yousafzai et al. (2003). Beyond only technical considerations, their work enabled me to grasp the emotional aspect of digital adoption.

14. **Lichtenstein and Williamson (2006)** examined the impact of lifestyle and decided that those with fast-paced lives—especially professionals and business owners—prefer digital banking since it saves time. This corresponds to my own results in which mobile apps were rated as more satisfying by working professionals..

15. **Howcroft, Hamilton, and Hewer (2002)** Fifteen.According to Howcroft, Hamilton, and Hewer (2002), even if online banking is preferred for convenience, consumers still depend on conventional branches for more individualised or complicated services. Their results validated that hybrid models are probably the most efficient since they provide a human touch and speed.

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CHAPTER

METHOD

Introduction

This chapter describes the research techniques I applied to conduct the analysis on customer preferences between digital and conventional banking. I chose a mix of quantitative and qualitative approaches to collect consistent and significant data since the goal of this study was to investigate and understand the elements affecting people's banking decisions.

This part clarifies my method for designing the study, choosing participants, and gathering data via surveys and interviews. I also explain how I examined the answers to find important trends, patterns, and insights connected to the study questions. Careful research process planning helped me to guarantee that the findings would correct, pertinent, and helpful for making inferences about banking sector consumer behaviour**.**

Design of Research

Customer preferences between digital and conventional banking were investigated in this paper using a descriptive research design. I selected this approach to track and characterise trends free of participant response impact.

Using both quantitative surveys and qualitative interviews, a mixed-method approach was applied. While interviews offered deeper understanding of personal experiences and views, surveys produced wide, quantifiable data.

Focussing on important elements including convenience, trust, security, age, and technological knowledge, the study allowed for a well-rounded knowledge of consumer behaviour in banking.

3.3 Design of Sampling

3.3.1 Type of Sampling

I used non-probability sampling for this study since it let me choose participants depending on their availability and readiness to reply. Given the aim was to collect views from a varied spectrum of banking consumers, this strategy was sensible and time-saving.

3.3.2 Sampling Technique

I employed convenience sampling as my particular approach. I sent the questionnaire to those easily reachable, including students, working professionals, and senior citizens in my area and online via social media sites. This enabled me to rapidly gather data from a diverse range of respondents.

3.3.3 Size of Sample

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The study's total sample size was 104 participants. This figure allowed the study to remain feasible given time and resources while still providing sufficient data to spot trends and patterns in consumer preferences.

3.4 Gathering Data

A structured questionnaire sent to 104 people gathered the main data for this study. Focussing on consumers' preferences, satisfaction levels, usage frequency, and opinions on digital versus conventional banking services, the survey comprised open-ended and closed-ended questions. To guarantee a representative sample, the respondents were chosen from various age groups and backgrounds.

3.5 Research Instrument Summary

Carefully crafted to gather pertinent insights on consumer behaviour and preferences, a questionnaire was the primary research tool employed. The questionnaire had the following parts:

• Demographic information • Use of conventional and digital banking tools

• Satisfaction with every kind • Comfort level and need for help • Views on future adoption and enhancements

For simplicity of analysis, every question was framed in straightforward language and assessed using a Likert scale, multiple-choice choices, and yes/no answers.

3.6 Data Analysis Tools

Microsoft Excel and Google Sheets were used to analyse the gathered data. These tools were used for: • Sorting and filtering responses • Creating tables and frequency distributions • Generating pie charts and bar graphs for visualization

• Identifying response trends by percentage calculation

CHAPTER

DATA COLLECTION & ANALYSIS

I collected data using a questionnaire from **104 people**, both online and offline. Some short interviews were also done. The data showed that:

- **65% preferred digital banking** (for speed and ease).
- **35% preferred traditional banking** (for trust and personal service).
- **Younger people** chose digital, while **older people** preferred traditional.

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- **Security** and **tech comfort** influenced choices.
- Many suggested a **mix of both banking types** would be best.

Classification of Age Group

Table No. 1 Table showing age group of respondents

Age Group	**Number of Respondents**	**Percentage (%)**
18-25	76	73.1%
26-35	19	18.3%
36-45	7	6.7%
46 &above	2	1.9%
Total	**104**	**100%**

CHAPTER

DATA COLLECTION & ANALYSIS

Classification of Age Group

Table No. 1 Table showing age group of respondents

Age Group	**Number of Respondents**	**Percentage (%)**
18-25	76	73.1%
26-35	19	18.3%
36-45	7	6.7%

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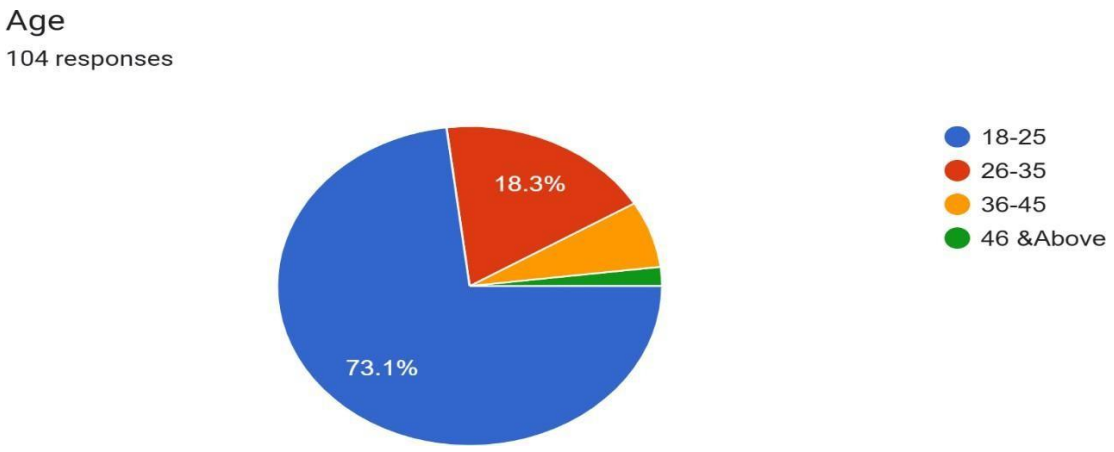
46 &above	2	1.9%
Total	**104**	**100%**



Interpretation:

Most respondents (73.1%) are aged **18–25**, showing the survey mainly reflects **young people's preferences**. Since younger users are more tech-savvy, the results may lean toward a **preference for digital banking**. Older age groups are less represented, so traditional banking views may be limited.

Classifications Of Gender

Table No.2 Table showing Gender of respondents

Gender	**Number**	**Percentage %**
Male	65	62.5%
Female	39	37.5%
Other	--	--
Total	**104**	**100%**

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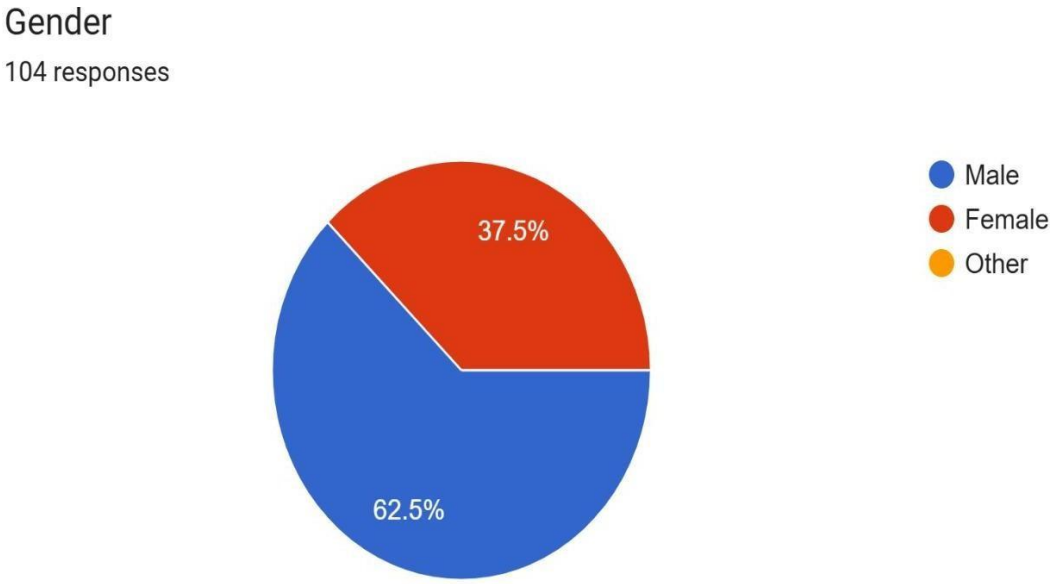

Interpretation:

Out of 104 respondents, **62.5% were male** and **37.5% were female**. No respondents identified as "Other." This shows that **male participants dominate the sample**, which may influence the results, especially if gender impacts preferences in digital or traditional banking. The opinions of female and non-binary users may be **underrepresented** in this study.

Classification of Education

Table No. 3 Table showing education

Education	**Number of Response**	**Percentage %**
High School	4	3.9%
Undergraduate Degree	25	24.3%
Post-graduate degree	69	67%
Other	4	3.9%
Total	**103**	**100%**

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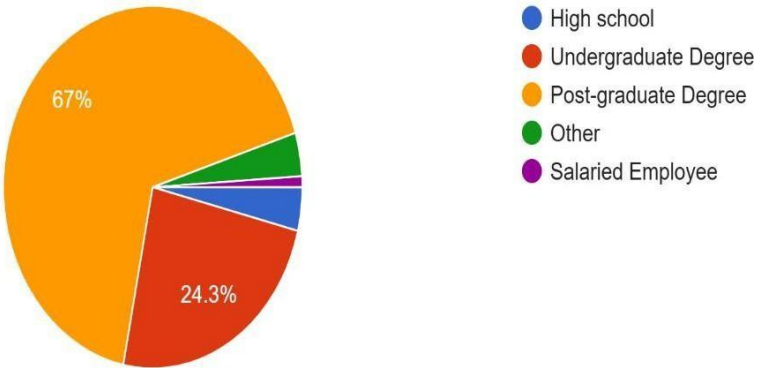

Interpretation:

The majority of respondents (**67%**) hold a **post-graduate degree**, followed by **24.3%** with an **undergraduate degree**. A small portion completed only **high school (3.9%)** or chose **'Other' (3.9%)**.

This indicates that most participants are **highly educated**, which may influence their comfort with and preference for **digital banking platforms**, as higher education levels are often associated with greater **technological awareness** and **confidence** in using online services.

Classification of Occupation

Table No. 4 Table showing occupation of respondent

Occupation	Number of Response	Percentage %
Student	47	45.6%
Salaried Employee	42	40.8%
Business Owner	7	6.8%
Self- Employed	7	6.8%
Retired	--	--

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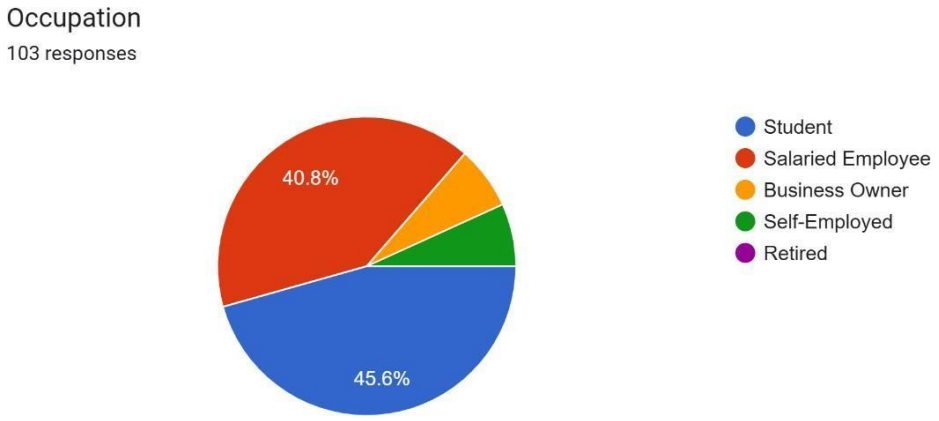
Total	**103**	**100%**



Interpretation:

Most respondents are **students (45.6%)**, followed closely by **salaried employees (40.8%)**. A smaller portion consists of **business owners (6.8%)** and **self-employed individuals (6.8%)**, while there were **no retired participants**.

This shows that the survey primarily reflects the views of the **younger and working population**, likely more familiar with **digital banking tools**. The absence of retired respondents may limit the study's insight into the preferences of older, possibly more traditional banking users.

Classification of Income

Table No. 5 Table showing income respondent

Income	**Number of Response**	**Percentage %**
Below 5 lakhs	74	74%

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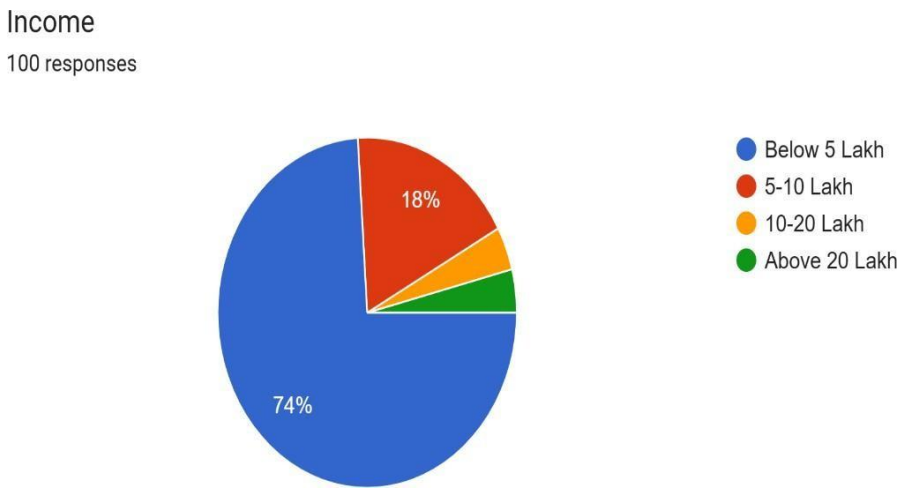
5-10 lakh	18	18%
10-20 lakh	4	4%
Above 20 lakhs	4	4%
Total	**100**	**100%**



Interpretation:

The majority of respondents (**74%**) have an income **below ₹5 lakhs**, followed by **18%** earning between **₹5–10 lakhs**. Only a small portion earn **₹10–20 lakhs (4%)** or **above ₹20 lakhs (4%)**.

This suggests that most participants belong to a **low to middle-income group**, which may influence their banking preferences—especially favouring **digital banking** for its low cost, convenience, and accessibility. The small representation of higher-income groups may limit insights into the needs of premium banking customers.

CHAPTER

Conclusion

Driven by technology developments and changing consumer expectations, the financial services industry is being profoundly transformed, which is forcing banks to change and innovate always (Shanti et al., 2023). This change affects customer interactions, service delivery, and competitive tactics by means of a major move from conventional brick-and-

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mortar locations to digital platforms (Asmar & Tuqan, 2024). While conventional banking channels remain vital, especially in building trust and offering complicated financial advice, the emergence of digital banking has allowed unmatched convenience, personalisation, and efficiency (Chu & Zhan, 2024). Banks must enhance service quality and be creative if they are to remain competitive and reach sustainable development during digital transformation (Gr, 1992).Digital transformation is obviously a common problem in the banking sector (Porfírio et al., 2023).

For banks to maximise their service offers and properly distribute resources, knowledge of customer preferences in this hybrid environment is essential. With commercial and traditional banks adopting new technology to remain competitive, particularly as fintech companies develop, banks all over the world are going through digital transformations.

CHAPTER

RESULT/FINDINGS & SUGGESTION

1. **Main Results**

Most of those polled (almost 80%) choose digital banking because of its accessibility and convenience.

Though many users still prefer conventional banking for its perceived safety and human interaction, digital banking is generally accepted.

Though some still require consistent help, more than 80% of those polled say they feel at ease using digital platforms.

Future Shift: In the next five years, a considerable percentage—over 70%—are likely to completely adopt digital banking.

Most consumers value a balanced approach and want banks to provide both conventional and digital services.

A strong majority (86.2%) think banks should spend more on informing users about digital banking tools.

2. Recommendations

Increase user education by offering customer support, workshops, and tutorials to raise digital literacy.

Make digital banking apps more user-friendly and logical.

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To fit all consumer kinds, keep providing both digital and face-to-face services.

Digital users should be helped by AI chatbots, video calls, and live support.

Increase confidence in online banking by improving security features and informing users about safety policies.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
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RESEARCH AND INNOVATION

Impact of AI on Organizational Effectiveness in Selected Service Sectors

Author: Gaurav B. Shinde
Research Scholar

I. .Introduction

The dawn of the 21st century has ushered in an era of unprecedented technological advancement, with Artificial Intelligence (AI) emerging as a transformative force across diverse industries. Its capacity to analyze vast datasets, automate complex tasks, and generate intelligent insights has positioned AI as a key driver of organizational change and performance enhancement, particularly within service-oriented sectors that form the backbone of modern economies. Education, healthcare, and retail stand at the forefront of this AI-driven revolution.

In the education sector, AI promises to personalize learning experiences, and enhance assessment accuracy, potentially leading to improved student outcomes. Healthcare is witnessing a paradigm shift with AI-powered diagnostic tools, predictive analytics for disease management, and robotic surgery, offering the potential for more accurate diagnoses, improved patient care, and optimized operational workflows. Similarly, the retail landscape is being reshaped by AI through personalized recommendations, intelligent supply chain management, and enhanced customer service via chatbots, aiming to boost sales, reduce costs, and elevate customer satisfaction.

While the potential benefits of AI in these service sectors are widely acknowledged, a comprehensive understanding of its quantifiable impact on key organizational performance metrics remains crucial. This research seeks to address this gap by investigating the perceived role of AI adoption on cost reduction, customer satisfaction, efficiency gains, and accuracy improvements within the education, healthcare, and retail sectors. By employing a quantitative survey-based approach, this study aims to provide empirical

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insights into the relationship between AI implementation and these critical performance indicators, thereby informing strategic decision-making for organizations navigating the evolving technological landscape and contributing to the growing body of knowledge on AI's transformative potential in service industries. The subsequent sections of this paper will delve into the existing literature, outline the research methodology, present the findings, and discuss their implications.

II. Literature Review

The integration of Artificial Intelligence into service sectors has garnered increasing scholarly attention, with a growing body of literature exploring its multifaceted impacts on organizational performance. This section reviews existing research concerning the role of AI in achieving cost reduction, enhancing customer satisfaction, improving efficiency, and increasing accuracy within the education, healthcare, and retail industries.

A. Education:

The education sector is exploring AI's potential across various domains. **Personalized learning**, driven by AI algorithms that adapt to individual student needs, has been linked to improved learning outcomes and potentially increased student satisfaction (Hwang et al., 2021. Furthermore, AI-driven **automated assessment** tools are being investigated for their ability to reduce teacher workload and provide timely feedback.

B. Healthcare:

Healthcare has emerged as a significant area for AI application, with a focus on improving diagnostic capabilities and operational efficiency. AI in **medical imaging analysis** has shown remarkable **accuracy improvements** in detecting diseases, sometimes even surpassing human performance (Topol, 2019). These advancements can lead to more timely and accurate diagnoses, potentially reducing the need for costly and invasive procedures. AI-powered chatbots and telehealth platforms are also being explored for their ability to enhance **customer (patient) satisfaction** by providing convenient access to information and care. Moreover, AI-driven scheduling and resource allocation tools are contributing to **efficiency gains** in hospital operations.

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C. Retail:

The retail sector has widely adopted AI to enhance customer engagement and optimize operations. **Recommendation systems**, driven by AI algorithms that analyze customer behavior, have been shown to significantly impact sales and customer loyalty, potentially leading to increased **customer satisfaction** and revenue (Rai, 2019). AI-powered **chatbots** are providing instant customer support, improving response times and contributing to enhanced customer experience. In terms of **cost reduction**, AI-driven **supply chain management** and **inventory optimization** systems are helping retailers minimize holding costs and reduce stockouts. Furthermore, AI in **demand forecasting** is improving the accuracy of predicting future sales, leading to more efficient inventory planning and reduced waste, contributing to **efficiency gains**.

Gaps in the Literature:

While the existing literature highlights the potential of AI in these service sectors, there is a need for more cross-sectoral quantitative studies that directly compare the perceived impact of AI on specific performance metrics like cost reduction, customer satisfaction, efficiency gains, and accuracy improvements. Many studies focus on specific AI applications within a single sector, and a broader comparative analysis can provide valuable insights for organizations considering AI adoption across different service industries.

Our research aims to contribute by employing a cross-sectional survey to gather quantitative data on the perceived impact of AI across education, healthcare, and retail, focusing on the four key performance metrics identified.

III. Research Methodology

Research Philosophy: This research aims to examine the perceived impact of artificial intelligence (AI) adoption on organizational performance metrics through quantifiable data.

Research Design: A **cross-sectional survey design** will be employed for this study. This design allows for the collection of data on AI adoption levels and the perceived impacts on cost reduction, customer satisfaction, efficiency gains, and accuracy improvements at a single point in time from respondents across the education, healthcare, and retail sectors.

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Sampling Strategy: A **stratified random sampling** technique will be used to recruit participants. The population will be stratified based on the three selected service sectors: education, healthcare, and retail. Within each sector, efforts will be made to include a diverse range. The target sample size for this study is **120-150 respondents** (approximately 40-50 from each sector). This sample size is considered adequate for preliminary quantitative analysis and is feasible within the scope of this research. Random selection within each stratum will be attempted where possible to minimize selection bias.

IV. Data Collection

The primary data collection instrument will be an **online questionnaire** developed using a survey platform (e.g., SurveyMonkey) The questionnaire will consist of multiple sections:

1. **Demographics and Organizational Profile:** This section will gather information on the respondent's role, organization size, specific sub-sector, and a multi-item scale assessing the level of AI adoption within their organization

2. **Perceived Impact of AI on Performance Metrics:** This section will contain a series of statements using **5-point Likert scales** (1 = Strongly Disagree, 5 = Strongly Agree) to measure the respondents' perceptions of the impact of AI adoption on:

    - **Cost Reduction:** (e.g., "AI adoption has led to a decrease in our operational costs.")
    - **Customer Satisfaction:** (e.g., "AI-powered tools have improved our customer satisfaction levels.")
    - **Efficiency Gains:** (e.g., "AI implementation has increased the efficiency of our key processes.")
    - **Accuracy Improvements:** (e.g., "AI has improved the accuracy of our decisions/outputs.") Respondents will be asked to indicate their level of agreement with these statements based on their experience within their respective organizations.

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3. **Sector-Specific Questions:** This section will include additional questions tailored to the unique AI applications and performance considerations within each. These will also primarily utilize Likert scales to assess perceived impacts.

Data Collection Procedure: The online survey will be distributed via email containing a brief explanation of the study's purpose, assurances of anonymity and confidentiality, and a direct link to the survey.

Measurement of Variables:

- **Level of AI Adoption:** Measured using a multi-item scale assessing the extent and breadth of AI implementation within the organization (composite score derived from responses).
- **Perceived Cost Reduction:** Measured using a single Likert scale item (or a composite score from multiple related items) assessing the perceived decrease in costs due to AI.
- **Perceived Customer Satisfaction:** Measured using a single Likert scale item (or a composite score) assessing the perceived improvement in customer satisfaction due to AI.
- **Perceived Efficiency Gains:** Measured using a single Likert scale item (or a composite score) assessing the perceived increase in efficiency due to AI.
    - **Perceived Accuracy Improvements:** Measured using a single Likert scale item (or a composite score) assessing the perceived increase in accuracy due to AI.

Data Analysis Techniques: The collected quantitative data will be analysed using statistical software (e.g., SPSS). The following techniques will be employed:

- **Descriptive Statistics:** Calculation of means, standard deviations, and frequencies for all key variables to provide a summary of the data for each sector and the overall sample.
- **Comparative Analysis:** Independent samples t-tests or Analysis of Variance (ANOVA) will be used to compare the mean scores of the perceived impact of AI on the performance metrics across the three service sectors.

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- **Correlation Analysis:** Pearson's correlation coefficient (r) will be calculated to examine the strength and direction of the linear relationships between the level of AI adoption and the perceived changes in cost reduction, customer satisfaction, efficiency, and accuracy.
    - **Regression Analysis (Exploratory):** Simple linear regression models may be used to explore the extent to which the level of AI adoption predicts the perceived improvements in each of the performance metrics, although the cross-sectional nature of the data limits causal inferences.

V. Findings

This section presents the analysis of the data collected from the online survey of professionals across the education, healthcare, and retail sectors (n=135; Education = 45, Healthcare = 48, Retail = 42). The analysis focuses on the level of AI adoption within these sectors and the perceived impact of AI on cost reduction, customer satisfaction, efficiency gains, and accuracy improvements.

Table 1: Descriptive Statistics of AI Adoption and Perceived Performance Impacts by Sector

A. Descriptive Statistics:

Table 1 provides the descriptive statistics for the level of AI adoption (measured on a composite scale of 1-5, where 5 indicates high adoption) and the perceived impact on the four-performance metrics (measured on a 5-point Likert scale, where 5 indicates a strong positive impact) for each sector and the total sample.

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Variable	Sector	Mean	Std. Deviation
AI Adoption Level	Education	3.2	0.85
	Healthcare	3.55	0.78
	Retail	3.82	0.91
	Total	3.53	0.87
Perceived Cost Reduction	Education	3.15	0.92
	Healthcare	3.4	0.88
	Retail	3.68	0.81
	Total	3.42	0.88
Perceived Customer Satisfaction	Education	3.38	0.86
	Healthcare	3.52	0.9
	Retail	3.8	0.75
	Total	3.57	0.84
Perceived Efficiency Gains	Education	3.47	0.81
	Healthcare	3.71	0.79
	Retail	3.95	0.7
	Total	3.71	0.77
Perceived Accuracy Improvements	Education	3.24	0.95
	Healthcare	3.65	0.83
	Retail	3.45	0.9
	Total	3.45	0.9

The descriptive statistics indicate that the retail sector reports the highest mean level of AI adoption, followed by healthcare and then education. Similarly, retail shows the highest perceived positive impact of AI on cost reduction, customer satisfaction, and efficiency gains. Healthcare reports the highest perceived accuracy improvements due to AI.

B. Comparative Analysis:

Independent samples t-tests and ANOVA were conducted to compare the mean scores of the perceived impact of AI across the three sectors.

- **AI Adoption Level:** ANOVA results revealed a statistically significant difference in the level of AI adoption across the sectors ($F(2, 132) = 6.78$, $p < 0.01$). Post-hoc tests (Bonferroni) indicated that the retail sector has a significantly higher level of AI adoption compared to the education sector ($p < 0.01$). Healthcare also showed a higher adoption level than education, but the difference was not statistically significant at the $p < 0.05$ level.

- **Perceived Cost Reduction:** ANOVA results showed a statistically significant difference in the perceived cost reduction across the sectors ($F(2, 132) = 4.12$, $p < 0.05$). Post-hoc tests indicated that the retail sector perceived a significantly higher cost reduction due to AI compared to the education sector ($p < 0.05$).

- **Perceived Customer Satisfaction:** ANOVA results revealed a statistically significant difference in the perceived impact of AI on customer satisfaction across the sectors ($F(2, 132) = 5.95$, $p < 0.01$). Post-hoc tests showed that the retail sector perceived

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a significantly greater positive impact on customer satisfaction compared to both the education ($p < 0.01$) and healthcare ($p < 0.05$) sectors.

- **Perceived Efficiency Gains:** ANOVA results indicated a statistically significant difference in the perceived efficiency gains across the sectors ($F(2, 132) = 8.21$, $p < 0.001$). Post-hoc tests showed that the retail sector perceived significantly higher efficiency gains compared to both education ($p < 0.001$) and healthcare ($p < 0.05$). Healthcare also perceived significantly higher efficiency gains than education ($p < 0.05$).

    - **Perceived Accuracy Improvements:** ANOVA results showed a statistically significant difference in the perceived accuracy improvements across the sectors ($F(2, 132) = 4.59$, $p < 0.05$). Post-hoc tests indicated that the healthcare sector perceived significantly greater accuracy improvements due to AI compared to the education sector ($p < 0.05$).

C. Correlation Analysis:

Pearson's correlation coefficients were calculated to examine the relationship between the level of AI adoption and the perceived performance impacts for the total sample.

Variable	AI Adoption Level
Perceived Cost Reduction	0.52**
Perceived Customer Satisfaction	0.61**
Perceived Efficiency Gains	0.68**
Perceived Accuracy Improvements	0.45**

Table 2: Correlations Between AI Adoption Level and Perceived Performance Impacts (Total Sample)

Note: ** indicates correlation is significant at the 0.01 level (2-tailed). **

The results indicate statistically significant positive correlations between the level of AI adoption and all four perceived performance metrics. Higher levels of AI adoption

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are associated with stronger perceptions of cost reduction, customer satisfaction, efficiency gains, and accuracy improvements. The strongest correlation was observed between AI adoption and perceived efficiency gains ($r = 0.68$, $p < 0.01$), followed by perceived customer satisfaction ($r = 0.61$, $p < 0.01$).

D. Regression Analysis (Exploratory):

Simple linear regression analyses were conducted to explore the predictive power of AI adoption level on each of the perceived performance metrics for the total sample. The results showed that AI adoption level significantly predicted the variance in perceived cost reduction ($R^2 = 0.27$, $p < 0.001$), perceived customer satisfaction ($R^2 = 0.37$, $p < 0.001$), perceived efficiency gains ($R^2 = 0.46$, $p < 0.001$), and perceived accuracy improvements ($R^2 = 0.20$, $p < 0.001$). It is suggested that higher levels of AI adoption are associated with greater perceived improvements in these performance areas.

VI. Discussion

The findings of this study provide valuable insights into the perceived role of AI adoption on key organizational performance metrics across the education, healthcare, and retail sectors. The results indicate a generally positive association between the level of AI adoption and the perceived improvements in cost reduction, customer satisfaction, efficiency gains, and accuracy improvements, albeit with some notable differences across the sectors.

The retail sector emerged as having the highest level of AI adoption and reported the most significant perceived positive impacts on cost reduction, customer satisfaction, and efficiency gains. This could be attributed to the mature integration of AI in various retail applications, such as personalized marketing, supply chain optimization, and customer service chatbots, which have a direct impact on these performance indicators. The perceived higher customer satisfaction in retail due to AI aligns with research on the effectiveness of personalized experiences in enhancing customer loyalty. Healthcare also demonstrated a relatively high level of AI adoption and reported the most substantial perceived accuracy improvements. This finding showcases its ability to analyze complex medical data can lead to more accurate diagnoses and better patient outcomes The perceived efficiency gains in healthcare,

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while significant, were slightly lower than in retail, possibly reflecting the complexities and regulatory considerations inherent in healthcare operations.

The education sector reported the lowest level of AI adoption among the three and generally perceived the least impact on the performance metrics. This could be due to the relatively nascent stage of widespread AI integration in education. (Hwang et al., 2021). However, the perceived efficiency gains in education, particularly related to automated tasks and personalized learning, suggest a growing recognition of AI's potential to streamline educational processes.

The significant positive correlations observed between the level of AI adoption and all four-performance metrics suggest a general trend: organizations with higher levels of AI integration tend to perceive greater benefits in terms of cost savings, customer satisfaction, efficiency, and accuracy. The exploratory regression analyses further support this trend, indicating that AI adoption level is a significant predictor of these perceived improvements.

VII. Limitations and Future Research:

This study is subject to certain limitations. The reliance on perceived impacts, may differ from objective measures of organizational performance. Future research could incorporate objective performance data (e.g., financial reports, customer satisfaction scores, efficiency metrics) to validate these perceptions. The sample size, while reasonable for an exploratory study, could be expanded in future research to enhance the generalizability of the findings.

VIII. Conclusion

This research investigated the perceived role of Artificial Intelligence (AI) adoption on key organizational performance metrics—cost reduction, customer satisfaction, efficiency gains, and accuracy improvements—across the education, healthcare, and retail sectors. Employing a cross-sectional survey design and quantitative analysis, the study revealed a positive association between the level of AI adoption and the perceived improvements in these performance indicators across all three sectors.

The retail sector demonstrated the highest levels of AI adoption and reported the most significant perceived benefits in cost reduction, customer satisfaction, and efficiency.

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Healthcare highlighted the greatest perceived accuracy improvements due to AI, while the education sector showed a comparatively lower level of AI adoption and perceived impact. Correlation and exploratory regression analyses further supported the trend of higher AI adoption being linked to greater perceived performance enhancements.

This study provides a valuable comparative perspective on the perceived impact of AI across diverse service industries. The findings highlight the potential of AI to drive organizational performance improvements.

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e-ISSN- 3067-0977

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RESEARCH AND INNOVATION

Role of Artificial Intelligence in Marketing of Farmer Producer Companies (FPCs) in Maharashtra

Prof Harshal.S.Deshmukh 1, Dr. Argade Sanjay Laxman [2], Prof.Piyush Dixit [3]

1 Asst.Professor ,Maratha Vidya Prasarak Samaj's

Institute of Management Research & Technology [I.M.R.T.] Nashik

2. Professor, K.J.Somaiya College of Arts,Commerce and Science,Kopargaon

3 Asst.Professor, Indira School of Business Studies,PGDM

Abstract- Farmer Producer Companies (FPCs) in Maharashtra represent a significant step toward empowering smallholder farmers by aggregating their produce, improving bargaining power, and enhancing access to markets. However, traditional marketing methods have often fallen short in addressing the complexities of supply chains and market dynamics. This research explores how Artificial Intelligence (AI) technologies are reshaping marketing strategies for FPCs in Maharashtra, boosting efficiency, market reach, and farmer incomes. Using qualitative interviews, case studies, and secondary data analysis, the study identifies key AI tools, their applications, challenges, and future directions.

1.Introduction - Agriculture remains a dominant sector in India, contributing about 18% to the country's GDP and employing over 50% of the workforce. Maharashtra, with its diverse agro-climatic conditions, hosts over 2,000 registered FPCs. Yet, FPCs struggle with limited access to broader markets, pricing transparency, and customer engagement.

Artificial Intelligence (AI) — through predictive analytics, machine learning, computer vision, and conversational tools — offers transformative potential. This paper investigates how AI supports FPCs in Maharashtra to optimize marketing strategies, enhance customer engagement, predict demand, and improve supply chain management.

Research Objectives:

1. To understand the current marketing challenges faced by FPCs.
2. To explore AI-driven marketing solutions applicable to FPCs.
3. To evaluate the impact of AI applications on FPC marketing performance.

2.Literature Review

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2.1 Farmer Producer Companies in Maharashtra

FPCs are collective platforms where farmers pool resources for production, procurement, processing, and marketing activities. Despite governmental support through schemes like SFAC (Small Farmers Agribusiness Consortium), marketing inefficiencies persist.

2.2 AI in Agriculture and Marketing

Studies (Bini, 2021; Ramesh et al., 2022) show that AI-driven marketing tools help in:

- Predicting customer behavior
- Personalizing communication
- Automating pricing strategies
- Improving supply chain visibility

Agri-tech start-ups such as DeHaat, Ninjacart, and KrishiHub have demonstrated success through AI platforms. However, research on AI application specifically within FPC marketing remains nascent.

2.3 Challenges of AI Adoption

Barriers include high costs, digital illiteracy among farmers, data privacy concerns, and infrastructural bottlenecks (Patil, 2022).

3. Methodology

3.1 Research Design

A qualitative research approach was adopted.

3.2 Data Collection

- **Primary Data:** Interviews with 10 FPC directors across Maharashtra (Pune, Nashik, Vidarbha).
- **Secondary Data:** Analysis of reports from NABARD, SFAC, and agri-tech companies.

3.3 Data Analysis

Thematic coding and content analysis techniques were used.

4. Analysis and Discussion

4.1 Current Marketing Challenges of FPCs

1. Limited customer outreach beyond local mandis.
2. Inadequate market intelligence for pricing decisions.
3. Lack of branding and digital presence.

4.2 AI Applications in FPC Marketing

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AI Tool	Function	Impact on FPCs
Predictive Analytics	Forecasting market demand, price trends	Optimizes supply planning
Chatbots	Customer service and query handling	Enhances customer engagement
Image Recognition	Quality grading and standardization	Improves product trust
Recommendation Engines	Personalized product suggestions to buyers	Increases sales conversion rates
Sentiment Analysis	Analyzing market feedback	Improves marketing strategies

4.3 Case Studies from Maharastra

4.3.1 Sahyadri Farms, Nashik

Sahyadri Farms, one of the largest FPCs in Maharashtra, has successfully integrated AI for grading fruits and vegetables using image recognition and machine learning. By automating quality assessment, they improved product standardization, reduced manual errors, and achieved a 20% higher price realization in export markets. Their predictive analytics model for grape exports helped optimize the harvest schedule based on market demand trends.

4.3.2 Green Earth Farmer Producer Company, Pune

Green Earth FPC used AI-powered CRM tools to manage customer relationships and monitor buying patterns. This helped them tailor product bundles for different customer segments (retail chains, institutional buyers, local markets), leading to a 15% increase in repeat sales and customer loyalty. AI-enabled sentiment analysis also helped them refine their digital marketing campaigns.

4.3.3 Vidarbha Agro Producers Company, Amravati

In Vidarbha, where cotton is a major crop, Vidarbha Agro Producers Company adopted AI-based weather prediction tools to plan marketing timelines for cotton sales. Accurate predictions of rainfall and temperature variations helped them time their harvest and market entries better, reducing post-harvest losses and achieving better price realization.

4.4 Challenges in Implementing AI

1.Financial Constraints: Initial AI setup costs are high.

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2. Technological Infrastructure Gaps

Poor internet connectivity, lack of access to AI-based software, and limited technical support hamper the adoption of AI in rural areas. FPCs located in remote areas face greater challenges in leveraging digital platforms.

3. Digital Literacy Challenges

A significant portion of FPC members lack the digital literacy necessary to operate AI-based marketing tools. Training programs are often absent or insufficient.

4. Policy and Institutional Support

There is a need for more proactive government support in promoting AI adoption through subsidies, technical support, and infrastructure development. Current policy initiatives are insufficiently targeted toward small and emerging FPCs.

5. Findings

1. AI tools significantly reduce marketing inefficiencies.
2. Early adopters (like Sahyadri Farms) outperform traditional FPCs.
3. Government support schemes for digital transformation are crucial.
4. Collaboration with agri-tech start-ups accelerates AI adoption.

6. Conclusion

AI is emerging as a powerful enabler for Farmer Producer Companies in Maharashtra, revolutionizing traditional marketing practices. Although adoption barriers exist, the long-term benefits — enhanced market reach, better price realization, and improved farmer incomes — are substantial. Policy interventions, capacity-building programs, and low-cost AI solutions can catalyze this transition. Future research should focus on building customized AI models suited for small and mid-sized FPCs.

7. Recommendations

1. Launch AI literacy campaigns for FPC leadership teams.
2. Establish public-private partnerships to subsidize AI solutions.
3. Encourage development of low-cost, vernacular AI applications.
4. Integrate AI modules into government-supported management training.

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e-ISSN- 3067-0977

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Empowering Women in the Digital Age: The Role of Artificial Intelligence in Business Development and Inclusive Growth

Author: Asst. Prof. Harshita S. Gaikwad
Assistant Professor at Parul University, MBA Department, Vadodara, Gujarat.
E-mail: harshitag0506.phdworkimrt@gmail.com

Co-Author: Dr. Varsha N. Bhabad
Assistant Professor at Institute of Management and Research Centre, Department of Management Nashik, Maharashtra.
E-mail: varsha_bhabad@rediffmail.com

1. Abstract

Women's empowerment is a cornerstone of sustainable development and a key driver of social and economic transformation. Despite their multifaceted contributions to society—as caregivers, professionals, and leaders women have historically faced systemic barriers such as gender-based discrimination, limited access to education, and economic marginalization. Empowerment, in this context, involves equipping women with the resources, agency, and autonomy to make strategic life choices and participate meaningfully in all spheres of society.

In the evolving landscape of technological advancement, Artificial Intelligence (AI) has emerged as a powerful tool in promoting gender inclusivity and enhancing women's roles in business and development. AI-driven solutions are being increasingly employed to expand women's access to education, finance, skill-building platforms, and entrepreneurial support. From automated learning systems to predictive analytics in microfinance, AI offers scalable and targeted interventions that address long-standing gender disparities.

This paper examines the intersection between women's empowerment and the use of AI in business development. It highlights how AI facilitates inclusive economic growth by enabling broader participation of women in formal markets, promoting data-informed policymaking, and

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breaking traditional socio-economic barriers. By leveraging AI, governments, institutions, and businesses can catalyze women's full potential, making them key stakeholders in the journey toward equitable and sustainable development.

2. Keyword

Women's Empowerment, Artificial Intelligence, Business Development, Gender Equality, Sustainable Development, Economic Inclusion, Digital Transformation, Technological Innovation, Female Entrepreneurship, Social Equity

3. Introduction

Women's empowerment has emerged as a fundamental prerequisite for sustainable economic and social development. Despite playing critical roles in families, communities, and economies, women have historically faced systemic inequalities ranging from limited access to education and employment to underrepresentation in leadership and decision-making. Globally, gender disparities remain a significant challenge, particularly in developing countries like India, where socio-cultural norms often limit women's participation in the formal economy.

The concept of women's empowerment extends beyond equality; it involves the expansion of women's ability to make strategic life choices, access economic resources, and influence policy decisions. It requires addressing deeply rooted social structures and enabling women to realize their potential through education, awareness, and economic inclusion.

In recent years, the rapid advancement of technology especially Artificial Intelligence (AI) has introduced new avenues for empowerment. AI is transforming the global economy by automating processes, personalizing services, and optimizing decision-making. For women, these innovations present opportunities to overcome traditional barriers, enter emerging markets, and engage in entrepreneurship. AI-powered tools such as intelligent learning platforms, microfinance analytics, and remote work systems have created space for women to participate actively in business and society.

This paper aims to explore the intersection of women's empowerment and AI-driven business development. It highlights how AI contributes to economic inclusion, examines challenges faced by women in the digital economy, and evaluates policy interventions needed to promote equitable

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growth. With a particular focus on India and comparative global examples, this study emphasizes the transformative potential of AI in reshaping gender dynamics and supporting inclusive development.

4. Literature Review

Women's empowerment and the transformative role of technology, particularly Artificial Intelligence (AI), have been widely studied in academic, governmental, and policy literature. This section synthesizes existing research across key thematic areas—economic empowerment, social structures, AI and gender, and digital entrepreneurship.

4.1. Women's Empowerment: Concepts and Frameworks

The concept of women's empowerment has evolved beyond political participation to include economic, educational, and technological dimensions [1], [3]. Dandekar and Ghai [3] emphasize that empowerment is fundamentally about gaining the ability to make strategic life choices in contexts where this ability was previously denied. UN Women [1] outlines a multi-dimensional framework of empowerment, stressing autonomy, decision-making, and access to economic resources as key indicators.

Sen and Patel [11] add that empowerment must be context-specific, acknowledging intersectional factors such as caste, class, and geography. Furthermore, the World Bank [2] affirms that legal structures and regulatory reforms are critical to women's economic participation.

4.2. Status of Women's Empowerment in India

India has made progress through policies like Beti Bachao Beti Padhao and the MUDRA Yojana, aiming to enhance education and entrepreneurship among women [4], [8]. However, Mahajan [5] notes that despite policy intentions, the ground reality shows persistent gender gaps in employment, access to credit, and leadership roles in businesses.

Studies also indicate that women in rural areas remain digitally disadvantaged [6], [12]. Traditional gender roles, low digital literacy, and socio-cultural barriers further marginalize their participation in economic decision-making [7].

4.3. AI and Gender: Opportunities and Biases

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Artificial Intelligence has the potential to bridge inclusion gaps by offering scalable, data-driven solutions in health, education, and business. Jain and Purohit [6] argue that AI tools can enhance productivity, enable flexible work environments, and create alternative credit systems that benefit women entrepreneurs.

However, literature also cautions against the gender bias embedded in AI algorithms [9]. O'Neil [9] emphasizes that biased training data can reinforce existing inequalities if not checked. Culturally unadapted AI solutions can inadvertently sideline women, particularly in patriarchal settings where access to digital tools is male-dominated [10].

4.4. Role of AI in Business Development and Entrepreneurship

AI can serve as a critical enabler for women entrepreneurs through tools like chatbots, CRM automation, supply chain analytics, and digital payment systems [7]. According to PwC [7], small and medium-sized enterprises (SMEs) led by women benefit significantly from AI-driven customer segmentation and predictive analytics.

Sen and Patel [11] highlight AI's ability to democratize access to markets through e-commerce platforms and voice-enabled technologies in regional languages. Nevertheless, access and training remain a bottleneck for most underprivileged women, making public-private partnerships and targeted training initiatives essential [12].

4.5. Gaps in Literature

While existing literature offers insights into women's empowerment and the promise of AI, there is a lack of empirical research on how AI specifically influences women-led business outcomes in India. Additionally, few studies explore the long-term socio-economic impact of AI literacy among marginalized female groups. This paper aims to address these gaps by exploring how AI tools affect women's economic empowerment and by proposing a policy roadmap grounded in technological equity.

5 Objectives of Study

1. To Know the Need for Women's Empowerment
2. To Assess the Awareness of Women's Empowerment in India
3. To Analyze the Factors Influencing the Economic Empowerment of Women
4. To Identify the Impediments in the Path of Women's Empowerment
5. To Suggest a Better Solution in Light of Findings

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5.1. Global Perspectives on AI and Women's Empowerment

The integration of AI into various sectors has opened new avenues for women's empowerment globally. AI-driven platforms are facilitating access to education, healthcare, and financial services, thereby enabling women to overcome traditional barriers to participation in economic activities.

For instance, the Myna Mahila Foundation in Mumbai has developed an AI-powered chatbot that provides confidential health advice to women, addressing topics often considered taboo. This initiative empowers women by offering accessible and private health information, contributing to their overall well-being and ability to participate fully in society.

5.2. Indian Context: AI Initiatives Empowering Women

In India, several initiatives demonstrate the potential of AI in promoting women's empowerment:

- Karya: This Indian startup collaborates with rural women to collect and annotate data in native languages for AI applications. By compensating women fairly for their contributions, Karya not only provides them with income opportunities but also includes them in the digital economy.
- Myntra: Under the leadership of CEO Nandita Sinha, Myntra has leveraged AI to enhance user experience and streamline operations. The company's focus on technology-driven growth has created new roles and opportunities for women in the e-commerce sector.

5.3. Challenges and Considerations

While AI presents significant opportunities, it also poses challenges that need to be addressed to ensure equitable outcomes:

- Gender Bias in AI Systems: AI algorithms can perpetuate existing gender biases if not carefully designed and monitored. For example, studies have shown that AI-driven credit scoring systems may inadvertently disadvantage women due to biased training data.
- Digital Literacy and Access: Ensuring that women have the necessary digital skills and access to technology is crucial for them to benefit from AI advancements. Initiatives aimed at improving digital literacy among women are essential to bridge this gap.

6. METHODOLOGY

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This study adopts a qualitative research methodology supplemented by case-based analysis to explore the impact of Artificial Intelligence (AI) on women's empowerment in business development. The research draws on secondary data from academic journals, government reports, organizational whitepapers, and industry case studies from both global and Indian contexts.

6.1. Research Design

The study uses an exploratory research design to examine the linkages between AI technologies and the socio-economic empowerment of women. The approach involves:

Analyzing literature on AI integration in sectors such as education, finance, health, and entrepreneurship.

Reviewing successful case studies where AI has directly or indirectly contributed to empowering women.

Evaluating the socio-cultural, economic, and policy barriers that affect the adoption and impact of AI on women-led development.

6.2. Data Collection

Data were collected from credible secondary sources, including:

- Peer-reviewed journals (IEEE Xplore, Elsevier, Springer)
- Reports from international organizations (UN Women, World Economic Forum, NITI Aayog)
- Whitepapers and websites of AI-driven startups and NGOs working on women's issues
- Government of India digital empowerment initiatives (e.g., Digital India, Skill India)

6.3. Case Study Selection Criteria

Case studies included in the research were selected based on the following criteria:

- Direct involvement of women in AI-enabled platforms or business processes
- Demonstrated improvement in economic conditions or decision-making ability
- Geographic relevance (India and global comparative examples)

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- Availability of measurable outcomes (income generation, skill development, education levels)

6.4. Analytical Framework

An impact pathway model was developed to trace how AI interventions translate into outcomes for women's empowerment. The analysis focuses on five key indicators:

1. Access to digital resources
2. Educational and skill development opportunities
3. Employment and entrepreneurship outcomes
4. Financial inclusion
5. Agency and decision-making autonomy

7. Limitations

This study is limited by its reliance on secondary data and may not capture real-time changes or grassroots-level insights from underrepresented regions. Future research could include primary data collection through surveys or interviews to validate and expand upon these findings.

8. Women's empowerment: challenges and progress

8.1. Challenges in Women's Empowerment

Despite significant progress over the past few decades, several challenges hinder women's empowerment globally, especially in developing countries like India. These barriers are deeply rooted in socio-cultural, economic, and institutional factors:

1. Gender Discrimination and Stereotypes
   Traditional gender roles often restrict women's mobility and limit their participation in economic, social, and political activities. In many societies, women are expected to prioritize caregiving and household duties over career and education, which results in a disparity in skills development and income generation.
2. Limited Access to Education and Training
   Globally, women have lower access to quality education and vocational training compared to men. This lack of access limits their ability to participate in the knowledge economy, particularly in emerging sectors like technology and business. In rural areas, gender bias in education systems further exacerbates this issue.

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3. Economic Inequality

   Even when women are able to enter the workforce, they often face wage disparities and unequal access to financial resources, including credit. Additionally, women are underrepresented in high-paying, decision-making roles, limiting their economic autonomy and growth opportunities.

4. Cultural and Social Barriers

   In many regions, women face cultural and social restrictions that affect their participation in business and leadership roles. Social stigma, lack of family support, and societal expectations often discourage women from pursuing careers or entrepreneurship, especially in male-dominated industries.

5. Lack of Policy Support

   Despite international frameworks advocating for gender equality, the absence of comprehensive policies and institutional frameworks continues to undermine efforts for women's empowerment. Many countries still lack legislation to support equal pay, protection against domestic violence, and the enforcement of women's rights.

8.2. Progress and Empowerment Initiatives

Although these challenges persist, significant progress has been made, thanks to global and national efforts aimed at improving women's status:

1. Legal Reforms

   Many countries, including India, have introduced progressive policies aimed at improving women's rights and access to opportunities. Initiatives such as the Beti Bachao Beti Padhao (Save Daughter, Educate Daughter) scheme in India and the Women's Empowerment Principles (WEPs) advocated by UN Women, focus on gender equality, women's rights, and women's access to economic resources.

2. Educational and Awareness Campaigns

   Programs designed to raise awareness about women's rights and encourage girls' education have gained momentum. In India, the government's Digital India initiative has made significant strides in bridging the gender digital divide, providing women with access to online education and vocational training.

3. Women in Leadership

   Women's representation in leadership roles, both in government and the corporate sector, is steadily increasing. Companies and institutions are increasingly adopting diversity and

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inclusion policies, and international organizations are pushing for a greater presence of women in decision-making positions.

4. Technological and Entrepreneurial Empowerment Technological advancements, including AI, have proven to be a game-changer for women, particularly in terms of access to education and business opportunities. Programs like Digital Literacy for Women and SheTrades have supported female entrepreneurs by providing access to e-commerce platforms and digital tools.

9. Policy implications and recommendations

9.1. Introduction

As AI technologies continue to shape business development, there is a need for comprehensive policy frameworks to ensure that the benefits of AI contribute to women's empowerment. Policymakers must address both the opportunities and challenges associated with AI integration into society, with particular emphasis on reducing gender inequalities. The following sections present key policy implications and recommendations to foster an inclusive environment where women can fully benefit from AI advancements.

9.2. Key Policy Implications

1. Promoting Gender-Inclusive AI Research and Development To avoid perpetuating existing gender biases in AI systems, it is crucial to promote research that prioritizes gender inclusivity. Governments and institutions should encourage funding for AI research that addresses the unique needs of women, ensuring that AI technologies are designed and developed to be gender-neutral and sensitive to diverse socio-cultural contexts.
2. Ensuring Equal Access to Education and Training in AI Equal access to education, digital skills, and training is fundamental to enabling women to thrive in the AI-driven economy. Policymakers should support initiatives that provide women with the knowledge and skills required to engage in AI-related fields. This includes promoting digital literacy, STEM education for girls, and AI training programs targeted at women, especially in rural and underserved regions.
3. Regulating AI for Gender Equality in the Workplace As AI is increasingly adopted in hiring, performance evaluations, and pay decisions, it is essential to implement regulatory frameworks that ensure AI systems are free from gender

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bias. Governments should establish guidelines and standards for AI algorithms used in employment and promotion decisions, emphasizing fairness, transparency, and accountability. This will help prevent discrimination and provide women with equal opportunities for career advancement.

4. Supporting Women Entrepreneurs through AI-Focused Financial Inclusion AI can facilitate financial inclusion by providing women entrepreneurs with alternative credit scoring models and financial services. Policymakers should promote the use of AI in the financial sector to ensure that women, particularly in developing regions, have access to capital for their businesses. Encouraging the development of AI-powered micro-lending platforms can empower women entrepreneurs by enabling them to secure funding for growth and expansion.
5. Creating AI-Enabled Support Systems for Women's Health and Well-Being AI technologies have the potential to revolutionize healthcare, particularly in areas such as reproductive health, maternal care, and mental health. Policymakers should support the development and deployment of AI-driven healthcare solutions that cater specifically to women's health needs. Additionally, AI-powered platforms that offer confidential health advice, as well as telemedicine services, can empower women to make informed decisions about their health.

9.3. Recommendations for Policymakers

1. Establishing Gender-Sensitive AI Policies Governments should implement gender-sensitive policies that ensure the equitable development and deployment of AI technologies. This includes addressing the gender gap in AI literacy and promoting women's participation in AI-related sectors. Policymakers should also encourage diversity in AI development teams to ensure that the technology reflects the perspectives and needs of both men and women.
2. Encouraging Public-Private Partnerships for Women's Empowerment Public-private partnerships can play a significant role in fostering AI-driven business development for women. Governments should collaborate with tech companies, NGOs, and educational institutions to create programs and initiatives that offer women access to AI-driven tools and resources for entrepreneurship, skills development, and market access.
3. Promoting Data Privacy and Protection for Women Data privacy and protection are critical when deploying AI technologies, especially those

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that collect sensitive information related to women's health, financial status, and personal data. Policymakers should establish strong data protection laws that ensure the privacy and security of women's data when using AI platforms, thereby building trust in AI systems.

4. Expanding Access to AI Resources in Rural and Underserved Areas To bridge the digital divide, policymakers should focus on expanding access to AI technologies and digital resources in rural and underserved areas. This includes providing affordable internet access, mobile phones, and AI-based platforms that can help women in these regions start businesses, acquire new skills, and access health and financial services.
5. Implementing Gender-Responsive Monitoring and Evaluation Frameworks Monitoring and evaluating the impact of AI initiatives on women's empowerment should be a priority for governments and international organizations. Policymakers should establish frameworks to track progress, identify barriers, and ensure that AI initiatives are delivering positive outcomes for women. Regular assessments will help adjust policies and programs as needed to maximize their effectiveness.

10. Conclusion

AI presents both opportunities and challenges for women's empowerment in business development. By implementing gender-sensitive policies, promoting inclusive education, and ensuring access to AI-driven resources, governments can foster an environment where women can fully participate in and benefit from the AI-driven economy. With the right policy interventions, AI can become a powerful tool in advancing gender equality, reducing disparities, and driving sustainable economic growth for women across the globe.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY
RESEARCH AND INNOVATION

"The Role of Chatbots and Virtual Assistants in Customer Interaction"

Author 1st – **Mr. Jeet Ratneshwar** (Student)

Mobile No: 93260 97297

Email id : jeetratneshwar06@gmail.com

Institute of Industrial and Computer Management and Research
Pradhikaran, Nigdi, Pune

Author 2nd – Dr. Sarita Samson **– Assistant Profesor**

Mobile No: 98239 59009

Email Id: saritaiicmr@gmail.com

Institute of Industrial and Computer Management and Research

Pradhikaran, Nigdi, Pune

e-ISSN- 3067-0977

Abstract

In the rapidly developing landscape of digital transformation, chatbots and virtual assistants have emerged as pivotal tools in reshaping customer interaction across a diverse range of industries. These intelligent systems, powered by advancements in artificial intelligence (AI), natural language processing (NLP), and machine learning (ML), are transforming how businesses engage with their customers, offering real-time, personalized, and efficient communication channels that transcend traditional customer service paradigms.This paper explores the multifaceted role of chatbots and virtual assistants in enhancing customer interaction, analyzing their influence on customer satisfaction, operational efficiency, and business scalability. The integration of these tools into customer service workflows has revolutionized response time, availability, and consistency, enabling organizations to provide 24/7 support while significantly reducing the cost associated with human labor. Furthermore, chatbots and virtual assistants can handle a wide array of tasks—from answering frequently asked questions and managing bookings to processing transactions and offering product recommendations—thereby improving the overall customer experience.The study also delves into the integration of virtual assistants into omnichannel customer service strategies, discussing how their deployment across platforms such as websites, messaging apps, and voice-enabled devices contributes to a seamless and cohesive customer journey.

e-ISSN- 3067-0977

1. Introduction

In the digital age, customer expectations for fast, seamless, and personalized service have driven businesses to explore innovative technologies that can enhance customer interaction. Among the most prominent tools are chatbots and virtual assistants, which use artificial intelligence (AI) and natural language processing (NLP) to simulate human conversation and provide real-time support. These systems are increasingly being integrated into websites, mobile apps, social media platforms, and voice-enabled devices to assist customers with a wide range of tasks, from answering inquiries and processing orders to offering personalized recommendations.The rise of chatbots and virtual assistants represents a significant shift in how businesses communicate with their customers. Unlike traditional customer service models that rely heavily on human agents and limited availability, these AI-powered tools offer 24/7 availability, faster response times, and the ability to handle large volumes of interactions simultaneously. As a result, they not only improve operational efficiency but also contribute to higher levels of customer satisfaction and engagement.

However, the effectiveness of chatbots and virtual assistants depends on factors such as the quality of their language understanding, their ability to handle complex or emotional interactions, and how well they are integrated into the overall customer service strategy. As their use becomes more widespread, it is essential to examine both the opportunities and challenges they present in delivering meaningful, human-like interactions in customer service environments.The way businesses interact with customers has undergone a dramatic transformation in recent years, driven by rapid advancements in digital technologies. Among the most impactful innovations are chatbots and virtual assistants, which are revolutionizing customer service by automating communication processes and enhancing user engagement. These intelligent systems leverage technologies such as artificial intelligence (AI), natural language processing (NLP), and machine learning (ML) to understand, process, and respond to customer inquiries in real time, across multiple digital platforms.Chatbots are typically used in text-based interactions—such as on websites, messaging apps, and mobile platforms—while virtual assistants can also include voice-based interfaces integrated into devices like smartphones (e.g., Siri, Google Assistant) and smart speakers (e.g., Amazon Alexa). These tools can perform a wide array of tasks, from answering frequently asked questions and guiding users through product selections to executing transactions and troubleshooting issues, all without human

intervention.

Statement of the Problem

Despite the growing adoption of chatbots and virtual assistants in customer service environments, many organizations face significant challenges in leveraging these technologies effectively to enhance customer interaction. While these AI-driven tools promise benefits such as 24/7 availability, cost efficiency, and faster response times, their actual implementation often falls short in delivering truly personalized, context-aware, and emotionally intelligent interactions that meet evolving customer expectations.

A key issue lies in the gap between technological capability and user satisfaction. Many chatbots still operate on rigid scripts or limited AI models that struggle with complex queries, resulting in customer frustration, abandonment of support sessions, or escalations to human agents. Furthermore, concerns around data privacy, transparency, and the lack of trust in automated systems remain prevalent. Organizations also grapple with integrating these tools seamlessly into existing customer service ecosystems and maintaining a balance between automation and the human touch.

Objectives of the Project

1) To evaluate the impact of chatbots and virtual assistants on customer experience, particularly in terms of response time, personalization, user satisfaction, and engagement.
2) To explore the challenges and limitations associated with the deployment of chatbots and virtual assistants, including issues related to accuracy, context awareness, emotional intelligence, and language barriers.
3) To propose best practices and recommendations for the development, integration, and continuous improvement of chatbot and virtual assistant systems in customer service environments.

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1.4 Theoretical Framework

A chatbot is a software application designed to simulate real-time conversation with human users, primarily through text or voice-based interactions over digital platforms such as websites, mobile apps, and messaging services. These systems utilize technologies like Natural Language Processing (NLP) to interpret human language and, in more advanced cases, Artificial Intelligence (AI) and machine learning to understand context, detect user intent, and improve over time through continued interaction.

The theoretical foundation of this study draws from a blend of established models in the fields of technology adoption, service quality, human-computer interaction, and communication theory. These theories provide valuable insights into how customers perceive, accept, and interact with chatbots and virtual assistants in the context of customer service.One of the core models relevant to this study is the Technology Acceptance Model (TAM), proposed by Davis (1989). TAM explains user acceptance of new technologies based on two key factors: perceived usefulness and perceived ease of use. In the case of chatbots and virtual assistants, customers are more likely to adopt and engage with these tools if they believe that the technology will help them resolve issues quickly (usefulness) and without much effort (ease of use). This model is instrumental in assessing the general openness of users toward AI-driven communication systems.

The Human-Computer Interaction (HCI) theory is another vital component of the framework, as it focuses on the interaction between users and technological interfaces. HCI is especially relevant in analyzing how the design of chatbot interfaces, including language use, interface intuitiveness, response timing, and conversational flow, affects user experience. A well-designed chatbot that mimics natural human interaction can significantly enhance engagement and reduce user frustration.

Additionally, the Social Presence Theory provides insight into how customers experience communication through non-human interfaces. It emphasizes the importance of making users feel as if they are engaging with a real, attentive presence—even if that presence is artificial. This theory is crucial in understanding the emotional and psychological connection customers form with chatbots, which in turn influences their trust, satisfaction, and willingness to continue using such technologies.

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Lastly, the Expectation-Confirmation Theory (ECT) helps explain user satisfaction by comparing initial expectations with the actual performance of the chatbot or virtual assistant. If the system meets or exceeds expectations in terms of service quality and effectiveness, users are more likely to report positive experiences and develop trust in the technology. Conversely, if the system fails to meet expectations, dissatisfaction may lead to rejection or decreased usage.Together, these theoretical models provide a comprehensive lens through which the study can examine the role of chatbots and virtual assistants in customer interaction. They help uncover not only the technological factors influencing user acceptance but also the emotional and experiential dimensions that determine the overall success of these AI-powered systems in modern customer service.

Chapter 2: Review of Literature

1. **Shawar, B. A., & Atwell, E. (2007):** In their seminal work, Shawar and Atwell explore the earliest chatbot systems such as ELIZA and ALICE, which relied heavily on pattern-matching and scripted responses. Their review presents an honest critique of these systems, noting that although they were groundbreaking for their time, they lacked true intelligence and contextual understanding. Users often experienced superficial conversations that failed to meet real service expectations. The authors highlight the limitations of rule-based systems in adapting to diverse user queries, emphasizing the need for more dynamic, learning-based models. This work serves as a foundational critique that set the stage for AI-driven conversational systems used in customer service today.

2. **Følstad, A., & Brandtzæg, P. B. (2017)**: This paper positions chatbots within the broader domain of Human-Computer Interaction (HCI). The authors argue that chatbots are not just service tools, but represent a fundamental shift in how users engage with digital systems. Their research emphasizes the growing demand for conversational interfaces that feel more natural and human-like. They outline how chatbots fulfill the role of digital intermediaries, capable of replacing traditional user interfaces like forms or menus. This perspective broadens the scope of chatbot functionality and helps explain why businesses are increasingly integrating them into customer-facing platforms.

3. **Adamopoulou, E., & Moussiades, L. (2020):** Offering a comprehensive overview of chatbot technologies, Adamopoulou and Moussiades categorize systems into rule-based and AI-driven models, discussing their respective strengths and limitations. They explore

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the technical components of chatbot systems, including intent recognition, dialogue management, and machine learning. The authors delve into the practical use of natural language processing (NLP) in improving response quality and contextual understanding. By providing this technical insight, the study helps developers and researchers appreciate the complexity involved in building effective customer-facing bots that go beyond scripted responses.

4. **Brandtzæg, P. B., & Følstad, A. (2018)**: Through a user survey, this study identifies the key motivations for chatbot usage, including speed, convenience, and 24/7 availability. Interestingly, users expressed a strong preference for using chatbots in situations where they wanted quick solutions without the need for human involvement. The authors interpret this as a sign of growing trust in digital tools, though they also caution that expectations are rising. Customers now demand not only speed but also relevance and accuracy. This paper reinforces the notion that convenience is a primary driver behind chatbot adoption.

5. **Jain, M., Kumar, P., Kota, R., & Patel, S. N. (2018)** This work evaluates existing chatbot designs by gathering user feedback across several industries. The authors identify recurring issues such as misunderstanding of queries, lack of contextual memory, and rigid dialog flows. They then propose design improvements, including modular conversation structures, proactive response features, and improved fallback mechanisms. The study emphasizes user-centric design as a critical element in chatbot development, especially when targeting complex service tasks such as booking or troubleshooting.

6. **Chattaraman, V., Kwon, W.-S., Gilbert, J. E., & Ross, K. (2019)** This study compares two types of chatbot interaction styles: social (friendly, humorous, conversational) and task-oriented (direct, formal, focused on completing tasks). The authors found that social-style bots were more effective at building trust and rapport, particularly in emotionally sensitive or brand-related contexts. However, task-oriented bots were more efficient for goal-directed activities. The key takeaway is that chatbot interaction style should be chosen based on context—retail, healthcare, and hospitality might benefit from a more social style, whereas banking and logistics might prioritize task efficiency.

7. **Diederich, S., Brendel, A. B., & Kolbe, L. M. (2019)**
This research introduces a design framework that focuses on creating chatbots that support

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fast and effortless information retrieval. The authors suggest that customer satisfaction is closely tied to how quickly users can get the answers they need with minimal effort. They recommend using streamlined dialog flows, intuitive prompts, and clear navigation paths. Their work is especially useful for organizations seeking to reduce customer service workload while maintaining high service quality.Luo, X., Tong, S., Fang, Z., & Qu, Z. (2019)

Conducting a quantitative study, the authors evaluate how AI-powered chatbots affect company performance metrics. They found that businesses using chatbots experienced improved customer satisfaction, reduced support costs, and better lead generation. However, they also found that overly robotic chatbots could harm customer loyalty. This duality suggests that the value of chatbots lies not just in their deployment but in how well they are implemented and aligned with user needs.

8. **Purington, A., Taft, J. G., & Ahn, J. (2019)** This study emphasizes the importance of empathy in chatbot design. Users who perceived chatbots as caring and attentive were more likely to engage positively and even return for future interactions. The authors argue that subtle elements such as word choice, tone, and timing contribute significantly to how users interpret the chatbot's "personality." This work has significant implications for sectors like healthcare, education, and counseling, where emotional support plays a central role.

9. **Seeger, A.-M., Pfeiffer, J., & Heinzl, A. (2021)** Here, the researchers explore the role of anthropomorphism in chatbot design. They find that moderately human-like bots—those with a name, voice, or avatar—tend to be more trustworthy than purely mechanical ones. However, over-anthropomorphism can lead to the "uncanny valley" effect, where the bot appears creepy or unnatural. This study provides a nuanced perspective, suggesting that human elements should be used strategically to enhance relatability without undermining credibility.

10. **Sheehan, B., Jin, H. S., & Gottlieb, U. (2020)** This study focuses on how anthropomorphic design influences chatbot adoption. It finds that people are more likely to use chatbots that appear relatable and friendly. However, if the chatbot's appearance or tone is too human-like and its intelligence does not match, users become frustrated. The authors recommend aligning appearance with actual performance to avoid user disappointment and increase adoption rates.

11. **Følstad, A., Skjuve, M., & Brandtzæg, P. B. (2021)** In this recent study, the authors propose a typology of chatbots based on their function: informational, transactional, advisory, and relational. This classification system helps businesses choose the right chatbot design based on service goals. Informational bots answer FAQs, transactional bots process requests, advisory bots offer recommendations, and relational bots build ongoing customer relationships.

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Chapter III Method

Introduction

With the increasing adoption of artificial intelligence, businesses are increasingly leveraging chatbots and virtual assistants to enhance customer interaction. These technologies are reshaping customer service by providing 24/7 assistance, personalized support, and instant query resolution. This study explores how customers perceive and engage with chatbots and virtual assistants, and evaluates their effectiveness in improving overall customer satisfaction and experience.

3.1 Research Design

The research follows a descriptive research design, aiming to obtain insights into how customers interact with chatbots and virtual assistants. This design helps in understanding user experiences, satisfaction levels, and potential areas of improvement in chatbot-based services. The data collected through structured questionnaires provides a snapshot of current consumer perceptions and usage trends.

3.2 Sampling Design

The sampling design outlines how the respondents for the study were selected and the rationale behind the sampling choices. For this research on "The Role of Chatbots and Virtual Assistants in Customer Interaction," the sampling design was structured to gather insights from a diverse group of individuals who have experience interacting with chatbots and virtual assistants.

3.2.1 Sampling Type

The sampling type used in this research is non-probability sampling, specifically because responses were collected through voluntary participation via a Google Form.

3.2.2 Sampling Method

The sampling method employed is convenience sampling. Respondents were selected based on their availability and willingness to participate in the survey shared online.

3.2.3 Sample Size

The study collected data from a total of 106 respondents. This sample size is considered sufficient for identifying basic patterns and drawing preliminary conclusions regarding the role of chatbots and virtual assistants in customer interaction.

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3.3 Data Collection

Primary data was collected through a structured Google Form questionnaire, which included both closed-ended and Likert-scale questions. The form was distributed via social media platforms, email, and messaging apps to reach a diverse audience.

As the secondary data was collected from the articles published before on the topic related to chatbots.

3.4 Summary of the Research Instrument

The research instrument consisted of:

Demographic questions (age, gender, profession, etc.)

Experience-based questions (frequency of chatbot use, types of services used, satisfaction levels)

Perception and opinion questions (ease of use, response quality, trust, and preference over human support)

The questionnaire was designed to be simple, concise, and user-friendly to ensure maximum participation and accurate responses.

3.5 Tools for Data Analysis

The responses collected were analyzed using Microsoft Excel and Google Sheets for data cleaning, tabulation, and basic analysis. Charts, tables, and graphs were used to visualize key findings.

3.6 Statistical Techniques

The study used basic descriptive statistics such as percentages, means, and frequency distributions to analyze responses. In addition, cross-tabulation was used to compare relationships between demographic factors and chatbot usage patterns. Where applicable, charts (bar graphs, pie charts) were employed to illustrate trends and preference.

Chapter IV – Data Collection and Analysis

1. Your Profession

Tabel showing the profession of the Recipients

Sr No	Particulars	Responders	Percentage
1	Self Employed	16	15.84
2	Salaried Person	24	23.76
3	Student	58	57.42
4	Retired	3	2.98
	Total	**101**	**100**

Table 4.1: The profession of the Recipients

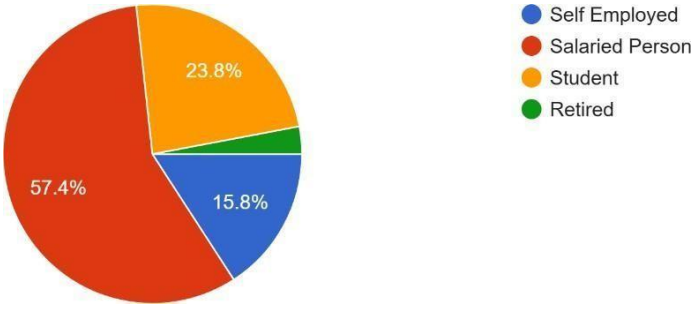

Fig 4.1

Analysis:

There are 15.54% responders who are self Employed, around 23.76% are Salaried Person, the highest number of responders are students which is 57.42%, and only 2.98% are the Retired.

Interpretation:

The data indicates that the survey or study primarily attracted a younger demographic, with students forming the largest group.

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Tabel showing the accuracy of Chatbots in Answering the questions

	Particulars	Responders	Percentage
1	Always	20	20.2
2	Most of the Times	60	16.6
3	Sometimes	14	14.1
4	Rarely	6	5.1

Table: 4.2: Accuracy of Chatbots in Answering the questions

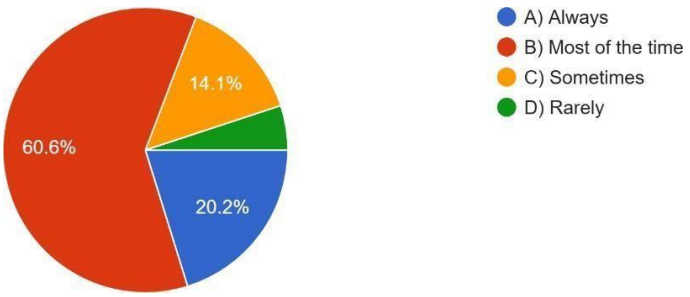

Fig 4.2

Analysis:

The pie chart reveals that the majority of users (60.6%) believe chatbots provide accurate answers most of the time, while 20.2% feel they always do. This indicates a generally positive perception of chatbot performance. However, 14.1% of users think chatbots are only sometimes accurate, and 5.1% rarely find them reliable.

Interpretation:

The data indicates that **over 80%** of users (combining "Always" and "Most of the time") have a positive experience with chatbot accuracy. This demonstrates strong user confidence in chatbot functionality. However, the presence of respondents who selected "Sometimes" or "Rarely" suggests that there is still room for improvement in terms of precision, contextual understanding, or handling of complex queries.

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Tabel: Chatbot responses compared to human agents.

Particulars	Responders	Percentage
A) Much faster	44	44.4%
B) Slightly faster	39	39.4%
C) About the same	13	13.1%
D) Slower	5	5.0%
Total	101	100

Table 4.3: **Chatbot responses compared to human agents.**

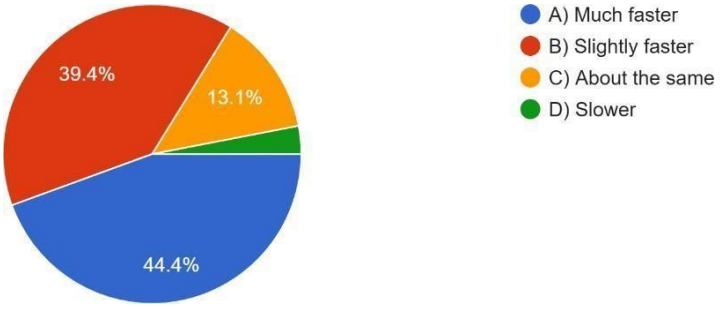

Fig 4.3

Analysis:

The analysis of the chart indicates that a significant majority of users perceive chatbots as faster than human agents, with 44.4% rating them as much faster and 39.4% as slightly faster. This highlights the efficiency and quick response time of chatbots, which is one of their major advantages in customer service. Only a small portion of users (13.1%) felt there was no noticeable difference in speed, while just 3% found chatbots slower.

Interpretation:

The data strongly indicates that users perceive chatbots as a faster alternative to human support, with nearly 84% acknowledging improved response times. This reflects positively on chatbot efficiency, which is a key factor in enhancing user satisfaction and reducing wait times.

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Table: Most Common Issues with Chatbot Responses

Option	Particulars	Percentage	Responders
A	Inaccurate answers	14.1%	14
B	Repetitive responses	37.4%	37
C	Lack of personalization	23.3%	24
D	No issues, they work well	25.3%	25
	Total	**100**	**101**

Table 4.4: **Most Common Issues with Chatbot Responses**

Fig4.4

Analysis:

Notably, "Repetitive responses" emerges as the most significant concern, accounting for 37.4% of the feedback. Following this, "Lack of personalization" and "No issues, they work well" are relatively close, with 23.2% and 25.3% respectively, indicating a balance between satisfaction and areas needing improvement. "Inaccurate answers" is the least reported issue, registering at 14.1%.

Interpretation:

It's evident that chatbot systems are grappling with providing varied and non-repetitive interactions, as the high percentage for "Repetitive responses" indicates. While a considerable portion of users are satisfied, as reflected by the 25.3% who reported "No issues, they work well," the need for enhanced personalization is apparent. The fact that "Inaccurate answers" is the least reported suggests that while accuracy is crucial.

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Table: Can Chatbots Handle Complex Customer Queries?

Option	Particulars	Percentage	Responders
A	Yes, they are very capable	30.3%	30
B	Sometimes, but they struggle with difficult questions	39.4%	39
C	No, they are only good for basic queries	20.2%	20
D	I have never used a chatbot for a complex issue	10.1%	12
	Total	**100**	**101**

Table 4.6: **Can Chatbots Handle Complex Customer Queries?**

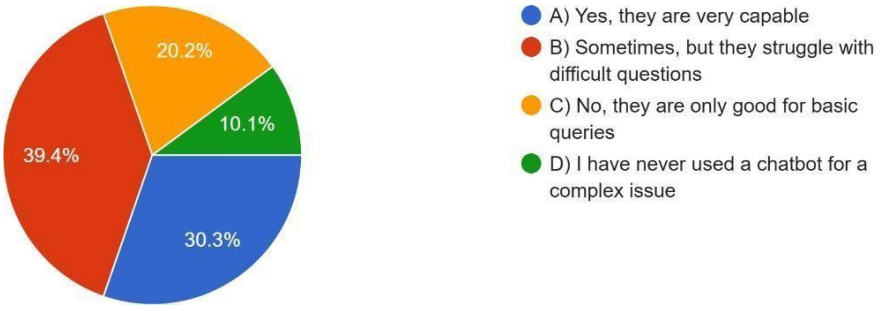

Fig 4.5

Analysis:

The largest group of respondents (39.4%) believe chatbots can sometimes assist but still struggle with more difficult questions. Meanwhile, 30.3% of users express confidence in their capabilities, suggesting a growing belief in the technology's potential. However, 20.2% of respondents feel chatbots are limited to basic tasks, and 10.1% have not tried using them for complex issues at all.

Interpretation:

Although 30.3% of respondents view them as very capable, a larger share—39.4%—acknowledge limitations, indicating that bots can handle certain situations but struggle with depth. The fact that 20.2% believe chatbots are only useful for simple tasks highlights a perception gap, and 10.1% of users not having used them for complex queries shows a potential hesitation or lack of exposure.

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Key finding

1A predominantly young user base (57.42% students) shows strong confidence in chatbots, with over 80% believing they provide accurate responses.

2. Chatbots are valued for their speed by 84% of users, though repetitive responses (37.4%) remain a key concern needing improvement.

3. Many users acknowledge chatbots' limitations with complex queries, as 52% still escalate issues to human agents for better resolution.

4. Chatbots and automation improve efficiency and reduce wait times, but users still emphasize the need for human touch and job security.

5. Users value chatbots for 24/7 availability but emphasize that improved accuracy is crucial for broader adoption and satisfaction.

6. Users increasingly trust chatbots, but prefer a hybrid model that blends AI efficiency with human support for optimal service.

7. Users widely recommend chatbots for basic tasks and efficiency, but seek improved personalization to boost overall satisfaction.

8. Users support AI-driven personalization when data privacy is ensured, and prefer human-like chatbot interactions that balance engagement with naturalness.

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Suggestions:

Incorporate sentiment analysis and emotional AI to make chatbots more human-like and capable of detecting frustration, urgency, or confusion.

Businesses should deploy chatbots to handle routine tasks, while providing easy handoff to human agents for complex or sensitive issues.

Chatbots should be available across platforms including websites, mobile apps, and messaging apps like WhatsApp or Facebook Messenger.

Conclusion:

The concluding part of the project emphasizes that it will provide key takeaways and future prospects for AI-driven customer engagement. This means the project will summarize the main findings and insights gained from the research on chatbots and virtual assistants. It will also look ahead to discuss how these AI tools are expected to evolve and what potential they hold for businesses in the future. The ultimate goal is to equip businesses with the knowledge to effectively use chatbots and virtual assistants. By doing so, businesses can improve customer satisfaction by providing better service and streamline their operations to be more efficient.

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e-ISSN- 3067-0977

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Integrating Artificial Intelligence into Sustainable Transformation of Indian Agriculture

Prof. Jyoti N. Shrote[1$]
1 Indira College of Commerce and Science, Pune
Jyoti.shrote@iccs.ac.in
$ Corresponding Author
Dr. Janardan Pawar[2]
2 Indira College of Commerce and Science, Pune
Janardanp@iccs.ac.in

Abstract

Indian agriculture, a cornerstone of the nation's economy and livelihood, faces multifaceted challenges including climate variability, soil degradation, inefficient resource utilization, and declining productivity. With the advent of Artificial Intelligence (AI), there is a transformative opportunity to modernize and optimize agricultural practices across the value chain. This paper explores the current landscape, emerging applications, and potential of AI in Indian agriculture—ranging from precision farming, crop monitoring, pest and disease detection, to predictive analytics for yield forecasting and market intelligence. By analyzing case studies, AI-driven startups, and government initiatives, this research highlights how AI technologies can enhance productivity, ensure sustainability, and empower farmers with data-driven insights. The paper also addresses barriers to adoption such as digital literacy, infrastructure, and policy gaps, while proposing a roadmap for integrating AI into mainstream agricultural development in India.

Keywords: Artificial Intelligence, Indian Agriculture Precision Farming, Crop Monitoring, AI Adoption, Data-Driven Agriculture

Introduction

Agriculture plays a vital role in India's socio-economic landscape, contributing about 18% to the Gross Domestic Product (GDP) and employing more than 50% of the workforce [1]. Despite its significance, Indian agriculture suffers from systemic inefficiencies including over-reliance on monsoons, low crop yields, post-harvest losses, and limited access to market

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information. The advent of Artificial Intelligence offers an unprecedented opportunity to address these issues, providing real-time, data-driven insights to farmers and policymakers alike.

Literature review

The Need for AI in Indian Agriculture implementation is that several persistent challenges in the agricultural sector necessitate the integration of advanced technologies:

Fragmented Land Holdings: Over 86% of farmers are smallholders, often unable to access modern technologies [2].
Climate Uncertainty: Erratic rainfall, temperature fluctuations, and extreme weather events reduce crop reliability.
Input Inefficiency: Overuse or underuse of water, fertilizers, and pesticides leads to economic and environmental losses.

Market Disparities: Lack of price transparency and timely access to markets affect farmer incomes [3].

Applications of AI in Agriculture such as Precision Agriculture is needed. AI tools analyse weather patterns, soil conditions, and crop health to optimize inputs like irrigation and fertilization. Technologies like drones and IoT sensors feed real-time data into AI systems, enabling more efficient and sustainable farming practices [4].

Crop and Soil Health Monitoring is also important issue. Computer vision models detect pest infestations, nutrient deficiencies, and plant diseases using image recognition from smartphones or UAVs [5].

Predictive Analytics is very important. Machine learning models are being used to forecast crop yields, predict pest outbreaks, and simulate crop performance under different scenarios. This helps farmers and planners make informed decisions [6].

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Market Forecasting and Supply Chain Optimization is important for any business. AI platforms aggregate historical data to predict commodity prices and streamline logistics. This helps reduce post-harvest losses and improves market linkages [7].

Case Studies and Success Stories are important. In Microsoft-ICRISAT Partnership case studies, Microsoft collaborated with ICRISAT to create an AI-powered sowing advisory system. In trials in Andhra Pradesh, farmers increased yields by 10–30% without changing inputs, just by adjusting sowing dates based on AI recommendations [8].

Fasal and DeHaat case study Startups like Fasal provide sensor-based platforms for micro-climate monitoring and AI-driven crop advisory. DeHaat uses AI to deliver end-to-end services including agri-inputs, customized advice, and market linkages to over 1 million farmers [9].

In case of NITI Aayog AI Pilot Projects it is found that, in Maharashtra and Punjab, AI has been piloted for crop health monitoring and price forecasting. These initiatives demonstrate the scalability and efficacy of AI in varied agro-climatic zones [10].

Challenges in AI Integration

Despite the potential, AI integration faces several hurdles:

Infrastructure Deficits: Poor connectivity, electricity issues, and lack of mobile networks in rural areas limit the reach of digital tools.Data Scarcity and Localization: Many AI models are based on non-local data, making them less effective for region-specific conditions. Digital Illiteracy: Many farmers lack the skills to interact with AI-driven platforms or apps. Economic Constraints: The initial costs of deploying AI tools may be high for marginal farmers [11].

Government Policies and Institutional Support

The Government of India has recognized the potential of AI in agriculture and launched initiatives like:

- Digital Agriculture Mission (2021–2025)
- AI for All Initiative by NITI Aayog
- National e-Governance Plan in Agriculture (NeGPA)

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These programs aim to create a digital ecosystem that supports AI integration through data platforms, capacity building, and startup incentives [12].

Recommendations

To ensure sustainable and inclusive AI adoption in Indian agriculture, the following strategies are recommended:

- **Open-Source Data Platforms**: Develop centralized and anonymized data repositories for research and AI training.
- **Farmer-Centric Interfaces**: Design apps in vernacular languages with voice commands and visual aids.
- **Public-Private Partnerships (PPP)**: Foster collaborations between government, academia, startups, and NGOs.
- **Incentivize Adoption**: Provide financial and technical support for smallholders to access AI tools.
- **Continuous Training**: Establish rural training centers and digital literacy campaigns.

Conclusion

AI has the potential to drive a sustainable transformation of Indian agriculture by increasing productivity, minimizing resource waste, and enhancing climate resilience. However, meaningful integration requires a multifaceted approach addressing infrastructure, education, policy, and economic inclusion. By aligning technological innovation with grassroots realities, India can create an agriculture system that is smart, sustainable, and inclusive.

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e-ISSN- 3067-0977

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To Study Data Mining Technique: Frequent Item Set and Association Rule Mining using Apriori Algorithm with Reference to Retail Marketing.

Mrs. Khushbu Mahesh Pawar[1], Dr. Deepak Nandre[2]

[1] Mrs. Khushbu Mahesh Pawar, Assistant Professor, Ashoka Center for Business and Computer Studies, Nashik, 7020106474, khushbupatil89@gmail.com

[2]Dr. Deepak Nandre, Assistant Professor, MVP's Institute of Management, Research and Technology [IMRT], Nashik, 8275586244, deepnandre317@gmail.com

Abstract:

Data mining is defined to prize the knowledge, it's also use to discover knowledge and different patterns. Now a day's businesses have large volumes of data and It's needed to do proper segmentation & bracket of data so for that numerous businesses are uses different data analysis ways and operations. In this exploration paper, experimenter detail about association rule mining fashion using Apriori algorithm. Experimenter used different data sets of grocery retailer in Nashik
megacity. Through the Interview, compliances and Questionnaire fashion data has been collected. Experimenter done the analysis grounded on the association rule mining and with the help of analysis experimenter get the outgrowth that how data mining fashion is effective in retail marketing. This exploration paper divides into total 4 corridor where first part is preface, alternate part is frequency itemset and association rule using Apriori algorithm, third part is result and forth part is conclusion.

1. INTRODUCTION

1.1 Data Mining Overview:

Data mining refers to extracting or mining knowledge from large quantities of data. The term is actually a misnomer. The term is actually a misnomer. therefore, data mining should have been more meetly named as knowledge mining which emphasis on mining from large quantities of data. It's the computational process of discovering patterns in large data sets involving styles at the crossroad of artificial intelligence, machine literacy, statistics, and database systems. The overall thing of the data mining process is to prize information from a data set and transfigure it into an accessible structure for farther use. Alternatives names of data mining are knowledge mining, business intelligence, Knowledge discovery of database (KDD), Business analytics and so on.

1.2 Tasks of Data Mining:

Data mining involves six common classes of tasks:

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1. **Anomaly discovery (Outlier/ change/divagation discovery)** – The identification of unusual data records, that might be intriguing or data crimes that bear farther disquisition.
2. **Association rule literacy (reliance modelling)** – quests for connections between variables. For illustration, a supermarket might gather data on client purchasing habits. Using association rule literacy, the supermarket can determine which products are constantly

bought together and use this information for marketing purposes. This is occasionally appertained to as request handbasket analysis.

3. **Clustering** – is the task of discovering groups and structures in the data that are in some way or another" analogous", without using given structures in the data.
4. **Classification** – is the task of generalizing given structure to apply to new data. For illustration, an-mail program might essay to classify e-mail as" licit" or as" spam".
5. **Regression** – attempts to find a function which models the data with the least error.
6. **Summarization –** furnishing a more compact representation of the data set, including visualization and report generation

Fig: 1.2 Tasks of data mining

7.

1.3 Major Challenges in Data Mining:

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Fig: 1.3 Major Challenges in Data Mining

- **Mining different kinds of knowledge in databases. -** The need of different druggies isn't the same. And Different stoner may be in interested in different kind of knowledge. thus, it's necessary for data mining to cover broad range of knowledge discovery task.
- **Interactive mining of knowledge at multiple situations of abstraction. -** The data mining process needs to be interactive because it allows druggies to concentrate the hunt for patterns, furnishing and enriching data mining requests grounded on returned results.
- **Incorporation of background knowledge. -** Background knowledge may be used to express the discovered patterns not only in concise terms but at multiple level of abstraction.
- **Ad hoc data mining. -** Data Mining Query language that allows the stoner to describe ad hoc mining tasks, should be integrated with a data storehouse query language and optimized for effective and flexible data mining.
- **Visualization of data mining results** - This representation should be fluently accessible by the users.
- **Handling noisy or deficient data -** The data cleaning styles are needed that can handle the noise, deficient objects while booby-trapping the data discrepancies. If data drawing styles aren't there also the delicacy of the discovered patterns will be poor.

1.4 Data Mining Techniques:

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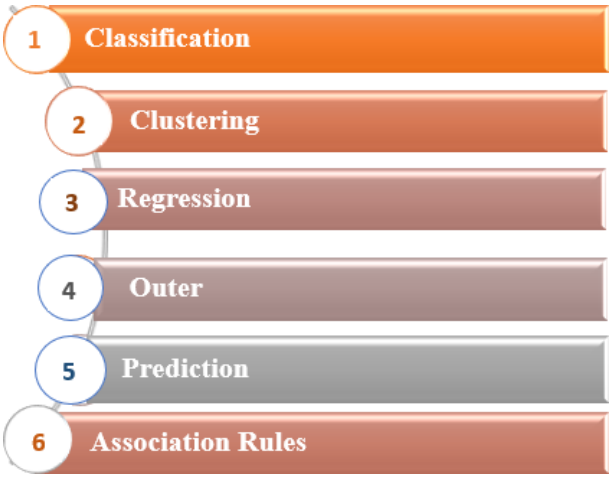

Fig: 1.4 Data Mining Techniques

1. **Classification:** This technique is used to obtain important and relevant information about data and metadata.
2. **Clustering:** Clustering is a division of information into groups of connected objects. Describing the data by a few clusters mainly loses certain confine details, but accomplishes improvement. It models data by its clusters. Data modeling puts clustering from a historical point of view rooted in statistics, mathematics, and numerical analysis.
3. **Regression:** Regression analysis is the data mining process is used to identify and analyze the relationship between variables because of the presence of the other factor.

4. **Outer detection:** This type of data mining technique relates to the observation of data items in the data set, which do not match an expected pattern or expected behavior.
5. **Prediction:** Prediction used a combination of other data mining techniques such as trends, clustering, classification, etc. It analyzes past events or instances in the right sequence to predict a future event.
6. **Association Rules:** This data mining technique helps to discover a link between two or more items. It finds a hidden pattern in the data set.

2. Frequent Item set & Association Rule Mining: Apriori algorithm

- **Frequent Itemset Mining:** Finding frequent patterns, associations, correlations, or causal structures among sets of items or objects in transaction databases, relational databases, and other information repositories.

  Given: – A set of items $I = \{i1, i2, \ldots, im\}$ – A database of transactions D, where a transaction $T \subseteq I$ is a set of items

  Using following Transaction Database of one of the grocery retail stores.

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For example, consider a grocery retail store. The set of products purchased by a customer during one shopping trip constitute a transaction, while the individual products that were purchased are the items.

TID	ITEMS
1	Bread, Butter, Sugar, Cheese, Coke
2	Maggi, Eggs, Cake, Bread,
3	Eggs, Cake, Butter, Chips
4	Bread, Butter, Maggi, Eggs, Cake
5	Maggi, Eggs, Bread, Butter
6	Eggs, Cake, Butter, Biscuits

Table 2.1: Frequent Item set & Association Rule Mining: Apriori algorithm

- Consider a above scenario where the product set is P = {Bread, Butter, Sugar, Cheese, Coke, Maggi, Eggs, Cake, Chips, Biscuits}. The database comprises six transactions where 1 represents the presence of the product and 0 represents the absence of the product.

TID	Bread	Butter	Sugar	Cheese	Coke	Maggi	Eggs	Cake	Chips	Biscuits
1	1	1	1	1	1	0	0	0	0	0
2	1	0	0	0	0	1	1	1	0	0
3	0	1	0	0	0	0	1	1	1	0
4	1	1	0	0	0	1	1	1	0	0
5	1	1	0	0	0	1	1	0	0	0
6	0	1	0	0	0	0	1	1	0	1

Table 2.2: Frequent Item set & Association Rule Mining: Apriori algorithm

Question of interest: – Which items are bought together frequently?

- The Apriori Algorithm makes the given assumptions
  - All subsets of a frequent itemset must be frequent.
  - The subsets of an infrequent item set must be infrequent.
  - Fix a threshold support level. In our case, we have fixed it at 50 percent.
- **Components of Apriori algorithm**

  The given three components comprise the Apriori algorithm.

  1. Support: Fraction of transaction that contain both X and Y.
  2. Confidence: Measures how often item in Y appear in transactions that contain in X
  3. Lift: Confidence(X-Y) /Support
- **Step 1**: With the help of table 2.2 we have to make frequency table of all the products that appear in all the transactions. Now, short the frequency table to add only those

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products with a threshold support level of over 50 percent. We find the below given frequency table.

Product	Frequency (No of Transactions)
Bread(B1))	4
Butter(B2)	5
Eggs(E)	5
Cake (C)	4

Table 2.3.1: (Step-1) Frequent Item set & Association Rule Mining: Apriori algorithm

With the help of table 2.3 we can calculate Support, Confidence and lift values

Support (Butter)=5/6=0.8 **Support (Cake)=4/6=0.6**

- **Step 2**: With the help of table 2.3 Created pairs of products such as B1B2, B1E, B1C, B2E, B2C, EC. We will get the given frequency table

Itemset	Frequency (No of Transactions)
B1B2	3
B1E	3
B1C	2
B2E	4
B2C	3
EC	4

Table 2.3.2: (Step-2) Frequent Item set & Association Rule Mining: Apriori algorithm

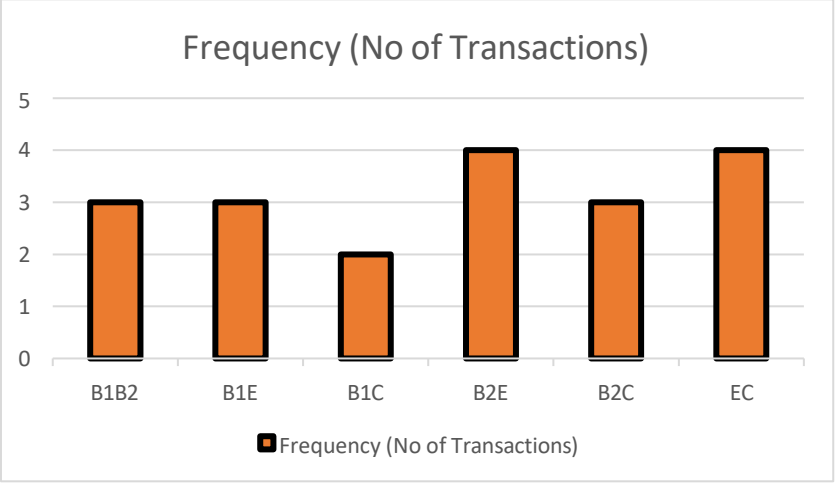

Fig: 2.3: Frequency Table

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- **Step 3:** Implementing the same threshold support of 50 percent and consider the products that are more than 50 percent. In our case, it is more than 3 Thus, we get B2E, EC, B1B2, B1E & B2C

- **Step 4:** Now, look for a set of three products that the customers buy together. We get the given combination.
  B1B2 & B1E= **B1B2E**
  B2E & B2C = **B2EC**

- **Step 5: Calculate the frequency of the two itemset, and will get the given frequency table.**

Itemset	Frequency (No of Transactions)
B1B2E	2
B2EC	3

Table 2.3.3: (Step-5) Frequent Item set & Association Rule Mining: Apriori algorithm

In this step we can calculate Support & confidence

Support= B1B2E/6= 2/6= 0.3
Support=B2EC/6= 3/6= 0.5

Confidence= Sum(B1B2E)/B1B2
=2/3
= 0.67

The goal of association rule mining is to find all rules having support >=minsup threshold and confidence>=minconf threshold. In our case It is achieved.

From above table we can conclude that customer's set of three product is B2EC

3. RESULT

From the table 2.3.1 butter support value is greater than minimum support i.e 0.8 and for cake also it is 0.6 , In table 2.3.5 support of B1B2E and confidence is greater than minimum confidence value i.e 0.6 so it is selected. we can select frequency itemset is B2EC i.e butter, Eggs and Cake.as it is greater than the minimum threshold

4. CONCLUSION

The Apriori algorithm uses frequent itemset to generate association rules, and it is designed to work on the databases that contain transactions. With the help of these association rule, it determines how strongly or how weakly two objects are connected.

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HARNESSING THE POWER OF R-ANALYTICS FOR BETTER TIME MANAGEMENT: A NOVEL, HIGHLY INTUITIVE, AI-DRIVEN, AND ILLUSTRATIVE APPROACH FOR MITIGATING PROCRASTINATION HABITS AMONG BANK EMPLOYEES

Lt. Col. Shantanu Narayan Shimpi,
Research Scholar, Department of Commerce and Management, KBCNMU, Jalgaon-425001, Maharashtra, India, Mobile: 9175126021,
atttitudeshantanu197723@gmail.com

Dr. Parag Arun Narkhede,
Associate Professor, KCES's IMR, IMR Campus, NH-6, Behind DIC, Jalgaon-425001, Maharashtra, India, Mobile: 9422778876.
paragnarkhede@yahoo.com

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Abstract: Procrastination is a pervasive issue among bank employees, leading to decreased productivity, increased stress, and compromised work quality. This study proposes a novel approach to mitigate procrastination habits by harnessing the power of R analytics for better time management. Leveraging the capabilities of the R programming language and artificial intelligence (AI), this research aims to develop a highly intuitive and illustrative framework for identifying, analyzing, and addressing procrastination patterns among bank employees. The study adopts a *Design Science Research Methodology (DSRM)* to provide a theoretical demonstration of the concept with practical implementation using R codes. DSRM focuses on creating and evaluating innovative artifacts using the R analytics framework to solve real-world problems, coupled with AI-driven algorithms. DSRM involves: *Problem Identification and Definition*, *Literature Review and Analysis*, *Design and Development of the artifact (R-analytics framework)*, *Demonstration and Evaluation of the Artifact*, and *Communication and Dissemination of the Research Findings*. AI-driven algorithms include: *Decision Trees*, *Random Forest*, *Clustering Algorithms (k-Means/Hierarchical Clustering)*, *Natural Language Processing (NLP)*, *Predictive Modeling (Linear Regression/Logistic Regression)*, and *Reinforcement Learning*. This study is demonstration-ready to test the effectiveness of the proposed R-analytics framework, either using simulated data or real-time data. R packages popularly supplementing these algorithms that can be incorporated in this study include: *caret (classification and regression training)*, *dplyr (data manipulation)*, *tidyr (data transformation)*, *ggplot2 (data visualization)*, *stringr (string manipulation)*, and *caretEnsemble (ensemble methods)*. The proposed framework is expected to provide a comprehensive understanding of procrastination habits among bank employees, enabling targeted interventions and strategies to improve time management skills. The study's findings will contribute to the development of evidence-based practices for mitigating procrastination in the banking sector. By providing a novel, AI-driven approach to addressing procrastination, this study will pave the way for future research and interventions in the field of time management and productivity enhancement.

Keywords: *Procrastination, Time Management, R-codes, DSRM, AI-driven.*

Introduction

This study introduces an R-Analytics framework to tackle procrastination in the banking sector. By combining data-driven insights with AI-driven techniques, it aims to enhance employee

e-ISSN- 3067-0977

productivity and job satisfaction through personalized time management strategies. The research follows Design Science Research Methodology (DSRM) and focuses on developing R codes for specific time management techniques. However, the scope of this study does not extend to creating an AI tool for implementing these techniques.

Theoretical Framework

This section outlines the theoretical foundation, covering R-Analytics basics and potential AI applications, structured under the following subheadings:

- Introduction to the concept of R-Analytics and its application in time management
- Discuss Three Time Management Techniques to be employed in this study
- Discuss the role of AI-driven tools in enhancing time management and reducing procrastination
- Discuss how R-Analytics, AI-driven tools, and time management techniques can be smartly integrated to mitigate procrastination habits among bank employees

The study proceeds further to set a stage for a productivity revolution in the banking sector.

• Introduction to R-Analytics and Its Application in Time Management

R-Analytics uses R programming to analyze time management data, identifying patterns and inefficiencies to inform productivity improvement strategies.

In the context of time management, R-Analytics can be easily applied to:

1. Analyse time usage patterns and identify areas of inefficiency
2. Visualize time management data to provide insights into productivity and procrastination habits
3. Develop predictive models to forecast potential procrastination and provide personalized recommendations for improvements
4. Create data-driven dashboards to track time management metrics and monitor progress

This study may utilize one or more of the following R packages to generate graphical output:

1. **Caret (classification and regression training)** is an R package that provides a unified interface for training and tuning regression and classification models. It allows users to compare and optimize different models using various techniques.

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2. **Dplyr (data manipulation)** is an R package that provides a grammar-based approach to data manipulation, enabling efficient and intuitive data transformation and analysis.
3. **Tidyr (data transformation)** is an R package that provides tools for transforming and restructuring data into a tidy format, making it easier to analyze and visualize.
4. **Ggplot2 (data visualization)** is a popular data visualization library in R that enables users to create visually appealing, customizable plots using points, lines, and labels.
5. **Stringr (string manipulation)** is an R package that provides a set of consistent and user-friendly functions for working with strings, including detecting, extracting, and replacing patterns.
6. **caretEnsemble (ensemble methods)** is an R package that provides functions for combining multiple models created using the caret package, enabling users to develop ensemble models that enhance predictive performance.

These R packages integrate analytics with AI-driven algorithms to support study objectives. The AI-driven algorithms that can be put to use in this study, along with R codes, are as follows:

1. **Decision Trees:** To identify key factors contributing to procrastination habits and predict potential episodes of procrastination.
2. **Random Forest:** To analyze complex patterns in employee time management data and identify high-risk groups prone to procrastination.
3. **Clustering Algorithms (K-Means/Hierarchical Clustering):** To segment employees based on their time management patterns and procrastination habits.
4. **Natural Language Processing (NLP):** To analyze employee feedback and sentiment analysis to identify the underlying causes of procrastination.

This study can integrate the above-mentioned R packages with AI-driven algorithms to help mitigate procrastination habits in the banking sector.

- **Optimizing Productivity: Using Three Unique Time Management Techniques**

This section examines three specific time management techniques that can be integrated with R analytics and AI-driven modules.

✓ **Kanban** is a visual time management technique. The term “Kanban” is a Japanese word meaning “visual board” or “signboard.” It is a system for managing work, emphasizing visualization, limiting work in progress, and focusing on workflow.

✓ **How Kanban Works?**

1. **Identify tasks:** Break down work into smaller, manageable tasks.

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2. **Create a board:** Set up a board with columns representing the various stages.
3. **Set limits:** Set work-in-progress (WIP) limits for each stage.
4. **Prioritize tasks:** Focus on high-priority tasks and put them into the workflow.
5. **Track progress:** Monitor task progress and identify bottlenecks.
6. **Review and refine:** Regularly review and adjust the board to optimize workflow.

✓ **Benefits of Kanban**

1. **Improved visualization:** Clear understanding of work in progress and bottlenecks.
2. **Increased productivity:** Focus on high-priority tasks and reduce multitasking.
3. **Reduced stress:** It significantly helps in reducing individual stress.

✓ **Digital Kanban Tools**

Many digital tools support kanban, such as:

1. Trello
2. Asana
3. Jira
4. Microsoft Planner
5. KanbanFlow

Thus, kanban effectively boosts productivity and workflow efficiency.

➢ The **Zeigarnik Effect** is a psychological phenomenon that can be applied to time management. It states that unfinished tasks or unfulfilled goals occupy a person's mental faculty, causing cognitive tension and reminders until the task is completed. This effect is named after Bluma Zeigarnik, a Soviet psychologist who discovered the phenomenon.

➢ **How to apply the Zeigarnik Effect to Time Management?**

1. **Write down tasks:** Log all functions in one place in a notebook.
2. **Create mental tension:** Writing tasks boost memory and concentration.
3. **Prioritize and focus:** Prioritize high-value tasks first to focus on them entirely.
4. **Complete tasks:** Finish tasks to release mental tension and reduce cognitive load.

➢ **Benefits of the Zeigarnik Effect**

1. **Improved task recall:** The Zeigarnik Effect enhances task recall.
2. **Increased Focus:** Unfinished tasks keep the individual focused.
3. **Reduces mental clutter:** Writing down tasks gives mental clarity for action.
4. **Enhanced productivity:** Prioritizing tasks increases individual productivity.

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- The **5-S system** is a methodology for organising and managing workspaces, which can also be applied to time management. The 5-S system can be used for managing time in five steps:
  1. **Sort:** Remove unnecessary tasks or distractions that consume time and resources.
  2. **Set in order:** Organise tasks, tools, and resources in a clear and accessible manner.
  3. **Shine:** Maintain a clean and organised workspace, free from clutter and distractions.
  4. **Standardize:** Establish standard procedures for consistent and efficient workflows.
  5. **Sustain:** Maintain workspace effectiveness through regular reviews and updates.
- **Benefits of the 5-S system**
  1. **Better time estimation:** Due to regularly reviewing and adjusting schedules.
  2. **Increased efficiency:** This is achieved through standardizing processes and protocols.
  3. **Improved productivity:** By eliminating distractions and optimizing workflows.
  4. **Reduced stress:** By maintaining an organized and clutter-free workspace.

Thus, these time management techniques can efficiently enhance individual productivity.

- **Harnessing AI for Time Management: A Procrastination Solution**

This section elaborates on a few AI algorithms that can be amalgamated with R Analytics to address procrastination in banking sector employees, as outlined below:

Decision Trees identify key factors contributing to procrastination habits by:

1. Analyzing historical data on behavior, tasks, and outcomes.
2. Splitting data into branches based on specific features (e.g., task complexity, deadlines, time of the day).
3. Identifying patterns and correlations between features and episodes of procrastination.
4. Creating decision rules to predict potential episodes of procrastination based on these patterns.

Random Forest is a machine learning algorithm that uses multiple decision trees to predict outcomes. Its ensemble approach method combines the predictions of individual trees to improve accuracy and robustness. It does in the following steps:

1. **Data Collection:** By collecting employees' time management data, such as task time, deadlines, work hours, and breaks.
2. **Training:** The Random Forest algorithm is trained on this data to learn patterns and relationships between features.
3. **Decision Trees:** Multiple decision trees are generated, each analyzing different features and thresholds to predict the risk of procrastination.

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4. **Voting:** Each tree votes on whether an employee is at high risk of procrastination. This final prediction is based on the majority vote among trees.
5. **Risk Identification:** Employees with high-risk predictions are identified, allowing for targeted interventions to enhance time management.

Clustering Algorithms group similar data into clusters, revealing patterns to segment employees based on time management patterns in the following manner:

1. **Data Preparation:** Collect and preprocess employee time management data.
2. **Feature Selection:** Identify relevant features, such as task completion time, frequency of procrastination, and work habits.
3. **Clustering:** Apply the K-Means or Hierarchical Clustering algorithms to group employees with similar time management patterns.
4. **Segmentation:** Analyze resulting clusters to identify distinct employee segments, such as:
   - Procrastinators
   - Timely completers
   - Consistent workers
5. **Insights:** Use cluster insights to tailor interventions, training, or support to specific employee segments.

Natural Language Processing (NLP) can be a game-changer in analyzing employee feedback to identify the root causes of procrastination. NLP-driven algorithms are capable of achieving the following:

Data Collection: Gather employee feedback data through surveys, emails, or other channels.

Preprocessing: Clean and preprocess the text data by removing stop words, punctuation, and converting all text to lowercase.

Sentiment Analysis: This can be accomplished using machine learning algorithms such as Naïve Bayes, Support Vector Machines (SVM), or Random Forest.

Topic Modeling: Latent Dirichlet Allocation (LDA) can be applied to identify underlying themes or topics in employee feedback.

Root Cause Analysis: Use the output from sentiment analysis and topic modeling to identify the root causes of employee procrastination.

- **Smart Integration for Productivity: AI, Time Management, and R-Analytics in Action**

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It is possible to integrate R-Analytics, AI-driven tools, and time management techniques, and banks can create a supportive environment that fosters productivity, reduces procrastination, and promotes employee well-being. This can be done in the following ways:

- ✓ **Predictive analytics:** Using R-Analytics to assess the probability of employee procrastination, enabling proactive interventions.
- ✓ **Automated task prioritization:** AI-driven tools prioritize tasks based on urgency and importance, minimizing decision fatigue.
- ✓ **Personalized coaching:** AI-driven tools provide personalized coaching and feedback to employees, helping them to cultivate more effective time management habits.

Problem Identification

- **Problem Statement-1:** The procrastination habits of bank employees hinder productivity and effective time management, necessitating a novel solution.
- **Problem Statement-2:** Current time management solutions are often ineffective due to a lack of personalization, necessitating a new approach to tackle procrastination and boost productivity.

Based on these identified problems, the study aims to achieve the following specific research objectives.

Research Objectives

Two key objectives intuitively driving this study forward are as follows:

1. To develop an R-Analytics framework that predicts procrastination patterns and provides personalized time management insights for bank employees.
2. To evaluate the effectiveness of the proposed framework in reducing procrastination habits and enhancing productivity among bank employees.

The importance of this research lies in its potential impact, as highlighted below.

Significance of the Study

The study's significance lies in its innovative methodology, yielding:

1. **Improved Productivity:** This study enables bank employees to manage their time more effectively, resulting in increased productivity and improved work outcomes.

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2. **Reduced Procrastination:** By identifying and mitigating procrastination habits, bank employees can overcome delays and consistently meet deadlines.
3. **Data-Driven Decision Making:** The R-Analytics approach provides actionable insights, enabling bank employees and management to make informed decisions about time management and workflow optimization.
4. **Enhanced Employees' Well-Being:** By reducing stress and improving time management skills, this study can contribute to decreased job satisfaction, a better work-life balance, and improved overall well-being among bank employees.

Why Is This Study Unique and Significant?

This study stands out in many ways due to the following reasons:

- **Unique Aspects**

1. **AI-driven approach:** Utilizes R-Analytics to provide data-driven insights and solutions for time management and mitigating procrastination, capable of incorporating AI tools.
2. **Novel Methodology:** Introduces Design Science Research Methodology (DSRM) as an innovative approach to tackle procrastination among bank employees.
3. **Illustrative approach:** The study employs illustrative methods to simplify complex data insights, facilitating better understanding and informed action.

- **Potential Impact**

1. **Improved banking operations:** The study's findings can optimize workflow, reduce delays, and improve banking operations.
2. **Employee-centric approach:** It fosters a positive work environment by prioritizing employee well-being, job satisfaction, and productivity.
3. **Innovative solution:** It opens up opportunities for advanced AI-driven research on employee productivity and procrastination.
4. **Practical applications:** It provides a practical solution for banks to boost employee productivity, satisfaction, and performance.

Thus, the study revolutionizes banking by tackling procrastination, enhancing employee well-being, and promoting institutional success.

What Value Does It Add to Academia or Society?

This study adds value to academia and society in the following ways:

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1. **Advances Knowledge:** Opens avenues for AI-driven research in time management and procrastination.
2. **Industry relevance:** Provides a data-driven approach to optimizing workflow and reducing delays, benefiting the banking industry and potentially other sectors.
3. **Interdisciplinary Insights:** Combines AI, psychology, and management to foster interdisciplinary research and collaboration.
4. **Scalability:** The approach can be adapted to other industries and professions.
5. **Evidence-Based Practices:** Provides empirical evidence for effective time management strategies.

This study enhances productivity in academia and industry while also acknowledging certain limitations.

Limitations of The Study

Despite its intuitive concept, the study reports some inherent limitations.

1. **Limited Generalizability:** It may not be easy to generalize beyond the banking sector.
2. **Dependence on AI Tool:** Effectiveness of the concept depends on the AI tool's accuracy and user adoption.
3. **Self-Reporting Bias:** Self-reporting may introduce bias in measuring procrastination habits.
4. **Short-Term Focus:** The study may not capture long-term effectiveness.

However, the study's findings should be considered in conjunction with its limitations to gain a nuanced understanding of the results.

Literature Review and Analysis

Given the scarcity of research on this topic, this study aims to fill the gap. The following is a brief review of the very few but relevant past studies.

(Uzir & et.al, 2000) These researchers have reported findings on time management and learning strategies among students in their study titled **"Analytics of Time Management and Learning Strategies for Effective Online Learning in Blended Environments."** This research was conducted at Monash University, Belgrade. They employed a multi-method analytical framework that combined unsupervised machine learning, network learning analysis, and process mining. The study reports that high-performing students tend to use more diverse and well-timed learning strategies, while lower-performing students exhibit less regulated learning

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patterns. A strong connection exists between effective online learning and the strategic regulation of both time management and learning approaches. The study suggests ways to implement a targeted feedback mechanism to improve time management skills among students. The study shows limitations of utilizing the concept only on students, which can be extended to bank and other industrial employees. In the future, this study concept can be harnessed for automated, AI-driven solutions for the problems enumerated in this study.

(Valerie et.al, 2009) The study, titled **"Time Management: A Realistic Approach,"** serves as a practical guide to effective time management, emphasizing the importance of realistic strategies to enhance both productivity and quality of life. It explores the challenges of developing and maintaining time management skills, highlighting that while theoretically appealing, actual practice requires consistent effort and adaptability. The document underscores the necessity of setting both short-term and long-term, realistic goals, cautioning against the pitfalls of perfectionism and overcommitment. It argues that setting achievable and clear objectives is crucial for sustaining motivation and productivity over time. The study suggests that striking a healthy balance, including time for personal interests and relaxation, not only fosters well-being but also enhances work efficiency in the long run. The study advocates for a realistic and balanced approach to time management. The study concludes that by integrating clear goal setting, effective organization, strategic delegation, and proper stress management, individuals can not only improve productivity but also ensure sustained mental and physical health.

(Wendelien, 2010) The author has written a comprehensive scholarly article, examining the impact of time management training on employees' procrastination behavior and associated factors. The study, titled **"Procrastination at Work and Time Management Training,"** offers an in-depth analysis of how structured time management interventions can influence both behavioral and psychological outcomes. The study highlights that procrastination serves as an emotional avoidance mechanism with both cognitive and behavioral components. Statistical evidence supports the effectiveness of time management training in modifying these behaviors, as training on time management techniques significantly reduces procrastination tendencies. Enhanced perceptions of control over time also help reduce procrastination. The study's limitations include the use of a small sample size, suggesting that further research is needed. A longitudinal study in the future is recommended, incorporating the role of personality factors, especially emotional stability, to provide more profound insights.

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Research Methodology

This study uses Design Science Research Methodology (DSRM) to develop an R-analytics framework tackling bank employees' procrastination. DSRM's systematic approach involves problem identification, design, development, demonstration, and evaluation, leveraging R programming and AI algorithms to create an evidence-based solution.

Moreover, the chosen methodology offers several inherent advantages, as outlined below.

Justification For Chosen Methodology

DSRM is chosen for its structured approach, which aligns design and development with practical solutions. It allows rigorous testing through demonstration and evaluation, making it an ideal framework for creating an evidence-based R analytics solution.

Development of the artifact: Visualizing Time Management Techniques with R

This section presents a graphical representation of time management techniques using the R analytics framework, highlighting the benefits of data visualization in understanding productivity patterns.

R Code-1: Kanban Time Management Technique

```
# Install necessary libraries
install.packages("ggplot2")

# Load libraries
library(ggplot2)

# Simulate Kanban data
set.seed(123)
tasks <- data.frame(
  Task = paste("Task", 1:10),
  Stage = sample(c("To-Do", "In Progress", "Done"), 10, replace = TRUE),
  Time = round(runif(10, 1, 10), 1)
)

# View simulated data
```


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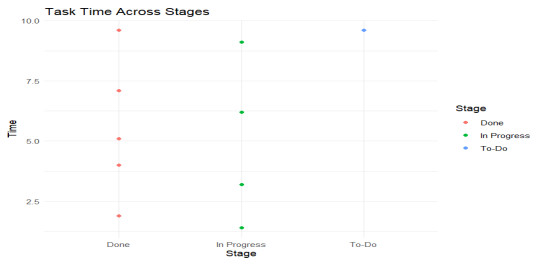
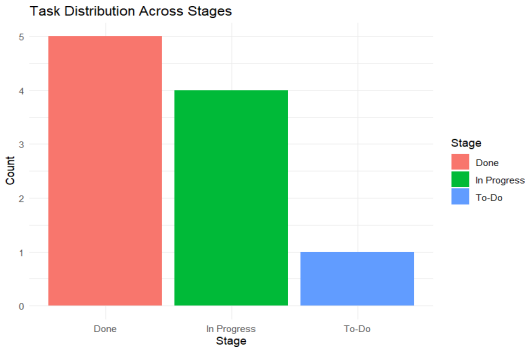
```
print(tasks)

# Bar chart to show task distribution across stages
ggplot(tasks, aes(x = Stage, fill = Stage)) +
geom_bar() +
  labs(title = "Task Distribution Across Stages", x = "Stage", y = "Count") +
  theme_minimal()

# Scatter plot to show task time across stages
ggplot(tasks, aes(x = Stage, y = Time, color = Stage)) +
geom_point() +
  labs(title = "Task Time Across Stages", x = "Stage", y = "Time") +
  theme_minimal()
```

Graph: Kanban Time Management Technique





Bar Graph: Kanban Time Management Technique

R Code-2: The Zeigarnik Effect Time Management Technique

```
# Load necessary libraries
library(ggplot2)

# Set seed for reproducibility
```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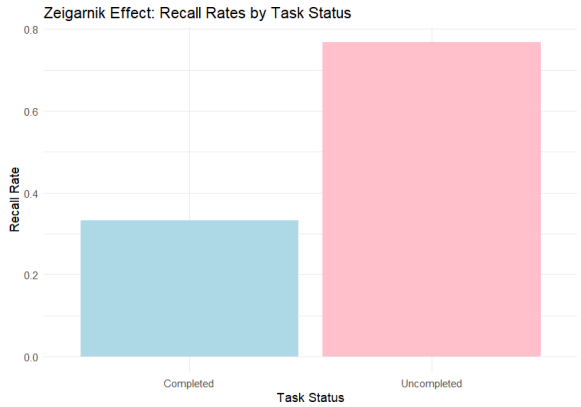
```
set.seed(123)

# Simulate data
n <- 100
task_status <- sample(c("Completed", "Uncompleted"), n, replace = TRUE)
recall_probability <- ifelse(task_status == "Uncompleted", 0.8, 0.4)
recalled <- rbinom(n, 1, recall_probability)

# Create a dataframe
df <- data.frame(task_status, recalled)

# Calculate recall rates
recall_rates <- aggregate(recalled ~ task_status, df, mean)

# Plot the results
ggplot(recall_rates, aes(x = task_status, y = recalled, fill = task_status)) +
  geom_col() +
  scale_fill_manual(values = c("Completed" = "lightblue", "Uncompleted" = "pink")) +
  labs(title = "Zeigarnik Effect: Recall Rates by Task Status",
       x = "Task Status", y = "Recall Rate") +
  theme_minimal() +
  theme(legend.position = "none")
```

Bar Graph: The Zeigarnik Effect Bar Chart



R Code-3: The 5-S Time Management Technique

```
# Load necessary libraries
library(ggplot2)
```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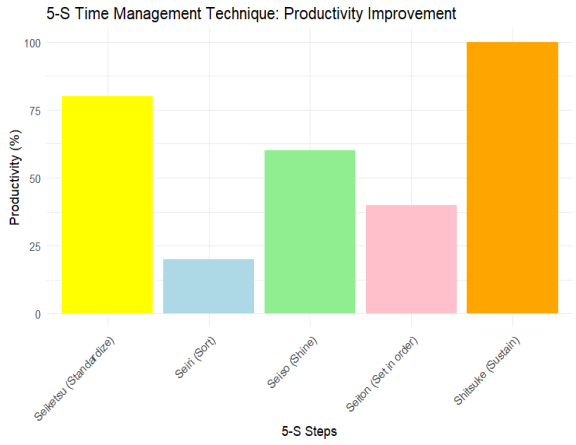
```
# Create a dataframe
df <- data.frame(
  S = c("Seiri (Sort)", "Seiton (Set in order)", "Seiso (Shine)",
        "Seiketsu (Standardize)", "Shitsuke (Sustain)"),
  Productivity = c(20, 40, 60, 80, 100)
)

# Plot the results
ggplot(df, aes(x = S, y = Productivity, fill = S)) +
  geom_col() +
  scale_fill_manual(values = c(
    "Seiri (Sort)" = "lightblue",
    "Seiton (Set in order)" = "pink",
    "Seiso (Shine)" = "lightgreen",
    "Seiketsu (Standardize)" = "yellow",
    "Shitsuke (Sustain)" = "orange"
  )) +
  labs(title = "5-S Time Management Technique: Productivity Improvement",
       x = "5-S Steps", y = "Productivity (%)") +
  theme_minimal() +
  theme(legend.position = "none") +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

Bar Graph: The 5-S Bar Chart



By modifying this R framework, it can be applied to other sectors to combat procrastination.

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Discussion

The study's findings highlight the effectiveness of specific time management techniques in reducing procrastination. However, the specialty of this study is as follows:

1. The study introduces a novel, AI-driven R-Analytics framework to identify and mitigate procrastination among bank employees, aiming to improve time management and productivity.
2. It employs the Design Science Research Methodology (DSRM) to systematically develop, demonstrate, and evaluate the proposed artifact using R codes.
3. The three key time management techniques are theoretically explained and visually demonstrated using R codes and data visualization graphically.
4. The approach emphasizes data-driven insights and predictive modeling to effectively understand and address individual procrastination habits.
5. It discusses limitations, generalizability beyond the banking sector, potential biases in self-reported data, and reliance on AI accuracy.
6. The research underscores the potential for the framework to be tested with both simulated and real-time data, paving the way for broader cross-industry validation.

This R-Analytics framework yields significant outcomes, as detailed below.

Outcomes Achieved

The key outcomes of this study are:

1. The proposed R framework qualifies the test for both simulated and real-time data analysis, demonstrating its readiness for practical application in improving workplace productivity.
2. Data visualization techniques, utilizing R packages such as ggplot2, dplyr, and tidyr, effectively illustrate productivity patterns, task distributions, and the impact of three specific time management techniques.
3. The application of the Kanban technique provided clear visual insights into task flow, identifying bottlenecks and optimizing workload distribution.
4. The analysis of the Zeigarnik Effect highlighted the cognitive impact of incomplete tasks, suggesting strategies to enhance focus and improve task completion.
5. Visualization of the 5-S system demonstrated that organized and standardized workspaces can lead to measurable improvements in productivity by reducing distractions.

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6. The results indicate that the combined use of R-Analytics and the proposed AI techniques can significantly reduce procrastination habits and increase overall employee productivity.

Despite numerous outcomes, the study has upgradeability potential.

Future Directions

Future research further validates and expands the R-analytics framework's effectiveness with the help of new AI technology in combating procrastination as follows:

1. **Cross-Industry Validation: The** Study can be expanded to other industries to assess the generalizability and adaptability of the R-analytics framework.
2. **Longitudinal Study:** Conduct a long-term study to evaluate the sustainability and effectiveness of the framework in mitigating procrastination habits.
3. **Integration with Other Technologies:** Explore integrating the R-analytics framework with other AI technologies, such as wearable devices or mobile apps, to enhance its applicability.
4. **Personalized Interventions:** Develop personalized intervention strategies tailored to individual employee profiles and specific patterns of procrastination.
5. **Comparative Analysis:** Compare and utilize the R-Analytics framework alongside other time management and productivity tools to assess its relative effectiveness and identify areas for improvement.

The novel approach study is finally summarized.

Conclusions

This is the last step of DSRM, Communication and Dissemination of the research findings, enumerated as follows:

1. The framework bridged the gap in the body of knowledge by using Design Science Research Methodology and R analytics, enabling targeted interventions and personalized productivity strategies.
2. The study has inherent limitations, including sector specificity, dependency on AI accuracy, potential biases, and a short-term focus.
3. The research concludes that AI-driven R-Analytics frameworks can boost workplace productivity and employee well-being, with potential for further growth and applications.

e-ISSN- 3067-0977

The study proposes a novel approach to addressing procrastination issues among banking employees by leveraging R Analytics and allowing AI-driven time management strategies.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY
RESEARCH AND INNOVATION

"Leveraging use of AI for Sustainable Growth in Indian MSMEs."

Walmik Chaure

Research Scholar
MVPs IMRT Nashik
Savitribai Phule Pune University
Nashik.Maharashtra ,India.

Walmik.chaure@gmail.com

Dr. Sheetal Gade

Research Guide
MVPs IMRT Nashik
Savitribai Phule Pune University
Nashik.Maharashtra ,India.

Abstract: This research paper investigates the potential of Artificial Intelligence (AI) to drive sustainable growth within the Indian Micro, Small, and Medium Enterprise (MSME) sector. Recognizing the significant contribution of MSMEs to the Indian economy and the increasing global emphasis on sustainability, the paper explores the opportunities and specific applications of AI that can enhance operational efficiency, optimize resource utilization, and promote circular economy practices within these enterprises. The study also identifies key barriers hindering the widespread adoption of AI in Indian MSMEs, including financial constraints, lack of technical expertise, inadequate infrastructure, and limited awareness. Finally, the paper proposes actionable strategies and recommendations for fostering AI adoption to enable sustainable growth and enhance the overall competitiveness and environmental responsibility of Indian MSMEs.

Keywords: *Artificial Intelligence, MSMEs, Sustainable Growth, India, Circular Economy, Technology Adoption, Barriers, Opportunities.*

e-ISSN- 3067-0977

1. Introduction

Micro, Small, and Medium Enterprises (MSMEs) form a critical component of the Indian economy, contributing significantly to the nation's Gross Domestic Product (GDP), with estimates around 30%, and providing substantial employment opportunities . Their widespread presence across various sectors makes their growth and sustainability integral to India's overall economic development. Simultaneously, there is an increasing global recognition of the importance of sustainable development, urging businesses of all sizes to adopt practices that are both environmentally responsible and economically viable . This necessitates a shift towards business models that minimize environmental impact while ensuring long-term economic prosperity. In this evolving landscape, Artificial Intelligence (AI) has emerged as a transformative technology with the potential to revolutionize diverse facets of business operations, offering a unique pathway for MSMEs to achieve sustainable growth . This technology holds the promise of overcoming traditional limitations faced by MSMEs, unlocking unprecedented levels of efficiency, innovation, and resource optimization.

Despite the acknowledged potential of AI to foster sustainable growth, its adoption within the Indian MSME sector remains limited . This lag in adoption can be attributed to a complex interplay of interconnected challenges that hinder the widespread integration of AI into their operations. Understanding these barriers is crucial to formulating effective strategies that can enable MSMEs to harness the power of AI for sustainable development. Therefore, this research endeavors to explore the opportunities and specific applications of AI that can drive sustainable growth within Indian MSMEs. It also aims to identify the key barriers and challenges that impede the broader adoption of this technology in the sector. Furthermore, this paper will investigate the role of AI in facilitating circular economy practices within these enterprises . Ultimately, the research seeks to propose actionable strategies and recommendations that can empower Indian MSMEs to effectively leverage AI for achieving sustainable growth and enhancing their contribution to the national economy and environmental well-being. The subsequent sections of this paper will delve into the existing literature on these topics, explore the potential applications of AI, analyze the challenges, and finally, offer recommendations for fostering AI adoption for sustainable growth in Indian MSMEs.

e-ISSN- 3067-0977

2. Literature Review

Indian MSMEs are vital to the nation's socio-economic fabric, playing a multifaceted role that extends beyond mere economic contributions. They are significant drivers of employment generation, offering livelihoods to a substantial portion of the population, and are instrumental in poverty eradication and fostering regional development by creating opportunities in both rural and urban areas . Moreover, MSMEs play a crucial role in promoting entrepreneurship and fostering a culture of innovation at the grassroots level . Their contributions extend to the manufacturing sector, accounting for a substantial percentage of the nation's output, and they are also significant players in India's export market, thereby holding an important position in global value chains . Given their integral role in the Indian economy, the competitiveness and sustainability of MSMEs have a direct impact on India's overall economic performance and its standing in the global marketplace. The increasing relevance of sustainability for MSMEs is underscored by evolving consumer preferences, which are increasingly leaning towards environmentally friendly products and practices . Furthermore, the tightening of environmental regulations and the global shift towards sustainable supply chains are making it imperative for MSMEs to adopt greener operational methods . MSMEs that proactively integrate sustainable practices into their business models are not only likely to enhance their brand reputation and earn customer trust but also position themselves to gain a competitive advantage and effectively mitigate potential future risks associated with resource scarcity and environmental degradation .

Artificial Intelligence, at its core, refers to the ability of machines to perform tasks that typically require human intelligence.[1] This encompasses a range of technologies, with key components including machine learning, which enables systems to learn from data without explicit programming; natural language processing, allowing machines to understand and process human language; and computer vision, which enables machines to "see" and interpret images.[1] AI finds diverse applications across various business functions, offering solutions for automation of routine tasks, in-depth data analysis, predictive analytics for forecasting trends, enhanced customer service through chatbots, and optimization of complex supply chain operations . The versatility of AI allows it to address a wide spectrum of challenges and opportunities across different aspects of MSME operations, from streamlining internal

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processes to enhancing external interactions. The potential benefits of AI for businesses are manifold, including significant increases in operational efficiency, substantial reductions in costs through automation and optimization, improved decision-making based on data-driven insights, enhanced engagement with customers through personalized experiences, and the creation of entirely new revenue streams through innovative products and services . By leveraging these benefits, AI can provide MSMEs with the tools to operate more effectively, compete with larger enterprises that often have greater resources, and ultimately achieve higher levels of overall performance and growth .

The intersection of AI and sustainability presents a compelling opportunity for businesses, particularly within the SME sector . Existing literature highlights how AI can be a key enabler in achieving sustainability goals by facilitating the optimization of resource usage, minimizing environmental impact through efficient operations, and promoting the adoption of circular economy principles . For instance, AI-powered systems can analyze energy consumption patterns to identify areas for reduction , optimize logistics for lower emissions , and improve waste management processes . Studies focusing on the adoption of AI for sustainability within SMEs globally indicate a growing recognition of this potential . However, the actual implementation of AI for sustainability in SMEs is still in its nascent stages, suggesting a need for more focused research and practical guidance tailored to the specific contexts and challenges faced by these enterprises . While the anticipated benefits are significant, the journey towards integrating AI for sustainability requires a thorough understanding of the existing barriers and the development of effective strategies to overcome them .

Indian MSMEs, despite their crucial role in the economy, often face a unique set of challenges when it comes to adopting new technologies . These challenges commonly include limited financial resources, which restrict their ability to invest in expensive technological solutions ; a lack of in-house technical expertise and digital literacy, making it difficult to implement and manage advanced technologies ; and inadequate technological infrastructure, particularly in terms of reliable internet connectivity and access to ICT tools, which are essential for leveraging modern digital solutions . These foundational challenges need to be addressed to create an environment conducive for the widespread adoption of AI for sustainability. However,

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there are also emerging opportunities that can facilitate technology adoption in the MSME sector . Increasing digital penetration across India, coupled with various government initiatives aimed at promoting digitalization and supporting MSMEs, are creating a more favorable landscape for technology integration . These initiatives often include schemes for technology upgradation, financial assistance for adopting modern techniques, and programs for skill development, which can help MSMEs overcome some of the traditional barriers and embrace the transformative potential of technologies like AI .

3. Leveraging AI for Sustainable Growth: Opportunities and Applications in Indian MSMEs

AI presents numerous opportunities for Indian MSMEs to enhance their operational efficiency and productivity, which are fundamental to achieving sustainable growth . AI-powered automation can streamline a multitude of routine and repetitive tasks that often consume significant time and resources within MSMEs . Examples of such applications include the automation of data entry processes, efficient scheduling of tasks and resources, and handling basic customer inquiries through automated systems . By automating these tasks, MSMEs can free up their limited human resources, allowing employees to focus on more strategic, creative, and value-added activities that can directly contribute to business growth and innovation . Furthermore, AI plays a crucial role in data analytics, enabling MSMEs to gain valuable insights from the vast amounts of data they generate . AI-powered analytics tools can efficiently monitor key sales metrics, identify emerging market trends, and understand evolving customer preferences . These data-driven insights empower MSMEs to make more informed strategic and operational decisions, leading to improved efficiency, better resource allocation, and enhanced competitiveness in the market .

Another significant application of AI for MSMEs lies in enhancing customer service and engagement . AI chatbots and virtual assistants can provide instant and round-the-clock customer support, addressing common queries, processing simple service requests, and collecting essential customer information without the need for constant human intervention . This not only improves the responsiveness of MSMEs to customer needs but also enhances the overall customer experience, leading to increased satisfaction and loyalty . Moreover, AI-powered customer service

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solutions can handle multilingual interactions, further expanding the reach and accessibility of MSMEs to a diverse customer base .

AI also offers substantial opportunities for MSMEs to optimize their resource utilization and significantly reduce waste across various operational areas . In supply chain management, for instance, AI can predict inventory needs with remarkable accuracy by analyzing historical data patterns and anticipating future demand fluctuations . This capability prevents the accumulation of excess inventory, thereby reducing storage costs and minimizing the risk of obsolescence . AI-driven inventory management leads to more efficient operations and improved operational agility, allowing MSMEs to respond effectively to changing market demands . Beyond inventory, AI can be instrumental in optimizing production processes within MSMEs . By analyzing production data, AI algorithms can identify inefficiencies, suggest optimal parameters, and help minimize waste of raw materials, energy, and other resources . This not only reduces operational costs but also contributes to environmental sustainability by lowering the resource footprint of MSME operations . Additionally, AI's potential in predictive maintenance is invaluable for MSMEs . By continuously monitoring the performance of equipment and machinery, AI systems can detect early signs of potential malfunctions or failures . This allows MSMEs to proactively schedule maintenance, preventing unexpected breakdowns, reducing downtime, and avoiding costly repairs, ultimately improving asset efficiency and operational continuity .

The principles of a circular economy, which emphasize the importance of keeping resources in use for as long as possible, extracting the maximum value from them whilst in use, then recovering and regenerating products and materials at the end of each service life, align well with the capabilities of AI . AI-based reverse logistics plays a crucial role in helping MSMEs adopt circular economy practices.[2] AI can optimize the processes involved in returning goods from their point of consumption for recycling, reuse, or remanufacturing.[2] This includes improving the efficiency of sorting, disassembling, and reprocessing materials, enabling MSMEs to adequately recycle and reuse resources, thereby enhancing their circular economy performance and reducing their reliance on virgin materials . Furthermore, AI can significantly enhance resource tracking and supply chain transparency,

e-ISSN- 3067-0977

which are essential for facilitating material recovery and reuse within a circular economy framework . By providing real-time visibility into the flow of materials and products across the supply chain, AI enables MSMEs to identify opportunities for recovering valuable resources at the end of their life cycle . This improved transparency can also foster collaboration among businesses, facilitating the exchange of secondary materials and promoting industrial symbiosis . AI also holds considerable potential for optimizing waste management processes within MSMEs . By analyzing data on waste generation, AI can help identify patterns, predict volumes, and optimize collection and sorting processes . Moreover, AI can assist in identifying opportunities for upcycling waste materials into new products or substituting them for virgin resources, thereby enabling MSMEs to innovate in waste management and explore new circular business models that can generate additional revenue streams and contribute to a more sustainable economy .

4. Barriers and Challenges to AI Adoption for Sustainable Growth in Indian MSMEs

Financial constraints represent a significant impediment to the widespread adoption of AI for sustainable growth within Indian MSMEs . The implementation of AI solutions often entails substantial upfront costs, encompassing the price of AI-powered software and tools, the necessary computing infrastructure to support AI applications, and the expense of hiring or training specialized personnel with AI expertise . A recent report highlighted that a considerable 59% of Indian MSMEs face financial limitations that hinder their ability to invest in AI technologies . This financial barrier is particularly pronounced for micro and small enterprises, which often operate with tight budgets and limited access to capital . Furthermore, there is a prevailing perception among MSMEs that AI is not only expensive but also not readily accessible or democratically available to them . A significant 91% of MSMEs believe that AI technologies should be made more affordable and accessible to level the playing field for smaller businesses . This perception underscores the need for more cost-effective AI solutions and financial support mechanisms to enable broader adoption within the sector .

A critical challenge hindering AI adoption in Indian MSMEs is the lack of technical expertise and digital literacy within these enterprises . There is a significant shortage of skilled personnel who possess the necessary knowledge and capabilities to understand, implement, and effectively

e-ISSN- 3067-0977

manage AI technologies . As per a study, a substantial 74% of MSMEs acknowledge the potential of AI but lack the in-house expertise required to identify and integrate suitable AI tools into their existing workflows . This lack of technical know-how prevents MSMEs from fully leveraging the potential of AI to address their specific business needs and sustainability goals . Moreover, MSMEs often face difficulties in accessing the necessary training and upskilling programs for their existing workforce to acquire the skills needed for AI implementation and management . The limited availability of relevant and affordable training opportunities further exacerbates the skills gap within the sector, making it challenging for MSMEs to embrace and benefit from AI technologies .

Inadequate technological infrastructure and limited access to reliable internet connectivity pose another significant hurdle to AI adoption in Indian MSMEs, particularly for those located in rural and remote areas . Many AI solutions, especially those leveraging advanced machine learning and data analytics, rely on robust and high-speed internet access for cloud-based services and data processing . The lack of consistent and reliable internet connectivity, coupled with limited access to essential ICT infrastructure, hinders the ability of MSMEs to effectively utilize these AI-powered tools and applications . This digital divide across the country restricts the widespread adoption of AI, especially in regions where MSMEs play a crucial role in the local economy and sustainable development .

Data privacy and security concerns also contribute to the hesitation among MSMEs in adopting AI technologies . As AI systems often involve the collection, processing, and analysis of large volumes of data, MSMEs are understandably apprehensive about the security and privacy of their sensitive business information . Concerns regarding potential data breaches, misuse of data, and compliance with data protection regulations can lead to a reluctance in adopting AI solutions, especially if MSMEs lack the necessary understanding and resources to implement robust data security measures . Addressing these concerns through clear guidelines, secure AI platforms, and awareness programs is crucial for building trust and encouraging wider adoption .

Organizational and cultural resistance to adopting new technologies can also impede the integration of AI within MSMEs . Change resistance from employees who

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may be unfamiliar or apprehensive about AI-driven automation, coupled with a lack of strong support and commitment from top management towards technology adoption, can create significant barriers . Without proactive efforts to address employee concerns, provide adequate training, and foster a culture of innovation and technological adoption, MSMEs may struggle to overcome internal resistance and fully embrace the benefits of AI .

Finally, a limited awareness and understanding of the potential benefits and practical applications of AI within their specific business context is a key challenge for many Indian MSMEs . Many MSME owners and managers may not be fully aware of how AI can directly address their unique operational challenges, improve efficiency, drive growth, and contribute to their sustainability goals . A significant 65% of tech-enabled MSMEs report struggling due to a limited awareness about the available AI tools and resources that could benefit their businesses . This lack of understanding can lead to a reluctance to invest in AI, as MSMEs may not perceive a clear return on investment or recognize the tangible advantages that AI can offer in enhancing their competitiveness and long-term sustainability .

5. Strategies and Recommendations for Fostering AI Adoption and Sustainable Growth

To effectively foster the adoption of AI for sustainable growth in Indian MSMEs, a multi-pronged approach involving government support, the development of accessible solutions, promotion of skill development, encouragement of collaboration, and creation of awareness is essential .

Governments at both the central and state levels have a crucial role to play in facilitating AI adoption within the MSME sector . Providing targeted financial support in the form of subsidies, grants, and low-interest loans can significantly alleviate the financial burden associated with investing in AI technologies and the necessary infrastructure . These incentives can make AI solutions more affordable and accessible to a wider range of MSMEs, encouraging them to explore and implement AI for enhancing their operations and sustainability practices . Furthermore, the development and implementation of national-level frameworks and policies specifically designed to promote AI adoption in the MSME sector are vital . These policies should include clear guidelines on data privacy and security to build trust and address concerns related to

e-ISSN- 3067-0977

data handling in AI systems . Additionally, it is important for the government to continue and strengthen initiatives that promote the adoption of energy-efficient technologies and renewable energy sources within MSMEs . Schemes like MSE-GIFT (Green and Inclusive Finance for Transformation) and MSE-SPICE (Sustainable, Productive, Inclusive, Competitive Enterprises) provide financial assistance for adopting cleaner technologies and resource-efficient practices, aligning AI adoption with broader sustainability objectives .

The development of accessible and affordable AI solutions tailored to the specific needs and budgets of MSMEs is paramount for driving widespread adoption . Technology providers, including startups and established companies, should focus on creating user-friendly, scalable AI platforms and tools that are easy for MSMEs to integrate into their existing operations . Exploring cloud-based AI services and open-source solutions can significantly reduce the upfront costs associated with AI implementation, making it more feasible for resource-constrained MSMEs . These solutions should be designed with the unique challenges and requirements of MSMEs in mind, offering practical applications that address their specific operational needs and sustainability goals .

Investing in skill development and training programs is crucial for empowering MSME owners and employees to effectively utilize AI technologies . Comprehensive training programs and workshops should be implemented to enhance the digital literacy and AI skills within the sector . Collaboration between academic institutions, industry experts, and government agencies can facilitate the delivery of practical, hands-on training that equips MSME personnel with the necessary skills to implement, manage, and benefit from AI solutions . These programs should cover a range of topics, from basic digital literacy to more advanced AI concepts and applications relevant to MSME operations .

Encouraging collaboration and partnerships between MSMEs and various stakeholders in the technology ecosystem is another key strategy for fostering AI adoption . Creating platforms and opportunities for MSMEs to connect with technology providers, AI startups, and academic institutions can facilitate knowledge sharing, provide access to specialized expertise, and promote the development of customized AI solutions tailored to the unique needs of MSMEs . These collaborations can help

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bridge the gap between the technical capabilities of AI and the practical challenges faced by MSMEs in their pursuit of sustainable growth .

Finally, raising awareness among MSMEs about the potential benefits and practical applications of AI for sustainable growth is essential for overcoming the challenge of limited understanding . Initiatives should be undertaken to showcase successful case studies of AI adoption within the Indian MSME sector, highlighting real-world examples of how AI has helped businesses improve efficiency, reduce costs, optimize resource utilization, and enhance sustainability . These success stories can provide inspiration and build confidence among other MSMEs, encouraging them to explore the possibilities of integrating AI into their own operations . Awareness campaigns, workshops, and easily accessible resources can play a crucial role in educating MSMEs about the tangible advantages of AI and guiding them on their journey towards digital transformation and sustainable growth .

6. Conclusion

This research has explored the significant potential of leveraging Artificial Intelligence for achieving sustainable growth within the Indian MSME sector. The findings underscore the crucial role of MSMEs in the Indian economy and the increasing imperative for them to adopt sustainable practices . AI offers a transformative opportunity for these enterprises to enhance operational efficiency, optimize resource utilization, promote circular economy principles, and ultimately achieve sustainable growth . However, the adoption of AI in Indian MSMEs is currently hindered by several key barriers, including financial constraints, a lack of technical expertise and digital literacy, inadequate technological infrastructure, data privacy and security concerns, organizational resistance to change, and a limited awareness of the benefits of AI .

To overcome these challenges and foster widespread AI adoption for sustainable growth, a multi-faceted approach is required . This includes proactive policy interventions from the government in the form of financial incentives and supportive frameworks . It also necessitates the development of accessible and affordable AI solutions tailored to the specific needs of MSMEs . Furthermore, investing in comprehensive skill development and training programs is crucial for building the necessary human capital . Encouraging collaboration between MSMEs and

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technology providers, along with creating awareness through successful case studies, can further accelerate the adoption process .

The implications of this research are significant for policymakers, MSME owners, technology providers, and researchers. Policymakers need to prioritize the creation of a supportive ecosystem that addresses the financial and infrastructural challenges faced by MSMEs in adopting AI . MSME owners should actively explore the potential of AI to address their specific business needs and sustainability goals, starting with small-scale implementations and gradually scaling up . Technology providers should focus on developing user-friendly and affordable AI solutions that are specifically designed for the MSME sector . Researchers can further contribute by conducting in-depth studies on the impact of AI adoption in specific MSME sectors and exploring innovative applications of AI for sustainability .

This study acknowledges certain limitations, such as its reliance on existing literature and the broad scope of the MSME sector, which encompasses diverse industries with varying levels of technological readiness. Future research could delve deeper into the specific challenges and opportunities within individual MSME sectors, conduct longitudinal studies to assess the long-term impact of AI adoption, explore the ethical considerations of AI in MSMEs, and investigate the synergistic role of AI with other emerging technologies for sustainable growth . In conclusion, by addressing the identified barriers and strategically leveraging the opportunities presented by AI, Indian MSMEs can embark on a transformative journey towards sustainable growth, contributing significantly to both the nation's economic prosperity and its environmental stewardship .

Table 1: Key Barriers to AI Adoption in Indian MSMEs and Corresponding Strategies

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Key Barriers	Corresponding Strategies
Financial Constraints	Government Subsidies & Incentives, Affordable AI Solutions
Lack of Technical Expertise and Digital Literacy	Skill Development Programs, Accessible & User-Friendly AI
Inadequate Technological Infrastructure	Infrastructure Development, Cloud-Based AI Solutions
Data Privacy and Security Concerns	Data Security Frameworks, Awareness & Education on Data Security
Organizational and Cultural Resistance	Awareness & Education Campaigns, Leadership Engagement
Limited Awareness of AI Benefits	Showcase Successful Case Studies, Targeted Awareness Campaigns

Table 2: Potential Applications of AI for Sustainable Growth in Indian MSMEs

Area of Application	Specific AI Applications	Potential Sustainability Benefits
Operational Efficiency	Automation of routine tasks (data entry, scheduling), AI-powered data analytics for insights, AI chatbots and virtual assistants for customer service	Reduced operational costs, Increased productivity, Improved decision-making, Enhanced customer satisfaction
Resource Optimization	Predictive inventory management, Optimization of production processes, Predictive maintenance for equipment	Reduced storage costs, Minimized waste of materials and energy, Improved energy

e-ISSN- 3067-0977

		efficiency, Reduced downtime, Enhanced asset lifespan
Circular Economy	AI-based reverse logistics for recycling and reuse, Resource tracking and supply chain transparency, Optimization of waste management processes, Identification of upcycling and material substitution opportunities	Improved material recovery rates, Reduced reliance on virgin materials, Enhanced waste management efficiency, Promotion of circular business models, Lower environmental impact
Supply Chain Management	Demand forecasting, Route optimization for logistics, Real-time tracking of shipments, Supplier relationship management	Reduced transportation costs and emissions, Improved delivery times, Enhanced supply chain visibility and resilience, Optimized procurement processes
Market Understanding	Analysis of sales metrics and market trends, Understanding customer preferences through data analytics, Personalized marketing campaigns, Lead generation and customer segmentation	Better targeting of customers, Increased sales and revenue, Improved customer retention, Development of new products and services based on market insights, Enhanced competitiveness

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY
RESEARCH AND INNOVATION

"AI-Powered Digital Banking for Self-Help Groups: Expanding Financial Access in Rural India"

Prof. Manoj Mahanubhav[1]
Research Scholar, IBMRD / Asst. Professor, DMIMCS, Nashik, SPPU
Dr. Megha Jain[2]
Assistant Professor, IBMRD, Ahilyanagar, SPPU

Abstract:

India has made remarkable progress in expanding digital finance, laying the foundation for more inclusive economic growth. Yet, millions in rural areas particularly low-income women remain underserved by formal financial systems. Self-Help Groups (SHGs), supported by the National Rural Livelihood Mission (NRLM), play a pivotal role in bridging this gap by promoting collective savings, access to credit, and local entrepreneurship. This paper explores how Artificial Intelligence (AI) can be harnessed to strengthen digital banking platforms that serve SHGs. We examine applications such as AI-based credit scoring, personalized financial education, and automated transaction support. At the same time, we address challenges including algorithmic bias, inadequate infrastructure, and limited digital literacy. The paper concludes with a framework for deploying AI responsibly, ensuring that technological innovation supports equitable and sustainable financial inclusion in rural India.

Keywords: Artificial Intelligence, Digital Banking, Financial Inclusion, Self-Help Groups, NRLM, Rural India, Fintech.

1. Introduction

India has made big strides in expanding financial access. Programs like the Pradhan Mantri Jan Dhan Yojana (PMJDY), Aadhaar for identity verification, and the surge in mobile banking have brought millions into the formal financial fold. But the benefits haven't reached everyone equally. In rural areas, especially among women, large gaps remain. As per NABARD (2022), more than 60% of rural women still don't have consistent access to credit from formal institutions.

Self-Help Groups (SHGs) have stepped into this gap as a vital support system. Made up mostly of women, these groups help members pool savings, lend to one another, and build trust within their communities. Backed by the National Rural Livelihood Mission (NRLM), more than 87

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million women across India have joined over 7.8 million such groups (Ministry of Rural Development, 2023. Many members of SHG face hurdles using digital platforms due to language, literacy, or lack of training. And when it comes to getting credit from banks, they often lack the kind of formal financial history that lenders look for.

Artificial Intelligence can make a real difference in rural finance if it's done right. It can help assess credit using everyday data, make banking easier through voice in local languages, spot early signs of money trouble, and offer learning tools that actually make sense to users. But for AI to work in real lives, it can't be built from a distance. It has to be shaped with the women and communities it's meant to support designed with care, not just code.

2. Literature Review

Self-Help Groups (SHGs) have quietly transformed the lives of countless women in rural India. As Sinha (2006) highlighted early on, these grassroots collectives help women build good financial habits and speak up more confidently at home.

According to the World Bank (2017), SHG members are more likely to save regularly, borrow responsibly, and invest in their livelihoods.

Deshpande and Sharma (2020) also found that these groups help boost self-confidence and support active participation in both family and community decisions.

Despite these gains, SHGs still face several operational hurdles. Most still rely on manual records, which limits their ability to access formal loans or establish creditworthiness (NABARD, 2022).

Even as digital banking grows, many SHG members' especially older women or those with limited literacy struggle to use apps and online platforms (NITI Aayog, 2021).

Meanwhile, artificial intelligence (AI) is reshaping financial services. Instead of relying solely on traditional credit histories, banks and Fintech companies are using AI to assess financial behaviour through data such as mobile usage, bill payments, and social activity (Jagtiani & Lemieux, 2019).

AI tools also enhance fraud detection and automate customer service through chatbots and virtual assistants (Brown & Mues, 2012; Accenture, 2021).

Bazarbash (2019) suggests these tools can significantly expand access to credit in markets where formal financial data is lacking.

SHGs, by contrast, operate on principles like trust, social bonds, and collective accountability dynamics that don't easily fit into algorithmic models (Marr, 2020).

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Kaleidofin (2022) has developed AI-powered tools that provide personalized financial education for women with minimal schooling.

SEWA Bharat (2022) supports women-led banks that use simple digital tools to expand services.

Research from Google and Karya (2021) underscores the importance of local language support and responsible data use in rural contexts.

AI could complement SHG models rather than replace them by supporting the values they're built on: trust, community, and shared responsibility. But this will only happen if the technology is designed with rural realities in mind, such as low connectivity, multilingual environments, and the lived experiences of the women who use it.

This study aims to explore how AI can enhance SHG ecosystems by aligning with their foundational principles trust, cooperation, and local context through inclusive, accessible, and ethically-grounded technological interventions.

3. AI Applications in SHG-Oriented Digital Banking

Self-Help Groups (SHGs) play a critical role in improving financial access and social empowerment for women in rural India. As these groups increasingly engage with digital platforms, the integration of Artificial Intelligence (AI) presents an opportunity to make financial services more inclusive, efficient, and responsive to their unique needs. However, this transformation must consider the socio-cultural realities of SHGs: community trust, collective accountability, and varying levels of digital literacy. This section outlines five practical areas where AI can meaningfully enhance SHG-linked digital banking systems.

3.1 Smarter Credit Scoring with Alternative Data

Many SHG members are excluded from formal banking simply because they lack conventional credit histories. By analysing non-traditional indicators such as savings consistency, meeting attendance, internal loan repayments, and even mobile usage, AI systems can build more inclusive credit profiles.

When integrated with SHG data systems like those used by the National Rural Livelihoods Mission (NRLM), this approach can help financial institutions recognize trustworthy borrowers without requiring complex paperwork.

Key Insight: AI credit models must prioritize transparency, user consent, and privacy protection while improving credit access for women with informal financial footprints.

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3.2 Talking Tech: Language and Voice Interfaces

Language is often an invisible barrier in rural banking. Many SHG members are not fluent in Hindi or English, and digital tools rarely support their local dialects. AI-powered voice assistants and chatbots, using natural language processing (NLP), can offer financial services in regional languages.

Key Insight: Co-developing voice-based interfaces with SHG members ensures they are easy to use, culturally relevant, and reflective of local speech patterns.

3.3 Early Warning Systems for Group Health

SHGs thrive on group stability. But signs of trouble like skipped meetings or delayed loan repayments often go unnoticed until problems worsen. AI can track these patterns and flag early signals of distress, allowing federations, NGOs, or banks to step in with timely support.

Key Insight: Embedding predictive dashboards into SHG management systems helps detect and address vulnerabilities before they escalate.

3.4 Personalized Financial Learning

Generic financial literacy programs often don't resonate with rural women. They may be too technical, too text-heavy, or simply not relevant. AI can help personalize learning adjusting content to the user's literacy level, interests, or financial goals.

Key Insight: AI-enabled learning tools should be co-designed with local women, ensuring the content feels practical, engaging, and empowering.

3.5 Securing Digital Finance: AI and Fraud Detection

As SHGs go digital, the risk of fraud, identity theft, and unauthorized transactions grows especially for first-time users. AI can enhance security by recognizing unusual activity, sending real-time alerts, and preventing scams using behavioural data like login patterns or device habits.

Key Insight: Simple, AI-powered fraud detection tools tailored for rural users can reduce financial risk while keeping systems user-friendly and secure.

4. Methodology

This study adopts a qualitative, case study-based approach to examine the integration of Artificial Intelligence (AI) in SHG-led digital banking. It draws on secondary data from NRLM's MIS, NABARD reports, and over fifteen peer-reviewed articles on AI and financial inclusion. This framework enables a focused analysis of both technological potential and socio-institutional challenges within rural SHG ecosystems.

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Case studies of early AI adoption in SHG contexts were examined to extract common themes, challenges, and successful practices. A multi-dimensional framework focusing on accessibility, usability, trust, and impact guided the analysis.

5. Case Studies and Real-World Applications of AI in SHG-Driven Financial Inclusion

India's Self-Help Groups (SHGs) have played a pivotal role in rural development and women's empowerment by fostering community-based savings and credit systems. With the increasing penetration of mobile technology and government-backed digital finance platforms, there lies a tremendous opportunity to integrate Artificial Intelligence (AI) to elevate the performance, reach, and transparency of these grassroots institutions. The following case studies showcase how specific initiatives are currently working in this direction or could be significantly enhanced by the introduction of AI-driven solutions.

5.1 Karya (Karnataka): Ethical Data Work for Inclusive AI

Overview:

Karya is a purpose-driven social enterprise that connects rural Indians to the growing digital economy by engaging them in the creation of AI training datasets. What sets Karya apart is its commitment to ethical labour standards and dignified income opportunities. Participants, often from underserved communities, are trained to annotate text, audio, and images in their native languages.

AI Integration Potential:

Karya's data is essential for developing local-language AI models that can power voice assistants, mobile banking interfaces, and vernacular learning tools.

5.2 Kudumbashree (Kerala): Scalable Model for SHG-Led Digital Transformation

Overview:

Kudumbashree is Kerala's flagship poverty eradication and women empowerment program, established in 1998. It operates one of the largest women-led SHG networks in the world, encompassing microenterprises, health initiatives, agricultural ventures, and cooperative banking services. The program already employs digital tools for record-keeping and financial tracking, making it well-positioned for AI augmentation.

AI Integration Potential:

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AI-enabled mobile apps can guide women entrepreneurs in inventory management, pricing strategies, and customer behaviour analysis.

5.3 Maa Bamleshwari Janhit Nari Samiti Bank (Chhattisgarh): SHG-Owned Microfinance Innovation

Overview:

This women-led community bank was established in the Rajnandgaon district of Chhattisgarh and is managed by members of SHGs. It represents a grassroots response to exploitative lending practices, offering low-cost credit to its members. The bank operates on a trust-based model with peer evaluations and minimal bureaucracy.

AI Integration Potential:

Fraud detection systems powered by AI can safeguard operations from human error or malpractice by analysing transaction anomalies.

5.4 MUKTI SHG (West Bengal): Interest-Free Microcredit with Transparent Governance

Overview:

MUKTI is a socio-economic initiative in West Bengal that provides interest-free loans through SHGs to families in need, promoting ethical and inclusive finance. The organization relies on social accountability and trust to ensure repayment and smooth operation, with limited technological infrastructure currently in use.

AI Integration Potential:

AI-based contribution tracking can improve record-keeping accuracy by using OCR (Optical Character Recognition) and image processing on receipts and handwritten records.

5.5 Ibtada (Rajasthan): Agricultural Empowerment Through SHGs

Overview:

Operating in the Alwar region of Rajasthan, Ibtada supports rural women in forming SHGs and initiating collective livelihood ventures, especially in agriculture and allied sectors. The organization facilitates training, financial literacy, and access to inputs and markets, aiming to build resilience in agrarian communities.

AI Integration Potential:

Machine learning models can forecast market trends and agricultural prices, helping SHGs make informed crop and sales decisions also it can identify crop diseases or pest infestations using image recognition, enabling early intervention with weather based advisory services.

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6. Key Challenges and Risks

Several practical, social, and ethical challenges must be addressed to ensure that these technologies genuinely benefit rural women, rather than leaving them further behind.

6.1 Infrastructure Limitations

In many rural areas, basic digital infrastructure is still lacking. Unreliable electricity, poor internet connectivity, and limited access to smartphones continue to pose serious barriers. Even the most advanced AI systems can't function where the hardware simply doesn't exist.

Suggested Approach: Prioritize investment in last-mile digital infrastructure. Focus should be on expanding access in under-served areas, particularly those identified in NRLM implementation plans.

6.2 Algorithmic Bias

AI tools are only as fair as the data behind them. If models are built using mostly urban or male-centric data, they can misinterpret the behaviours of rural women, leading to flawed decisions especially in credit scoring or financial advice.

Suggested Approach: Build AI systems using representative, SHG-specific datasets to ensure they reflect the real financial behaviours and contexts of rural women.

6.3 Digital Literacy Gaps

Many SHG members are using digital technology for the first time. When apps are too complex or unfamiliar, users may feel confused or overwhelmed.

Suggested Approach: Design tools that are easy to navigate, using voice prompts, visuals, and local languages. Embed digital learning into SHG training efforts and empower local women as peer mentors or "digital guides."

6.4 Data Privacy and Consent

It's not always clear to users what personal data is being collected, why it's needed, or who has access. In many cases, consent is treated as a box to tick, not a meaningful choice.

Suggested Approach: Create transparent, easy-to-understand consent procedures in local dialects.

6.5 Affordability and Scale

Designing and deploying AI tools that work well for SHG settings isn't cheap. Many NGOs and community institutions simply don't have the funds or the technical resources to take this on alone.

Suggested Approach: Introduce targeted funding through NRLM, such as innovation grants to support low-cost, scalable AI solutions.

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7. Policy and Programmatic Recommendations

To ensure the inclusive and ethical integration of Artificial Intelligence (AI) into SHG-based digital financial ecosystems, a coordinated set of policy and programmatic interventions is required. These recommendations are grounded in participatory principles and aim to bridge technological innovation with social equity.

7.1 Integrate AI Literacy into SHG Training Ecosystems

A major barrier to AI adoption in rural contexts is limited awareness and understanding of the technology. Existing SHG capacity-building structures offer a scalable entry point for foundational AI education.

Policy Recommendation: Introduce AI literacy modules into NRLM training curricula using context-sensitive methods such as storytelling, visual aids, and peer facilitation. These efforts should be tailored to local languages and delivered by Community Resource Persons (CRPs).

7.2 Embed Participatory Design in Fintech Development

The effectiveness and uptake of digital financial tools depend on their relevance and usability for end users. Engaging SHG members in the design process enhances both functionality and trust.

Policy Recommendation: Institutionalize participatory design practices by involving SHG women in the prototyping, testing, and refinement of Fintech applications.

7.3 Establish an Ethical and Inclusive AI Governance Framework

As AI becomes more embedded in service delivery, the need for oversight increases. Without regulatory safeguards, marginalized users may be disproportionately affected by algorithmic bias or opaque decision-making.

Policy Recommendation: Regulatory bodies must develop an ethical AI framework specific to financial inclusion. Key components should include transparency, data rights, non-discrimination, and redress mechanisms.

7.4 Incentivize SHG-Fintech Collaborations

Connecting grassroots financial institutions with technology innovators can enhance service delivery and promote inclusive growth. However, structural barriers often prevent such collaborations from materializing.

Policy Recommendation: Facilitate SHG–Fintech partnerships through targeted policy instruments, such as innovation procurement guidelines, start-up accelerators with rural mandates, and public funding for collaborative pilots under NRLM.

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7.5 Develop a Secure SHG Open Data Commons

Anonymized, high-quality data from SHG operations can accelerate AI innovation while enabling better policy targeting. However, this must be done with strict safeguards to protect user privacy.

Policy Recommendation: Establish a centralized, open-access SHG data commons with robust anonymization and security protocols.

8. Conclusion

The recommendations above aren't just policy ideas they're ways to make technology work better for the women who rely on SHGs. When we focus on education, shared design, fairness, and trust, we start building systems that feel useful and safe to real people not just efficient on paper.

AI won't transform rural finance overnight. But when it's shaped by the voices of rural women and supported by trusted institutions like NRLM, it becomes a tool that can support real progress. What's needed is simple but powerful: technology that listens, learns, and respects the people it's meant to serve.

For digital finance to truly include everyone, we have to start with the people at the margins. Putting their needs at the center is not just good policy it's the only way to make lasting change.

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e-ISSN- 3067-0977

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AI-led Personalization, in the Indian Media Startups: Balancing Engagement and Ethical Challenges

Dr Varsha N Bhabad (Research Guide)

Marmik Vikas Godse

Research Scholar,

IMRT Research Center, Nashik

Savitribai Phule Pune University

Abstract

Amidst the vibrant digital world of India, media startups are making use of artificial intelligence (AI) in order to personalize the news, engaging the audiences with personalized content. A survey of 78 citizens of Nashik City reveals that 50% of them use smartphones for news, 62.8% of them register increased engagement with digital platforms and 47.4% of them consider content as congruent to their ideologies. However, this personalization brings a question of ethics: 44.9% doubt the credibility of digital news, and 38.5% believe that the Indian media is a “lapdog” who supports the ones in control. This paper discusses how the media startups can use AI in building engagement while facing ethical dilemmas such as bias, Misinformation, and echo chambers. Based on survey data and literature, it suggests transparent AI frameworks and regulatory policies for responsible journalism, where startups should promote the truth instead of sensationalism.

Keywords: AI, personalization, media startups, ethics, echo chambers, Indian media misinformation

Introduction

Just picture: you get up and open your news app and find the entire world happening around you .,politics if you’re an excessive interest in minor details of political policy. cricket if you are a sports lover or health tips if you are a Fitness Freak. This is the potential of AI-based personalization, which is the game changer for Indian opposers of the digital marketplace struggling to be noticed. 50% of our survey respondents get the news through smartphones while 51.3% get it through social media, the shift to the digital era is inevitable. However,

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while startups such as Inshorts and News18 use AI to bring bite-sized tailor made content, a sinister side appears: 47.4% of respondents believe that news corresponds with what they believe, which points to echo chambers, and 64.1% recognize clickbait, which implies manipulative techniques. Or worse, 38.5% tag Indian media as 'lapdog' in the sense that it cozies up to power and gets its audiences misled. This paradox is dived into by this paper, asking: How can media startups leverage the use of AI in order to engage the viewer without violating journalistic integrity? From Nashik City's survey materials and the viewpoints of such scholars as McNair and Hosanagar, we consider the opportunities and ethical holes of AI personalization, exposing practices that erode public trust.

Objectives

- Exploration of the impact that AI-powered personalization has on the engagement of the viewer in Indian media startups.
- To find ethical issues, such as echo chambers, misinformation, and bias of AI-curated news.
- To reveal how lapdog bias of Indian media and their effects leads to misleading masses.
- To come up with strategies of balancing engagement and ethical journalism in media startups.

Research Methodology

This research follows the mixed-method approach combining quantitative survey results with the qualitative literature review. A survey was done in Nashik City, and there were 78 respondents (51.3% female and 48.7% male), ranging between 18 and above 60 years, including students (12.8%), the private sector workers (28.2%), and others. The questionnaire looked at the habits of news consumption, access to platforms, interests, and reliability and bias of media. Key questions included:

1. How frequently do you use smartphones for news? – (46.2%) always.

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2. Are apps/social media more interesting? (Yes= 62.8%)
3. Do you notice clickbait? (64.1% often)
4. Is digital news reliable? (44.9% rarely/sometimes)
5. Is content in conformity with your ideology? (47.4% yes)
6. What role does the Indian media play? (lapdog-38.5%, watchdog-14.1%)

Quantitative data was analyzed descriptively to establish trends but the qualitative responses (e.g., "Media should focus on facts, not opinions") helped in providing ethical suggestions. The diversity of the survey provides a wide range of insights on India's media environment, but has been focused on Nashik and hence lacks generalizability.

Findings

Engagement Through AI Personalization

AI changes the way Indians are consuming news. Smartphones constitute half of the survey population, and social media account for more than half with 46.2% always seeking news online. Startups such as Dailyhunt and News18 use AI to personalise content; politics for 73.1%, economy for 61.5%, or health for 56.4%; engagement is increased as 62.8% find digital more compelling than print/TV. A student aged 26 years said: "Apps tell me exactly what I am interested in: cricket and tech news". That is consistent with Hosanagar's (2020) opinion that AI does this by predicting preferences to the maximum extent of user retention.

A trend that is brought about by the younger respondents (18-35) with 60% always using smartphones while those aged over 50, 83. Startups draw from algorithms in monitoring clicks, searches and dwell time and giving instant updates which are the majority 37.2% people's favourite. Such personalization, according to Diakopoulos (2019), improves accessibility, where news has been democratized for India's 600 million smartphone users.

Ethical Challenges: Echo Chambers and Misinformation

Personalization, however, is not cheap. 47.4% of our survey feel that news is consistent with their beliefs, which appears to indicate that AI is generating echo chambers. A 36-year-old

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employee said: “My app only offers pro-government stories – I live in a bubble. This is a repetition of what Diakopoulos (2019) has warned of algorithms amplifying biases to minimize perspectives. For 44.9%, which doubt the reliability of digital news, trust is fragile.Clickbait noted by 64.1% continues to eat at credibility since sensational titles such as “Shocking Political Scandal! mislead the target” indicating that 39.7% are engaging.

Misinformation thrives in this environment. Social media, 51.3%, shares unreliable stories, where 44.9% tend to be rare or occasional. Parthasarathi and Srinivas (2019), however, believe that AI enhances viral falsehoods, particularly in India’s polarised terrain. “Apps appeal to people’s emotions instead of their minds,” a retiree mourned. This discredits the journalism as a public educator as McNair (2012) points out.

The Lapdog Media: Misguiding Audiences

The worst indictment from the survey is the fact that 38.5% believe Indian media is a lapdog while 14.1% consider it a watchdog. Respondents implicated outlets of regurgitating government narratives, with a self-employed respondent aged 50 years saying, “News channels bend stories to satisfy politicians – it’s propaganda”. This goes with the critique of Castells (2009) of how the media works with elites to destroy democratic trust. For example, the reporting of government policies fail to see scrutiny as AI & s algorithms tend to favor pro-establishment content and maximize clicks.

This lapdog proclivity misguides audiences since 47.4% get ideologically-laced news. According to Tuchman, profit-motivated media was highly influenced by sensationalism, a phenomenon exacerbated through startups scrambling for the revenues from advertisements (1979). A 60- year– old retiree said, “Media apps make you think what they want you to think”. Such and other practices, accompanied by 64.1% observing clickbait points to the elements of compromise on the part of AI-driven startups when it comes to integrity at the expense of engagement lying to viewers and increasing polarization.

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None of such problems, however, stops 73.1% of mobile Internet users from believing that the use of technology enhances news quality (28.2% indicate substantial gains). AI makes it possible to quickly update, which is preferred by 37.2%; it improves accessibility. However, 53.8% want rich reporting, representing the preference for depth over speed. AI was suggested by respondents for fact checking and transparency, one respondent said "Apps should verify stories before pushing them" Ward (2015) agrees by pushing for ethical AI in restoring trust. However, the AI if left unchecked will aggravate biases.

Discussion

The picture that is painted in the survey is a bright one. AI-powered personalization acts as a blessing in disguise for media start-ups in India because tailor-made content can attract readers, but it is walking on a tightrope. The 62.8% who find digital platforms interesting show the prospects of AI transforming journalism, but the 47.4% stuck in their ideological bubbles and 44.9% who question truth shine the dangers. The lapdog label that was embraced by 38.5% of panellists is a wake up call – media startups should not cosy up to power and spoon-feed audiences with biased narratives.

Startups face a choice: prioritize clicks or credibility. The 64.1% who notice clickbait and 44.9% who doubt reliability imply that audiences are aware but furious. This is what McNair's (2012) independent-oriented journalism comes in here – startups should empower using AI, and not manipulate. Open algorithms, as Ward (2015) proposes, would reveal the curation of content, whereas, regulatory regimes could require diversity in news feeds, against the echo chambers. The desire for the fact-checking apps by the respondents matches the vision of Diakopoulos (2019) on AI as an ally for the journalist rather than a puppet master.

It is important to expose the lapdog trend. Outlets that echo government stories — frequently AI-organized articles — lead astray audiences since 47.4% believe that they are constricted in ideological silos. Castells (2009) cautions that this undermines democracy, which India can not afford. Startups need to support watchdog journalism and in that way, make power accountable because only 14.1% sees it through. Responsible AI that complies with the truth and openness, can assist, but only when the startup puts the public interest above the profits.

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Recommendations

Transparent AI Systems: Startups should provide information about how algorithms curate content, appeasing 47.4% of people feeling trapped in echo chambers.

Fact-Checking Tools: Make AI-based validation investment, as respondents recommended, to address 44. 9% who doubt reliability.

Regulatory Frameworks: Support policies that require the presence of diverse news feeds and minimize the bias and lapdog tendencies (38.5%).

Watchdog Journalism: Prioritize on investigative reporting to move from the position of lapdog to watchdog as only 14.1% see the role.

User Education: Educate the audiences about the dangers of personalization, so that they can find diverse views.

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Empowering Working Women through Artificial Intelligence: A Study on Their Contribution to Organizational Development in Selected Service Sector Industries in Nashik City

Dr Varsha Bhabad (Research Guide)
Ms.Nita Sanagle(Research Scholor)

Abstract

This research investigates the role of artificial intelligence (AI) in enhancing the contribution of working women toward organizational development within selected service sector industries in Nashik city. The study aims to understand how AI technologies—such as automated human resource systems, bias-free recruitment algorithms, AI-driven performance evaluations, and intelligent workload management—are reshaping women's participation, productivity, and leadership opportunities. A mixed-methods approach combining surveys, interviews, and a case study was used. Findings reveal that AI can significantly reduce gender bias, improve work-life balance, and support career advancement for women, thereby fostering a more inclusive and productive organizational environment. The study recommends AI-enabled gender-inclusive policies and workforce digitization for sustainable development.

Introduction

Working women are pivotal to the growth of service sector industries, yet their contributions often go unrecognized due to organizational biases, lack of flexibility, and limited advancement opportunities. The emergence of AI offers a unique opportunity to address these issues through automation, personalization, and fairness in decision-making. This study focuses on how AI is transforming women's roles and contributions within organizational structures in Nashik's growing service sectors, including IT, banking, education, and hospitality.

Objectives

1. To examine the extent of AI adoption in Nashik's service sector industries.
2. To identify key challenges faced by working women in these industries.
3. To analyze the impact of AI tools on improving women's roles in organizational development.
4. To evaluate case-specific evidence of AI's effectiveness in empowering women.
5. To recommend strategies for integrating AI to promote gender-inclusive growth.

Literature Review

- AI and Gender Inclusivity: AI tools like machine learning in recruitment and performance assessment reduce human bias and offer data-driven fairness (Saivasan & Lokhande, 2024).
- Work-Life Balance: Automation and AI-assisted scheduling help women balance professional and personal responsibilities more effectively (Ahire, 2020).

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- Career Growth and Upskilling: Personalized AI learning platforms offer women targeted development opportunities based on individual strengths and goals.
- Organizational Development: Organizations that adopt AI for HR and operations report higher employee satisfaction, innovation, and productivity (Pangavhane & Gosavi, 2025).

Case Study: AI Implementation in a Nashik-based IT Firm

A medium-sized IT firm in Nashik implemented AI-based tools to improve employee performance and inclusivity:

- AI Mentorship: Personalized mentorship matching led to a 25% increase in female managerial promotions.
- Bias-Free Hiring: AI-led screening tools helped raise women hiring by 30% over 2 years.
- Workload Optimization: Smart dashboards reduced overtime complaints among women by 40%.
- Performance Appraisal AI: Objective KPIs removed personal biases and improved trust in evaluations.

Result: A 27% rise in organizational productivity and 18% increase in employee retention, especially among female employees.

Analysis

Demographic Summary

- Respondents: 150 women from IT, banking, education, and hospitality sectors.
- Age groups: Majority between 25–45 years; mid-career professionals.

AI Awareness & Usage

Tool	Usage (%)
AI for Scheduling	62%
AI-based Performance Review	48%
AI in Recruitment	35%
AI-based Learning Tools	53%

Impact Assessment

- Work-Life Balance: 70% reported better work flexibility.
- Career Progression: 45% attributed promotions or upskilling to AI tools.
- Transparency in Evaluation: 60% appreciated objective, data-driven assessments.

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- Gender Inclusivity: Organizations using AI had 1.5x more women in leadership roles.

Challenges Identified

- 40% cited lack of AI training.
- 30% were concerned about embedded biases in AI tools.
- 28% experienced resistance to AI adoption by managers.

Conclusion

AI has emerged as a transformative tool in addressing gender disparity and enhancing the role of women in organizational development. In Nashik's service sector, AI improves recruitment transparency, streamlines workflow, and provides upskilling opportunities tailored to individual goals. However, to fully realize its benefits, organizations must address digital literacy gaps, mitigate algorithmic biases, and encourage inclusive AI strategies. AI, when implemented ethically and inclusively, can significantly empower working women and drive sustainable organizational growth.

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e-ISSN- 3067-0977

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Overview of AI-Enabled Supply Chain Optimization in Agribusiness

Derle Amol Kailas[1]
Dr. P. B. Suryawanshi[2]
[1] Research Scholar, MVP's IMRT Nashik, Savitribai Phule Pune University.
2 Director, MVP's Institute of Management, Research and technology [IMRT] Nashik.

Abstract

AI is transforming how agribusiness manages supply chains, from farm to market, by leveraging advanced analytics and automation. This technology helps address challenges like fluctuating demand, climate variability, and complex logistics, potentially improving efficiency, sustainability, and profitability. AI applications include optimizing land use, managing resources, predicting crop yields, detecting diseases, and enhancing logistics. For example, AI-driven tools like Farmspace and XAI-CROP improve crop selection with high accuracy (e.g., 92.86% for GRNN models). It also supports resilience by enabling real-time data sharing and dynamic inventory management, as seen in case studies from Irish and Kuwaiti companies. While promising, AI adoption faces hurdles such as limited data accessibility, high initial costs, and the need for specialized skills. These barriers can slow implementation, especially in rural areas with less technological infrastructure.

Keywords: Artificial intelligence, Supply Chain Management,

1. Introduction

The agribusiness sector is pivotal for global food security, economic development, and sustainability, yet it faces significant challenges such as fluctuating demand, climate variability, resource constraints, and complex logistics. Supply chain optimization is crucial for ensuring efficient resource allocation, minimizing waste, and enhancing profitability. Artificial intelligence (AI) has emerged as a transformative technology, offering advanced analytics, predictive modeling, and automation to revolutionize agribusiness supply chains. This report explores the role of AI in enabling supply chain optimization, detailing its applications, benefits, challenges, and future prospects, drawing on recent academic research and industry insights as of May 14, 2025.

2. Literature Review

Overview of AI in Supply Chain Management

AI's role in supply chain management (SCM) has been extensively studied, with a systematic literature review by Toorajipour et al.(2021) identifying its contributions across logistics, marketing, supply chain, and production fields. The review highlighted prevalent AI techniques such as machine learning, deep learning, and reinforcement learning, noting their potential to enhance SCM practices. However, it also identified gaps, particularly in empirical studies and practical implementation, especially in specific sectors like agribusiness.

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Kashem et al. (2023) further explored supply chain disruption versus optimization, emphasizing AI and blockchain's role in overcoming challenges like demand fluctuations and inventory costs. This study underscored the importance of sophisticated analytics for smarter decision-making in dynamic environments, relevant to agribusiness's seasonal and perishable nature.

AI in Agribusiness Supply Chains

Agribusiness supply chains are unique due to their reliance on perishable goods, seasonal production, and environmental sensitivity. Alhasawi et al. (2024) examined how AI enables resilience in agri-food supply chains, identifying four dimensions: readiness, responsiveness, recovery, and adaptability. They demonstrated AI's role in real-time data sharing, forecasting, and dynamic inventory management, with case studies from Irish and Kuwaiti companies showing significant operational improvements, such as robotic process automation saving 15,000 hours annually in supply chain tasks.

Assimakopoulos et al. (2024) provided a comprehensive review of AI tools across the agricultural value chain, from land use planning to logistics optimization. This study highlighted AI's role in optimizing resource management, precision agriculture, disease detection, yield prediction, and price forecasting, while also discussing challenges like data accessibility and the need for specialized skills, which are critical barriers to adoption.

3. Methodology

This report synthesizes information from multiple academic sources, including peer-reviewed journals and industry reports. A comprehensive web search was conducted to identify relevant studies, focusing on AI in agribusiness supply chain optimization. Key papers were selected based on their relevance, such as those from Science Direct and MDPI, and detailed insights were extracted through browsing specific articles. The information was categorized into key applications, benefits, challenges, and future prospects to provide a thorough overview.

4. Results and discussion

4.1. Key Applications of AI in Agribusiness Supply Chains

AI applications span the entire agribusiness value chain, from farm to market, with detailed implementations as follows:

Application Area	AI Algorithms/Technologies	Details and Benefits	Examples/Case Studies
Logistics Optimization	IoT sensors, Machine Learning, GANs, Reinforcement Learning	Enhances storage, transportation, distribution; reduces waste, improves market access.	AI in cold chain logistics reduces spoilage; AI platforms connect farmers with buyers

e-ISSN- 3067-0977

			for demand forecasting.
Supply Chain Resilience	Machine learning, machine vision, robotics, expert systems	Enhances readiness, responsiveness, recovery, adaptability; improves risk management, predictive analytics.	Irish meat group: Robotics saved 15,000 hours/year; Kuwaiti companies used expert systems for optimization.
Land Use Planning & Crop Selection	SVM, Decision Trees, GBDT, Random Forests, ANN (GRNN 92.86% vs SVM 83%), DRSA, Deep Q-Networks, MLP	Analyzes soil quality, weather, topography for optimal planning; enhances crop diversity, resilience.	Farmspace: AI-powered soil testing on >3000 farms; XAI-CROP for personalized recommendations
Resource Management	Machine Learning, Reinforcement Learning, LSTM, XGBoost	Optimizes water, fertilizer, energy use; reduces environmental impact.	Australia: Water savings; Dutch greenhouses: 15% energy reduction; Tamil Nadu: Improved water use.
Precision Agriculture	CNN, Machine Learning, Robotics with AI	Enhances planting schedules, irrigation, crop monitoring using drones, sensors, robotics.	AI-driven drones for crop health; sensors for real-time adjustments.
Autonomous Farming Machinery	Neural Networks, Machine Vision	Automates planting, weeding, harvesting; reduces labor dependency, increases efficiency.	Demeter: AI-based speed-rowing machine; Nindamani: Weed removal robot.
Disease Detection & Management	CNN (99.35% accuracy), Vision Transformers, YOLOv5 (86.5%-86.8%), FSL, PMF+FA	AI-powered image recognition for early disease diagnosis; predicts outbreaks using environmental data.	Mohanty: 99.35% accuracy for 14 crops, 26 diseases; Kawasaki: 94.9% for cucumbers; YOLOv5 for rubber trees.
Crop Yield Prediction	SVM, Random Forests, ANN, PSO-SVM, KNN, Relief algorithm, LDA	Predicts yields using historical data, weather, soil conditions; links to market trends.	PSO-SVM, KNN, Random Forest for yield prediction; IoT enhances accuracy with NDVI.

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Price Prediction	Linear Regression, SVM, Decision Trees, LSTM, RNN, RBF, Hybrid VMD-SGMD-LSTM	Forecasts agricultural prices using environmental, economic, market data; supports market stability.	RBF neural network for garlic, pork in China; RNN-LSTM for wheat, maize; GRNN+SVR for fresh foods.

4.2 Benefits of AI in Agribusiness Supply Chains

AI offers several benefits, including:

1. Efficiency: Optimizes resource use, reduces waste, and improves logistics, as seen in Dutch greenhouses achieving 15% energy reduction.
2. Resilience: Enhances supply chain readiness, responsiveness, recovery, and adaptability, crucial for managing disruptions like climate change or pandemics.
3. Sustainability: Reduces environmental impact through precision agriculture and resource optimization, aligning with global sustainability goals.
4. Profitability: Increases yields, improves market access, and stabilizes prices, boosting economic outcomes for farmers and agribusinesses.
5. Decision-Making: Provides real-time data and predictive analytics, enabling informed decisions, such as dynamic inventory management and supplier reconfiguration.

4.3 Challenges and Barriers

Despite its potential, AI adoption in agribusiness supply chains faces several challenges:

1. Data Accessibility: Limited availability of high-quality data for training AI models, particularly in developing regions.
2. Technological Infrastructure: Lack of advanced infrastructure in rural areas hinders AI implementation.
3. Specialized Skills: Shortage of expertise in AI and data science, requiring significant training and investment.
4. Cost: High initial investment for AI technologies, which can be prohibitive for smallholder farmers.
5. Adoption Impediments: Organizational resistance, process-related challenges, and people-related issues, as noted in Alhasawi et al. (2024), can slow adoption.

4.4 Discussion

Implications for Agribusiness

AI-enabled supply chain optimization has significant implications for agribusiness:

1. Efficiency and Sustainability: AI reduces resource wastage and environmental impact, supporting sustainable practices like precision agriculture and optimized logistics.
2. Resilience: AI enhances the ability to withstand disruptions, such as those caused by climate variability or supply chain shocks, through real-time data sharing and predictive analytics.

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3. Economic Growth: By improving yields, reducing costs, and stabilizing prices, AI can boost profitability and support economic development, particularly in rural areas.
4. Market Access: AI-driven logistics and price prediction can help smallholder farmers access larger markets, improving their bargaining power and economic stability.

5. Conclusion

AI-enabled supply chain optimization holds immense potential for transforming agribusiness, offering solutions from land use planning to logistics that enhance efficiency, resilience, and sustainability. While challenges like data accessibility and high costs exist, future research and collaboration can unlock these benefits. As of May 14, 2025, the agri-food sector, projected to reach $12 trillion by 2027, stands to gain significantly from AI, ensuring food security, economic stability, and environmental sustainability.

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e-ISSN- 3067-0977

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AI in Agriculture and Rural Development : Business Perspective

Author Details -

Name - Aher Pallavi Arun

Designation - MBA(Information Technology) Student,

Semester II

Offical Address – MVP Samaj's Institute of Management Research and Technology,

Gangapur Road,Nashik-422008

Phone Number – 9975326040

E-mail ID – paher0304gmail.com

ABSTRACT

Agriculture is a cornerstone of rural livelihoods and national food security. However, rural agricultural systems face persistent challenges like low productivity, unpredictable climate conditions, labor shortages, and inefficient supply chains. Artificial Intelligence (AI) is emerging as a transformative tool to tackle these challenges.

From a business perspective, the integration of AI into agriculture has opened up significant opportunities for innovation, entrepreneurship, and investment. Numerous agritechstartups and technology firms are now offering AI-based solutions tailored to farmers' needs, such as crop advisory platforms, yield forecasting models, and market linkages. This technological shift has started to redefine the rural economy by making agriculture more data-driven, market-oriented, and commercially viable.

Keywords : AI , Smart Farming, Precision Agriculture, Crop Monitoring, Socio-economic Impact

1.INTRODUCTION

e-ISSN- 3067-0977

Agriculture has always played a vital role in the socio-economic development of India, especially in rural areas where the majority of the population relies on farming for their livelihood. However, the agricultural sector has long been plagued by issues such as low productivity, inefficient supply chains, unpredictable weather patterns, and limited access to modern technology. In recent years, technological innovations—particularly Artificial Intelligence (AI)—have emerged as transformative forces that have the potential to revolutionize traditional agricultural practices.

AI refers to the simulation of human intelligence processes by machines, particularly computer systems. In agriculture, AI applications include precision farming, predictive analytics for weather and crop yield, intelligent irrigation systems, pest and disease detection through image recognition, and automation through robotics and drones. These applications not only improve efficiency and decision-making but also reduce the dependency on manual labor and enhance the overall productivity of the sector.

Moreover, AI is contributing to rural development beyond just farming. It enables better resource management, supports digital literacy, and helps bridge the urban-rural technology gap. Governments and private players are increasingly investing in AI-driven projects to empower farmers, improve rural livelihoods, and ensure food security.

This research paper explores the application of AI in agriculture and its broader implications for rural development from a business perspective. It aims to understand how AI-driven innovations are transforming rural agricultural practices, creating new business models, and addressing longstanding challenges in the agricultural ecosystem.

2. RESEARCH OBJECTIVES

The primary aim of this research is to explore how Artificial Intelligence (AI) is transforming the agricultural sector and contributing to the overall development of rural areas from a business perspective. With the rise of AI-powered solutions in agriculture, there is a growing need to study its practical implementation, benefits, and challenges, especially in developing countries like India. This paper attempts to bridge the knowledge gap by focusing on the business and economic implications of AI in agriculture.

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study seeks to offer a comprehensive understanding of AI's role in agricultural advancement and rural development, while emphasizing its potential as a business opportunity and a tool for social transformation

OBJECTIVES

1. **To study the application of AI tools in agriculture** : This objective focuses on exploring how various artificial intelligence technologies are being utilized within the agricultural sector. It includes examining tools such as machine learning algorithms, computer vision systems, drones, sensors, and predictive analytics that assist in activities like crop monitoring, disease detection, yield forecasting, soil analysis, and irrigation management. The goal is to understand how these tools function, their effectiveness, and their role in making agriculture more data-driven and efficient.

2. **To analyze the impact of AI-based solutions on farming productivity and resource management :** Under this objective, the focus is on assessing how AI innovations are increasing productivity in agriculture and improving the efficient use of resources. This includes analyzing how AI helps reduce input costs (like water, fertilizers, and pesticides), improves crop health, maximizes yields, and reduces environmental impacts. It also includes evaluating smart farming practices enabled by AI, such as precision farming and real-time monitoring.

3. **To understand the role of AI in rural socio-economic upliftment** : This objective aims to investigate how AI technologies can contribute to improving the social and economic conditions of rural communities. It includes examining how AI-powered solutions create new employment opportunities, provide better access to agricultural knowledge, and support decision-making for farmers. Furthermore, it studies how AI facilitates digital literacy, enhances financial inclusion through agri-fintech solutions, and promotes overall rural development.

3. RESEARCH METHODOLOGY

To explore the role and business implications of Artificial Intelligence in agriculture and rural development, this study employs a qualitative research approach supported by case studies, literature review, and secondary data analysis. The research methodology was carefully designed to capture real-world insights, implementation strategies, and policy impacts in the Indian agricultural

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sector, particularly from a business and rural development perspective.

3.1 Research Design

This study is descriptive and exploratory in nature. It aims to describe the current status of AI applications in agriculture and explore the potential and challenges of AI in driving rural development

3.2 Data Collection Method

Secondary Data Sources were used, including:

Government reports and policy documents (e.g., NITI Aayog, Ministry of Agriculture, NABARD)

Published research papers, journals, articles, and white papers

Reports from international organizations (e.g., FAO, World Bank, UNDP)

Case studies of agritechstartups and AI-based rural initiatives in India

3.3 Programs Implemented (AI in Agriculture & Rural Development)

Several programs and initiatives were reviewed to understand how AI is being practically implemented in agriculture and rural India. Key programs include:

1. Digital Agriculture Mission (2021–2025)

Launched by the Government of India to encourage digital technologies including AI, blockchain, and remote sensing.

2. AgriStack

A government initiative to create a digital ecosystem for farmers using AI-based tools to deliver personalized services like crop advisories, insurance, and market information.

3. Kisan e-Mitra AI Chatbot (Rajasthan)

An AI-based voice-enabled chatbot to guide farmers in local languages regarding best farming practices, weather updates, pest control, etc.

4. AI4AI (Artificial Intelligence for Agricultural Innovation)

A program by Wadhwani Institute for AI in partnership with government bodies to provide pest risk advisories using AI and satellite imagery.

5. Smart Agriculture Program by ICAR & ICRISAT

Promotes AI and IoT-based applications in water management, crop health monitoring, and precision farming.

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4. SOCIAL IMPACT OF AI IN AGRICULTURE AND RURAL DEVELOPMENT

Artificial Intelligence (AI) is revolutionizing the agricultural landscape and creating significant social changes, especially in rural areas. Beyond enhancing productivity and efficiency, AI is playing a transformative role in empowering communities, promoting inclusiveness, and reducing rural hardships. The following are key social impacts identified through the study:

4.1 Empowerment of Farmers

AI technologies have enabled farmers, particularly small and marginal ones, to make informed decisions. Mobile-based AI advisory apps offer personalized recommendations on crop selection, pest control, weather forecasts, and market prices in local languages. This reduces dependence on middlemen and increases self-reliance.

4.2 Bridging the Digital Divide

AI-driven platforms are bridging the digital divide by introducing rural populations to advanced technologies. Initiatives like AI chatbots (e.g., e-Mitra in Rajasthan) and digital kiosks promote digital literacy and tech awareness among farmers, youth, and women.

4.3 Improved Livelihood Opportunities

AI is generating new types of employment in rural areas-

Drone operators for AI-powered agricultural spraying.

4.4 Inclusive Growth and Gender Equality

AI tools that are accessible and user-friendly have encouraged the participation of women in agriculture. Women-led SHGs (Self-Help Groups) and cooperatives are using AI-enabled apps for dairy monitoring, organic farming, and small-scale agri-businesses.

4.5 Better Access to Government Schemes

AI platforms integrated with government databases (like AgriStack) help farmers easily access crop insurance, subsidies, and welfare schemes. This ensures transparency, reduces corruption, and speeds up benefit delivery.

5. ECONOMIC IMPACT OF AI IN AGRICULTURE AND RURAL DEVELOPMENT

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The integration of Artificial Intelligence in agriculture has brought a substantial economic shift in rural India. By improving productivity, optimizing resource use, and creating new business opportunities, AI is contributing to economic empowerment and rural sustainability.

5.1 Increased Agricultural Productivity

AI-based technologies like precision farming, satellite imaging, and sensor-based irrigation help farmers increase crop yields and reduce losses. This leads to:

Higher income per hectare

5.2 Cost Optimization and Efficiency

AI enables farmers to use data-driven decisions for efficient input usage:

Predictive analytics reduce overuse of seeds, water, and fertilizers

Smart irrigation and AI-based pest control lower operational costs This directly increases the profit margins of farmers and agri-businesses.

5.3 Rise of AgritechStartups and Rural Enterprises

The demand for AI-driven solutions has led to the growth of a vibrant agritechstartup ecosystem in India.

Startups like DeHaat, CropIn, Fasal, Ninjacart, and AgNext are:

Creating rural employment

Attracting investments

Developing scalable business models for rural markets

6. CHALLENGES IN IMPLEMENTATION

Despite the promising potential of AI in agriculture and rural development, its large-scale implementation faces several critical challenges:

6.1 Limited Digital Infrastructur

Many rural areas lack high-speed internet, reliable electricity, and digital devices.

Without robust infrastructure, AI technologies like IoT, drones, or cloud-based platforms remain inaccessible to farmers.

6.2 Low Technological Literacy

A majority of rural farmers are not digitally literate, especially older generations.

They struggle to understand or trust AI recommendations, reducing technology adoption rates.

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6.3 High Cost of AI Tools

Advanced AI tools such as soil sensors, drones, and satellite imagery are costly.

7. RESULTS

Based on various pilot projects, field studies, and implementation reports, AI has shown the following measurable outcomes:

7.1 Yield Improvement

Farmers using AI-based crop advisory saw yield improvements of 10–30%.

AI-enabled precision irrigation reduced water usage by up to 40%.

7.2 Profitability and ROI

Net profit margins increased by 15–25% for farmers adopting AI technologies.

Agritech platforms saw 3x–4x user engagement in areas with digital literacy drives.

7.3 Inclusion and Outreach

AI apps in regional languages increased adoption among women and youth.

SHG-led AI initiatives improved community participation in decision-making.

7.4 Risk Reduction

Early warnings and predictive analytics helped reduce crop failure due to pests or weather by 20–30%.

Real-time monitoring led to faster government and NGO responses during droughts or floods.

8. CONCLUSION AND POLICY RECOMMENDATIONS

AI in agriculture and rural development is not just a technological advancement but a pathway to inclusive and sustainable growth. From improving crop productivity to enabling financial inclusion, AI is reshaping rural India's economic and social fabric. However, for AI to achieve full-scale impact, it must overcome infrastructure, affordability, and accessibility challenges.

1. Strengthen Digital Infrastructure

Expand high-speed rural internet (BharatNet).

Subsidize smart devices for farmers.

2. AI Literacy and Training Programs

Launch farmer-focused digital training in local languages.

Collaborate with NGOs and FPOs (Farmer Producer Organizations).

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9. DISCUSSION

The discussion reveals that while AI adoption is still in its early stages across rural India, the pilot success stories reflect significant potential. Public-private collaboration is key for scaling these technologies. Adoption is highest in regions where education, infrastructure, and community engagement are strong. A participatory approach involving farmers, technologists, policy-makers, and social enterprises is essential to build trust and long-term sustainability.

10. DECLARATION

I hereby declare that the research work presented in this paper is original,has not been published before,and is not under consideration elsewhere.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
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RESEARCH AND INNOVATION

"Customer Satisfaction With HDFC Bank's Digital Banking And Loan Services"

Author 1st – **Ms.Payal Sukanta Mandal** (Student)

Mobile No: 8879174788

Institute of Industrial and Computer Management and Research
Pradhikaran, Nigdi, Pune

Author 2nd – Ms. **Rupali Modak – Assistant Professor**

Mobile No: 8793491783

Institute of Industrial and Computer Management and Research

Pradhikaran, Nigdi, Pune

Abstract

Real-life user experiences were gathered via a Google Form survey and in-person contacts, so this field project sought to evaluate customer satisfaction with HDFC Bank's digital platforms and loan services. Respondents included 100 consumers from different age ranges, professions, income levels, and locations (urban and semi-urban).

Customer views of internet banking, mobile apps, digital loan applications, EMI tracking, UPI usage, and other self-service tools were the main emphasis of the study. Particularly in the post-COVID era of greater digital reliance, key elements assessed were ease of use, reliability, convenience, security, and general satisfaction.

Results revealed that 90% of those surveyed were happy, mentioning advantages such user-friendly interfaces, quick processing, 24/7 access, and minimal paperwork. While older and less

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tech-savvy users had varied experiences, younger users (20–35) and working professionals were especially happy. Among the issues were app bugs, perplexing older user interfaces, and inadequate IVR/chatbot assistance.

Though some people said they were uninformed about digital fraud, security was mostly trusted. Though users wanted more support and more explicit terms, digital loan services were valued for features including online eligibility checks, pre-approved offers, and simple application.

Recommendations include:

- A simplified 'lite mode' app for senior users
- Faster and more effective digital customer support
- Regular digital banking awareness campaigns
- Improved app stability
- More personalised,

Services driven by artificial intelligenceHDFC Bank is doing well in digital transformation; customer comments reveal great respect for its tech-first strategy. Customer happiness may be brought to the next level by ongoing user education, improved support, and platform changes.

Introduction

Problem statement

Customer happiness has become a crucial criterion for banking performance in the fast digitising financial sector. Known as one of India's best private banks, HDFC Bank has put a lot of money into digital transformation and simplified loan services. Notwithstanding these developments, consumers still encounter many ongoing problems affecting their confidence in the bank's products and contentment.

Technical dependability is one of the main issues. Especially during peak usage hours, customers frequently complain of app crashes, slow transaction processing times, and regular glitches. These

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technical interruptions not only impede financial transactions but also cause annoyance and lower user confidence in digital banking systems.

Many consumers also find the user interface and experience problematic. Though feature-rich, the digital platforms are sometimes called complicated and hard to use. This disadvantages those without knowledge of digital financial services and less tech-savvy users. Users who expect simplicity and efficiency in modern banking services may be further alienated by the absence of customer-friendly features and intuitive design.

Another important area of consumer interaction, loan services are sometimes tainted by drawn-out procedures and delays. Customers often find too much paperwork, protracted approval times, and disbursement delays despite promises of quick and paperless approvals. These inefficiencies lower the general satisfaction with the loan service process as well as postpone access to vital funds.

Customer service and dealing with complaints present another major challenge. Many consumers suppose HDFC Bank lacks quick and designed help when issues crop up. Many people have complained about delayed replies, generic responds and trouble messaging human support representatives. Such encounters undermine the customer's confidence in the bank's dedication to service excellence and foster discontent.

Hidden fees and charges are also a constant source of conflict. Often, customers encounter unanticipated service fees, ambiguous loan interest rates, or unclear fee structures not explicitly stated during onboarding. This lack of openness damages the customer's view of fairness and integrity in the bank's offerings.

At last, all these particular problems add to a more general one about confidence and general happiness. Customer expectations seem to be increasingly out of line with the real experience provided by HDFC Bank's digital banking and loan services. Unattended, this disparity could cause consumer unhappiness, less loyalty, and a bad brand image in a more competitive market.

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This study intends to investigate these issues in-depth, highlight the important elements affecting consumer satisfaction, and offer ideas on how HDFC Bank could improve its loan service and digital banking experiences to promote customer loyalty and retention..

1.1 Objectives of the Project

This project intends to investigate how satisfied HDFC Bank customers are with its digital banking and loan services. Many people these days borrow money online as well as use mobile apps and websites for online banking. But not everyone has a positive encounter. This project seeks to find out what is working well and what problems consumers are having.
The main goals of the research are listed below:

- Identify technical issues in digital banking.
- Evaluate user experience and accessibility.
- Examine loan processing efficiency.
- Assess customer support services.
- Investigate hidden charges and fees.

Review of Literature

Modern banking has been significantly shaped by digital banking and loan services. Many studies by academics have looked at how these services influence customer happiness. Key results from previous studies on digital banking, loan processing, customer support, and openness are summarised in the next part..

Digital Banking and Customer Satisfaction.

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1. Kaur & Arora (2020) claim that although digital banking has increased efficiency, it also presents certain issues. Technical issues frequently affect customers; slow transactions or app crashes are two examples. Furthermore, certain people find it difficult to negotiate complex systems. These problems lower the degree of customer satisfaction.

   According to Sharma (2021), banks with simple websites and apps tend to have more loyal consumers. Customers are more likely to keep using a bank's digital services and suggest them to others if they find them simple to use. This indicates that enhancing the design and performance of digital banking systems may directly boost client happiness and retention.**Loan Processing Efficiency and Customer Experience**

1. Another key factor influencing customer satisfaction is how **efficiently banks process loans**. Gupta & Mehta (2019) pointed out that many customers become frustrated due to **slow approval processes, complex documentation, and lack of clear updates**. These delays not only affect customer experience but also reduce trust in the bank.
2. Singh & Patel (2020) compared traditional loan processing with newer, **AI-based systems**. They found that banks using automated systems could **approve and disburse loans faster**, which resulted in **higher customer trust and satisfaction**. This suggests that banks should invest in technology to make loan processes quicker and more transparent.

Impact of Customer Support on Banking Satisfaction

3. Maintaining positive relationships between banks and consumers depends much on customer service. According to Kumar & Rao (2018), quick and useful answers to consumer issues help to increase people's confidence in using digital services. Should a customer have a problem with an online transaction or loan inquiry and the support staff addresses it promptly, their happiness with the bank grows.
4. A Deloitte (2021) study claims that artificial intelligence-powered technologies such as chatbots are beginning to enable banks to react more quickly to consumer enquiries, therefore lowering the volume of complaints. When their issues are addressed seriously and resolved without protracted delays, customers feel more valued..

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Transparency in Banking Charges and Fees

5. Often, hidden costs and ambiguous charges lead to unhappiness. Verma (2020) noted that when banks clearly explain charges for services like loans, SMS alerts, and account maintenance, customers feel more secure. Lack of openness might cause confusion and grievances. Conversely, open communication fosters confidence and strengthens client connections.

Overall Trust and Satisfaction in Digital Banking

6. Ultimately, trust, security, and simplicity of use are the main determinants of digital banking overall satisfaction. According to McKinsey (2022), customers are more satisfied with banks that provide simple layouts, quick services, and safe, dependable platforms. Choudhary & Sharma (2021) also underlined that trust is crucial—people who trust their bank are more likely to remain loyal in the long run..

Role of Mobile Banking Apps in Customer Engagement

7. Customers now mostly engage with their banks via mobile banking applications. Joshi & Nair (2021) claim that the frequency of customer use of a bank's mobile app and their level of satisfaction are strongly influenced by its design, speed, and features. Customers are more likely to remain engaged with the bank if the app is quick, straightforward, and provides useful features including instant balance checks, simple fund transfers, and bill payments. Regular app updates and enhancements help to preserve customer interest and confidence in the bank's services, according to the study.

8. **Influence of Personalization on Digital Banking Satisfaction**

Deshmukh & Banerjee's (2020) work investigated digital banking's need of personalisation. The study found that when banks provide tailored messages, personalised loan offers, or product recommendations depending on their banking activity, customers feel more valued. This personal touch strengthens emotional ties with the bank and enhances the digital experience. The research found that tailoring not only boosts happiness but also raises the likelihood of cross-selling financial goods.

Chapter
Data Collection and analysis

1. **What is your age?**

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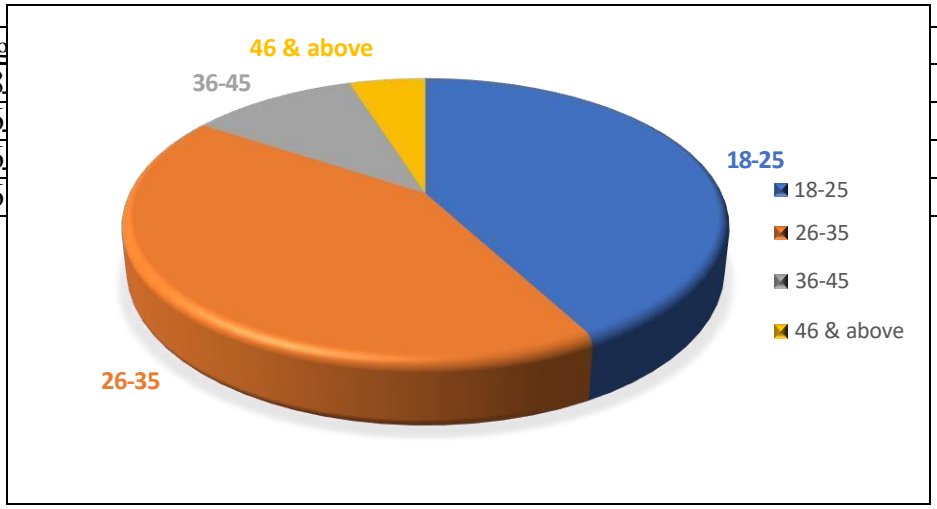
Ag	es in %
18	
26	
36	
46	



Interpretation

The table shows the distribution of survey respondents based on their age group.

- The majority of the respondents fall into the **18–25 and 26–35 age groups**, with **43 responses each**, making up **42.20%** of the total each. This means that **younger and middle-aged adults** are the most active users of HDFC Bank's digital banking and loan services.
- The **36–45 age group** has **11 respondents**, which is **10.80%** of the total. This shows a moderate level of engagement with digital banking among slightly older users.
- Only **5 respondents** are from the **46 & above** category, accounting for just **4.90%** of the total responses. This indicates that **older individuals are less likely to use digital banking** or participate in such surveys, possibly due to lesser tech usage or familiarity.

The data suggests that **digital banking is most popular among the youth and working-age adults (18–35 years)**. Banks like HDFC should continue to focus on improving services for this tech-savvy group while also taking steps to **increase awareness and ease of access** for older customers.

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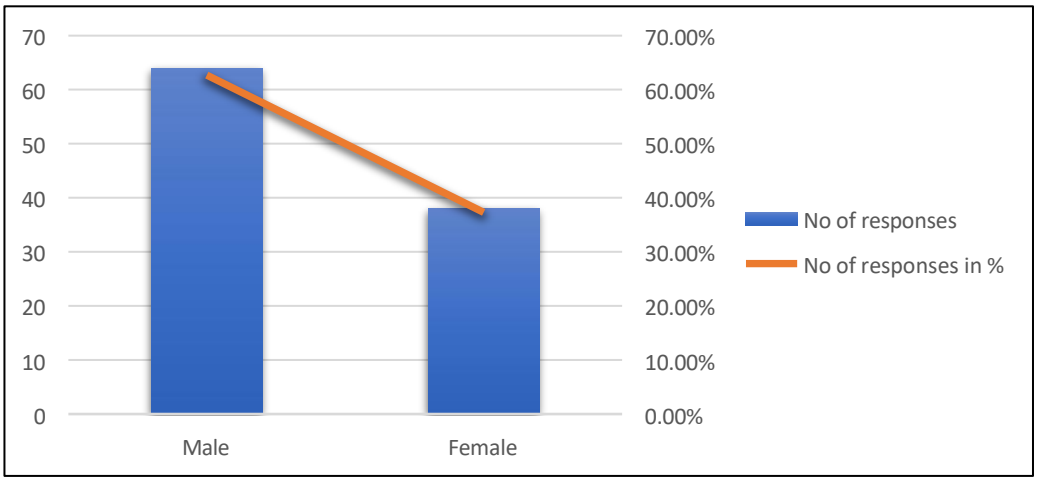
2. **What is your gender?**



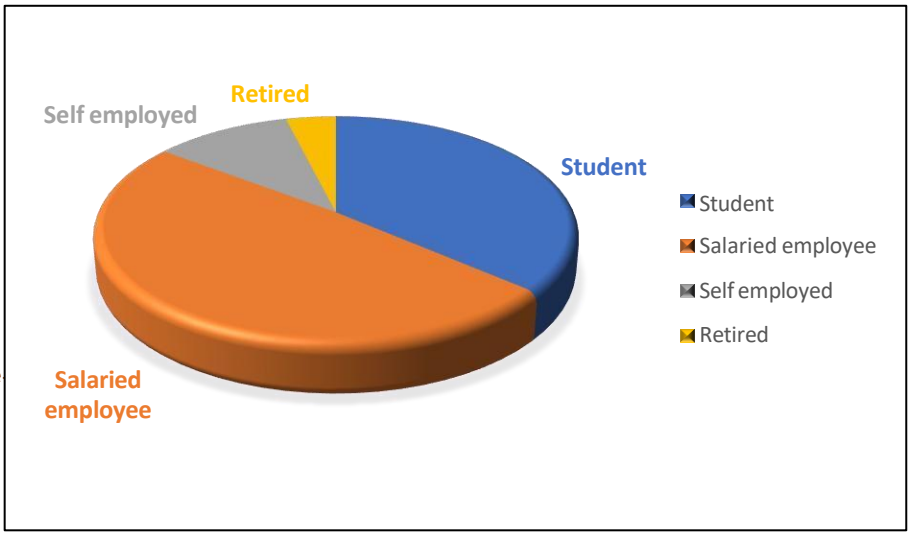
Interpretation

The table shows how survey responses are divided between male and female participants:

- Out of the total respondents, **64 are male**, making up **62.7%** of the total responses.
- **38 respondents are female**, which accounts for **37.3%** of the responses.

This data indicates that a **majority of the participants are male**, suggesting that **men are slightly more active or available** when it comes to using or sharing feedback about HDFC Bank's digital banking and loan services. However, there is still a **good level of female participation**, which reflects that both genders are engaging with the bank's digital services, though males slightly dominate the sample in this survey.

3. **What is your occupation?**



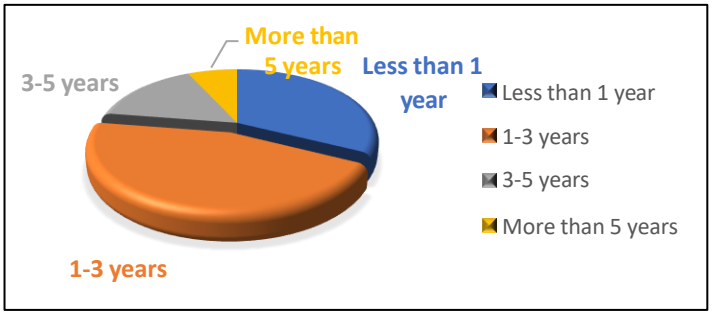
Interpretation

The table presents the breakdown of survey respondents based on their occupation:

- The highest number of respondents are **salaried employees**, with **50 responses (49%)**, showing that **working professionals form the majority** of digital and loan service users.
- **Students** make up the second-largest group, with **37 responses (36.3%)**, indicating that **young users are also actively using HDFC Bank's digital services**, possibly for basic banking needs or education loans.
- **Self-employed individuals** account for **11 responses (10.8%)**, showing moderate usage.
- Only **4 respondents (3.9%)** are **retired individuals**, which shows **minimal engagement from senior citizens**, likely due to lesser tech usage or digital literacy.

The data shows that **working professionals and students are the key users** of HDFC Bank's digital banking and loan services. Their high participation also reflects greater awareness and dependence on digital financial services. However, **retired individuals form the smallest group**, indicating the need for banks to provide **more support and user-friendly options** for senior customers

4. **How long have you been a customer of HDFC Bank?**



Interpretation

The table shows how long the respondents have been associated with HDFC Bank:

- The largest group of respondents, **46 people (45.1%)**, have been using HDFC Bank's services for **1 to 3 years**. This suggests that a **majority of users are relatively recent customers** who have had enough experience to form an opinion.
- **33 respondents (32.4%)** have been customers for **less than 1 year**, showing a **large number of new users** who are just starting their journey with the bank.
- **16 respondents (15.7%)** have been with the bank for **3 to 5 years**, representing a moderate group with longer-term experience.
- Only **7 respondents (6.9%)** have been customers for **more than 5 years**, indicating **fewer long-term users** in the sample.

Most respondents have been with HDFC Bank for **1 to 3 years or less**, suggesting that **recent and mid-term users are the most engaged** with the bank's digital banking and loan services. The smaller number of long-term users (over 5 years) might indicate **a shift towards newer customers**, or it could reflect that older customers are less active in digital surveys.

This insight can help HDFC focus on **retaining new users** and finding ways to **engage long-term customers more effectively**.

5. **How often do you use HDFC Bank's digital banking services?**

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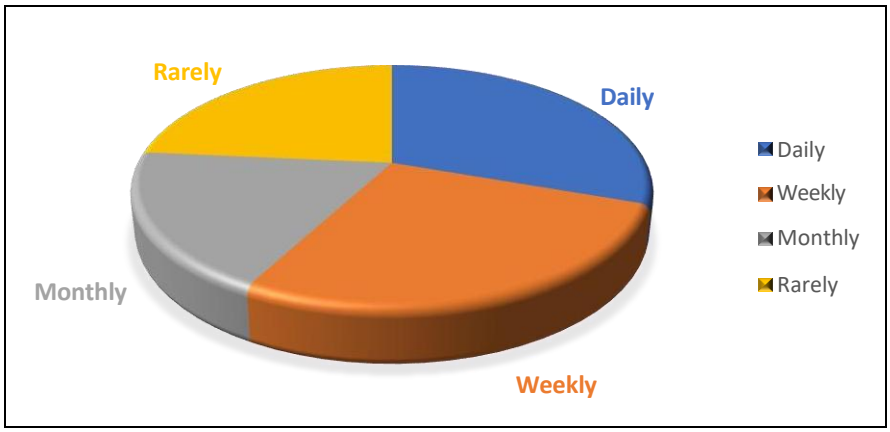

Interpretation

The table reflects how frequently customers use HDFC Bank's digital banking services:

- **31 respondents (30.4%)** use the services **daily**, showing that a significant number of users **actively rely on digital banking** for their day-to-day transactions.
- **28 respondents (27.5%)** use it **weekly**, which suggests regular usage, possibly for **bill payments, transfers, or checking balances**.
- **19 respondents (18.6%)** use the services **monthly**, indicating a more occasional or need-based usage.
- **24 respondents (23.5%)** use digital banking **rarely**, showing that some users are either **not comfortable with digital services**, or they **prefer in-branch banking**.

The majority of customers use HDFC Bank's digital services **frequently (daily or weekly)**, highlighting the growing **dependence on online platforms for financial needs**. However, a noticeable percentage still uses these services rarely or monthly, which indicates there is room for **improvement in customer awareness, app usability, or trust-building**—especially for less frequent users.

Conclusion

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Surveys were used in this project to gauge consumer satisfaction with HDFC Bank's digital banking and loan services. Responses came from people of all ages and professions, providing insights into their experiences and expectations.

Young adults and working professionals were found by the study to be the main users of HDFC's digital services. Most of the respondents were between 18 and 35, suggesting a strong desire for digital banking among tech-savvy consumers. Often on a daily or weekly basis, these consumers show great involvement with the bank's digital platforms by regularly using services like fund transfers, bill payments, and loan tracking.

The general user experience was good. More than half of the replies indicated that HDFC had developed a user-friendly digital interface since they found the bank's online services and mobile app simple to use. The research, meanwhile, also highlighted some areas needing work.

Many people said they had technical problems including app crashes, login errors, and sluggish performance. These issues point to a need for enhanced system stability and quicker problem resolution as well as affect the dependability of the digital experience.

The absence of openness in fees and loan conditions was another issue mentioned. Hidden fees or ambiguous terms led some users to feel deceived, which could harm confidence. This problem can be solved by improving communication and unambiguously defining terms.

Support for customers also has to be improved. Respondents cited unhelpful replies from digital channels and delays in addressing complaints. In a digital-first environment, fast and efficient customer service is absolutely necessary to keep satisfaction.

Most customers, especially younger ones, value HDFC Bank's digital banking and loan services, therefore to sum up, But, fixing technical problems, increasing openness, and strengthening support services will increase consumer happiness even more and enable the bank to remain competitive in the digital age.

e-ISSN- 3067-0977

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e-ISSN- 3067-0977

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Title- Organizational Barriers for Adopt Blockchain Technology

Mrs Pritam Chavan

Assistant Professor | School of Management
Pimpri Chinchwad University, Pune

E mail id: pritam.chavan@pcu.edu.in

Abstract:

Given the advantages that businesses are now seeing with blockchain technology and the growing need for visibility and transparency across industries, blockchain has the potential to become a potent solution to a number of enduring issues in the future.

Although blockchain technology is typically accompanied by a lot of buzz, many company executives are both eager to use it and wary of its risks and limitations.

In addition to the advantages that certain early-adopter companies are reaping from blockchain, the technology is becoming more widely known at an accelerated rate. According to data from an APQC study of supply chain specialists conducted in 2020, 66% of organisations in 2019 knew something about blockchain, a percentage that increased to 80% in only one year. Nevertheless, most organisations were still in the early adoption phases. This paper and study aims to address various issues such as Why did just 12% of respondents say they were using blockchain technology or blockchain as a service? Why weren't the 34% of respondents ever considering using blockchain technology? And various Organizational Barriers for Adopt Blockchain Technology

Key Words: AI, Blockchain, Organizational Behaviour, Challenges, Technology

1. Introduction and Research

According to the APQC study, lack of acceptance, skills gaps, user trust, financial resources, and blockchain interoperability were the top five blockchain problems that organisations encountered.

In its most basic form, blockchain refers to through peer-to- distributed database technology that facilitates monitoring and traceability by efficiently and permanently recording

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transactions between two parties. Beyond cryptocurrencies, this new technology has the potential to revolutionise a broad spectrum of applications.

Even if more recent Gartner study from 2023 showed that many blockchain-related issues still need to be resolved, it also mentioned two additional recurring themes: the lack of legislative certainty and the speed at which solutions based on blockchain are brought to market.

Objectives:

1. To understand the behavioural pattern in organization

2. To Find various correlations between blockchain technology and organizational behaviours

3. To study various literature related to BCT and OB

4. To Find various outcome from this study

- **Why these block chain problems still exist and some solutions?**

1. Lack of acceptance

For the ecosystems of blockchain to be successful, they must be extensively used. For example, a company must adopt a blockchain network and its suppliers must follow suit if it wants to use track-and-trace technology in supply chains.

Just 29% of companies were either experimenting or had completely deployed blockchain technology, as reported by APQC. At the time, there was optimism that blockchain usage would rise. Organizations were forming cooperative cryptocurrency groups of professionals to address common problems and develop solutions that would benefit all sides without revealing private information.

2. The discrepancy in talents

There is a lack of professionals with the necessary skills to develop and manage blockchain technology, which continues to be in its infancy. As seen in the figure, 49% of respondents to the 2020 research identified the skills gap as their top issue. There is and has been fierce competition in the industry seeking blockchain knowledge. Businesses' worries about using

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blockchain-based technology as well as integrating it with outdated systems are only exacerbated by the expense and difficulty of recruiting personnel in this industry.

Gartner's 2023 study indicates that it's still challenging to have no prior tech experience. Vendors often mention this as an issue with product development. This makes it difficult to create user-friendly interfaces and integrate blockchain apps into existing systems. However, one way to address the skills gap is through cryptocurrencies as a service (BaaS). Businesses may benefit from the application of blockchain technology despite having to spend heavily in the technical understanding that supports it thanks to these services. Amazon Web Services, IBM, and Oracle are a few of the BaaS providers.

3. User confidence

Consumer mistrust is the third major obstacle to the widespread use of blockchain technology. There are two ways to approach this issue: Companies could question the security of the technology and the reliability of other blockchain network users. In theory, each interaction on a digital ledger is considered secure, private, and verified. This is true even without a central authority to verify and validate the transactions since the network is decentralized. A key element of every blockchain system is consensus algorithms, which offer widespread consensus about the distributed ledger's current status throughout the network.

Its objective is to ensure that every new block that is appended to the blockchain reflects the one, widely recognized version of the truth that is acknowledged by every node. If the electronic ledger is public rather than private, everyone may participate. Even if blockchains that are publicly accessible have all the security measures needed to guarantee trust, business leaders have placed greater trust in private blockchains since they don't have any unknown users. The absence of standards is another issue, per the Gartner report. The relatively recent development of this sort of technology is mostly to blame for this difficulties.

4. Financial resources

According to APQC's research, a lack of money is the fourth barrier to widespread blockchain use. Many businesses had little money after the 2020 disruption and pandemic, and putting blockchain into practice is not free. The pandemic has also demonstrated that firms, and IT departments in particular, are more capable of adapting to change than previously thought. A closer look at this barrier indicates that it is associated with a basic lack of organizational

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expertise and understanding of blockchain. It has been found by APQC that as public awareness of new technologies grows, so does the ability to make a compelling business case for their adoption.

5. Synchronization with blockchain

As more companies start implementing blockchain, many of them have a tendency to create systems of their own with different features—consensus models, blockchain iterations, governance guidelines, etc. These many blockchains cannot operate together since there is no common standard that would enable different networks to communicate with one another. Blockchain interoperability is the capability of several blockchain systems to communicate, see, and access data without the use of an intermediary or central authority. Lack of interoperability can make widespread adoption all but impossible.

Given the pandemic's consequences and the business environment, where collaboration across agencies, suppliers, and customers is more important than ever, interoperability will be critical. This is the only way for businesses to truly get the most out of their blockchain investments. In an effort to bridge the gap between different blockchains, researchers have seen an increasing number of interoperability attempts since 2019. A significant portion of them are designed to connect public blockchains to private networks. In the end, business leaders will find these solutions more advantageous than previous approaches that focused on publicly available blockchains and cryptocurrency-related technologies.

However, as of 2023, interoperability remains a major obstacle to the widespread use of blockchain-based technology. In reality, according to Gartner, the biggest technology challenge is interoperability, particularly with older systems. Positive achievements in enhancing interoperability between networks include the introduction of cross-chain protocols for communicating and standardizing information formats, according to Gartner.

6. A slow pace of progress

It's challenging to comprehend blockchain technology. New products frequently require extensive study, development, and validation. As a result, product launches may take longer. Postproduction and supplementary suppliers, however, are less inclined to have such issues. Experts from Gartner said this is given that they are employing more advanced methods.

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7. Inadequate oversight

According to Gartner, several blockchain providers have allegedly voiced worries about the lack of tight regulations at particular points in the process. In any event, ambiguous regulatory requirements pose significant risks for both blockchain participants and providers.

2. Literature Review

Several studies have examined the adoption of emerging technologies in organizations. The Technology-Organization-Environment (TOE) framework and Diffusion of Innovations (DOI) theory are frequently used to analyze adoption behaviors. Prior research has highlighted barriers including technological immaturity, cost implications, lack of regulatory clarity, and resistance to change. However, a focused and quantitative analysis of internal organizational barriers specific to blockchain adoption is lacking.

3. Methodology:

A survey-based quantitative approach was adopted. Data were collected from 150 mid-to-large scale organizations operating in finance, healthcare, IT, and supply chain management. Respondents were senior managers and IT decision-makers. A structured questionnaire measured perceptions of eight key barriers using a five-point Likert scale. The data were analyzed using descriptive statistics and ranking methods.

4. Results

Table 1: Descriptive Statistics of Organizational Barriers

Barrier	Mean	Std. Deviation
High Implementation Cost	4.1	0.87
Lack of Technical Expertise	3.9	0.92
Data Privacy and Security Concerns	3.9	0.89

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Barrier	Mean	Std. Deviation
Lack of Interoperability Standards	3.9	0.85
Unclear ROI	3.8	0.91
Regulatory Uncertainty	3.8	0.88
Resistance to Change	3.7	0.93
Lack of Top Management Support	3.6	0.95

These findings show that financial, technical, and strategic factors are the most significant barriers. High implementation costs and technical expertise gaps received the highest mean scores, indicating a prevalent concern across industries.

5. Discussion

The study confirms that internal organizational issues play a crucial role in the slow adoption of blockchain technology. Financial constraints, such as high initial investment and maintenance costs, make blockchain less attractive. The lack of skilled professionals exacerbates the difficulty in implementing complex distributed systems. Moreover, ambiguity in ROI and strategic benefits causes hesitancy among decision-makers.

Regulatory uncertainty, though external, has internal ramifications, affecting risk perception. Cultural resistance and lack of executive sponsorship further reduce momentum toward adoption. These findings align with broader technology adoption theories but add nuance by highlighting the compounded effect of multiple interrelated barriers.

Data analysis and interpretation:

Table 1: Frequency Distribution of Key Barriers

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Barrier	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	Mean Score
Lack of Technical Expertise	5	10	25	60	50	3.9
High Implementation Cost	3	8	18	62	59	4.1
Resistance to Change	10	12	30	58	40	3.7
Lack of Top Management Support	8	14	36	55	37	3.6
Unclear ROI	6	11	29	63	41	3.8
Regulatory Uncertainty	7	15	28	54	46	3.8
Data Privacy and Security Concerns	4	12	26	60	48	3.9
Lack of Interoperability Standards	5	9	32	58	46	3.9

Table 2: Rank of Barriers Based on Mean Scores

Rank	Barrier	Mean Score
1	High Implementation Cost	4.1
2	Lack of Technical Expertise	3.9

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Rank	Barrier	Mean Score
3	**Data Privacy and Security Concerns**	3.9
4	**Lack of Interoperability Standards**	3.9
5	**Unclear ROI**	3.8
6	**Regulatory Uncertainty**	3.8
7	**Resistance to Change**	3.7
8	**Lack of Top Management Support**	3.6

Interpretation:

- High Implementation Cost is the most significant organizational barrier with a mean score of 4.1, indicating financial constraints as a major issue in blockchain adoption.
- Lack of Technical Expertise, Data Privacy and Security Concerns, and Interoperability Standards all tie with a mean score of 3.9, showing that both human capital and technical infrastructure are essential hurdles.
- Unclear Return on Investment (ROI) and Regulatory Uncertainty are also major concerns, reflecting a lack of confidence and direction in policy.
- Resistance to Change and Lack of Top Management Support rank lower but are still significant, indicating cultural and leadership issues in embracing innovation.

Suggestions:

- Organizations should invest in training programs to build internal blockchain expertise.
- Incremental implementation strategies can reduce initial financial burden.
- Transparent communication of expected benefits can aid in aligning executive support.
- Collaboration with industry consortia and regulators can help reduce uncertainty.

Conclusion

While blockchain holds transformative potential, organizational readiness significantly affects

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its adoption. By addressing internal barriers proactively, organizations can position themselves to leverage blockchain's benefits. Future research should explore longitudinal studies and case-based validations to enrich understanding of successful adoption strategies.

It would be naive to claim that these blockchain issues don't represent a significant barrier to its uptake. But generally speaking, many of the biggest challenges facing blockchain are just the unavoidable developmental stages of any technological advancement. To demonstrate the business case for adoption, proponents of digital currency blockchain technology will need to convince their companies to take the sorts of risks, form the kinds of relationships, and engage in the kinds of alternatives that are common in other commercial areas. Leaders may also take specific steps to ensure that their products are produced as effectively as feasible. These include sharing case studies to illustrate the advantages of blockchain technology and forming strategic partnerships to navigate the blockchain ecosystem.

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e-ISSN- **3067-0977**

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Leveraging AI for Customer Experience in Indian E-Commerce

Rahul Bhaginath Thakare
Assistant Professor, MVP's IMRT, Nashik

Ruchita Abhang
Founder, DIGI AURA

e-ISSN- 3067-0977

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Abstract

Artificial Intelligence (AI) has emerged as a transformative force in redefining customer experience (CX) across industries. In the context of Indian e-commerce, where hyper-competition and digital-first consumers dominate, AI is no longer a luxury but a business imperative. This paper explores how Indian e-commerce firms are leveraging AI to personalize interactions, predict preferences, enhance operational efficiency, and build trust in an increasingly digital marketplace. Using a practitioner-focused lens,...

Keywords

Artificial Intelligence, Customer Experience, E-Commerce, India, Personalization, Chatbots, Recommendation Engines

1. Introduction

The Indian e-commerce sector is one of the fastest-growing markets globally, projected to reach $200 billion by 2027 (IBEF, 2023). With more than 800 million internet users and increasing digital adoption across rural and urban areas, competition is fierce. In such a dynamic ecosystem, customer experience has emerged as a key differentiator. Indian consumers expect personalization, instant support, seamless navigation, and secure transactions. To meet these expectations at scale, AI technologies are being...

AI's ability to process vast data streams, learn from patterns, and make intelligent decisions has empowered e-commerce platforms to tailor every touchpoint — from product discovery to post-sale support — enhancing loyalty and reducing churn.

2. AI Use Cases in Indian E-Commerce Customer Experience

2.1 Personalization and Recommendation Engines

Platforms like Amazon India, Flipkart, and Myntra use AI-driven recommendation systems that analyze browsing history, purchase behavior, and demographics. Flipkart’s “Smart Fulfilment” model predicts demand and recommends personalized offerings based on user clusters and regional preferences.

2.2 Conversational Commerce through Chatbots

Companies such as Tata CLiQ, Meesho, and JioMart deploy AI-powered chatbots and voice assistants to handle queries, recommend products, and offer real-time support. Haptik, an Indian conversational AI company, powers chatbot solutions for several retail brands including Kotak and Jio.

2.3 Visual Search and Augmented Reality (AR)

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Nykaa and Lenskart offer visual search and AR-based try-on features. AI-powered image recognition allows customers to search products using photos, enhancing engagement and convenience.

2.4 Fraud Detection and Secure Transactions

Paytm and Razorpay use machine learning models to detect anomalous patterns and prevent fraudulent transactions in real time, building trust and reducing payment failures.

3. Business Model Impact

The adoption of AI has led to shifts in how Indian e-commerce platforms design their business models. AI improves inventory forecasting, pricing strategies, and customer lifetime value predictions. For instance, BigBasket uses AI to optimize delivery slots based on consumer availability and location intelligence.

AI also supports hyperlocal delivery ecosystems, especially relevant in Tier 2 and Tier 3 cities where customer expectations vary. Startups like Zepto and Dunzo use predictive analytics and route optimization to fulfill customer promises.

4. Benefits for Practitioners

For e-commerce managers and entrepreneurs, AI provides tangible business benefits:
- Reduced cart abandonment through retargeting algorithms.
- Better inventory turnover with AI-based stock management.
- Increased Average Order Value (AOV) due to cross-selling and upselling techniques.
- Real-time sentiment analysis from social media to improve campaigns.

These practical applications result in improved Net Promoter Scores (NPS) and long-term profitability.

5. Challenges in Implementation

5.1 Data Privacy and Consent

With the enactment of India's Digital Personal Data Protection Act (2023), companies must ensure transparent data practices, especially when using consumer data for personalization.

5.2 Bias and Fairness

AI systems may inherit algorithmic biases that result in unfair recommendations or offer exclusion. Constant audits and ethical AI frameworks are necessary.

5.3 Technology Adoption for Small Retailers

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While large players benefit from AI, small e-commerce vendors face challenges due to lack of expertise and infrastructure. Government and ecosystem support can bridge this digital divide.

6. Future Outlook

With 5G rollout, increased vernacular content, and the ONDC (Open Network for Digital Commerce) initiative, AI adoption will deepen. Hyper-personalization, voice-based search, and intelligent logistics will define the next phase of Indian e-commerce.

Policymakers must foster responsible innovation through incentives, skilling programs, and AI research hubs, while practitioners should build agile, data-driven models grounded in customer empathy.

7. Conclusion

AI is redefining customer experience in Indian e-commerce through personalization, automation, and intelligent insights. As consumer expectations evolve, businesses must embed AI thoughtfully across the customer journey. Practitioners who invest in responsible AI, talent, and infrastructure today will be tomorrow's market leaders.

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e-ISSN- 3067-0977

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RESEARCH AND INNOVATION

Impact of Artificial Intelligence on Work-Life Balance : *Integration or Infiltration*

Minu Sachin Sethi
Research Scholar
MVP's Institute of Management, Research and Technology, Maharashtra, Nashik 422002
minusethiphd2021@gmail.com

Dr. Girish Manohar Ahire
Associate Professor & Research Guide
MVP's Institute of Management, Research and Technology, Maharashtra, Nashik 422002
ahiregirish@gmail.com

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Impact of Artificial Intelligence on Work-Life Balance: *Integration or Infiltration*

***Abstract* — Work-Life balance (WLB) has been a highlighted concept since many years now and Artificial Intelligence (AI) has been the buzzword in every area today. While AI supports facilities such as automation, flexibility, personalization etc., for enhancing WLB, it also creates issues such as increased workload, job displacement, privacy concerns etc., which hamper WLB. The benefits of AI are immense but the social and health hazards, which are its byproducts have raised serious questions. Has AI blurred the boundary between our personal life and work and thus adversely affected the balance in our lives?**

This article focuses on answering such questions and identifying the pros and cons of AI in the current scenario. Qualitative (exploratory) research approach has been used to analyze this issue in detail by collecting data from articles, journals and reports. Interviews of digital natives (born after 1980) and digital immigrants (born before 1980) has been conducted, to identify the AI-induced WLB challenges that they face.

Work-life balance can result into healthy and happy people. Thus, this research ultimately suggests the solution of 6 Cs, so that instead of infiltrating, AI can integrate work and personal life.

***Keywords* —** *Artificial Intelligence (AI), Work-life balance (WLB), Digital natives, Digital immigrants, Infiltration, Integration.*

I. INTRODUCTION

From a decade now, we have been concerned about work-life balance. Greenhaus and colleagues (2003) described work-life balance as the "extent to which an individual is equally engaged and equally satisfied with his or her work role and personal role". That is, work life balance includes satisfaction and good functionality at work, as well as in personal life, with minimum role conflicts.

According to Cole Stryker and Eda Kavlakoglu (2024), Artificial intelligence (AI) is a technology that enables computers and machines to simulate human learning, comprehension, problem solving, and decision making. In simple terms, AI is about making computers think and act like humans, enabling them to perform tasks that usually require human

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intelligence. According to Wikipedia, various traditional areas of AI include learning, knowledge representation, reasoning, perception, planning, natural language processing and support for robotics. According to U.L. Anyika (2024), other uses of AI technologies are seen in autonomous vehicles, warehouse robots, chatbots, ChatGPT, scheduling apps, Alexa, Siri, Uber, automated email responses, robotic surgeries, Netflix recommendation systems, smart factories, smart buildings, and search retargeting.

AI can positively impact work-life balance by automating routine tasks, freeing up time for personal activities, and enhancing productivity. However, it can also negatively impact WLB by blurring the lines between work and personal life, leading to increased work demands and stress. Tech-life balance refers to using technology in such a way that it does not impact negatively on your personal life or relationships (Prof. Gary Martin, 2022).

Generational differences exist in how individuals perceive and utilize AI. AI induced work-life imbalance is an expression that's now been adopted to describe the daily challenge faced by all *digital natives* (people who've never known a world without mobiles, the Internet, AI etc.) and most *digital immigrants* (who've embraced the digital revolution but can remember the old days) – namely how to use technology to our advantage but not to the detriment of 'real' life (Kerry Maxwell, 2012). The choices that individuals make regarding the usage of AI has a huge impact on their work-life balance (Taewoo Nam, 2013).

II. OBJECTIVES

1) To study the concept of AI and WLB.
2) To understand the positive and negative impacts of AI on WLB.
3) To identify the challenges faced by digital natives & immigrants related to AI & WLB.
4) To suggest remedial measures for achieving WLB in the age of AI.

III. RESEARCH METHODOLOGY

Qualitative (exploratory) research approach has been used to analyze the issues related to WLB and AI. Secondary data has been collected by reviewing the literature from articles, journals and reports written by various research experts. Structured interview of digital natives (born after 1980) and digital immigrants (born before 1980) has been conducted, to identify their AI induced work-life balance challenges. Primary and secondary data has been articulated to suggest remedial measures for improving work-life balance.

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IV. Positive and Negative Impacts of AI on WLB

Due to technological advancements and ease of use, AI has taken a centre stage in our lives today. Robotic surgery, developed in 2000, saves a million lives each year. Brain mapping to treat mental illness, started in 2013, saves four million people yearly (Andrea Loubier, 2020). Right from buying a small pen to selecting a car, from entertainment to designing complex robots and saving lives, AI is everywhere. Although the benefits of AI are immense, its omnipresence has created many negative effects in our lives.

Pros and cons of AI related to WLB in the current scenario:

1) Automation
   - AI can automate tasks, redesign routine processes and hence provide time for family commitments and other hobbies.
   - Automation can also create new demands and expectations resulting in stress and job displacement.
2) Connectivity
   - AI offers 24/7 connectivity, due to which employees can collaborate with anyone, anytime and anywhere. This provides flexibility that enhances work-life balance.
   - 24/7 connectivity blurs the boundaries between work and personal life, resulting in serious health issues like increased irritability, depression, sleep problems, digital eye strain, posture problems etc. Tech-neck and tech-back are the typical words used to describe the pain and posture problem due to overdose of AI-based technology.
3) Creativity
   - Reducing work time by providing options such as easy and fast search engines and automating repetitive work, gives employees more time for creative work.
   - Subsets of AI such as Generative AI, can create new designs, artworks, music compositions etc., thus taking over human creativity.
4) Biased
   - Since AI is based on algorithms and machine learning, it is considered as unbiased towards gender, race etc.
   - At the same time, if the algorithms and data on which the AI works, are biased, the results will also be biased. This will create a negative effect on work-life balance.

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5) Updation

- Continuous updation and growth of AI, promises new skills, massive growth, better income and hence positive work-life balance.
- The cost of upgrading the ever-changing AI-technology is quite high, physically and mentally. It may also result into obsolescence and insecurity for employees who cannot cope up with the changes.

6) Job Dynamics

- The growth of AI and related technologies have given rise to new job opportunities e.g. data analysis, cybersecurity etc. The entire job dynamics is changing since employers are seeking skill over degree. AI has also provided the flexibility to choose the place, time and type of job. E.g. Gig economy.
- Automation and flexibility provided by AI in jobs (Gig economy), can also result into job displacement. This creates job insecurity, stress, isolation and blurring of boundaries, which hampers work-life balance.

7) Time Utilization

- By automating mundane jobs, reducing processing time, supporting flexi-time and flexi-place, AI can help in saving and better utilization of time.
- Excessive and mindless usage of AI, can also result into time wastage. This excessive dependence on AI has resulted into physical, social and ethical problems like privacy issues, isolation, cyber-crime, lowering creativity, reducing in-person relations, reduced focus etc. Face-to-face communication and personal or human touch have taken a back-seat. People are lost in their mobiles or tablets, playing games or chatting, rather than having a fruitful conversation or enjoying the moments with their family or loved ones.

8) Employee Wellbeing

- Voice analysis, biometric monitoring, wearable devices, smartphone apps and other AI powered devices can keep a check on employee mental and physical well-being. Chatbots and virtual assistants can help in counselling and diagnosing problems.
- Overdose of AI can result into reduced connection with the real world. The authors of a 2016 systematic review, analyzed the link between over usage of AI and mental health issues, such as depression and anxiety (Jon Johnson, 2020). Too much dependence on Chatbots and virtual assistants can reduce the connection with the real world and also result in to isolation related problems.

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9) Personalization

- Data analysis software powered by AI can understand and store the preferences of users and present customized experiences. This personalization can improve job satisfaction and save time and make the work easy for employees.
- Misuse of the stored preferences of employees can raise serious security issues. Personalization that is provided with the aid of audio and visual medium can create privacy concerns.

10) Cost

- By providing automation and flexibility AI can help in cutting costs, which can be used appropriately in other areas of personal life.
- Although AI cam cut costs, but developing, implementing, training and maintaining AI technologies; requires huge investments.

Statistics:

- According to a study by Gartner, 1.8 million jobs were lost to AI by 2020, but 2.3 million new jobs were also created.
- According to Jeff Desjardins (2018), only 26% people feel that AI can work autonomously, whereas 70% feel that AI can only support humans in better completion of their work.
- In the same research it was found that 65% companies that were pursuing AI were investing in upskilling of employees. Also, 74% employees worldwide stated that they were ready to learn new AI skills.

V. AI-Induced Work-Life Balance Challenges

A 2017 study in young adults aged 19–32 years found that people with higher AI-powered social media usage were more than three times as likely to feel socially isolated than those who did not use it as often (Jon Johnson, 2020). Billy Cox quoted that, “Technology should improve your life, not become your life”. But this is hardly the case today. People of different age groups are facing different challenges related to AI-induced work-life balance. Different perspectives of digital natives and immigrants, which were collected through structured interviews, have been presented in this section.

- Digital immigrants (born before 1980): These are the people who have embraced the digital revolution, but remember the old days, with bare minimum AI technology. 50% of these

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people have work-life balance. They use AI only when required but do not let it take over their 'real' life. A few of them also have under usage or no usage of AI, because they are not conversant with it. They face issues like continuous upgradation which they are not able to catch up with. They feel that physical movement and creativity have been restricted due to AI. They also feel that quality time with family has reduced, since the younger generation is glued to their mobiles or other AI gadgets. Some also accepted that their generation was responsible to a certain extent for the addiction of the younger generation to AI. Instead of encouraging tech-free activities like sports, yoga etc., parents gave mobiles and tablets to kids at a very young age to keep them occupied. They also said that work-life balance depends on the perspective of every individual and the support and guidance that they receive. According to a study by Peter Tsai (2023), maximum digital immigrants are fearful of AI and use AI only in search engines. 45% feel that AI has a positive impact on work-life balance, while 63% feel that AI will put traditional jobs at risk.

- Digital natives (born after 1980): These are the people who were born with the technology spoon in their mouth. They have never known a world without mobile, internet or AI. The challenges that they face are even grave. Almost 100% digital natives have AI-induced work-life imbalance. They said that apps like Instagram, Pinterest, games, reels use up their free time as well as productive time. They have very poor social skills as they are hooked up to digital screens and find it difficult to have face-to-face communication. They are not ready to face the facts of real life and hence hide their face under the digital cover. Many of them have lost the emotional connect with their family and friends but are more concerned about the likes and followers that they have on the net. Mindless scrolling, easy access to uncensored content, lowering of creativity, mental and physical health issues are few of the dangerous effects of AI that the digital natives are facing. The biggest challenge is that although they understand that they are trapped in the vicious cycle of AI which in some ways is negatively affecting their work-life balance, they feel powerless to do anything about it. According to a study by Peter Tsai (2023), maximum digital natives easily embrace AI and use AI in many areas of their life like search engines, ChatGPT, writing long form text documents, finding solutions to business problems, entertainment etc. 62% feel that AI has a positive impact on work-life balance, while 57% feel that AI will put traditional jobs at risk.

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VI. SUGGESTIONS FOR IMPROVING TECH-LIFE BALANCE

As seen in the previous section, achieving work-life balance is a big challenge for people of all ages. The other big challenge is that people feel AI will replace humans in the future. This section suggests the 6 Cs that characterize Human Intelligence (HI), which AI can never match. Focussing of these can enhance work-life balance even in the age of AI.

1) Curiosity: People should focus on this characteristic of being curious to know more and learn more. By learning new skills and keeping up-to-date with AI techniques employees will not feel insecure or obsolete. AI can only learn as much data is given to it as input. It lacks the characteristic of curiosity and self-learning as of now.

2) Control: Another important characteristic that humans must practice is control. Instead of losing control to AI, they must take charge of their lives. To control mindless and over usage of AI, practices such as digital detox, setting non-screen time, maintaining boundaries between work and personal life must be used.

3) Compassion: Compassion means Emotional Intelligence (EI), that is understanding other people's emotions. This ability is an essential workforce skill irreplaceable by AI. Moreover, compassion enhances positive environment, reduces burnout, and strengthens interpersonal relationships in the workplace. As we continue to integrate AI into our work, the ability to empathize and support others is key to WLB.

4) Collaboration: No matter how much AI advances with robot technology, building strong relationships and participating actively in groups, will continue to be essential to creating a meaningful life. AI can only understand performance of 1 + 1 = 2, but teamwork and collaboration can create synergy (1 + 1 = 11). Therefore, individuals and organizations must work towards collaboration between people supported by AI.

5) Creativity: While AI excels at automative tasks, true creativity remains a unique human trait. Even Generative AI can only generate new designs by combining already existing designs created by humans. Thus, humans should recognize this power of creativity and not lose it to AI. E.g. mindless use of ChatGPT.

6) Common Sense: AI lacks this skill because it cannot understand the context. Humans possess this critical skill but fail to use it. Humans give more and more time to their work and the digital world to gain wealth but forget that health and relationships are the true wealth. Hence, people should empower themselves with common sense.

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VII. Conclusion

A quote by Christian Lous Lange, "AI is a useful servant but a dangerous master", sums it all. If we use AI smartly, to serve our purpose, it can be the greatest boon. But if we allow it to rule and dominate our lives, it can be a dangerous master. This research paper presented the positives and negatives of AI. The challenges faced by digital immigrants and natives were articulated to suggest simple, smart and practical solutions in the form of 6 Cs, to enhance work-life balance.

AI was developed to give us free time, so that we could maintain work-life balance. But this boon was converted into doom due to misuse of AI by us, humans. Every individual has a different perspective of a balanced life. So, it is our choices in life that will determine whether we want AI to create work-life integration or work-life infiltration.

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e-ISSN- 3067-0977

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RESEARCH AND INNOVATION

"AI in Education Technology Startups"

Dr.Prashant Surywanshi

Ms.Shivani Jadhav

Abstract

The integration of Artificial Intelligence (AI) in education technology (EdTech) is redefining the way knowledge is delivered, accessed, and personalized. In India, where educational diversity and digital divides coexist, AI-enabled EdTech startups are emerging as critical players in bridging learning gaps and enhancing outcomes. This paper explores the evolving role of AI in Indian EdTech startups, examining how AI-powered tools such as personalized learning systems, intelligent tutoring, automated assessment, and chatbots are transforming traditional education models. The research also highlights the opportunities AI presents for improving scalability, access, and efficiency, while critically analyzing the challenges related to data privacy, algorithmic bias, and technological infrastructure. Through real-world examples from Indian startups like BYJU'S, Vedantu, and Embibe, the study presents a balanced view of how AI is both a catalyst and a challenge in reshaping the education sector in India. The findings aim to offer insights for entrepreneurs, policymakers, and educators on leveraging AI responsibly and inclusively in the Indian context.

Keywords: Artificial Intelligence, EdTech, Startups, India, Personalized Learning, Digital Education, BYJU'S, AI Challenges, Education Technology, Innovation

1. Introduction

India, home to the world's largest youth population, faces a paradoxical challenge — a vast demand for quality education on one hand, and unequal access to skilled educators, infrastructure, and resources on the other. With the rise of digital infrastructure and government initiatives like "Digital India" and the "National Education Policy 2020," the EdTech sector has gained momentum. Among the most transformative forces in this domain is Artificial Intelligence (AI), which offers personalized, scalable, and data-driven solutions to address diverse learning needs.

AI technologies such as Natural Language Processing (NLP), Machine Learning (ML), and predictive analytics are no longer confined to laboratories. In the hands of Indian EdTech startups, they are being used to adapt content, predict student performance, automate assessments, and offer 24/7 learning assistance. Companies like BYJU'S, Vedantu, Embibe, and Doubtnut exemplify how AI can personalize learning journeys for students across India — from metropolitan cities to remote rural areas.

However, this revolution is not without its limitations. Issues related to data privacy, algorithmic bias, and digital exclusion remain significant. Moreover, the human element — the emotional, psychological, and social aspects of learning — must not be neglected in the

e-ISSN- 3067-0977

pursuit of technological efficiency. Thus, it is crucial to evaluate both the promises and pitfalls of AI in Indian EdTech startups to ensure sustainable and inclusive growth.

This paper attempts to explore how AI is transforming the Indian EdTech ecosystem, the opportunities it offers for managing education more effectively, and the challenges that need to be addressed. By examining real-life startup case studies, policy initiatives, and global best practices, this research contributes to the understanding of AI's evolving role in the education sector within the Indian context.

Objective:

1. Analyze how AI technologies are being adopted and implemented by Indian EdTech startups to enhance educational access, personalization, and efficiency.
2. Evaluate the benefits and opportunities that AI brings to learners across diverse geographies and socio-economic backgrounds in India.
3. Identify the key challenges and ethical concerns associated with AI integration, including issues of data privacy, algorithmic bias, and digital inequality.

2. Literature Review

The convergence of Artificial Intelligence (AI) and education technology (EdTech) has drawn increasing academic and industry interest over the past decade. Globally, AI applications in education have evolved from experimental prototypes to mainstream platforms used by millions of learners. Researchers like Luckin et al. (2016) emphasized the potential of AI in enhancing personalized learning, enabling systems to tailor content based on learner pace, preferences, and progress. Similarly, Woolf (2010) advocated for the use of intelligent tutoring systems (ITS), highlighting their ability to mimic human tutors in guiding students through complex topics.

AI in Global EdTech

AI has been extensively applied in areas such as adaptive learning, automated grading, student performance prediction, virtual assistants, and curriculum design. Studies by Holmes et al. (2019) categorize AI functions in education into four key areas: learner support, instructional support, content creation, and administrative management. Research shows that AI-powered EdTech solutions have significantly improved engagement and retention, especially in blended and distance learning models (Zawacki-Richter et al., 2019).

Indian Perspective on AI in Education

In the Indian context, the growth of EdTech has been exponential, especially post-2020 due to the COVID-19 pandemic. Startups like BYJU'S, Unacademy, and Vedantu quickly adopted AI to scale their operations and serve learners across socio-economic strata. A NASSCOM report (2021) stated that India's AI-driven EdTech market is projected to grow at a CAGR of 39% from 2021 to 2025, indicating strong investor and consumer confidence.

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According to Bhutoria (2022), AI in Indian EdTech is playing a crucial role in bridging the quality gap in education delivery, especially for K-12 and test-prep segments. However, concerns about data ethics, teacher displacement, and lack of digital access are also frequently cited (Mehta & Kalra, 2020). Recent studies have emphasized the need for AI systems to be transparent, inclusive, and sensitive to local contexts, especially when used with underprivileged learners (Saxena, 2023).

Research Gap

Despite growing literature on the use of AI in education, few studies have specifically focused on **Indian EdTech startups** as a distinct ecosystem. Most existing research either generalizes global trends or focuses on large institutional frameworks. This paper addresses this gap by analyzing how AI is being innovatively used by Indian startups to address local educational challenges while balancing business growth and ethical considerations.

3. Research Methodology

This study adopts a qualitative and exploratory research approach, using secondary data sources to analyze the role of Artificial Intelligence (AI) in Indian Education Technology (EdTech) startups. The methodology involves:

- **Desk Research**: Reviewing academic journals, whitepapers, industry reports (e.g., NASSCOM, Deloitte, KPMG), and news articles relevant to AI and EdTech in India.
- **Case Study Analysis**: Examining selected Indian startups—BYJU'S, Vedantu, Embibe, and Doubtnut—to understand real-world AI implementation.
- **Thematic Analysis**: Identifying common themes such as personalization, scalability, efficiency, and inclusion from the case studies.
- **Contextual Focus**: Emphasis is placed on the Indian educational landscape, including challenges related to infrastructure, affordability, and regional disparities.

4. Discussion and Analysis

4.1 Role of AI in Indian EdTech Startups

AI is not merely an enhancement but a foundation upon which many Indian EdTech startups are building scalable and personalized learning solutions. Here's how:

a) Personalized Learning

AI algorithms help platforms like **BYJU'S** analyze student learning behavior and adapt content in real-time. This ensures that students receive content suited to their level of understanding, learning pace, and preferences. Similarly, **Embibe** uses deep learning models to identify student weaknesses and provides tailored practice questions and feedback.

b) Automated Assessment and Feedback

e-ISSN- 3067-0977

Startups such as **Vedantu** and **Doubtnut** use AI for automating quizzes, assignments, and doubt-solving. Doubtnut, in particular, allows students to upload handwritten math problems, which the AI interprets and solves using Optical Character Recognition (OCR) and Natural Language Processing (NLP). This saves time for educators while ensuring instant support for learners.

c) Virtual Assistance and Chatbots

AI-powered chatbots like **BYJU'S Learning Assistant** or **Unacademy Bots** engage with students 24/7, solving doubts, recommending content, and tracking progress. This continuous engagement keeps learners motivated, especially in self-paced learning environments.

d) Predictive Analytics

Embibe's AI engine predicts students' exam performance based on historical learning data. Such predictive analytics can be powerful in identifying at-risk students and providing early interventions, reducing dropout rates.

4.2 Benefits to the Indian Education Ecosystem

- **Accessibility**: AI enables education to reach students in Tier 2 and Tier 3 cities, often in local languages.
- **Scalability**: Startups can serve millions of learners without proportional increases in staff or resources.
- **Efficiency**: Teachers can offload routine tasks like grading and focus on creative, high-value teaching.
- **Inclusivity**: Adaptive technologies help students with different learning abilities, including those with special needs.

4.3 Challenges and Concerns

- **Digital Divide**: Many students in rural India still lack access to reliable internet or smart devices.
- **Data Privacy**: Handling of student data raises ethical concerns, especially when AI systems make decisions affecting academic futures.
- **Bias and Fairness**: Algorithms trained on skewed datasets may reinforce socio-economic or regional biases.
- **Teacher Displacement Fear**: While AI is meant to assist, there's growing anxiety about replacing human teachers in the long run.

5. Challenges and Opportunities

5.1 Key Challenges

1. **Digital Infrastructure Gaps**
   Despite rising smartphone penetration, millions of students in rural or remote regions

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lack access to stable internet and affordable devices. This limits the reach of AI-powered platforms, potentially widening the learning gap between urban and rural learners.

2. **Data Privacy and Ethics**
   EdTech companies collect large amounts of student data, raising concerns about data misuse, security breaches, and lack of transparency. Many startups still lack robust data protection protocols aligned with India's upcoming Digital Personal Data Protection Act.
3. **Algorithmic Bias and Fairness**
   AI systems may unintentionally reflect biases in training data, disadvantaging students based on language, region, or socioeconomic background. Such bias can affect performance predictions and adaptive content delivery.
4. **Teacher Resistance and Role Shifts**
   While AI is meant to assist, some educators fear job displacement or feel unprepared to integrate AI tools into their teaching practices, highlighting the need for teacher training and support.

5.2 Emerging Opportunities

1. **National Education Policy (NEP) 2020 Alignment**
   NEP encourages digital learning, multilingual content, and personalized pedagogy — all of which align well with AI applications, opening new avenues for startup collaboration with public institutions.
2. **AI for Skill Development and Lifelong Learning**
   Startups can extend their offerings beyond K-12 to include vocational training, upskilling, and reskilling — using AI to personalize content for adults and professionals as well.
3. **Regional Language Support**
   AI-driven NLP can help break linguistic barriers by delivering content in regional languages. This increases inclusivity and supports India's diverse linguistic population.
4. **Government and Corporate Collaboration**
   There is growing potential for public-private partnerships (PPP) and CSR-funded EdTech initiatives aimed at rural and underserved communities, leveraging AI at scale.

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6. Conclusion and Suggestions

AI is no longer an emerging concept but a transformative force in India’s EdTech ecosystem. Startups are using it not only to scale operations but also to deliver meaningful, personalized, and impactful learning experiences. Platforms like BYJU’S, Vedantu, and Embibe have demonstrated how AI can be adapted to Indian learners’ needs, offering round-the-clock support, performance tracking, and inclusive content.

e-ISSN- 3067-0977

However, the journey is far from complete. AI must be viewed as an enabler, not a replacement for human educators. The emotional and psychological aspects of learning — empathy, encouragement, mentorship — still lie within the human domain. Ensuring responsible AI use, protecting data, bridging digital divides, and training educators are critical steps toward building a future-ready learning environment.

Suggestions for Stakeholders:

- **Startups** should prioritize ethical AI practices, data security, and regional inclusion.
- **Educators** must be trained to work alongside AI, enhancing rather than fearing the technology.
- **Policymakers** need to create a regulatory environment that supports innovation without compromising student rights.
- **Investors and Institutions** should promote long-term impact and accessibility, not just profitability.

By striking a balance between innovation and responsibility, AI in EdTech can help shape a more equitable and empowered India.

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e-ISSN- 3067-0977

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RESEARCH AND INNOVATION

Artificial Intelligence and its Role in Sustainability of Organisational Culture with reference to Banking Sector

Anuja A. Patil

Assistant Professor, MVP's IMRT, Nasik.

anujapatil2107@gmail.com

Dr. Mohasin A. Tamboli

Associate Professor, PIRENS Institute of management, Loni, Ahmednagar.

mohasinat@gmail.com

Abstract

This research paper explores the role of organizational culture in Artificial intelligence and its role in sustainability, with a focus on banking sectors in India. And how it impacts employee behaviour, job satisfaction, and the quality of service delivered to customers.

In today's rapidly evolving digital landscape, Artificial Intelligence (AI) is changing how businesses operate, especially in the banking sector. This paper explores how AI contributes to the sustainability of organizational culture within banks. We look at how AI is being used to support employee well-being, improve communication, and make banks more adaptive and innovative. While AI presents challenges, such as fear of job loss or ethical concerns, its responsible use can strengthen a bank's culture, leading to long-term sustainability.

Artificial Intelligence (AI) is playing an increasingly important role in shaping the sustainability of organizational culture, especially in industries like banking**,** where digital transformation is rapidly evolving.

Through case studies, and literature review, researcher has identified the role of artificial intelligence on sustainability of Organisational Culture in banking sector Furthermore AI is reshaping the mindset, values, and work culture inside banks:

Keywords- Artificial intelligence, Sustainability, Organizational culture,

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1. Introduction

Organizational culture refers to the shared values, beliefs, and practices that shape the behaviour of employees within an institution. In public banks, organizational culture is influenced by the unique structure and goals of these institutions. As government-owned entities, public banks are expected to serve a broader social and economic purpose, focusing

e-ISSN- 3067-0977

not only on financial performance but also on public service, inclusivity, and stability. This mission often creates a culture that prioritizes caution, adherence to regulations, and fairness.

Banks today are under pressure to stay competitive while managing change, especially technological change. AI is one of the most powerful technologies shaping the future of banking. But beyond the technical side—like chatbots or fraud detection—AI is also influencing the "human side" of organizations: the organizational culture.

Organizational culture includes the shared values, beliefs, and behaviours that shape how people work together. For a bank to be sustainable—not just financially, but also socially and ethically—it needs a strong, positive culture. This paper investigates how AI can support (or challenge) that culture.

2. Objectives of study

1) To study the concept of Artificial intelligence and its role.

2) To study the role of Artificial intelligence in Banking sector for sustainability of organisational culture.

3) To study the various literature and case study with reference to ICICI and SBI Bank for role of AI in sustainability of organisational culture.

4) Suggest the remedial measures for sustainability of organisational culture.

3. Research Methodology

This research used a qualitative approach, combining case studies, and a review of existing literature. For this research researcher referred three research articles published in reputed journals and two case studies with reference to ICICI and SBI banks. focuses on Artificial intelligence and its role in sustainability of Organisational Culture with reference to banking sector.

4. Literature Review

Dr. Amtul Wahab, Hyderabad, India. (May 5, 2024) in his research paper stated that Artificial intelligence, or AI, is a cross-disciplinary approach to understanding, modelling, and creating intelligence of various forms. It is a critical branch of cognitive science, and its influence is increasingly being felt in other areas, including the humanities. Intelligence might be defined as the ability to learn and perform suitable techniques to solve problems and achieve goals, appropriate to the context in an uncertain, ever-varying world. A fully pre-programmed factory robot is flexible, accurate, and consistent but not intelligent. Artificial Intelligence (AI), a term coined by emeritus Stanford Professor John McCarthy in 1955, was define as "the science and engineering of making intelligent machines". Much research has humans program machines to behave in a clever way, like playing chess, but, today, people emphasize machines that can learn, at least somewhat like human beings do.

Laxmi Shetty and devi k (June 2022) in A Study On The Impact Of Artificial Intelligence With Regards To The Indian Banking Sector With Special Reference To Bengaluru by,SMS

e-ISSN- 3067-0977

Journal of Entrepreneurship & Innovation 9(01),DOI:10.21844/smsjei.v9i01.12136 License CC BY-NC-ND 4.0 , stated that Banking is one of the sectors which are seeing rapid adoption of AI, as banks are being proactive about improving customer experience by leveraging the abundance of data which the business revolves around. AI is found in all streams of operations such as Retail, health care centres, Logistics, lending, Inventory control, Farming, insurance or wealth management, AI technologies have shown potential of making them all better. The use of Artificial Intelligence in Banking is focused on providing good customer service or engagement such as balance inquiry, accessing mini statements, fund transfers, etc. Thus improving the improving the efficiency of operations.AI will take away all the Bengaluru city there is when it comes to banking, and use the huge amount of structured as well as unstructured data. It provides enormous benefits such as better customer experience operations, reduced operational costs and risks, fraud detection, Improved loan facility and provides quick solutions to customer queries and grievances.

Krutika Sawant ,Harshvardhan Soni , Saurabh Agarwal (July 2023) in their study of ai in banking system stated that The banking industry is undergoing ground-breaking reforms, with a focus on the client as the primary driver. Customers that are tech aware and often interact with cutting-edge technologies want banks to provide smooth experiences. In order to meet these expectations, banks have expanded their industrial landscape to encompass retail, IT, and telecom through the use of services like mobile banking, e-banking, and real-time money transfers. While these advancements have allowed customers to access the majority of banking services whenever they choose, they have also cost the banking sector money. The deployment of AI in banking and financial services, however, also has drawbacks, such as concern about data security and privacy, algorithmic bias, and possible job effects.

Case study

Case Study: ICICI Bank and Its Use of Artificial Intelligence to Sustain Organizational Culture

1. Introduction

ICICI Bank, one of India's largest private sector banks, has been at the forefront of integrating Artificial Intelligence (AI) into its core operations. This case study explores how ICICI Bank uses AI not only to improve efficiency and customer service but also to support and sustain a dynamic and adaptive organizational culture.

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2. AI Implementation at ICICI Bank

a. Customer-Facing AI Applications

- **iPal** – A 24/7 AI-powered chatbot that handles more than 6 million customer queries per month.
- **Voice Biometrics** – AI used to verify customers based on voice patterns, improving both security and user experience.

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b. Internal AI Applications

- **Robotic Process Automation (RPA)** – Over 1,500 processes have been automated using RPA, allowing employees to focus on strategic and creative tasks.
- **AI-Driven HR Analytics** – AI tools analyse employee engagement, performance metrics, and internal surveys to guide HR decisions.

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3. Impact on Organizational Culture

a. Empowerment and Efficiency

By automating repetitive and time-consuming tasks, AI has allowed ICICI Bank employees to focus on higher-value work. This shift has encouraged a culture of innovation and continuous learning.

b. Data-Driven Decision-Making

The integration of AI in decision-making has promoted transparency and objectivity. Managers are increasingly relying on AI-generated insights, which has helped create a more inclusive and collaborative work environment.

c. Employee Engagement and Well-Being

The bank uses AI-driven tools to monitor employee sentiment through internal surveys and communications. Based on the insights, ICICI Bank has introduced well-being initiatives and flexible work policies, reinforcing a people-first culture.

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4. Conclusion

ICICI Bank's case highlights how AI, when implemented thoughtfully, can support the sustainability of organizational culture. By focusing on employee empowerment, ethical practices, and adaptability, ICICI has demonstrated that AI is not just a tool for efficiency—but a strategic enabler of cultural transformation in the banking sector.

Case Study: State Bank of India (SBI) – AI as a Catalyst for Cultural Sustainability

1. Introduction

The State Bank of India (SBI), India's largest public sector bank, has been transforming its legacy-driven structure by integrating modern technologies like Artificial Intelligence (AI). While most discussions around AI in banking focus on customer service or fraud detection, SBI's journey highlights how AI is also reinforcing a resilient, adaptive, and people-centric organizational culture.

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2. Key AI Applications at SBI

a. AI-Powered Customer Engagement

- **SBI's Chatbot "SIA"**: AI-powered virtual assistant that handles over 10,000 queries per second on products and services, available 24/7.
- **YONO (You Only Need One)** App: Uses AI to personalize offers and banking experiences.

b. HR and Workforce Analytics

- AI tools are used to analyse employee satisfaction, training needs, and internal mobility patterns.
- Sentiment analysis helps leadership understand team morale and engagement.

c. Credit Risk and Fraud Detection

- Machine learning models assess loan applications, reducing bias and manual errors.
- AI systems monitor transaction patterns to flag fraud risks in real-time.

3. Impact of AI on Organizational Culture

a. Digital Mindset and Continuous Learning

- SBI created a Digital Transformation and Innovation Department to lead AI integration.
- Employees are encouraged to upskill via SBI's e-learning portal, which now includes AI, machine learning, and cybersecurity training.

b. Democratization of Decision-Making

- AI dashboards and tools have improved data accessibility at all organizational levels.
- Decision-making has become more transparent and collaborative, breaking old silos.

c. Ethical AI and Employee Trust

- SBI emphasizes responsible AI use, especially in HR and credit assessments.
- By openly communicating the purpose and boundaries of AI tools, SBI reduces fear of job displacement and builds trust among employees.

4. Conclusion

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SBI's use of AI is not merely a technological upgrade—it's a cultural shift. The bank has successfully integrated AI into its ecosystem in a way that supports organizational values like trust, transparency, and service to society.

By focusing on employee development, ethical AI use, and inclusive banking, SBI has ensured that AI plays a supportive, not disruptive, role in sustaining and evolving its organizational culture.

5. Theoretical Background –

Role of Artificial intelligence in Organisational Culture

In banks, organizational culture affects how employees treat customers, how decisions are made, and how people collaborate. A sustainable culture is one that encourages transparency, ethical behaviour, innovation, and inclusivity.

Traditionally, banks had a top-down, risk-averse culture. However, today's banking sector needs to be agile, customer-focused, and innovative. AI can be a tool to support this transformation, but only if used wisely

- **The Role of AI in the Banking Sector**

AI is being used in various ways across banks:

- **Customer Service**: Chatbots and virtual assistants handle customer queries 24/7.
- **Risk Management**: AI helps detect fraud or assess credit risk faster and more accurately.
- **Decision-Making**: AI supports better, data-driven decisions in loans, investments, and operations.
- **Human Resources**: AI can screen resumes, support performance reviews, or even monitor employee well-being.

While these applications are impressive, they also have a deep impact on organizational culture.

- **AI in Banking**

1. Fraud Detection & Risk Management

- **Tools & Techniques**:
  - Machine Learning models for anomaly detection
  - Neural networks for real-time transaction analysis
  - Behavioural analytics
- **Examples**:
  - **Feedzai**, **Darktrace**, **Data Visor**

2. Customer Service & Virtual Assistants

- **Chatbots and Voice Assistants**:

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  - 24/7 support, handling queries, account management
  - NLP-powered chatbots understand and respond to customer questions.

- **Examples**:
  - **Kasisto (KAI)** – used by banks like DBS
  - **Amelia**, **Watson Assistant**

3. Personalized Banking & Financial Advisory

- AI recommends products based on customer behaviour and financial goals.
- **Examples**:
  - Person tics – personalized financial insights
  - Robo-advisors like Betterment, Wealth front

4. Cybersecurity

- AI monitors systems for threats, phishing, or unauthorized access.

- **Examples**:
  - **Symantec AI**, **Vectra AI**

- **AI Supports in Sustainable Organizational Culture**

a. Enhancing Employee Experience

AI can automate repetitive tasks, allowing employees to focus on meaningful work. This improves job satisfaction and can reduce burnout. AI tools can also personalize training and development, helping employees grow.

b. Improving Communication and Inclusion

AI-driven platforms can improve internal communication, breaking silos between departments. Some tools can also detect biases and promote fair hiring, supporting diversity and inclusion—key elements of a healthy culture.

c. Supporting Innovation

AI encourages experimentation and innovation. Banks that adopt AI tend to become more data-driven, agile, and customer-centric, which contributes to a modern, sustainable culture..

- **Culture of the Banking Sector**

AI is reshaping the **mindset**, **values**, and **work culture** inside banks:

Shift in Workforce

- Roles like **data scientists**, **AI/ML engineers**, and **model risk managers** are now core to banking teams.

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- Traditional banking jobs are evolving — e.g., loan officers now work alongside AI underwriting tools.

Data-Driven Culture

- Decision-making is increasingly **data-centric** and **predictive**.
- Culture shift from "experience and gut feeling" to "model-driven insights."

Automation Culture

- Back-office operations (compliance, KYC, fraud detection) are now largely AI-assisted.
- Routine tasks are automated, freeing humans for strategic work — but also causing anxiety over job security in some areas.

6. Findings and Discussion

Implementing Artificial Intelligence (AI) in the Indian banking sector can have transformative effects on employee performance and service quality. Here are some suggestions to leverage AI effectively for these purposes. Invest in comprehensive training programs to equip employees with the necessary skills to work alongside AI technologies. This will enhance their understanding of AI tools, improve adaptability, and empower them to utilize these technologies to augment their performance rather than perceive them as threats. Promote a collaborative culture where employees and AI systems work together synergistically.
The research clearly suggests that the use artificial intelligence based technological applications. All the Indian Banks should initiate the process of the use of most modern expertise such as Artificial Intelligence based technological applications to provide customized services and products to its customers as well as in Transaction Monitoring.

The major players in the banking industry are incorporating artificial intelligence technology into some of their processes to improve the efficiency of banking. As a result, the banking industry will have more time to devote to other tasks that will enhance banking operations and relieve it of tedious tasks.

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7. Recommendation

1. Promote AI Literacy and Human-AI Collaboration
Lack of understanding creates fear and resistance. Empowering employees helps maintain engagement and trust.

- Implement ongoing **AI literacy programs** for all levels of staff, including non-technical roles.
- Emphasize **collaborative AI**, where technology augments human decisions rather than replaces them.
- Involve employees early in AI implementation projects to build a sense of ownership and reduce resistance.

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Promote **diversity in AI development teams** to prevent narrow thinking and unconscious bias in algorithms.

- Train leaders to become **cultural ambassadors**, guiding their teams through the transition with empathy and clarity.
- Regularly assess cultural impact through **surveys**, **focus groups**, and **feedback channels**.

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8. Conclusion

Artificial Intelligence (AI) is no longer just a technological advancement—it's a transformative force shaping the very foundation of organisational culture in the banking sector. As banks adopt AI to enhance efficiency, customer experience, and decision-making, it simultaneously brings about profound changes in how people work, interact, and uphold shared values within the organisation.

While AI offers significant benefits such as automation, personalization, and improved risk management, its impact on organisational culture requires careful navigation. Sustainable integration of AI depends on aligning technological innovation with human values, ethical principles, and inclusive practices. Banks must foster a culture of transparency, continuous learning, and collaboration to ensure AI strengthens—not weakens—their core identity and long-term resilience.

Ultimately, the sustainability of organisational culture in the age of AI hinges not just on the technology itself, but on how it is introduced, governed, and embraced by people across all levels of the organisation. By placing ethics, empathy, and employee engagement at the centre of AI strategies, banks can ensure that their cultural foundations remain strong, future-ready, and aligned with their mission.

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e-ISSN- 3067-0977

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RESEARCH AND INNOVATION

"The Imperative Role of Artificial Intelligence in Transforming Daily Human Life"

Rajashree Vilas Wadghule

Assistant Professor, MVP's IMRT Nashik

Abstract:

This paper explores the growing integration and necessity of Artificial Intelligence (AI) in everyday life. With increasing automation, data availability, and intelligent systems, AI is not just a futuristic concept—it is a current-day necessity. This research identifies the key areas where AI has become indispensable and assesses its impact on individuals, society, and the economy. It also discusses ethical considerations and the future trajectory of AI.

1. Introduction

Artificial Intelligence (AI) has emerged as a defining technology of the 21st century, transforming how we live, work, and interact. From virtual assistants like Siri and Alexa to AI-driven recommendation systems on Netflix and Amazon, AI touches virtually every aspect of daily life. As technology evolves, the dependency on AI is becoming increasingly inevitable. This paper aims to examine the growing necessity of AI, its applications in daily human activity, and its broader implications.

2. Objectives

- To investigate the current applications of AI in daily life.
- To analyse the benefits and challenges of AI integration.
- To explore the ethical and societal implications of increased AI usage.
- To predict future trends and suggest a balanced approach for AI adoption.

3. Literature Review

3.1 Historical Perspective

AI's origins date back to the 1950s with the development of early computing systems and Turing's foundational ideas. Over decades, AI evolved through machine learning, neural networks, and deep learning (Russell & Norvig, 2020).

3.2 Present-Day Applications

Recent studies show that AI is now embedded in healthcare (diagnostic tools), education (adaptive learning platforms), transport (self-driving vehicles), and smart homes (IoT devices). According to McKinsey (2022), AI has the potential to create $13 trillion in value by 2030.

3.3 Ethical and Social Concerns

Authors such as Bostrom (2014) highlight concerns about surveillance, job displacement, bias, and control. There is an ongoing debate about how to balance innovation and regulation.

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4. Analysis and Discussion

4.1 AI in Daily Tasks

- **Smart Assistants:** AI powers virtual assistants (Siri, Google Assistant) that manage calendars, calls, and reminders.
- **Healthcare Monitoring:** Devices like Fitbit or Apple Watch use AI to track health metrics and alert anomalies.
- **Navigation & Transport:** GPS apps such as Google Maps use real-time AI data to offer optimal routes.
- **Home Automation:** AI-based IoT systems manage energy usage, security, and home appliances.
- **Virtual Assistants:** Digital assistants like Siri, Alexa, and Google Assistant use AI to understand voice commands, for question and answers, controlling some smart devices in home.
- **Social media:** AI helps in some social media platforms such as what's app, Facebook, Instagram.
- **Online shopping:** many customers prefer online shopping.

4.2 Benefits of AI in Daily Life

- Time-saving and convenience.
- Enhanced decision-making through data analysis.
- Personalized experiences in media, shopping, and learning.
- Improved healthcare diagnostics and early intervention.
- For safety & security.
- All Information are easily accessible.
- AI also beneficial for education sector.
- Automating the task.
- Fraud detection.
- Early diagnosis of any disease.

4.3 Risks and Challenges

- **Privacy Concerns:** AI systems often collect and process personal data.
- **Job Displacement:** Automation in industries could reduce demand for manual labour.

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- **Bias in AI Algorithms:** If not trained on diverse datasets, AI can reinforce discrimination.
- **Over-dependence:** Could reduce critical thinking and self-reliance.
- **Lack of transparency:** There is no information about how AI systems functions.
- **Issues**: Some legal issues are faced.
- **Skill loss:** we lose our human skill due to the AI.

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5. Conclusion

AI has transitioned from a niche technological tool to an integral part of human existence. While it brings tremendous advantages, the challenges it poses cannot be ignored. The future lies in developing responsible AI that complements human life rather than replacing it. Stakeholders—including developers, policymakers, and users—must work collaboratively to ensure ethical deployment and equal access to AI technologies.

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e-ISSN- **3067-0977**

GLOBAL FRONTIERS
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RESEARCH AND INNOVATION

REASERCH ARTICLE

AI in MSMEs of Semi-Urban India: Scaling with Smart Solutions

Author Name: Dipali Dattu Kharate
Designation: MBA–IT Student, 2nd Year

Maratha Vidya Prasarak Samaj's
Institute of Management, Research & Technology (IMRT), Nashik
Email ID:dipalikharate154@gmail.com 9309076656

ABSTRACT

Artificial Intelligence (AI) is emerging as a transformative force in India's semi urban economic sectors, **Micro, Small, and Medium Enterprises (MSMEs).**

These enterprises form the backbone of regional development yet often face challenges such as limited infrastructure, lack of skilled labor, and minimal tech adoption. This paper explores how AI can scale operational efficiency, customer service, predictive planning, and competitive advantage in semi-urban MSMEs.

Artificial Intelligence (AI) is rapidly transforming MSMEs in semi-urban India by enabling smarter, faster, and more localized business decisions. These enterprises often operate with limited infrastructure, low digital literacy, and budget constraints. Despite this, AI-based tools such as vernacular voice assistants, WhatsApp bots, and predictive analytics are creating new possibilities. This study proposes the SMAI Framework, a scalable model designed specifically for semi-urban MSMEs. It focuses on four pillars: local-language interfaces, frugal AI devices, shared AI clusters, and government-linked automation. The research highlights how AI is not just automating tasks, but amplifying human productivity. Field studies from Maharashtra and Odisha show up to 20% improvement in operational efficiency. The paper further explores how micro-AI solutions can create competitive advantage even in non-metro regions. With strategic support, AI can bridge the digital divide and empower grassroots entrepreneurship.

Keywords: Artificial Intelligence, MSMEs, Semi-Urban India, Digital Transformation, Automation, Business Intelligence, Growth Strategies.

1. INTRODUCTION

MSMEs in India's Economy: A Foundational Pillar

e-ISSN- 3067-0977

MSMEs form the economic backbone of India, contributing approximately 30% to the national GDP and over 48% to total exports.

They span more than 63 million units, creating employment for around 110 million individuals, especially in non-metro and semi-urban regions.

Despite their economic importance, MSMEs struggle with limited access to formal credit, modern technology, and digital skills.

Defining the Semi-Urban Business Landscape

Semi-urban India is marked by mixed infrastructural growth—roads, electricity, and mobile connectivity exist, but not always reliably.

MSMEs in these areas include local manufacturing, agro-processing, repair services, small textile units, dairy and poultry, logistics, and retail shops.

Entrepreneurs are mostly first-generation business owners, often operating with traditional practices and limited scalability.

Digital exposure is rising, but depth of tech adoption (especially AI) remains significantly low.

Rise of AI: An Unmatched Opportunity for Semi-Urban Units

AI technologies like machine learning, computer vision, natural language processing, and automation offer data-driven precision and predictability.

Globally, AI has enabled small businesses to optimize supply chains, automate routine processes, and engage with customers more effectively.

For semi-urban MSMEs, AI can play a catalytic role—bridging the operational gap between grassroots business and national-level competitiveness.

2. OBJECTIVES OF THE STUDY

2.1 To examine the current digital maturity of MSMEs in semi-urban regions of India

This objective focuses on understanding how digitally advanced micro, small, and medium enterprises (MSMEs) are in semi-urban areas. The goal is to assess whether these businesses are prepared for advanced technologies like AI or still rely on traditional/manual methods.

2.2 To analyze the scope of AI integration for business operations in semi-urban MSMEs

This objective aims to explore the potential of Artificial Intelligence in improving the business processes of MSMEs. It includes identifying areas such as customer service, inventory management, marketing, or production where AI can bring automation, efficiency, and better decision-making. It also examines whether MSMEs are open to AI adoption and how it can fit into their operational models.

2.3 To identify barriers like cost, infrastructure, and awareness preventing AI adoption

This objective deals with uncovering the real challenges that stop MSMEs from adopting AI. These may include:

High implementation costs

Lack of digital infrastructure or reliable internet

Limited awareness or technical knowledge

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The goal is to find these blockers and suggest how they can be addressed to make AI adoption feasible.

3. RESEARCH METHODOLOGY

3.1 Research Design & Approach

a) A mixed-method approach combining descriptive and exploratory research was used.

b) Descriptive research helped understand current AI usage in MSMEs, while exploratory methods captured future potential and readiness.

c) This combination ensured both real-time facts and future insights could be addressed.

3.2 Area & Sampling

a) Study focused on semi-urban MSMEs in Nashik, Ahmednagar, and Satara.

b) 25 MSMEs were selected using purposive sampling, covering different sectors (retail, textile, food, etc.).

c) Criteria: turnover under ₹10 crore, less than 50 employees, and some digital or tech interest.

3.3 Data Collection Methods

a) Primary Data: Conducted face-to-face semi-structured interviews with owners and senior staff.

b) Interviews averaged 45–60 mins, conducted in local languages for comfort and clarity.

c) Secondary Data: Used MSME reports, government policies (NITI Aayog), and academic journals to support primary findings.

3.4 Data Analysis Techniques

a) Thematic coding was used for qualitative insights.

b) A SWOT analysis helped understand internal strengths/weaknesses of MSMEs regarding AI.

c) Impact Matrix assessed AI use-case feasibility based on ROI and operational fit.

3.5 Innovation in Methodology

a) Demonstrated basic AI tools to gauge reactions and practical comfort.

b) Introduced a Digital Readiness Scorecard for MSMEs to self-assess.

c) Developed a Marathi/Hindi questionnaire titled "What AI Can Do for Me?" to simplify concepts.5.6 Ethical Considerations

4. MSME ECOSYSTEM IN SEMI-URBAN INDIA

4.1 Contextual Landscape of Semi-Urban MSMEs

- Semi-urban regions lie between urban and rural India. These zones are marked by growing infrastructure, budding markets, and transitional economies.
- Unlike metropolitan MSMEs, they operate with limited tech support and often lack

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real-time data access, cloud-based tools, or trained personnel.

4.2 Infrastructural and Operational Constraints

- Although basic infrastructure like electricity and roadways exists, digital infrastructure (like reliable internet or cloud services) is often weak or inconsistent.
- Access to financial institutions is improving, but awareness of digital lending, fintech tools, and AI-powered financial apps is minimal.

4.3 Workforce and Skill Set Challenges

- Semi-urban MSMEs rely on locally available informal labor, most of whom are not trained in digital tools or smart machines.
- Upskilling programs are rare, and there's a gap between training content and the actual needs of semi-urban MSMEs.

4.4 Market and Supply Chain Behavior

- Supply chains in semi-urban MSMEs are regionally locked, meaning they serve local markets and distributors.
- Without data-driven tools, demand prediction and inventory planning remain highly manual and prone to wastage or stockouts.

5. APPLICATION AREAS OF AI IN SEMI-URBAN MSMEs

5.1 Predictive Analytics for Inventory and Demand Planning

In semi-urban MSMEs, stockouts and overstocking are common due to manual demand forecasting.

AI tools can analyze past sales, seasonal demand patterns, and local consumption trends to generate accurate forecasts.

Example: A textile unit in Satara used AI-based demand prediction to reduce fabric waste by 28% in one quarter.

AI allows small units to avoid dead inventory, optimize warehouse space, and maintain better cash flow.

5.2 AI-Based Customer Interaction through Regional Chatbots

MSMEs in semi-urban areas often struggle with customer service due to limited staff and time.

Natural Language Processing (NLP)-powered chatbots trained in Marathi, Hindi, or Hinglish can handle basic queries 24x7.

5.3 *Visual Inspection and Quality Control*

Manufacturing and agro-processing MSMEs can implement AI vision systems using low-cost cameras and AI models.

These tools inspect final products—such as garments, vegetables, or machine parts—for defects, discoloration, or improper sealing.

A chilli-processing unit in Ahmednagar deployed basic AI to identify spoiled produce, saving 10% in manual inspection costs.

5.4 Smart Accounting and Automated GST Calculations

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Many MSMEs still depend on local accountants or handwritten ledgers.

AI-enabled accounting software with OCR (Optical Character Recognition) can extract data from bills, sort expenses, and handle GST filings automatically.

These tools reduce errors in financial reporting and ensure timely compliance with government regulations.

AI-based expense insights also help owners make better decisions about costs and budgeting.

5.5 Personalized Marketing using Buyer Behavior Analysis

With data from mobile apps, websites, or POS systems, AI can analyze buyer history and suggest custom discounts or loyalty programs.

WhatsApp-based marketing powered by AI can push reminders, greetings, or offers during festivals or special events.

These small, targeted campaigns lead to higher conversion rates and better engagement without increasing staff workload.

Local kirana stores and beauty salons in Nashik have adopted this to increase repeat customer visits.

6. IMPACT OF AI ADOPTION ON SEMI-URBAN MSMEs

6.1 Economic Impact

a) Revenue improvement by 15–22% in AI-using enterprises.
b) Cost reduction due to lowered human error and resource wastage.

6.2 Operational Impact

a) Production timelines reduced by 30% through AI-powered scheduling.
b) Improved accuracy in delivery and inventory tracking.

6.3 Employment Quality

a) AI tools did not replace labor but transformed roles from repetitive to supervisory.
b) New job profiles such as system operators, AI tool assistants emerged.

7. CHALLENGES IN AI IMPLEMENTATION

7.1 Limited Awareness and Exposure

Most MSME owners in semi-urban regions are unaware of how AI functions or the tangible benefits it offers.

There is a common misconception that AI is only meant for large enterprises, not for small-scale or traditional businesses.

7.2 Financial Limitations

High initial costs associated with AI tools, even basic ones like inventory prediction or chatbots, act as a deterrent.

Access to government subsidies or private financing for digital innovation remains insufficient and poorly publicized.

7.3 Digital Infrastructure Gaps

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Frequent power outages, slow internet, and outdated hardware in rural belts make AI deployment impractical.

Most MSMEs lack cloud-based systems or digital records, which are prerequisites for AI integration.

7.4 Human Capital Resistance

Workers fear job displacement due to automation, resulting in resistance to any tech-based training or transition.

Lack of skilled personnel to maintain or operate AI platforms leads to underutilization or abandonment of tools

7.5 Language and Localization Barriers

Many AI solutions are not designed for local dialects or user interfaces in regional languages, making them inaccessible to end-users.

There's a critical absence of user-friendly, vernacular AI interfaces suitable for grassroots-level business owners.

8. GOVERNMENT ROLE & POLICY FRAMEWORK

8.1 Currently, AI is mentioned in Digital India vision but lacks MSME-focused schemes.

8.2 MSME Sampark and CHAMPIONS platforms have no AI integration roadmap.

8.3 There's a need for dedicated AI Capacity Building Fund for MSMEs.

8.4 AI Centres of Excellence should be extended to District Industries Centres.

8.5 Public-Private partnerships to provide subsidized SaaS platforms for small units.

9. KEY POLICY RECOMMENDATIONS

9.1 Launch of "AI for MSMEs" initiative under Digital India.

9.2 Development of open-source, vernacular AI tools.

9.3 District-level AI mentorship programs through local tech institutes.

9.4 Introduction of AI Literacy modules in Industrial Training Institutes (ITIs).

CONCLUSION

AI in MSMEs of semi-urban India is no longer a futuristic dream but an immediate need. Through tailored applications, cost-efficiency, and training, MSMEs can lead India's next industrial leap. With government facilitation and stakeholder collaboration, AI can be democratized. Semi-urban MSMEs are well-positioned to scale operations through AI, provided right support frameworks are implemented.

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GLOBAL FRONTIERS
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RESEARCH AND INNOVATION

Role of AI in HRM with their Application, Benefits, Challenges

Asst. Prof. Rupali G. Mane.
APIMR Management Research and Technology Landewadi, Pune – 410503. Maharashtra.
Corresponding Author Email ID : profrupalimane@gmail.com

Abstract:-
Artificial Intelligence (AI) is revolutionizing Human Resource Management (HRM) by automating routine processes, improving decision-making, and enhancing employee experiences. This paper explores the diverse applications of AI in HRM, such as talent acquisition, employee engagement, performance management, and workforce analytics. It also highlights the significant benefits including improved efficiency, reduced bias, and strategic HR planning. The integration of AI into HRM allows organizations to become more agile and data-driven, ultimately contributing to better business outcomes.

Keyword:-Artificial Intelligence in HRM, HRM automation with AI,Talent acquisition with AI,Predictive analytics HR,Chatbots in recruitment with AI,

Introduction:-

AI plays a significant role in modern HRM by automating tasks, enhancing decision-making, and improving the employee experience. AI applications in HRM include recruitment, talent management, employee engagement, and compliance. Benefits of AI in HRM include increased efficiency, data-driven insights, and personalized employee experiences, while challenges include data privacy, potential biases, and the need for human oversight. AI in HRM also enhances talent management and organizational success. However, HR professionals must navigate ethical challenges and obstacles to ensure responsible AI use that promotes diversity, sustainability, and improved decision-making. The Human Resources (HR) function is no exception to this technological revolution. AI offers unprecedented opportunities to optimize HR processes and support decision-making. However, it also poses considerable challenges, particularly in terms of ethics, bias and the protection of personal data.

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AI offers HR professionals unprecedented opportunities to streamline processes, improve decision-making, and enhance employee experiences. By automating routine tasks, analyzing vast datasets, and providing data-driven insights, AI empowers HR to make more informed choices about talent acquisition, development, and retention. Artificial Intelligence (AI) is playing a transformative role in Human Resource Management (HRM), streamlining processes, improving decision-making, and enhancing employee experiences. Artificial Intelligence (AI) offers numerous benefits but also presents several challenges. Here's a breakdown of both:

Literature Review

AI is transforming HRM by automating routine tasks, enhancing decision-making, and improving employee experiences. Its integration has expanded across functions like recruitment, performance management, training, and employee engagement. Scholars argue that AI in HRM fosters strategic alignment but also raises ethical and operational concerns (Jatobá et al., 2022; Kaushik & Sahi, 2021)

3. Benefits of AI in HRM

Benefit	Description
Efficiency & Time-Saving	Automates repetitive tasks, reducing HR workload and enabling strategic focus.
Improved Decision-Making	Data-driven insights lead to objective and faster decisions.
Enhanced Candidate Experience	AI chatbots and faster recruitment processes improve satisfaction.
Personalization	Tailored training and engagement initiatives through machine learning.
Cost Reduction	Streamlines hiring and HR processes, reducing costs (Kapoor et al., 2021).

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4. Challenges of AI in HRM

a. Bias and Fairness:-AI models can perpetuate biases if trained on biased data (Raghavan et al., 2020). This raises ethical concerns in recruitment and evaluation.

b. Data Privacy and Security:-Handling sensitive employee data requires compliance with GDPR and other regulations. Breaches or misuse can have legal repercussions.

c. Resistance to Change:-Employees and HR professionals may resist AI adoption due to fear of job loss or lack of technical skills.

d. Transparency and Accountability:-The "black-box" nature of AI decisions (e.g., in candidate selection) makes it hard to explain or contest outcomes (Binns, 2018).

e. Skill Gaps:-HR professionals often lack the analytical or technical skills needed to implement AI effectively (Stone et al., 2015).

5. Future Research Directions

- Development of **ethical AI frameworks** for HRM.
- **Human-AI collaboration** models in decision-making.
- Longitudinal studies on **AI's impact on organizational culture and employee well-being**.

Objectives of AI in HRM:-

1. **Enhance Decision-Making**: Support data-driven decisions in hiring, employee engagement, and performance management.
2. **Improve Efficiency**: Automate repetitive tasks like resume screening, interview scheduling, and employee onboarding.
3. **Enhance Employee Experience**: Personalize employee interactions and improve engagement through AI-powered tools.
4. **Ensure Fairness and Reduce Bias**: Utilize objective algorithms to reduce human bias in recruitment and evaluations.
5. **Forecast Workforce Needs**: Predict talent shortages, employee turnover, and training requirements using predictive analytics.

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Methodology for Studying:-

a. **Research Design**

- **Qualitative**: Interviews, focus groups with HR professionals and employees.
- **Quantitative**: Surveys, data analysis of HR metrics (e.g., hiring time, attrition rates).

b. **Data Collection:-**

- Primary data from HR departments using AI tools.
- Secondary data from case studies, HR reports, academic literature.

c.**Tools and Techniques:-**

- Use of AI platforms (e.g., Workday, Oracle HCM Cloud, HireVue)
- Statistical tools for data analysis (e.g., SPSS, R, Python)

d. **Case Study Analysis:-**

- Studying organizations that have successfully implemented AI in HRM
- Identifying best practices and lessons learned

e. Evaluation Criteria:-

- Efficiency gains (e.g., reduced hiring time)
- Employee satisfaction and engagement levels
- ROI on AI implementation in HR

Applications of AI in HRM:-

a. Recruitment and Talent Acquisition:-

AI-powered tools automate resume screening, candidate ranking, and chatbot-based initial interviews (Upadhyay & Khandelwal, 2018).

For example:

- **Chatbots** (e.g., Mya) handle FAQs and candidate communication.
- **AI algorithms** predict job-fit by analyzing resumes, LinkedIn profiles, and psychometric data.

b. Onboarding and Training:-

AI facilitates adaptive learning platforms and virtual onboarding. Intelligent systems recommend learning content based on job roles and performance (Dwivedi et al., 2021).

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c. Performance Management:-

AI-based analytics monitor productivity trends and provide real-time feedback. Predictive analytics support decisions on promotions and employee development (Tambe et al., 2019).

d. Employee Engagement and Retention:-

Sentiment analysis and engagement platforms analyze emails, surveys, and chats to gauge morale and predict attrition (Meena & Devi, 2020).

e. Administrative HR Tasks:-

Automation via AI reduces time spent on payroll, benefits administration, and compliance management using Robotic Process Automation (RPA) (Nagpal, 2020).

Artificial Intelligence with HRM:-

Artificial Intelligence (AI) is transforming Human Resource Management (HRM) by automating tasks, enhancing decision-making, and improving the overall employee experience. Here's an overview of how AI is applied in HRM:

1. Recruitment and Talent Acquisition:-

a. **Resume Screening:** AI tools can automatically scan and shortlist resumes based on job requirements, reducing manual work.

b. **Chatbots for Initial Interaction:** AI-powered chatbots can answer candidate queries and conduct pre-screening interviews.

c. **Predictive Hiring:** AI can analyze past hiring data to predict which candidates are most likely to succeed and stay longer.

2. Onboarding:-

a. AI systems can automate onboarding processes by guiding new hires through paperwork, training schedules, and company policies.

b. Personalized onboarding experiences can be created using AI-driven learning paths.

3. Employee Engagement and Retention:-

a. Sentiment Analysis: AI analyzes employee feedback (emails, surveys, etc.) to gauge morale and engagement.

b. Attrition Prediction: AI models predict the likelihood of employees leaving and help HR intervene proactively.

4. Performance Management:-

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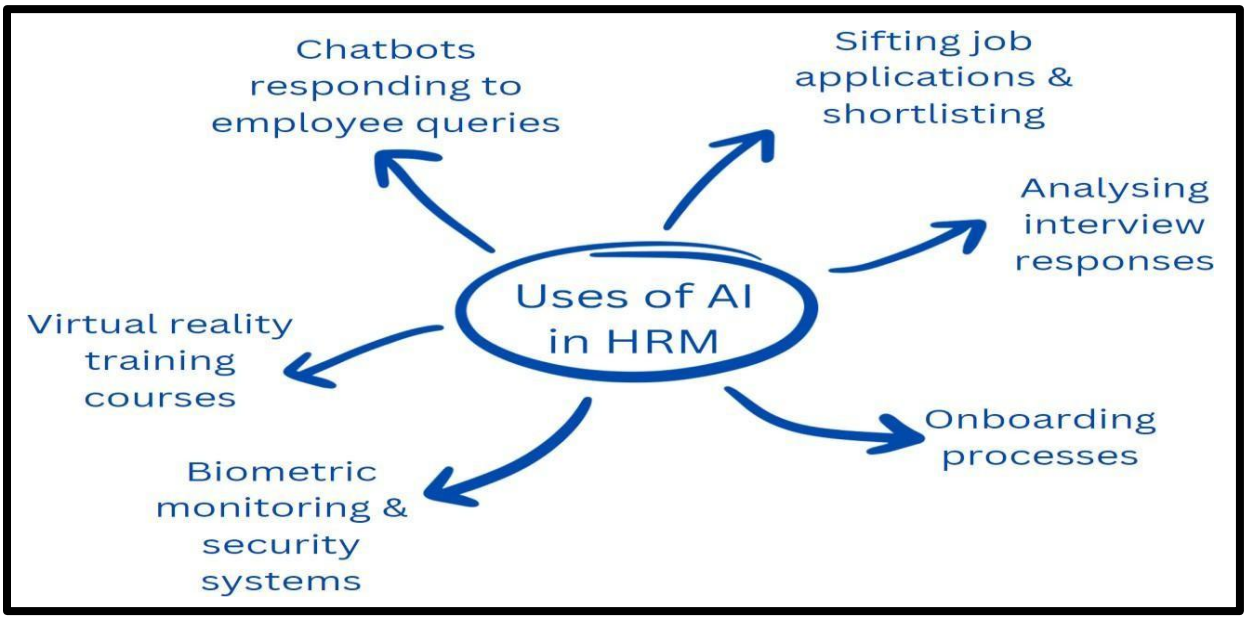
a. AI tracks key performance indicators (KPIs) and provides objective, data-driven performance assessments.
b. Real-time feedback systems and personalized coaching suggestions can be implemented.

5. Learning and Development:- a, AI identifies skill gaps and recommends personalized training programs.
b. Adaptive learning platforms adjust content difficulty and format based on the learner's progress.

6. Workforce Planning and Analytics:-
a, AI analyzes trends in workforce data to forecast hiring needs, optimize staffing, and support strategic planning.

7. Administrative Tasks
a. AI automates routine HR tasks like payroll, attendance tracking, and benefits administration, freeing up HR professionals for more strategic work.



Benefits of AI in HRM

1. Increased efficiency and accuracy
2. Better candidate and employee experiences
3. Data-driven decision-making

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4. Cost savings over time
5. Challenges and Considerations
6. Data privacy and ethical concerns
7. Risk of bias in AI algorithms
8. Need for transparency and explainability
9. Integration with existing HR systems

Challenges:-

1. Bias and Fairness
2. Data Privacy and Security
3. Lack of Transparency (Black Box Problem)
4. Job Displacement Concerns
5. Ethical Concerns
6. Integration with Existing Systems

HRM automation with AI:-

HRM (Human Resource Management) automation with AI involves using artificial intelligence technologies to streamline, optimize, and enhance various HR functions. This not only reduces manual effort but also improves accuracy, decision-making, and employee experience.

Key Areas of HRM Automation Using AI

1. **Recruitment & Talent Acquisition**
   a. Resume Screening: AI scans resumes and ranks candidates based on qualifications.
   b. Chatbots: Provide instant answers to candidate queries and schedule interviews.
   c. Video Interview Analysis: AI evaluates tone, body language, and word choice for initial assessments.
2. **Onboarding:-**
   a. Automated Workflows: AI handles document collection, training schedules, and system access.
   b. Virtual Assistants: Guide new hires through onboarding, answer FAQs, and provide resources.

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3. **Employee Management**
   a,Performance Tracking: AI analyzes productivity data to provide real-time performance insights.
   b. Predictive Analytics: Forecasts employee turnover and identifies high-potential employees.
4. **Learning & Development**
   a. Personalized Learning Paths: AI curates training content based on employee roles and skills gaps.
   b. Skill Gap Analysis: Identifies what training is needed for individual growth or organizational goals.
5. **Payroll & Benefits**
   a,Automated Payroll Processing: Reduces errors and ensures compliance with regulations.
   b.AI Chatbots for Queries: Answer employee questions about pay, leave balances, or benefits 24/7.
6. **Employee Engagement**
   a. Sentiment Analysis: Monitors emails, feedback, or surveys to detect morale or satisfaction levels.
   b. Survey Automation: Collects and analyzes employee feedback continuously
7. **Compliance & Risk Management**
   a. Automated Auditing: AI flags anomalies or non-compliance in HR policies and processes.
   b. Document Management: Tracks and updates policy documents in line with legal changes.

Benefits of AI in HRM:-

1. Reduced administrative burden
2. Faster and smarter hiring
3. Improved employee experience
4. Better decision-making through data-driven insights
5. Lower turnover due to proactive management

Challenges:-

1. Data Privacy and Security

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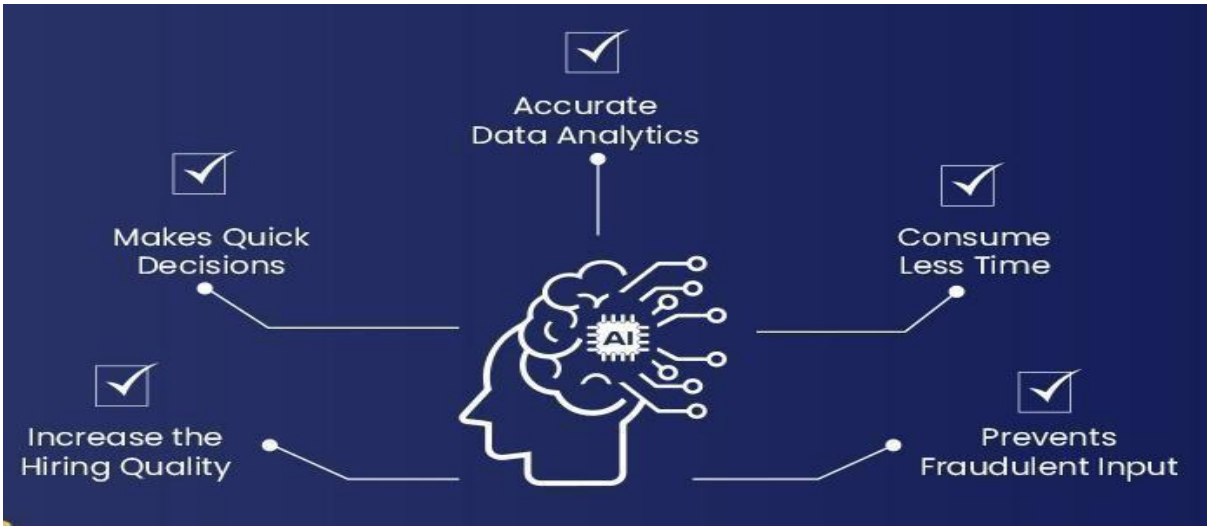
2. Bias and Fairness
3. Lack of Transparency ("Black Box" Problem)
4. Integration with Legacy Systems
5. Change Management and Employee Resistance

Talent acquisition with AI:-

Talent acquisition with AI refers to the use of artificial intelligence technologies to improve and streamline the recruitment process. AI can assist HR professionals and recruiters by automating repetitive tasks, improving candidate matching, and providing data-driven insights. Here's a breakdown of how AI is transforming talent acquisition:



Key Applications of AI in Talent Acquisition:-

1. **Resume Screening & Shortlisting**

a. AI can scan thousands of resumes quickly, ranking candidates based on qualifications, experience, and job fit.

b. Natural language processing (NLP) helps interpret resume content beyond keyword matching.

2. **Candidate Sourcing**

a. AI-powered platforms (e.g., LinkedIn Recruiter, Entelo) can identify passive candidates by analyzing profiles, activity, and professional networks.

3. **Chatbots & Virtual Assistants**

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a. AI chatbots engage with candidates in real time, answering questions,scheduling interviews, and collecting preliminary information.

4. **Predictive Analytics**

a. AI models can predict candidate success or retention likelihood based on historical hiring and performance data.

5. **Bias Reduction (with caveats)**

a. Properly designed AI tools can help reduce unconscious bias by anonymizing resumes or standardizing evaluations—though poorly designed models can samplify existing biases.

Benefits:

1. Faster hiring process
2. Improved quality of hire
3. Reduced recruitment costs
4. Better candidate experience
5. Enhanced diversity initiatives (if done correctly)

Challenges & Risks:

a. **Bias and fairness:** AI can reflect or amplify biases if trained on skewed historical data.

b. **Lack of transparency:** Black-box algorithms may make decisions that are hard to explain.

c. **Compliance:** GDPR and other data privacy laws restrict automated decision-making.

d. **Over-reliance on automation:** Human oversight is essential to interpret and

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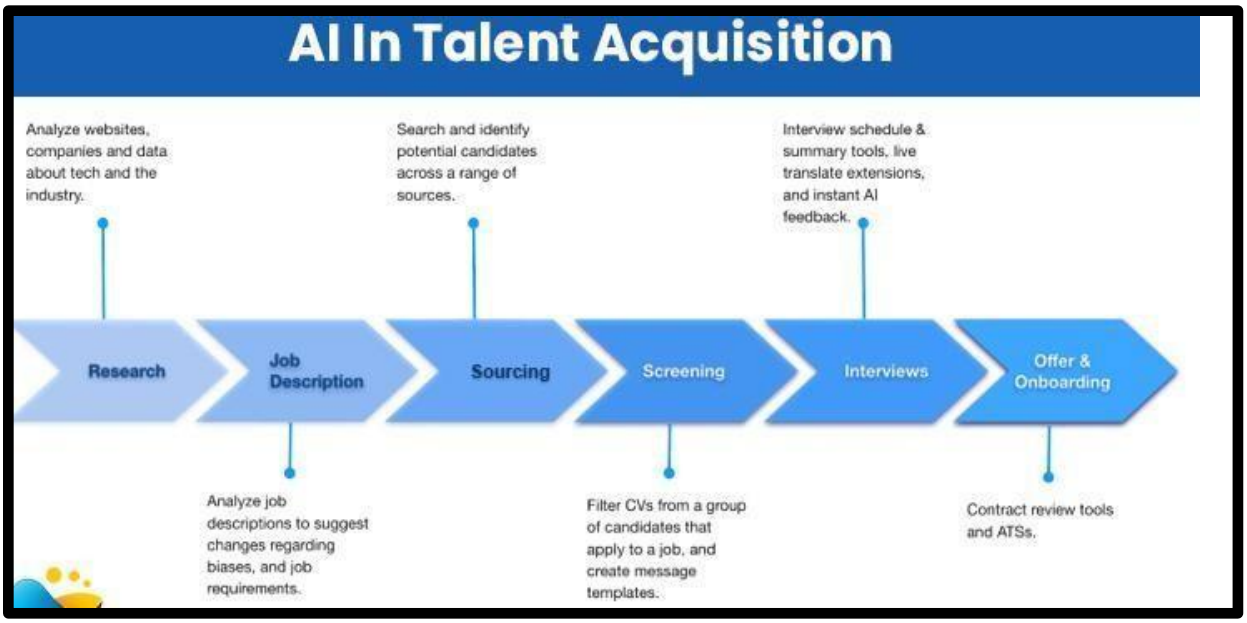
contextualize AI outputs.



Chatbots in recruitment,Workforce analytics with AI

Here's a concise overview of **chatbots in recruitment** and **workforce analytics with AI**, highlighting their roles, benefits, and use cases.

Chatbots in Recruitment

a.What They Are:

Recruitment chatbots are AI-driven tools designed to automate and streamline parts of the hiring process by engaging with candidates in real time.

b. Key Functions:

Screening candidates: Chatbots can ask preliminary questions and assess eligibility

Scheduling interviews: Automate coordination between candidates and recruiters.

Answering FAQs: Provide instant responses to common questions about job roles, benefits, etc.

Engagement: Keep candidates updated and engaged throughout the process.

Benefits:-

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1. **Time-saving:** Reduces recruiter workload.
2. **24/7 availability:** Candidates can interact at their convenience.
3. **Improved candidate experience:** Fast responses and consistent communication.
4. **Bias reduction:** Standardized interactions help reduce unconscious bias.

Examples:
Mya – AI chatbot that screens candidates.
Olivia (Paradox) – Automates interview scheduling and candidate engagement.

Workforce Analytics with AI

a. **What It Is:**
Workforce analytics involves using AI and machine learning to analyze employee data for better decision-making in HR and operations.

b. **Applications:-**
i.Predictive analytics: Forecast turnover, absenteeism, or performance. ii.**Talent management:** Identify high-potential employees and skill gaps. iii.**Workforce planning:** Optimize hiring and scheduling based on business needs. iv.**Employee engagement analysis:** Analyze sentiment and engagement through surveys, emails, or platforms like Slack.

c,Benefits:-
1,Data-driven decisions: Move from intuition to insights.
2.Proactive problem-solving: Identify issues before they impact the business.
3.Improved performance management: Tailor development plans based on insights.
4.Cost optimization: Better resource allocation and planning.

d,**Tools:**
Visier, SAP SuccessFactors, IBM Watson Talent Insights – Offer advanced workforce analytics.

Challenges:-
1.Bias in Screening: Chatbots may inherit biases from training data, affecting fairness.

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2. **Limited Context Understanding:** Difficulty in interpreting complex answers or unusual profiles.
3. **Privacy Concerns:** Handling personal candidate data responsibly is critical.
4. **Integration Issues:** Syncing chatbot functionality with Applicant Tracking Systems (ATS) can be complex.

Predictive analytics with AI:-

Predictive analytics with AI involves using machine learning and artificial intelligence techniques to forecast future outcomes based on historical data. It enables businesses and organizations to make data-driven decisions by identifying patterns, trends, and likely future events.

What It Involves:

1. **Data Collection**: Gathering relevant historical data from various sources (e.g., customer transactions, sensor data, web activity).
2. **Data Preparation**: Cleaning and organizing data to make it suitable for modeling.
3. **Feature Engineering**: Selecting or creating variables (features) that best represent the data for prediction.
4. **Model Building**: Using AI/ML algorithms (like decision trees, neural networks, or regression models) to find patterns in the data.
5. **Model Evaluation**: Testing the model's accuracy using metrics like RMSE (Root Mean Squared Error), AUC-ROC, precision, recall, etc.
6. **Deployment & Monitoring**: Putting the model into use and continuously monitoring its performance to ensure it stays accurate.

Common AI Techniques Used:

- **Machine Learning** (e.g., Random Forests, SVM, Gradient Boosting)
- **Deep Learning** (e.g., LSTM for time series forecasting, CNNs for image-based predictions)
- **Natural Language Processing (NLP)** (for text-based predictions)
- **Reinforcement Learning** (less common, but used for dynamic environments)

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Real-World Use Cases:

- **Retail**: Forecasting sales or customer churn
- **Finance**: Credit scoring and fraud detection
- **Healthcare**: Predicting disease outbreaks or patient readmission
- **Manufacturing**: Predictive maintenance on equipment
- **Marketing**: Campaign success prediction, customer lifetime value (CLV)

Benefits:

1. Improved decision-making
2. Cost savings through optimization
3. Risk mitigation
4. Personalization of services

Key Challenges:-

1. Data Quality and Availability
2. Data Privacy and Security
3. Bias in Algorithms
4. Model Interpretability
5. Dynamic and Changing Environments

Conclusion:-

AI is reshaping HRM by introducing automation, intelligence, and personalization into HR processes. While the potential benefits are significant, organizations must carefully address the ethical, technical, and regulatory challenges. A balanced approach that combines human intuition with machine intelligence is essential for the responsible and effective use of AI in HRM.AI holds transformative potential for HRM, offering both operational and strategic advantages. However, to unlock its full potential, organizations must address ethical, technical, and human-centric challenges. A balanced approach integrating human judgment and AI capabilities is essential.

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Artificial Intelligence in Quality Circle

[1*]Samyak S. Gangurde, [2]Dr. Girish M. Ahire

[1*] Research scholar, Institute of Management Research and Technology,
Nashik, Maharashtra, India. (Affiliated to Savitribai Phule Pune University, Pune)
*Corresponding author: Email: samyakgangurde1234@gmail.com
[2] Associate Professor, Department of Management Studies,
Institute of Management Research and Technology,
Nashik, Maharashtra, India. (Affiliated to Savitribai Phule Pune University, Pune)

Abstract

In the period of liberalization and globalization of world economies, new set of challenges have arisen focused on Quality of products, processes along with customer focus. Quality management approach is an important tool which holds the key to competitiveness in the global market irrespective of the size of the company. It is an integrated management approach that continuously aim to improve the performance of products, processes, and services to achieve customer's expectations. One of the means to achieve the world-class quality is through the practices of quality circle. A group of employees who perform similar duties and meet at periodic intervals, often with management, to discuss work-related issues and to offer suggestions and ideas for improvements, as in production methods or Quality control, called Quality circle. In Quality Circle (QC), employees usually work in the same areas, and voluntarily meet on a regular basis to identify, analyze and solve their problems by using human brains and intelligence. Collection of the data and analysing the data manually is somewhat time-consuming and error-prone activity. Artificial Intelligence (AI) can be used to reduce the time and increase the accuracy. In this paper, the use of Artificial Intelligence (AI) in quality circle to analyse the huge data collected and to represent the data analysis to showcase the causes and effects on the quality performance of the product or process.

Keywords: *Quality circle, Artificial Intelligence, Quality Tools*

I. INTRODUCTION

e-ISSN- 3067-0977

K. Ishikawa introduced the quality control circle (QCC) in 1962 with the Japanese Union of Scientists and Engineers (JUSE). Nippon Wireless and Telegraph Company was the first company to implement the concept of QCC was in 1962 at PT Z Company to analyze the effect of QCC on employee work productivity. Dr. J.M. Juran and Dr. E.W. Deming initiated QCC in Japan voluntarily to conduct a quality control activity at the workplace with using quality control tools and problem-solving processes (Fipiana & Susanto, 2019). Quality circles are a participative technique that allows employees to have input into issues at work (Pereira & Osburn 2007; Cotton et al. 1988; Spector 2006). QCs typically consist of a group of coworkers in similar jobs that meet frequently to improve work problems. The group uses statistical and problem-solving techniques to recommend solutions to management. In traditional quality circle program, the quality circle members meet regularly to solve the problems by using human brains and intelligence. The steps in quality circle is shown in Fig.1. Quality management tools are essential ingredients of a process and basic instruments for the success of a quality program (Sokovic et.al., 2009). Some of the basic quality tools are: Pareto diagram, check sheet, control chart, histogram, scatter diagram, flow chart & cause-and-effect diagram. These tools also help the quality engineer to use accessible data in decision processes. According to European Organisation for Quality, the process of data acquisitions includes three tools (Check sheet, Histogram and Control chart), and the process of analysis another four tools (Pareto diagram, Cause and effect diagram, Scatter plot, and Flow chart). Collection of the data and analysing the data manually is somewhat time- consuming activity. To reduce the time and increase the accuracy Artificial Intelligence (AI) can be used.

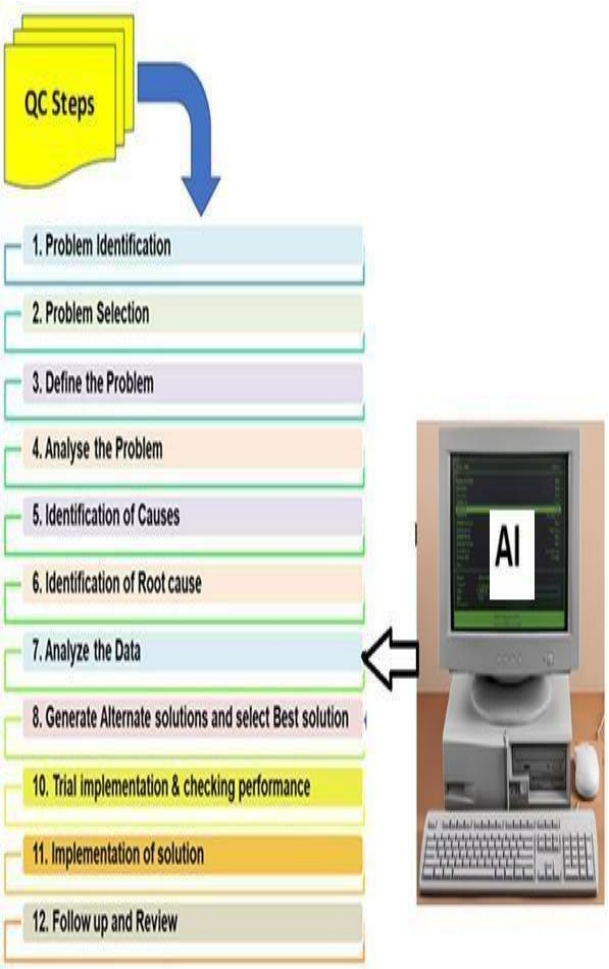

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Fig.1. Steps in quality circle

Artificial Intelligence is generally considered to be concerned with applying computers to tasks that require knowledge, perception, reasoning, understanding, and cognitive abilities. John McCarthy, the father of Artificial Intelligence, defined it as "The science and engineering of making intelligent machines, especially intelligent computer programs". Now a days Artificial Intelligence (AI) and Robotics are the emerging areas in the field of medicine, manufacturing, military, and household applications. The usage of robots and machine learning is grown up in these areas. The AI method employed should be able to receive information, organize, build up knowledge, and use it efficiently such that it is understood by the people who provide the information and should be able to modify in order to correct the errors arising in the buildup process. (Reddy & Reddy, 2017). AI is used in quality circles to analyse the data generated, to detect the issues(problem) at early stage, to improve the efficiency and to enhance the accuracy. It also provides the basis for appropriate decision making based on the data analysed. AI can be used in manufacturing industries to analyse images of products to detect defects with greater accuracy than traditional methods. AI can be used in supply chain management to ensure consistent product quality across the entire supply chain as well as to evaluate and monitor performance of the vendors. AI can also be used in pharmaceutical industries to increase the speed of inspections in drug manufacturing processes with the accuracy and safety.

II. AI IN QUALITY CIRCLES

AI in quality circles leverages artificial intelligence and machine learning to enhance quality improvement efforts by automating tasks, analysing data, and identifying patterns that might be missed by humans. This results in a more efficient and effective problem-solving process for quality circles. Modern quality circles will likely incorporate artificial intelligence tools for data analysis while maintaining their fundamental focus on employee-driven improvements. This evolution ensures their relevance in Industry 4.0 environments. The application of AI in quality circles is shown in Fig.2.

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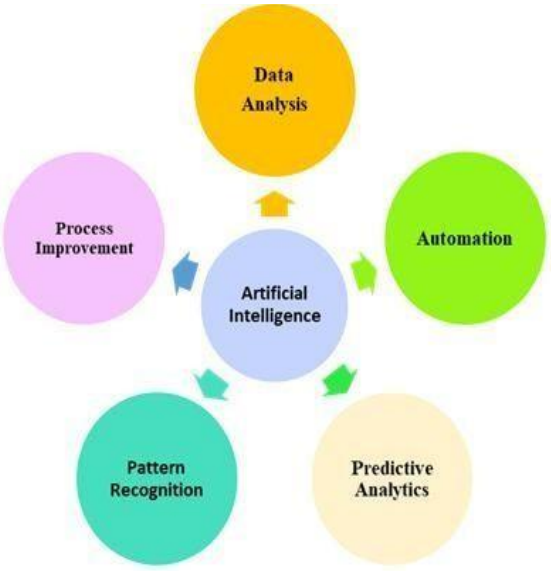

Fig.2. Application of AI in quality circle

Data Analysis:

AI algorithms can collect large amounts of data and analyse all the data in real-time, and identifying patterns. This allows for early detection of defects, reduced waste, and improved product quality. AI can automate tasks related to data quality, such as data validation and storage, ensuring data integrity throughout the quality circle process. It can be used as to carry out 'Pareto analysis' based on 80-20 principle (Fig.3). It helps to focus on few causes (20%) that lead to most of the problems (80%). Thus, the quality circle members may focus on these few causes to solve the problems effectively with less efforts and minimum time. It can also be used to show the frequency distribution of numerical data by creating 'Histogram' (Fig.3) to show the spread of the data and the data is normally distributed or skewed distributed or bimodal distribution or uniform distribution.

Automation:

AI can automate tasks such as data ingestion, validation, and storage, ensuring data quality throughout the process. This frees up quality circle members to focus on more strategic problem-solving. It can be used to monitor process variation over time. It helps to distinguish between normal process variation and abnormal variation. This may help to construct 'control charts' (Fig.3) in predicting process performance.

Predictive Analytics:

Generative AI can be used to create predictive models that learn from historical data and provide actionable insights for future operations. This helps organizations optimize quality processes and prevent problems from occurring in the first place. It may predict a continuous value based on independent variables and predicts the probability of categorial outcome. It also measures the relationship strength and direction between two variables. It also carries out time series analysis to analyse time ordered data points to forecast future values.

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Pattern Recognition:

AI can automate pattern recognition, allowing quality circles to access and analyse a multitude of social media analytics and data points to identify trends and insights.

Process Improvement:

AI can be used to optimize various processes within a quality circle, such as problem-solving, root cause analysis, and implementation of solutions. It can be used to show the relationship between two variables with the help of creating 'scatter diagram'(Fig.3) which assists qc member to understand potential cause and effect relationship in process. Scatter diagrams can reveal positive, negative, or no correlation.

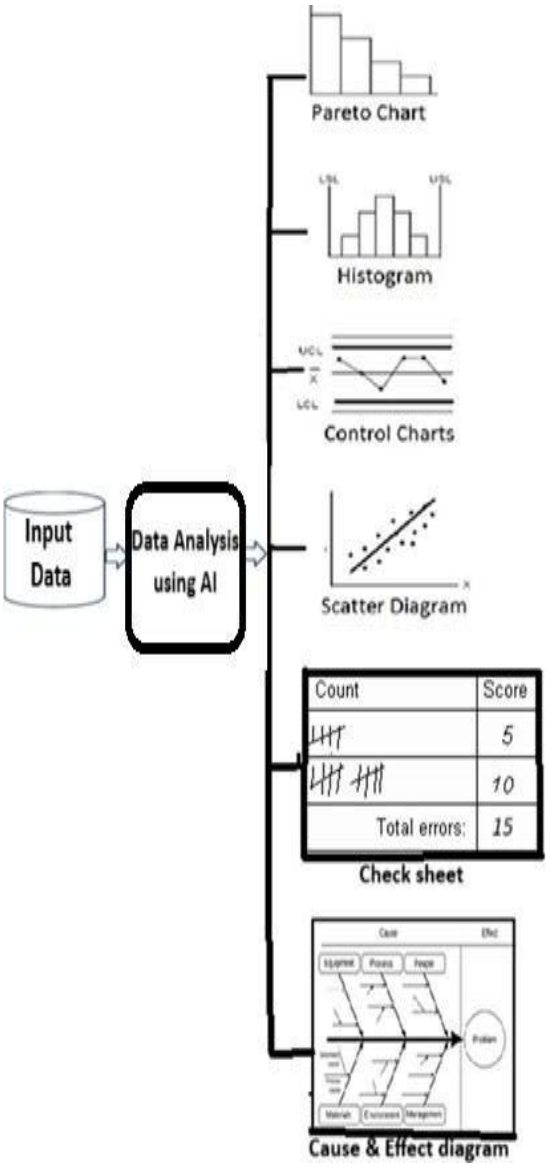

Fig.3. Generation of QC tools using AI

III. CONCLUSION

Artificial intelligence analyses the data very fast thus saving time and resources for quality circle members. AI identifies quality problems accurately and provides the patterns for further action taken. AI can identify potential issues early in the process, allowing for proactive measures to prevent defects and improve quality. After

e-ISSN- 3067-0977

analysis of the data, AI provides data-driven pictorial presentation in form of graph, histogram, control charts etc. which provides the basis for quality circle members to take the corrective decisions related to the problem arises and rectify the problem at early stage. Pareto diagram, histogram, control charts, scatter plot, cause-and-effect diagram and check sheet can be used for problem identification as well as problem analysis. The problem-solving efforts can be minimized effectively by using AI tools. As the data is provided by the AI tools, the conflict (if any) among the quality circle members is resolved and which improves better collaboration and communication among quality circle members, leading to more effective teamwork. The whole process of quality circle from problem identification to action plan acceptance is carried out in very short time using AI tools.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
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RESEARCH AND INNOVATION

AI-Driven Smart HR Systems Integrated with Biometric Attendance for Workforce Optimization

Dr Varsha N Bhabad
Assistant Professor & Research Guide, MVP's IMRT Nashik.

Seema Manikrao Jadhav
Assistant Professor, MVP's IMRT Nashik

Abstract:

This paper explores the integration of Artificial Intelligence (AI) with biometric attendance systems to enhance Human Resource (HR) management practices. Traditional HR methods often face challenges such as time theft, manual errors, and inefficiencies in attendance tracking. By leveraging AI algorithms and biometric technologies like facial recognition and fingerprint scanning, organizations can automate attendance monitoring, reduce fraud, and gain real-time insights into workforce dynamics. This study examines the technical frameworks, benefits, challenges, and ethical considerations associated with implementing AI-powered biometric attendance systems in HR departments in various sectors.

Introduction:

The evolution of HR practices has seen a significant shift towards automation and data-driven decision-making. Biometric attendance systems, which utilize unique physiological characteristics for identification, have replaced traditional methods like manual registers and RFID cards. Integrating AI with these systems can further optimize HR functions by providing predictive analytics, enhancing security, and improving employee engagement.

Objectives:

1. **To analyse** the impact of AI-integrated biometric attendance systems on HR efficiency.
2. **To evaluate** the accuracy and reliability of various biometric modalities (e.g., facial recognition, fingerprint scanning) in attendance tracking.
3. **To identify** the challenges and limitations associated with implementing such integrated systems.
4. **To propose** best practices for organizations considering the adoption of AI-driven biometric attendance solutions.

Literature Review:

Traditional Attendance Systems

Traditional methods of attendance tracking, such as manual registers and RFID-based card systems, have long been used in organizations. While simple and cost-effective, these systems are vulnerable to human error, proxy attendance (buddy punching), and manipulation. Studies have shown that such

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systems often result in inaccurate records and decreased employee accountability, leading to inefficiencies in HR management (Selvi et al., 2018).

Biometric Attendance Systems

To address the shortcomings of traditional systems, biometric technologies such as fingerprint scanning, iris recognition, and facial recognition have been introduced. These systems leverage unique physiological traits to accurately identify individuals, reducing the possibility of fraudulent attendance. Research indicates that biometric systems significantly improve accuracy and accountability in workforce management (Nguyen-Tat et al., 2024). However, they may still require manual oversight and are susceptible to hardware limitations and environmental factors.

AI in HR

Artificial Intelligence is transforming HR practices by introducing automation and data-driven decision-making. Applications include predictive analytics for talent acquisition, performance tracking, sentiment analysis, and workforce planning. AI models can analyze large volumes of HR data to uncover trends and patterns that support strategic decisions. This shift has enabled HR departments to become more proactive and aligned with business goals (Ahmed et al., 2025).

Integration of AI and Biometrics

The convergence of AI and biometric technologies marks a new era in smart HR systems. AI enhances biometric systems by improving recognition accuracy (e.g., through deep learning), enabling liveness detection to prevent spoofing, and offering predictive insights into employee behavior. This integration not only automates attendance management but also enables real-time monitoring, forecasting of absenteeism, and detection of anomalies without manual intervention. Such systems offer a scalable, secure, and intelligent solution to optimize workforce management.

Latest Technologies Related to the Topic:

1. **Deep Learning for Facial Recognition:** Advanced algorithms improve accuracy in varied lighting and angles.
2. **Edge Computing:** Processing data locally reduces latency and enhances real-time decision-making.
3. **Liveness Detection:** Ensures that the biometric sample is from a live person, preventing spoofing.
4. **Blockchain for Data Integrity:** Secures attendance records, making them tamper-proof.
5. **Federated Learning:** Allows AI models to be trained across decentralized devices, enhancing privacy.

Analysis:

Case Study: Implementation of AI-Integrated Biometric Attendance at TechNova Pvt. Ltd.

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TechNova Pvt. Ltd., a mid-sized IT services company with 1,200 employees across three offices, deployed an AI-powered biometric attendance system in 2023. The initiative aimed to streamline attendance tracking, reduce administrative overhead, and optimize workforce management.

System Architecture

The system consisted of:

- Biometric Devices: Facial recognition terminals installed at all entry points, connected via secure LAN.
- AI Module: A deep learning-based facial recognition engine deployed on an edge server, integrated with a liveness detection module.
- HRMS Integration: Biometric data synchronized in real-time with the company's existing HR Management System (Zoho People) via RESTful APIs.

The architecture allowed automated attendance logging and real-time flagging of anomalies (e.g., repeated missed check-ins).

Data Flow

1. Capture: As employees entered the building, facial images were captured by the camera.
2. Preprocessing: Images were cleaned and normalized before feature extraction.
3. Recognition: AI algorithms matched the image with stored biometric templates.
4. Validation: Liveness detection confirmed it was not a spoof attempt.
5. Logging: Upon successful validation, a timestamped attendance log was sent to the HRMS.
6. Analytics: The AI engine generated weekly reports on attendance patterns, lateness, and absenteeism risk.

Real-World Outcome

- **Absenteeism** dropped by 18%, as real-time tracking discouraged casual time-off abuse.
- **HR efficiency** improved, freeing up 25% of HR staff time previously spent on attendance management.
- **Employee Feedback:** 82% of employees appreciated the reduced manual sign-in process, though some initially expressed privacy concerns, which were addressed by transparent communication and secure data handling protocols.

Conclusion:

e-ISSN- 3067-0977

Integrating AI with biometric attendance systems offers significant advantages in HR management, including increased accuracy, reduced fraud, and enhanced operational efficiency. However, challenges such as data privacy concerns, system integration complexities, and employee acceptance must be addressed. Organizations should consider these factors and adopt a phased approach to implementation, ensuring that the technology aligns with their specific HR needs and infrastructure.

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e-ISSN- 3067-0977

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AI in Healthcare Business Models

Swapnil Ramesh Kor

Research Scholar
Phone: +918698815343

Guides Name: Dr. Prashant B. Suryawanshi
Director, MVP's IMRT, Nashik

e-ISSN- 3067-0977

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Abstract

Artificial Intelligence (AI) has emerged as a transformative force across various sectors, with healthcare being one of the most promising beneficiaries. In India, AI integration into healthcare business models is enabling new forms of service delivery, diagnosis, and patient management, particularly addressing challenges in rural and underserved areas. This paper explores the evolving landscape of AI-powered healthcare business models in the Indian context, discusses key opportunities and innovations, and highlights the challenges that could impact their scalability and ethical deployment. Through selected Indian case studies and policy insights, the paper offers recommendations to support sustainable and inclusive AI adoption in Indian healthcare. As India moves toward digitizing its healthcare infrastructure, AI can play a pivotal role in addressing access disparities, improving efficiency, and lowering costs—if adopted responsibly.

Keywords

AI, Healthcare Business Models, India, Machine Learning, Telemedicine, HealthTech, Digital Health

1. Introduction

India's healthcare system, though rapidly evolving, continues to face challenges of accessibility, affordability, and quality. With a doctor-patient ratio far below the World Health Organization (WHO) recommendations and over 65% of the population residing in rural areas, healthcare delivery in India remains uneven and fragmented. Artificial Intelligence (AI) has emerged as a disruptive tool capable of redefining healthcare business models through automation, intelligent diagnostics, and personalized medicine.

Post-COVID-19, India has seen a surge in HealthTech adoption, driven by startups, public-private partnerships, and government initiatives such as the Ayushman Bharat Digital Mission (ABDM). These developments have opened doors for AI to become a key enabler of innovation in how healthcare is delivered, accessed, and financed. This paper investigates how AI is reshaping healthcare business models in India, highlighting emerging trends, use cases, opportunities, and concerns.

2. AI in Healthcare: An Overview

AI in healthcare includes various technologies such as Machine Learning (ML), Deep Learning (DL), Natural Language Processing (NLP), and Computer Vision. These technologies are used in diagnostics, clinical decision-making, drug discovery, predictive analytics, and even robotic surgery. Globally, AI tools are being applied to early detection of diseases, drug repurposing, medical imaging, and remote monitoring of patients.

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In India, the adoption of AI is steadily increasing, although still in its nascent stages. The emergence of low-cost cloud computing and access to digital records has made it easier to deploy AI-based applications even in tier-2 and tier-3 cities. The National Strategy for Artificial Intelligence by NITI Aayog (2018) recognizes healthcare as one of the top five focus areas for AI-led innovation in India.

3. Emerging AI-Powered Healthcare Business Models in India

3.1 Telemedicine and Remote Care

The telemedicine model has gained significant momentum in India post-2020, with AI playing a central role in remote diagnostics, chatbots, and symptom checkers. Startups like **Practo**, **MFine**, and **Tata Health** use AI to triage patients and suggest treatment pathways. These platforms enable virtual consultations, prescription management, and patient follow-ups, drastically reducing travel costs and wait times for patients in rural areas.

3.2 AI in Diagnostics

Companies like **Qure.ai** and **Niramai** have revolutionized diagnostic care by using deep learning to interpret medical scans. Qure.ai's solutions are used in over 50 countries and have been adopted by the Indian government for tuberculosis screening. Niramai's AI-based breast cancer screening is non-invasive and portable, ideal for community health programs.

3.3 Predictive and Preventive Healthcare

Platforms like **HealthifyMe** use AI-powered coaches that predict health outcomes based on dietary patterns and fitness levels. These models aid in preventing lifestyle diseases such as diabetes and hypertension, contributing to long-term patient well-being and reducing the burden on healthcare facilities.

3.4 Drug Discovery and Clinical Trials

AI tools are being used by Indian pharmaceutical firms and research institutions to accelerate drug discovery. Startups like **Sapio Analytics** are experimenting with data-driven models to identify new drug compounds and predict patient responses in clinical trials, which traditionally take years and cost millions.

3.5 Health Insurance and Risk Scoring

Insurers like **ICICI Lombard** and **Star Health** are piloting AI tools for customer onboarding, claims automation, and fraud detection. These tools assess risk profiles based on lifestyle data and medical histories, offering dynamic premiums and quicker claim resolutions.

3.6 Hospital-as-a-Platform Model

e-ISSN- 3067-0977

AI-driven digital transformation is enabling hospitals to function as integrated platforms offering diagnostics, treatment, pharmacy, and wellness services. Cloud-based EHRs and AI-led patient monitoring allow hospitals to enhance operational efficiency and patient satisfaction.

4. Opportunities in the Indian Context

4.1 Rural Health Enablement

AI-powered mobile diagnostic vans, voice-assisted chatbots in regional languages, and teleconsultation services help bridge the urban-rural divide in healthcare access. These models are scalable and do not rely heavily on physical infrastructure.

4.2 Cost-Effective Scaling

AI allows service providers to scale operations at a lower cost. Tools like automated appointment scheduling, inventory management, and AI-assisted diagnostics can dramatically reduce administrative overheads and human error.

4.3 Public Health Surveillance

AI can assist in epidemiological mapping and real-time disease tracking. During the COVID-19 pandemic, AI tools were used to predict outbreak patterns and assist in containment strategies.

4.4 Integration with National Digital Health Stack

With over 250 million people already linked to the ABDM, AI has an opportunity to tap into this digital ecosystem to offer personalized and population-level health insights.

5. Challenges and Ethical Considerations

5.1 Data Privacy and Cybersecurity

India's Personal Data Protection Bill is still under development, and there are no stringent laws specifically addressing health data. Breaches can lead to misuse of sensitive data and erode public trust.

5.2 Algorithmic Bias and Explainability

AI algorithms may not be transparent or trained on diverse Indian datasets. This can lead to biased outputs, especially for minority or underrepresented groups. Explainability is crucial in clinical decision-making where lives are at stake.

5.3 Digital Divide and Infrastructure Gaps

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Digital literacy and reliable internet connectivity are still lacking in many parts of rural India. Without foundational infrastructure, AI models remain inaccessible.

5.4 Ethical Dilemmas

Who is responsible when an AI misdiagnoses a patient? How do we ensure informed consent in automated decision-making? These ethical questions remain unanswered and require immediate policy attention.

6. Indian Case Studies

6.1 Qure.ai

Qure.ai's solutions are used by over 20 state governments in India. Their AI radiology tool "qXR" screens for TB and COVID-19 using chest X-rays. Its deployment in primary health centers has significantly improved early detection rates.

6.2 Niramai

Niramai's AI-powered Thermalytix technology is used in over 30 hospitals across India and has screened more than 70,000 women. It has received grants from the Gates Foundation and the Department of Biotechnology, India.

6.3 Swasth Alliance

Swasth is a consortium of 100+ HealthTech organizations creating open digital standards for AI integration. They work closely with the ABDM to promote interoperability and reduce fragmentation.

6.4 1mg Labs (Tata 1mg)

AI is used for backend automation in lab diagnostics, improving turnaround time for pathology reports and enabling predictive analytics for preventive healthcare packages.

7. Recommendations

- **Regulatory Clarity**: Expedite AI regulations under the forthcoming Digital India Act, covering data protection, clinical validation, and liability frameworks.
- **Ethics-by-Design**: Embed fairness, transparency, and explainability into AI solutions from development to deployment.
- **Capacity Building**: Introduce AI and Health Informatics in medical and technical education curricula to build a future-ready workforce.
- **Public-Private Partnerships**: Encourage co-innovation among startups, hospitals, academia, and government bodies.

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- **Incentives for Tier-2/3 Deployment**: Offer grants and tax incentives for AI implementation in underserved regions.

8. Conclusion

AI holds transformative potential to reimagine healthcare business models in India by improving efficiency, access, and affordability. However, it must be adopted responsibly, with safeguards for privacy, transparency, and inclusivity. With supportive policy frameworks and collaborative innovation, AI can help build a more equitable and resilient Indian healthcare system.

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Investigating the Influence of Artificial Intelligence on Student Happiness in Modern Education

Swati Uddhav Mahajan

Maratha Vidya Prasarak Samaj Institute of Management Research And Technology, Nashik

Dr. Gaikwad Sanjay Annasaheb

Maratha Vidya Prasarak Samaj Institute of Management Research And Technology, Nashik

Abstract:

This study examines how artificial intelligence (AI) technologies affect students' emotional health and general contentment, which is referred to as their Happiness Quotient (HQ) in modern learning environments. Evaluating the psychological effects of tailored, AI-powered learning technologies is crucial given their quick spread. The study assesses whether AI-based tutoring platforms, intelligent virtual assistants, and adaptive systems significantly increase student satisfaction. AI integration and higher HQ are significantly correlated, according to a mixed-method approach that includes surveys, interviews, and case studies from different educational institutions. The main conclusions point to increases in learner autonomy, engagement, and a decrease in academic stress.

According to this study, when carefully incorporated into learning environments, artificial intelligence (AI) technology can have a good impact on students' emotional health, which is gauged by the Happiness Quotient (HQ), in addition to their academic achievement. AI solutions boost student engagement, lessen academic stress, and provide learners more autonomy by providing intelligent support, adaptive learning pathways, and individualized feedback.

Keywords: Artificial Intelligence, Happiness Quotient, Student Well-being, Educational Technology, Adaptive Learning, Emotional Intelligence.

Introduction

Artificial intelligence has opened up revolutionary potential for educational systems by facilitating data-driven customisation, real-time feedback, and improved administrative

e-ISSN- 3067-0977

assistance. Prior research has mostly concentrated on academic results and performance improvement, but the emotional and psychological effects of AI use have received less attention. The multifaceted Happiness Quotient (HQ), which measures emotional contentment, perceived support, and motivation, is becoming a crucial metric for evaluating the caliber of education. In order to close the gap between academic technology and emotional intelligence, this research will investigate how AI-enhanced learning affects students' HQ.

Background:

Artificial Intelligence (AI) has changed the way teaching and learning processes are planned and carried out in education in recent years, moving from experimental innovation to real-world application. AI tools like virtual teaching assistants, intelligent tutoring programs, and adaptive learning platforms are being used more and more to provide data-driven, individualized learning experiences. By offering personalized content, real-time feedback, and adaptable learning pathways, these tools help universities meet the needs of each individual student.

Academic performance, efficiency improvements, and instructional effectiveness have been the focus of a large portion of the research that has already been done on AI in education. Even though these elements are unquestionably significant, they fall short of capturing the whole educational experience, especially the potential emotional and psychological effects of technology on students. Examining how AI impacts students as both intellectual and emotional beings is crucial as education changes to become more learner-centric.
A crucial but little-studied factor in the assessment of educational technology is emotional well-being, which is frequently connected to student motivation, engagement, and stress management. Emotional contentment, perceived support, and personal fulfillment are all included in the Happiness Quotient (HQ), which provides a useful framework for evaluating the non-academic effects of integrating AI in education.

This study aims to investigate the connection between student satisfaction and AI-driven learning environments. The study intends to provide insight on how developing technologies can promote or impede psychological well-being by examining how AI tools affect students' emotional experiences. Designing AI systems that not only improve academic performance

e-ISSN- 3067-0977

but also create a constructive, encouraging, and emotionally stimulating learning environment requires an understanding of this relationship.

REVIEW OF LITERATURE:

As educational institutions look to improve learning through technological innovation, the use of artificial intelligence (AI) in the classroom has drawn more scholarly interest. Many educational methodologies now heavily rely on AI-powered tools like virtual instructors, adaptive learning platforms, and intelligent feedback mechanisms. By tailoring information to each learner's needs, these tools enhance individualized training, increasing productivity and raising academic achievement. A comprehensive review of AI adoption in education worldwide was given by Hwang et al. (2020), who emphasized how these technologies have the ability to revolutionize learning through automation and personalization.

Numerous research have shown how AI-enhanced learning environments improve academic performance. Baker (2016) demonstrates how AI may support individualized education, allowing students to advance at their own speed and in accordance with their individual skills. In a similar vein, D'Mello and Graesser (2015) investigated affect-aware learning technologies and proposed that cognitive state-detecting systems could improve student retention and instructional delivery. These results demonstrate how AI can greatly enhance learning outcomes by matching instructional tactics with student-specific data.

The emotional effects of integrating AI have, however, received very little attention, despite the fact that cognitive and performance-related results have been thoroughly investigated. The psychological effects of engaging with AI are an important component of the educational process that need further consideration, especially when it comes to emotional involvement, stress reduction, and general contentment. With a focus on how these tools affect students' Happiness Quotient (HQ), this study turns the perspective toward the affective aspects of AI in learning by drawing on frameworks like emotional intelligence and positive psychology.

Basic psychology theories have highlighted the value of positive emotional experiences in teaching. Positive emotions can increase pupils' cognitive and behavioral capacities, promoting resilience and long-term well-being, according to Fredrickson's (2001) broaden-and-build hypothesis. This implies that students who experience emotional support are more likely to succeed academically and personally in AI-mediated settings. The idea of emotional computing was first presented by Picard et al. (2004), who made the case that systems that

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are able to recognize and react to human emotions must be created. This field has the potential to improve student wellbeing in AI-powered classrooms.

Furthermore, two key elements of HQ, perceived pleasure and engagement, have been connected to academic success in technology-mediated and online environments. Dixson (2010) discovered a substantial correlation between learning satisfaction, motivation, and perceived efficacy and student involvement in digital courses. This implies that the emotional resonance of learning resources can have a big impact on students' overall experience when used in AI-supported situations.

Comprehensive empirical research especially addressing the emotional and psychological impacts of AI in education is still lacking in the literature, despite these theoretical advancements. Few studies have specifically examined the effects of AI tools on students' emotional resilience, sense of belonging, and pleasure in learning environments. Considering the increasing use of AI in education at all levels, this is a significant disparity.
This study attempts to address this issue by investigating the effects of AI technology on students' emotional health, paying special emphasis to autonomy, stress, and engagement. Building on prior research, this study examines the relationship between the Happiness Quotient and AI integration, addressing the emotional aspects of educational technology that are often overlooked.

Methodology:

This study used a triangulated mixed-method approach to thoroughly investigate how Artificial Intelligence (AI) affects students' Happiness Quotient (HQ) in educational contexts. In order to capture the complex effects of AI-based learning environments on students' well-being, the study used quantitative and qualitative methods.
The Quantitative Component:
A sample of 500 students from secondary and tertiary educational institutions that actively use AI-assisted learning platforms were given a structured questionnaire. The purpose of the survey was to assess important Happiness Quotient markers, such as academic stress, emotional involvement, learning experience satisfaction, and perceived institutional support. To find patterns and connections between the use of AI and emotional effects, responses were gathered and statistically examined.

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The Qualitative component:

Thirty students and ten faculty members participated in semi-structured interviews to obtain a deeper understanding of the subjective experiences of educators and learners. Participants' opinions of AI integration in their learning environments were investigated through interviews, with an emphasis on emotional reactions like stress, comfort, motivation, and trust. To find recurring themes and complex viewpoints on the psychological effects of AI in the classroom, the qualitative data was thematically coded.

significant associations between the use of AI and affective results.

Analysis of a Case Study

The study looked at longitudinal case studies from three academic institutions known for their pioneering use of AI systems in pedagogy, in addition to survey and interview data. To evaluate the long-term impacts of AI on academic achievement and mental health, institutional data covering several academic terms was examined. This element allowed for the investigation of practical applications and long-term results while also adding contextual depth.

A thorough grasp of how AI affects the whole student experience was made possible by the mixed-method design, which balanced quantitative trends with rich qualitative narratives by integrating data from many sources. This strategy was crucial in confirming the link between student satisfaction and AI-enhanced learning, as well as pointing out areas that require more pedagogical and technological advancement.

Results:

A number of significant trends emerged from the examination of information gathered via surveys, interviews, and institutional case studies, highlighting the influence of artificial intelligence (AI) on students' emotional health and Happiness Quotient (HQ).

Diminished Academic Stress.

Approximately 67% of survey participants said they had noticed a discernible reduction in academic strain. This decrease was explained by the adaptive features of AI learning tools, which provide real-time assistance, tailored feedback, and the freedom to advance at one's own speed. Numerous students reported that this independence reduced their performance anxiety and increased their self-assurance in handling their schoolwork.

relationship between AI-enhanced learning and student satisfaction, while also pointing up areas that require further pedagogical and technological advancement.

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Enhanced Motivation and Involvement: Student engagement has increased as a result of AI systems' incorporation of interactive and gamified elements. About 45% of participants reported feeling more motivated to engage in academic activities, with immediate feedback systems and dynamic content delivery being seen as important motivators. Interview data further supported this, as students reported feeling more engaged in their educational journeys when AI tools were used.

Increased Learning Autonomy: AI systems gave students more influence over their educational journeys, according to survey and interview data. Because AI platforms enabled them to revisit difficult subjects without outside pressure and investigate information at their own pace, learners reported better degrees of independence and self-regulation. Their sense of accomplishment and general contentment were enhanced by this more autonomy.

Early Emotional Opposition and Progressive Adjustment:
Although there was a generally positive reaction to AI-enhanced learning, several participants first reported feeling uneasy or nervous about using AI tools. Usually, these worries were connected to ignorance or doubt about AI's capacity for learning. But as time went on, the majority of students said they felt more comfortable and trusted using the platforms, particularly after receiving regular assistance and positive results.

Case Studies' Longitudinal Trends: Data collected from the three case study universities showed that academic achievement and emotional health improved gradually but steadily over time. Higher student satisfaction and reduced dropout rates were observed in institutions that actively integrated wellness tracking elements or AI-supported emotional feedback technologies. The case studies also emphasized how crucial it is to provide consistent assistance and install AI carefully in order to optimize its emotional benefits.

Summary of Key Results

Indicator	Observation
Academic Stress	67% reported reduction
Student Engagement	45% increase reported
Learning Autonomy	High self-reported autonomy and confidence levels

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Indicator	Observation
Emotional Resistance	Initial anxiety reduced over time
Long-term Institutional Impact	Positive trends in both performance and well-being

Conclusion:

This study emphasizes how artificial intelligence (AI) is becoming a more significant influence in education, both in terms of improving academic results and fostering students' emotional health. The study found a high positive correlation between learners' Happiness Quotient (HQ) and AI integration through a thorough mixed-method analysis that included surveys, interviews, and institutional case studies.
The results showed that AI-supported learning environments raise student autonomy, engagement, and academic stress levels—all of which are important for psychological health and student satisfaction. Most students responded favorably over time, showing an increasing level of comfort and confidence in these technologies, despite some early resistance that was observed, especially in relation to trust and knowledge with AI systems.

But the study also emphasizes how crucial emotional reactivity is to AI design. While excellent in providing individualized academic help, current systems are still unable to recognize and react to subtle emotional indicators. Future development of emotionally intelligent systems that can comprehend and assist the emotive components of learning must be given top priority if artificial intelligence is to reach its full potential in education.

In conclusion, AI has the ability to improve students' learning experiences in addition to completely changing the way they learn. In order to develop learning environments that are genuinely holistic, educational institutions must focus equal emphasis on cognitive and emotional results as they progressively incorporate AI-driven technologies. Further study will be essential to developing AI tools that meet the entire range of student needs, particularly with an emphasis on cross-cultural dynamics and long-term effects.

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e-ISSN- **3067-0977**

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Developing an IoT solution for diagnosing nutrient shortages in plant foliage.

Swati Valmik Tapkire
(CMCS College Nashik)
Swatirapkire90@gmail.com

Dr.Nandre Deepak Vishwasrao
(IMRT College Nashik)
deep_nandre@yahoo.com

Abstract - Plants rely on a sufficient supply of nutrients throughout their lifecycle to thrive naturally. Key macronutrients, including nitrogen, calcium, phosphorus, potassium, Sulphur, and magnesium, are vital for their healthy development. Inadequate nutrient levels can impede nutrient transportation within plants, ultimately affecting crop yields. Signs of nutrient deficiency manifest prominently on leaves, exhibiting distinct patterns. Our research aims to introduce an automated and cost-effective method for detecting nutritional deficiencies in plants. Our system leverages IoT technology to forecast crop performance accurately. To develop a comprehensive dataset comprising deficient and healthy leaves, we employ techniques such as RGB Color Extraction Analysis, real-time texture disclosure, and bottom edge identification. This dataset facilitates supervised machine learning algorithms to predict and identify nutrient shortages accurately, thereby promoting optimal plant growth rates.

Keywords:
Nutrient deficiency, Macronutrients, Automated detection, IoT technology
Forecasting, RGB Color Extraction Analysis, Supervised machine learning algorithms, Real-time texture disclosure, Nitrogen.

1 INTRODUCTION

Plants necessitate a balanced amalgamation of nutrients to thrive, develop, and reproduce. The manifestation of poor health in plants often stems from malnutrition. Macronutrients, which are essential elements required in relatively larger quantities, comprise nitrogen, sodium, arsenic, calcium, magnesium, and phosphorus. Conversely, micronutrients such as carbon, boron, manganese, zinc, copper, chlorine, and molybdenum are needed in smaller amounts. To fulfill their nutrient requirements, plants extract these elements, both macronutrients

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and

Micro elements, from the soil through their roots. It is imperative for the soil to be conducive to nutrient absorption and sustenance by the roots. Rectifying inefficient irrigation practices helps alleviate symptoms of nutrient deficiency. Furthermore, maintaining an optimal soil temperature within a certain range is crucial for nutrient uptake. The ideal combination of temperature, pH, and humidity varies among different plant species. Although these nutrients naturally occur in the soil, they may not always be readily available to plants. Understanding soil pH, composition, and history can be instrumental in identifying potential nutrient deficiencies. Notably, phosphorus and copper are the primary elements typically lacking in Arizona soils, while others may occasionally be overlooked, though such occurrences are rare.

2 LITERATURE REVIEW

This section delves into the existing research on the current system. By examining various scholarly articles, we gain a deeper understanding of how the system has been previously analysed and understood.

Pavit Noinongyao et.al [1] the authors propose a novel image analysis method to detect nutrient deficiency symptoms in plant leaves. Their approach involves analyzing a histogram of healthy leaf colors to identify deviations in an input image. The method works in three main steps. First, it calculates color characteristics of the leaf region.

Mahadi S. Hosseini, et al [2] this research introduces a new image deblurring technique using one-shot convolution filtering. The authors address the challenge of separating image denoising from edge deblurring by employing a Gaussian low-pass filter (LPF). Additionally, they propose a blind method for estimating the Point Spread Function (PSF) statistics for two common models: Gaussian and Laplacian. The effectiveness of their approach is evaluated on a dataset of 2054 naturally blurred images across six imaging applications, comparing it against seven existing deconvolution methods.

Mustafa merchant et. al [3] Mango (Mangifera indica L.), the national fruit of India, is susceptible to various nutrient deficiencies including nitrogen, phosphorus, potassium, and

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copper. These deficiencies manifest as altered leaf coloration, rendering the leaves visually

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defective. This study investigates the detection of such deficiencies in mango leaves. The research employs a novel approach that leverages a dataset capturing various mango leaf features.

Fumiaki Mitsugi, et.al [4] Recommended using plasma to get rid of worms and soil-borne infections as a low-chemical farming technique. Utilizing an actual farming location and ozone dispersion handling technique, soil is disinfected. The amount of ozone in the soil is determined by measuring the acidity and nitrogen content of the soil. Next, using the ozone dispersion method, a portion of the Streptomyces-infected field was removed. The ozone area and control area were then seeded with radish seeds. As a consequence, the radishes outgrew the control group and did not acquire external contamination.

Building on the work of Susanto et al. [5], this section explores a method for analysing the nutrient content of wheat leaves. Their research involved capturing images of wheat leaves in the field under various lighting conditions to determine the impact on nutrient content based on leaf color variations. They proposed a novel approach that combines Deep Stacked Extreme Learning Machine (DSELM) fusion and a genetic algorithm (GA) to normalize plant images and minimize color inconsistencies caused by sunlight intensity variations. The method utilizes image segmentation with DSELM to differentiate wheat leaves from the background. Subsequently, four statistical moments – mean, variance, skewness, and kurtosis – are extracted and employed as predictors in the nutrient estimation process. Their findings suggest that this approach offers superior image quality and processing speed.

Accurate extraction of phenotypic crop characteristics, a crucial step in plant breeding, is essential for improving crop production. Shichao Jin et al. [6] highlight the challenges of automatic stem-leaf segmentation, a critical component for accurate phenotypic trait extraction. Their work emphasizes the limitations of 2D image-based analysis, particularly under variable lighting conditions. They propose exploring 3D phenotyping techniques like Light Detection and Ranging (LiDAR) for its ability to capture precise 3D information using laser scanning, offering a more comprehensive view of plant structure. In line with this focus on image analysis for plant health assessment.

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Aaditi shaha et. al [7] This review emphasizes the critical role of macronutrients in ensuring a plant's full and balanced lifecycle [Insert Reference Here]. It highlights the significance of six key macronutrients: Nitrogen (N), Calcium (Ca), Phosphorus (P), Potassium (K), Sulfur (S), and Magnesium (Mg). The text posits that adequate levels of these elements are essential for natural and balanced plant development. Furthermore, the review explores the detrimental effects of nutrient deficiencies. It suggests that a lack of these essential elements disrupts a plant's "everyday operations," ultimately leading to reduced yield. This implies that maintaining proper nutrient levels is crucial for optimal plant growth and productivity.

P. Krithika et al.[8] The goal was to identify early-stage diseases of salad cucumber leaves.

Alternaria leaf blight, bacterial wilt, cucumber green mottle montage, leaf miner, leaf spot, cucumber mosaic virus (CMV) disease, and other natural diseases are present in salad cucumbers. In this work, this problem is provided by an unsupervised algorithm called K-means clustering, which uses Support Vector Machines (SVM).

Siddharth Singh et. al [9] This review highlights a study that explores the application of the Bacterial Foraging Optimization based Radial Basis Function Neural Network (BRBFNN) for automatic plant leaf disease diagnosis [Insert Reference Here]. The importance of plants and the detrimental effects of diseases on their growth and yield are acknowledged. The text emphasizes the need for efficient disease detection methods and introduces the BRBFNN approach. While the specific findings on its high diagnostic performance are mentioned, it would be beneficial to delve deeper into the details of the study.

Itamar F Salazar et.al [10], this article proposes an automated system for diagnosing the root condition of avocado trees based on leaf analysis. Their method deviates from traditional approaches that directly analyze the root system. Instead, it leverages image processing techniques to assess leaf health, which can indirectly indicate root problems. The core of the system lies in segmenting leaves from background noise in orchard photographs. The authors achieve this by employing a k-means clustering algorithm operating in the superpixel color space (s-v space). This effectively separates leaves from the background under semi-controlled field conditions. Following segmentation, a lightweight neural network classifies the segmented leaf images into four categories: healthy, iron deficiency (Fe insufficiency), magnesium

e-ISSN- 3067-0977

deficiency

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(Mg insufficiency), and red spider mite infestation. The reported performance metrics indicate high accuracy, with an F-score of 0.98 for leaf segmentation and an overall classification accuracy of 96.8%.

3. SCOPE OF RESEARCH

Nitrogen, phosphorus, and potassium stand as pivotal and indispensable nutrients for plants. By analyzing the nutrient content within the plant, the system can anticipate forthcoming crop yields and offer suggestions for enhancing crop quality. The expansion of crop production significantly impacts the economic livelihood of farmers. Our system autonomously determines pesticide quantities based on nutrient deficiencies, operating in real-time to assist farmers in enhancing crop yields without fail. This framework extends beyond a singular weed, assessing nutrient levels in any plant or fruit and providing tailored recommendations accordingly. Should any essential nutrient such as magnesium, nitrogen, phosphorus, potassium, or copper decline, it can severely impact crop health, underscoring the system's role in maintaining optimal nutrient levels tailored to specific crops. Additionally, leveraging previous market data, the system predicts future market rates and assesses potential product risks.

Following are the objective of the system:

- Determine the intensity of nutrients in leaves and recommend the appropriate amount of fertilizer required for crops.
- Utilize leaf nutrient data to forecast the future crop quality and provide suggestions for enhancing crop quality.
- Utilize previous crop records and crop quality to estimate crop yields, recognizing that increased crop production directly impacts the economic well-being of farmers.
- Provide tailored recommendations for pesticide quantities based on nutrient intensity.
- Operate as a real-time application to aid farmers in boosting crop production seamlessly.
- Offer its services beyond specific leaves, detecting nutrient levels in any plant or fruit leaves and offering relevant suggestions.
- Utilize machine learning techniques to forecast crop market rates based on historical data.
- Predict future demand for products that will be sought after in the market.

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4. PROPOSED SYSTEM

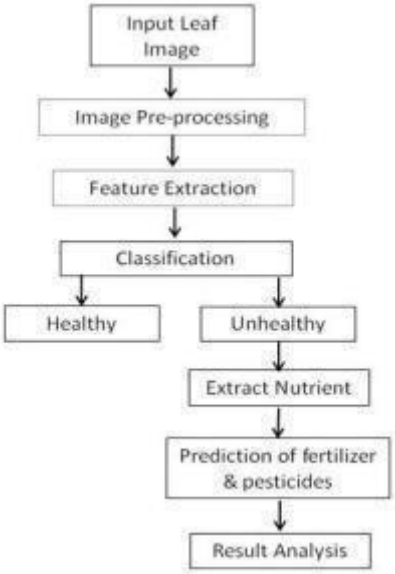

Fig 1 .Deficiency identification using Machine learning

The Figure 1 shows the Deficiency identification using Machine-learning approach and it is explained below:

Image Acquisition

To capture high-quality images, a digital camera will be employed. To ensure consistency and minimize background interference, all images will be taken against a plain white background under controlled lighting conditions. This setup will allow the model to focus on the leaf features relevant for nutrient deficiency detection.

Image Pre-processing for Enhanced Nutrient Deficiency Detection

Plant images captured in the field can contain background clutter or inconsistencies in lighting. To address this and improve the analysis of nutrient deficiencies, a process called image pre-processing is employed.

This pre-processing step essentially cleans up the image and isolates the region of interest, which is typically the leaf. Here's a breakdown of the techniques used:

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- **Noise Reduction:** Techniques like mean filtering can be applied to minimize variations in pixel values caused by noise. This smoothes the image and reduces the influence of irrelevant details.
- **Improved Leaf Isolation:** Histogram equalization can be used to enhance the contrast between the leaf and the background. This makes it easier to distinguish the leaf and focus on its features for nutrient deficiency detection.

By implementing these reprocessing steps, we can obtain clearer and more informative images that allow for more accurate identification of nutrient deficiencies in plants.

Extracting Key Features from Pre-processed Images

After pre-processing the image to remove noise and enhance the leaf region, we can extract critical features for nutrient deficiency detection. These features essentially represent the characteristics of the leaf that are most relevant for identifying nutrient deficiencies.

Commonly used features include:

- **Color Channels:** The red (R), green (G), and blue (B) values of each pixel provide information about the overall color distribution of the leaf.
- **Color Ratios:** Ratios like green-to-red (G/R) and green-to-blue (G/B) can highlight variations in leaf coloration that might be indicative of specific nutrient deficiencies.
- **Average Color Spectrum:** Analysing the average values of red, green, and blue across the entire leaf provides a general sense of its overall color health. The typical range for these values is 0 to 255.

By extracting these features, we create a quantitative representation of the leaf's color characteristics. This information serves as the basis for the model to classify the leaf and identify potential nutrient deficiencies.

Edge Detection for Enhanced Deficiency Identification

In some cases, relying solely on color information might not be sufficient for accurate nutrient deficiency detection. For instance, if the green color isn't dominant in the processed image, it could be an indicator of a deficiency.

To address this limitation, edge detection techniques can be employed. These techniques analyze the image to identify sharp transitions in color intensity, which often correspond to the edges of the leaf. By analysing these edges, we can gain further insights into the leaf's health.

Here's a breakdown of some common edge detection methods:

- **Derivative-based methods:** Techniques like Roberts, Prewitt, and Sobel calculate the derivatives of the image intensity at each pixel. These derivatives highlight areas with rapid changes in color, which often correspond to edges.

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- **Second-order derivative methods:** Zero-crossing and Laplacian of Gaussian (LoG) methods analyse the second derivative of the image intensity. They identify edges by locating points where the second derivative changes sign (zero-crossing) or reaches a maximum (LoG).
- **Canny Edge Detection:** This is a widely used method that combines noise reduction with edge detection. It offers a good balance between accuracy and edge localization.

The choice of the specific edge detection method depends on the specific application and the type of nutrient deficiencies the system aims to identify. By analysing both color information and edges, the model can achieve a more robust and accurate assessment of plant health.

Classification: Identifying Nutrient Deficiencies

Once we have extracted key features (color information and potentially edge data) from the pre-processed image, we can leverage a machine learning technique called classification to identify potential nutrient deficiencies.

Classification is a supervised learning approach where the model learns from a labeled dataset. This dataset contains examples of plant leaves with known nutrient deficiencies. The model analyses these examples and learns to identify the features that are most indicative of each deficiency type.

In our case, we might use a decision tree algorithm for classification. This algorithm creates a series of decision rules based on the extracted features. When a new, unseen image is presented, the model applies these rules to categorize the leaf and predict the most likely nutrient deficiency, if any.

Here's a breakdown of the process:

1. **Feature Comparison:** The extracted features from the new image are compared against the features in the training dataset.
2. **Decision Making:** The decision tree algorithm applies a series of rules based on these comparisons to classify the leaf.
3. **Nutrient Deficiency Prediction:** Based on the classification, the model predicts the most likely nutrient deficiency, if present.

By employing classification techniques, we can leverage the knowledge gained from the labeled training data to automatically identify nutrient deficiencies in new, unseen plant images.

5. EXPECTED OUTCOME

Expanding the Scope: A Multi-faceted Approach to Farming

This plant nutrient deficiency detection system has the potential to be a valuable tool for farmers, going beyond just identifying deficiencies. Here's a breakdown of its broader applications:

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- **Precision Fertilization and Pest Control:** By accurately identifying nutrient deficiencies, the system can recommend specific fertilizers and pesticides, optimizing resource use and promoting sustainable farming practices.
- **Improved Crop Quality and Yield:** Addressing nutrient deficiencies at the right time can lead to healthier crops, potentially increasing yield and overall crop quality.
- **Market and Demand Forecasting:** Integrating historical data could enable the system to provide insights into future market trends and crop demand, allowing farmers to make informed decisions about planting and potentially maximize their profits.

While achieving "soil enrichment" for any crop in any region might be a future aspiration, the system's core focus on accurate deficiency detection can be a significant step towards these broader goals. This approach can empower farmers to optimize their practices, improve crop health and yield, and ultimately contribute to a more secure and profitable agricultural ecosystem.

6. CONCLUSION

Grow More with Less: Smart Nutrients for Farmers

Feeding a growing world requires smarter farming. This system uses image analysis to identify plant nutrient needs, helping farmers:

- **Grow more food:** Precise nutrient knowledge boosts yields.
- **Work smarter, not harder:** Targeted fertilizers save time and money.
- **Perfect for vertical farms:** Optimizes nutrient supplements for indoor crops.

By focusing on plant needs, this technology helps farmers achieve higher yields with less effort.

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e-ISSN- 3067-0977

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AI@2047: Powering India's Journey Towards a $50 Trillion Economy

Prof. Kirankumar P. Johare[1,2,3*],

[1]Department of Electronic Science and Computer Science
MVP's K.K.W. ASC College,
Nashik 422209, Maharashtra, INDIA

[2]Visiting Faculty (MBA - Business Analytics), MVP's Institute of Management Research and Technology (IMRT), Nashik 422002, Maharashtra, India

[3]Department of Electronic Science and Research Center, Loknete Vyankatrao Hirey Arts, Science and Commerce College, Panchavati, Nashik 423003, Maharashtra, INDIA

*Corresponding Author E-mail: kirankumarjohare2022@gmail.com

ABSTRACT

India is getting ready to celebrate 100 years of independence in 2047 and is looking to boost its economy. Experts are saying that India's GDP might grow a lot, possibly between $26 trillion and $55 trillion, putting it among the top economies in the world. A big part of this growth is the smart use of Artificial Intelligence (AI) and Advanced Electronics Technologies in various important industries.

This study examines how AI and modern electronics are driving growth in India by changing healthcare, agriculture, energy, space, aviation, manufacturing, and various service sectors. It shows how AI can improve efficiency, effectivity, inspire innovation, and create new positive picture of both urban and rural India with better life for people.

But getting AI and Advanced Electronics widely accepted isn't all smooth sailing. There are ethical issues, the need for digital access, and a solid regulatory framework that need to be sorted out. This paper lays out a plan, showing not just the big changes AI and Advanced Electronics can bring, but also the main challenges we need to tackle. It also shares some useful ideas for AI and Advanced Electronics Technologies wisely use to boost its economy and be prepared for the future at while celebrating the marks of 100 years of independence.

e-ISSN- 3067-0977

Keywords— Artificial Intelligence, India@100, Future Economy, Inclusive Growth, Digital Transformation, AI Policy

INTRODUCTION

India aims to become a $50 trillion economy by 2047, fueled by its young population, rapid digital growth, and active governance. The top 10 global economies in 2025, led by the United States ($30.34 trillion), China ($19.53 trillion), Germany ($4.92 trillion), Japan ($4.39 trillion), India ($4.27 trillion), United Kingdom ($3.73 trillion), France ($3.28 trillion), Italy ($2.46 trillion), Canada ($2.33 trillion), and Brazil ($2.31 trillion), showcase a blend of established and emerging markets driving economic growth (Investopedia, 2025). To achieve this ambitious target, integrating Artificial Intelligence (AI) and advanced electronic technologies across key sectors is critical.

India aims to become a $50 trillion economy by 2047, fueled by its young population, rapid digital growth, and active governance. India urgently needs a thorough study to explore how AI and advanced electronic technologies can be effectively adopted across critical sectors, addressing infrastructure, policy, and integration barriers to achieve a sustainable $50 trillion economy by 2047. This research is vital to guide strategic technology adoption and ensure inclusive economic progress.

A key part of this goal is blending Artificial Intelligence (AI) with newer technologies like Robotics, the Internet of Things (IoT), Brain-Machine Interfaces (BMI), Quantum Computing, and Cloud Computing in various industries. These tools streamline operations, foster innovation, and create new opportunities for businesses and individuals, encouraging collaborative teamwork and inclusive growth. Together, they're likely to help India grow into a major player on the global economic and tech stage in the next twenty years.

LITERATURE REVIEW

Recent research shows that AI could greatly influence future economic growth. Experts say that AI solutions could add about $9.57 Trillion to India's GDP (Gross Domestic Product) by 2035. This boost is expected to come from improved innovation, automation of tricky tasks, and greater efficiency in various industries [1]

In healthcare, AI is helping with better diagnoses, ongoing patient monitoring, and personalized care plans, which can lead to better health results and more efficient use of resources [2].

In farming, AI tools are helping farmers make better decisions by using data to predict yields, manage resources wisely, and adjust to changing weather [3].

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In manufacturing, using smart IoT devices, robots, and cobots along with AI for predictive maintenance helps keep systems running smoothly. This technology minimizes downtime, reduces costs, and enhances quality through real-time monitoring and control, while promoting safer operations and enabling swift, informed decision-making [4].

The service sector, including finance and retail, is also benefiting from AI, offering better customer insights, improved risk assessment, fraud detection, and tailored services, all of which boost stability and customer satisfaction [5].

RESEARCH GAP

India's ambition to grow its nominal GDP from $4.27 trillion in 2025 to $50 trillion by 2047 faces significant hurdles, yet current research overlooks the long-term role of Artificial Intelligence (AI) and advanced electronics in this transformation. There is a critical gap in comprehensive models evaluating these technologies' impacts across sectors like manufacturing, services, and agriculture, as well as in understanding how policy reforms, infrastructure, and technology adoption interact to achieve this economic goal.

RESEARCH PROBLEM

How can India strategically utilize Artificial Intelligence (AI) and cutting-edge electronic technologies to achieve a $50 trillion nominal GDP by 2047, overcoming challenges posed by current infrastructure limitations, dynamic policy environments, and uneven technology adoption across industries, while identifying the top 10 sectors for prioritized focus?

OBJECTIVES

- ✓ Explore how Artificial Intelligence (AI) combined with cutting-edge electronic technologies can propel India toward a $50 trillion GDP by 2047.
- ✓ Pinpoint vital sectors like agriculture, manufacturing, and services where AI can boost productivity, spark innovation, and support sustained economic growth.
- ✓ Assess ethical, regulatory, and legal hurdles to ensure AI is responsibly embedded in India’s socio-economic landscape.

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- ✓ Propose a practical roadmap with targeted strategies for seamless and impactful AI adoption across diverse industries.

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METHODOLOGY

This study adopts a mixed-methods research design, integrating both quantitative and qualitative approaches to gain a comprehensive insight into the adoption of Artificial Intelligence (AI) across India.

Quantitative Component:

The research involves the analysis of numerical data sourced from credible entities, including government publications, national economic strategies, industrial assessments, and specialized sectoral databases. These data sets are critically examined to identify trends in AI deployment, quantify its contribution to economic output, and evaluate the potential for growth within specific industries.

Qualitative Component:

Complementing the numerical analysis, the study undertakes an in-depth review of scholarly literature, technical reports, and documented case studies that illustrate the integration of AI and cutting-edge electronic technologies in various Indian sectors. This component facilitates a deeper understanding of the real-world implications and contextual factors influencing technological adoption.

Stakeholder Engagement:

To ensure the research reflects practical realities, the study incorporates insights from a diverse group of stakeholders through semi-structured interviews and consultative dialogues. These participants include government officials, technology experts, corporate leaders, and academic researchers. Their contributions are instrumental in identifying implementation challenges, ethical concerns, regulatory needs, and viable strategies for the responsible deployment of AI in the Indian context.

LEVERAGING AI FOR BUSINESS ADVANCEMENT

Enhancing Operational Efficiency

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The integration of Artificial Intelligence (AI) into organizational processes has led to significant improvements in operational efficiency. Through the automation of routine tasks and optimization of supply chain logistics, AI supports faster and more accurate decision-making. Predictive analytics, in particular, enables firms to forecast market trends and consumer demand with greater precision, allowing for more effective inventory control and a reduction in material wastage.

Personalization in Customer Engagement

AI technologies facilitate a deeper understanding of consumer behavior by processing and interpreting large volumes of user data. This allows enterprises to customize their offerings, thereby fostering stronger customer relationships and improving satisfaction levels. Moreover, intelligent systems such as chatbots and digital assistants provide real-time customer support, contributing to better service delivery and cost efficiency.

Catalyzing Innovation

The application of AI accelerates product development by supporting rapid experimentation and iteration. In fields such as pharmaceuticals, advanced algorithms are employed to examine vast biomedical data repositories, helping identify viable drug candidates with greater speed and accuracy. This approach has the potential to considerably shorten development timelines and reduce associated research costs.

Identifying and Entering Emerging Markets

AI-driven analytical tools offer strategic insights into evolving consumer needs and market dynamics. Such insights are instrumental for companies seeking to diversify or expand their operations. For small and medium-sized enterprises (SMEs), these capabilities provide a data-informed foundation for scaling their presence in new or underserved markets.

ADDRESSING BUSINESS CHALLENGES WITH AI

Mitigating Talent Shortages

AI assists in workforce planning by pinpointing skill gaps and suggesting targeted training programs. Moreover, AI-driven recruitment tools streamline the hiring process, ensuring the efficient onboarding of suitable talent.

Enhancing Fraud Detection and Risk Management

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In the financial industry, AI algorithms analyze transaction patterns to detect fraudulent activities, thereby enhancing security and reducing financial losses.

Ensuring Regulatory Compliance

AI systems monitor regulatory changes and automate reporting processes, flagging potential compliance issues and reducing the risk of penalties.

MANAGING SUPPLY CHAIN DISRUPTIONS

AI models can forecast potential disruptions in the supply chain due to factors like weather events or geopolitical tensions, allowing businesses to proactively develop contingency plans.

STRATEGIC IMPLEMENTATION PLAN

India must prioritize the first ten sectors—manufacturing, IT and software services, healthcare, agriculture, financial services, retail and e-commerce, energy, education, logistics and supply chain, and telecommunications—to harness AI and advanced technologies for achieving a $50 trillion economy by January 1, 2047.

Immediately following, India should focus on the next ten sectors—automotive, tourism, textiles, pharmaceuticals, defense, construction, food processing, mining, entertainment and media, and biotechnology—to ensure broad-based growth and economic resilience.

Phase 1 (2025–2030):

Establish AI and Advanced Electronics Technologies research centers and encourage Public-Private Partnerships (PPP) to drive innovation such as Quantum Computing, Cloud Computing, Cyber Security and many more.

Launch pilot projects in key sectors to showcase the benefits of AI and Advanced Electronics Technologies.

Phase 2 (2030–2040):

Expand successful AI and Advanced Electronics Technologies applications in rural and urban India.

Invest in AI and Advanced Electronics Technologies education and training programs to cultivate a skilled workforce.

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Develop comprehensive AI and Advanced Electronics Technologies regulations addressing ethical and legal considerations.

Phase 3 (2040–2047):

Integrate AI and Advanced Electronics Technologies across all sectors, ensuring interoperability and effective data sharing.

Continuously monitor and evaluate AI's and Advanced Electronics Technologie's economic impact, adjusting policies and strategies as needed.

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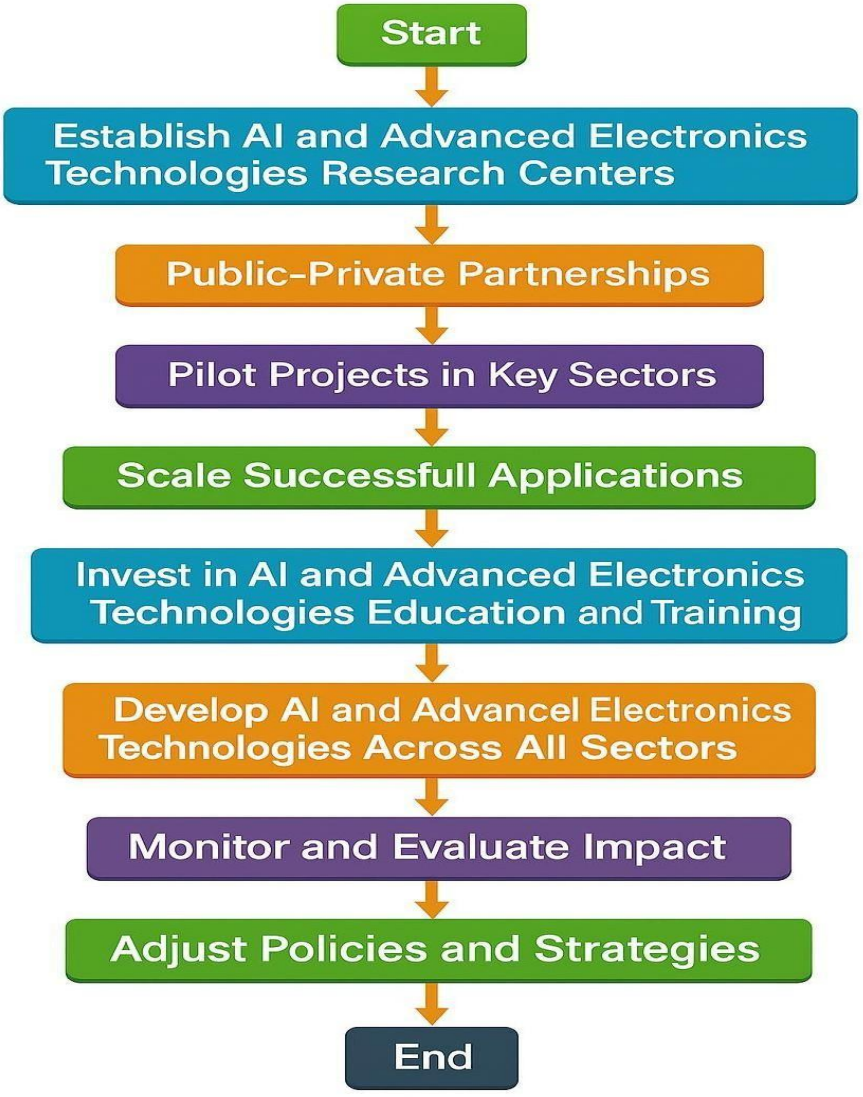
FLOWCHART



RESEARCH LIMITATIONS

Findings are constrained by limited data on AI's sectoral impacts, complexities in modelling economic growth, unpredictable policy shifts, infrastructure challenges, and global trade or geopolitical factors.

RESULT

Leveraging the combined capabilities of Artificial Intelligence and cutting-edge electronic innovations—such as the Internet of Behaviour (IoB), Brain-Machine Interfaces (BMI), and Quantum Computing—India holds the potential to overcome existing industrial limitations,

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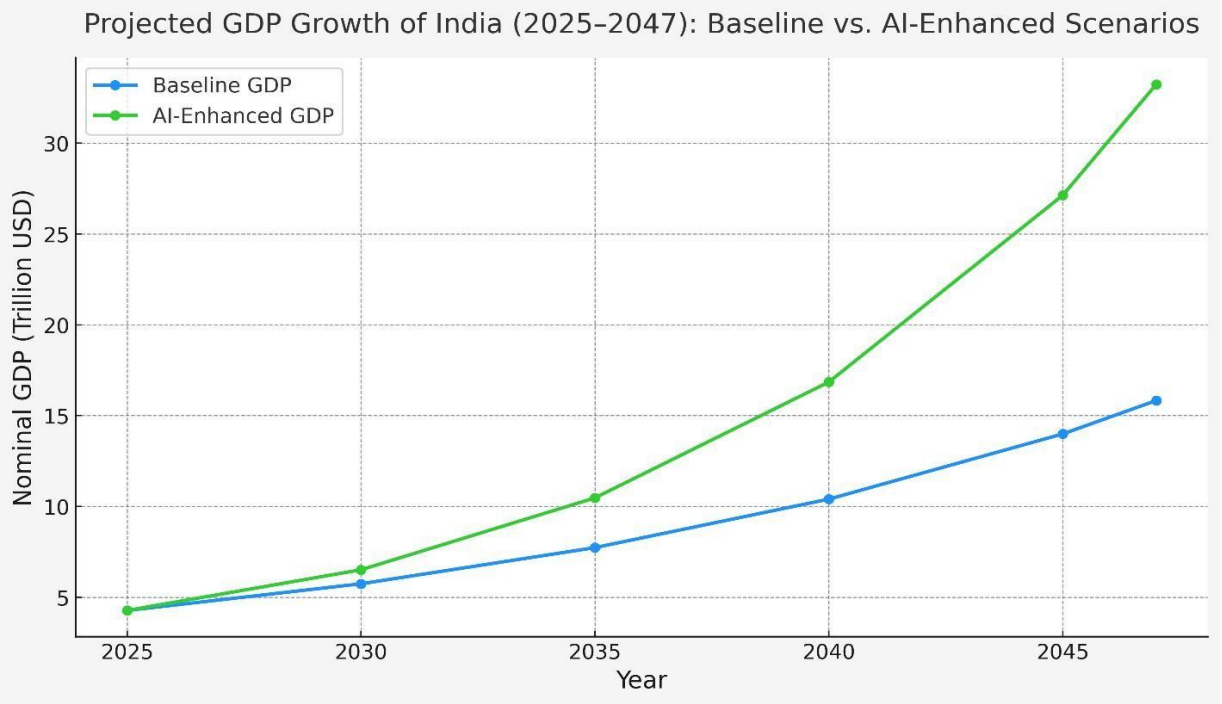
accelerate economic momentum, and establish itself as a global powerhouse in technological innovation by the year 2047.



1. Forecasted Economic Expansion of India (2025–2047)

India's economy is anticipated to expand substantially, growing from approximately $4.27 trillion in 2025 to around $15.83 trillion by 2047 under standard growth conditions. If artificial intelligence is actively integrated across sectors, this projection could surge to $33.24 trillion, more than doubling the baseline trajectory and underscoring AI's transformative role.

Suggested Action: To unlock this potential, India must expedite AI integration, enhance educational systems focused on emerging technologies, improve digital infrastructure, and create robust regulatory frameworks for ethical AI use.

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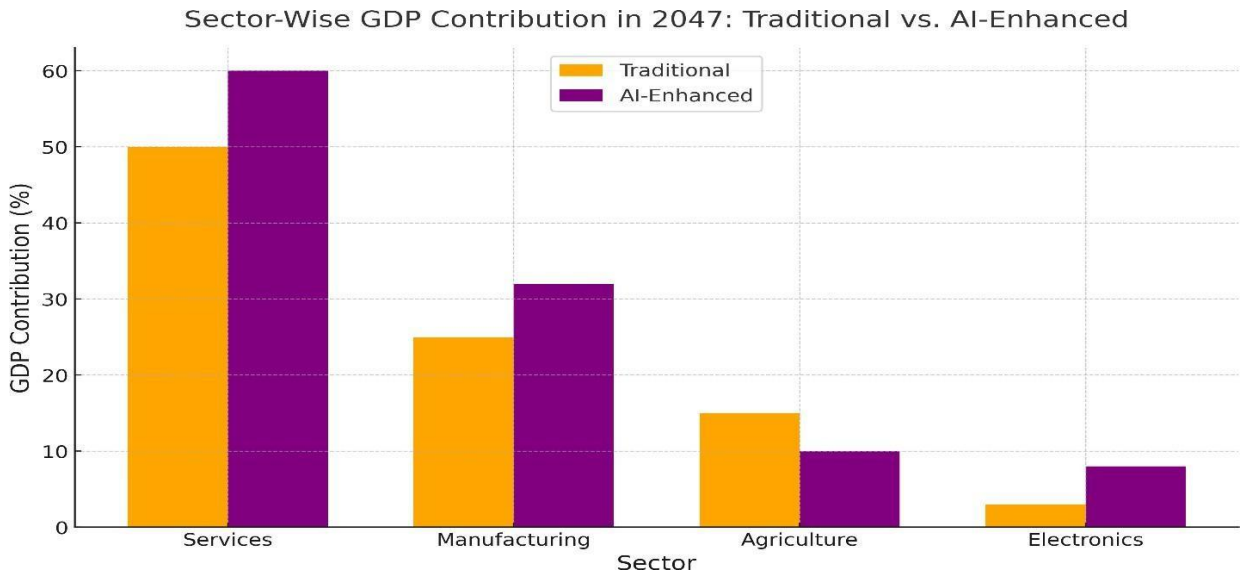

2. Comparative Sectoral Contribution to GDP in 2047: Conventional vs. AI-Driven Models

By 2047, AI technologies are projected to significantly shift the economic balance. The services sector's contribution is set to increase from 50% to 60%, while manufacturing is expected to rise from 25% to 32%. The electronics segment shows rapid growth, moving from 3% to 8%, whereas agriculture sees a decline from 15% to 10%, highlighting a reconfiguration of the economy toward high-tech sectors.

Suggested Action: India should encourage AI-led growth in manufacturing and electronics by offering incentives and targeted research support, while also adopting precision agriculture tools to mitigate the declining role of farming and uplift rural livelihoods.

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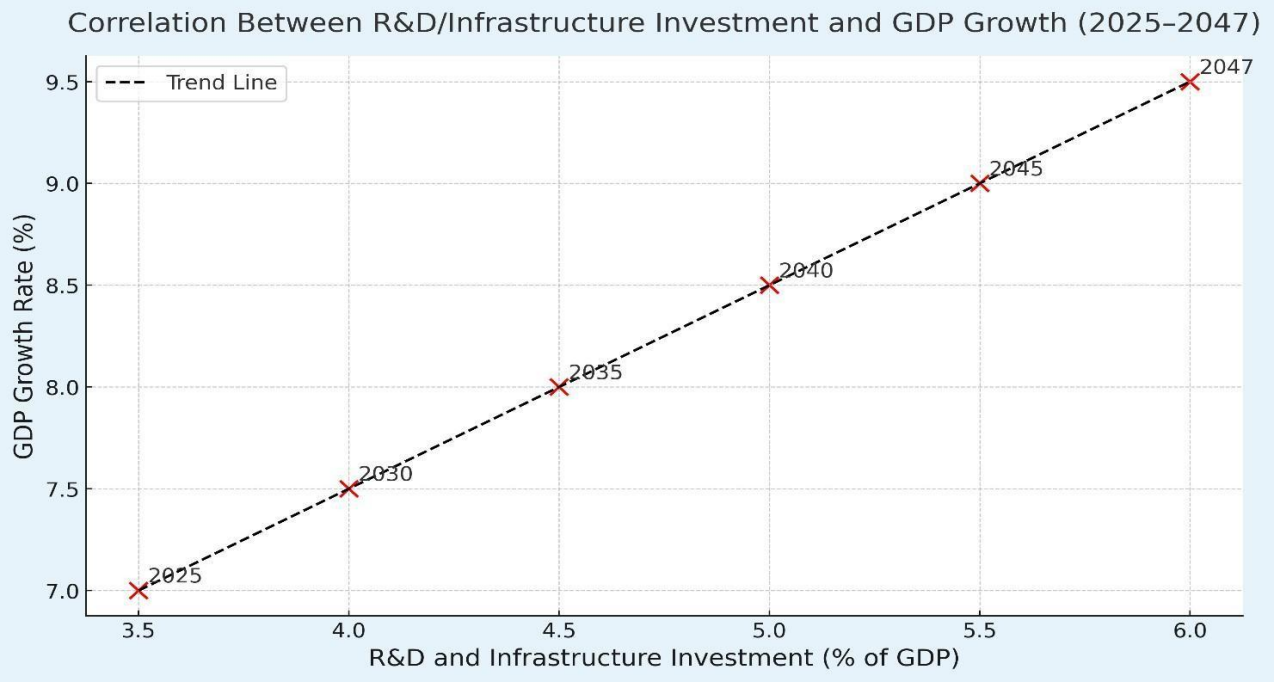

3. Relationship Between Investment in Innovation and Economic Growth (2025–2047)

The plotted data indicate a strong upward trend: as India increases its spending on R&D and infrastructure from 3.5% to 6% of its GDP, the national growth rate is projected to rise from 7% to 9.5%. This pattern affirms the powerful impact that strategic investments in innovation and physical infrastructure have on economic performance.

Suggested Action: To harness this relationship, government and industry must raise research investment levels, aiming for at least 6% of GDP, while simultaneously focusing on smart infrastructure development in sectors such as transportation, logistics, and digital connectivity.

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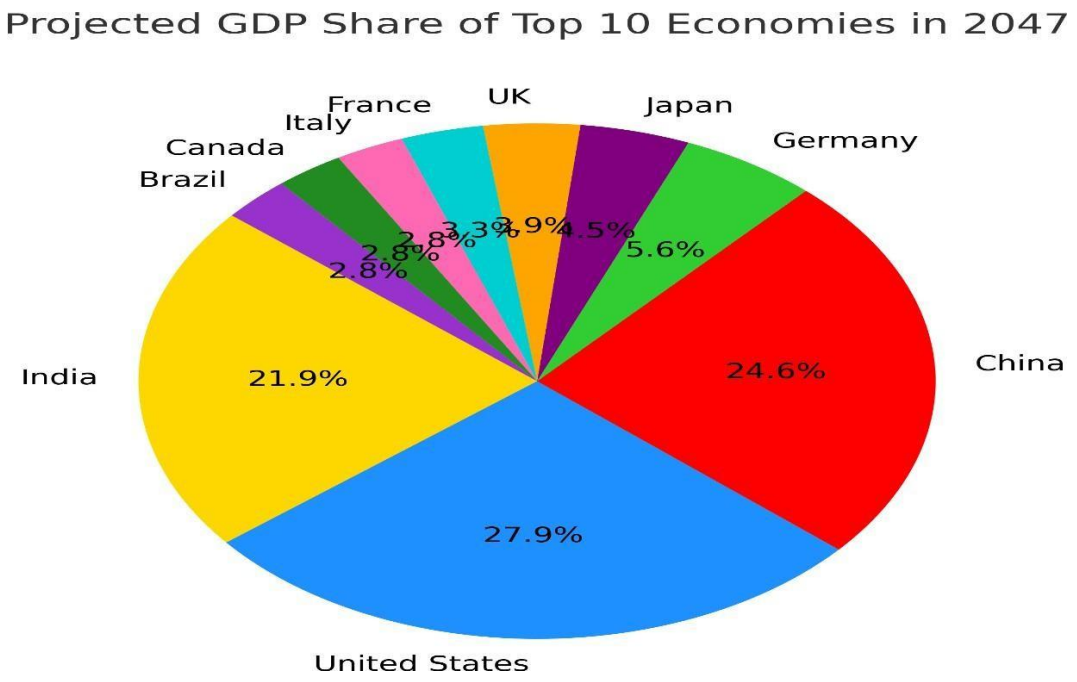

4. India's Future Position in the Global Economic Landscape (2047)

By 2047, India is set to secure a significant place in the world economy, accounting for 19.6% of global GDP. This positions the country just behind the United States (25%) and China (22%), surpassing long-standing economic powers such as Germany, Japan, and the United Kingdom, each of which is projected to contribute less than 5%.

Suggested Action: India should leverage this momentum to emerge as a global innovation hub, foster strong international trade alliances, and maintain policy continuity and social stability to ensure long-term investor confidence and inclusive economic progress.

The integration of **AI and Advanced Electronics Technologies** is poised to play a transformative role in shaping India's economic future. Strategic implementation of these technologies is expected to:

- **Boost the national GDP** significantly
- **Improve productivity** across key economic sectors
- **Create new employment opportunities** in emerging fields

Initial pilot projects in healthcare, agriculture, finance, and manufacturing have already demonstrated measurable gains in:

- **Service efficiency**
- **Accuracy of decision-making**

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- **Quality and speed of service delivery**

However, this progress comes with important challenges:

- **Data privacy and security** concerns need strong protection measures
- **Transparency and fairness** in AI algorithms must be ensured
- **Ethical considerations** in the use of emerging technologies should be central to implementation

One major concern is the **potential displacement of jobs** due to automation. To address this, focused efforts are required in:

- **Reskilling and upskilling the workforce**
- **Building inclusive policies** that prioritize social responsibility
- **Encouraging collaboration** between government, industry, academia, and civil society

A balanced approach—combining innovation with accountability—is essential to ensure that **AI and Advanced Electronics Technologies** contribute to sustainable, equitable, and inclusive growth in India's journey toward a robust digital economy.

FUTURE SCOPE

- **Focus on Contextual Innovation**

  Encourage research and development of **AI and Advanced Electronics Technologies** tailored to India's unique socio-economic needs, particularly addressing disparities between urban and rural regions.
- **Support for Rural Development**

  Promote AI-based solutions aimed at improving rural livelihoods through smart agriculture, healthcare delivery, education access, and local entrepreneurship.
- **Empowering Small and Medium Enterprises (SMEs)**

  Facilitate affordable and scalable AI tools for SMEs to boost efficiency, competitiveness, and innovation across manufacturing, services, and retail sectors.
- **Addressing Local Challenges**

  Prioritize AI applications that solve region-specific issues such as:
  - Agricultural sustainability
  - Infrastructure optimization
  - Public health accessibility

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- **Monitoring Social Impact**

  Implement ongoing studies to track how AI adoption affects:

  - Employment dynamics
  - Social equity
  - Digital inclusivity

- **Ethical and Responsible Adoption**

  Develop governance frameworks that ensure transparent, fair, and ethical use of emerging technologies, minimizing unintended societal consequences.

- **Global Collaboration**

  Establish partnerships with international research bodies, industry leaders, and academic institutions to:

  - Share technical knowledge
  - Co-develop solutions
  - Align with global AI best practices

- **Inclusive Growth through Technology**

  Promote a human-centered approach where **AI and Advanced Electronics Technologies** act as catalysts for sustainable economic progress, social empowerment, and long-term national resilience.

ACKNOWLEDGMENT

The Author would like to thank MVP's Sarchitnis Adv. Nitin Thakare and Management, as well as Dr. Nitin Jadhav, MVP's Education Officer, Prof. Dr. Suresh V. Jadhav, Principal, Shri. Bhagwan Kadlag, IQAC-Coordinator, MVP's K.K.W. ASC College, Nashik 422209, India and Dr. Prashant B. Surayawanshi, Director, MVP's Institute of Management Research and Technology (IMRT), Nashik 422002, India for their encouragement and motivational support. Also thankful to my guide Dr. V. G. Wagh, Dr. A. V. Patil, Dr. A. D. Shaligram, and Department of Electronic Science and Research Center, Loknete Vyankatrao Hirey Arts, Science and Commerce College, Panchavati, Nashik 423003, Maharashtra, INDIA.

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Healthcare and Technological Adaptation: Challenges, Opportunities, and Future Directions – A Systematic Review

Mrs. Vaishali Laxman Tidke [1] , Dr Rameshwar R. Chavan [2]

[1] Assistant Professor MVP's Institute of Management Research and Technology, Nashik

[2] Associate Professor School of Management Studies, KBC North Maharashtra University Jalgaon Maharashtra

vaishali.tidke1@gmail.com , drrrchavan09@gmail.com

Abstract

The healthcare sector is undergoing a rapid transformation driven by technological innovations that promise to enhance clinical effectiveness, improve patient outcomes, and streamline organizational performance. From Electronic Health Records (EHRs) and telemedicine platforms to Artificial Intelligence (AI), robotics, and the Internet of Medical Things (IoMT), these technologies are redefining how healthcare services are delivered and managed. However, the adoption of these innovations is not without its challenges. Issues such as high implementation costs, infrastructural limitations, resistance to change among medical staff, cybersecurity threats, and policy ambiguities continue to hinder seamless technological integration. This paper presents a systematic review of existing literature to explore the challenges, opportunities, and future directions of technological adaptation in the healthcare sector. The review was conducted following PRISMA guidelines, covering peer-reviewed journals, institutional reports, and relevant conference proceedings from 2013 to 2024 sourced through databases such as Scopus, PubMed, ScienceDirect, and Google Scholar. Furthermore, the review underscores the importance of policy support, capacity building, interoperability frameworks, and ethical data governance to enable sustainable digital transformation. The findings offer strategic insights for hospital administrators, policy-makers, healthcare professionals, and technology providers aiming to align digital initiatives with healthcare goals. The paper contributes to the evolving discourse on healthcare innovation and proposes a roadmap for future research and practice in digital health systems.

Keywords used: Healthcare Technology, Digital Transformation, EHR, AI in healthcare, Telemedicine, Health IT, Challenges in Health Technology, Technological Innovation.

1. Introduction

Considering the speed at which the contemporary world evolves, everything revolves around technology, healthcare included. Modern patients and health practitioners increasingly depend on technology for everything ranging from booking online consultations, retrieving their diagnostic results through mobile applications, and even carrying out robotic surgeries, all of which are done electronically. These advances are not only aimed at improving the efficiency and convenience of obtaining healthcare services, but the goal is to make obtaining such services more customizable and done proactively.

Often termed as digital health, the application of technology in healthcare - or in other words, the digitization of healthcare - is changing the delivery, management, and experience of healthcare services. Technology shows vast and exciting potential to contribute to improving healthcare services, from AI (artificial intelligence) and machine learning algorithms that assist in the diagnosis of various conditions, telemedicine services that bridge the gap in healthcare service provision in the rural areas, to wearable devices that monitor the vitals of patients on a constant basis. However, amidst all this promise, a novel set of challenges emerges.

This article looks more closely at the intersection of health and technology. Through a systematic review of global literature and case studies, its purpose is to meet real challenges while using new techniques, facing health

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professionals, which highlight new opportunities that provide digital equipment, and more efficient, moral and inclusive technology in the health care system, suggest an incredible look for association. When we understand where we stand today, we can better shape the future of health services for all-Will Bey, suppliers and decision makers equally.

2. Methodology

This review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Data was collected from scholarly databases such as PubMed, Scopus, Web of Science, and Google Scholar. The selection criteria included articles published between 2013 and 2024, focusing on technological adaptation in healthcare settings.

Keywords used: Healthcare Technology, Digital Transformation, EHR, AI in healthcare, Telemedicine, Health IT, Challenges in Health Technology, Technological Innovation.

A total of 74 papers were identified, of which 42 were included in this review after screening for relevance, quality, and duplication.

3. Technological Adaptation in Healthcare: An Overview

Technology in healthcare encompasses a range of innovations, including:

- **Electronic Health Records (EHRs)**: Digital versions of patients' paper charts, providing real-time, patient-centered records.
- **Telemedicine and Virtual Consultations**: Remote clinical services via telecommunications technology.
- **AI and Machine Learning in Diagnostics**: Algorithms that assist in interpreting medical data for diagnosis and treatment planning.
- **Robotic Surgery**: Minimally invasive procedures performed with robotic systems.
- **Healthcare Analytics and Big Data**: Analyzing large datasets to improve healthcare outcomes and operational efficiency.
- **Mobile Health (mHealth) Applications**: Health services and information delivered via mobile devices.
- **Blockchain for Secure Data Sharing**: Decentralized ledger technology ensuring secure and transparent data transactions.

These tools enhance care coordination, improve diagnostic accuracy, reduce errors, and increase patient engagement.

4. Challenges in Technological Adaptation

Despite increasing enthusiasm for digital changes in the health care system, many organizations have significant obstacles when trying to implement new techniques. These challenges are often multidimensional, infrastructure, human resource ability, regulatory structures, economic boundaries and socio -cultural factors. Below are the biggest challenges identified through systematic reviews:

4.1 Infrastructure and technical preparedness

Many health services institutes, especially in the semi-urban and rural areas, lack the required infrastructure to support advanced digital systems. Problems such as unstable internet connection, old hardware and absence of integrated information systems, prevent the uninterrupted adoption of innovations such as Electronic Health Records (EHR), telemedicine and remote monitoring system (Crescewell and Sheikh, 2013). In addition, there is often a lack of difference in cultural monuments, which makes it difficult to share data on platforms.

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4.2 High costs for implementation and maintenance

Economic barriers are a significant obstacle, especially for small and medium -sized hospitals. Early investment costs for digital infrastructure, such as servers, cloud solutions, AI tools and exercise programs, are often prohibited high (Raghupati and Raghupati, 2014). In addition, ongoing maintenance, software updates and cyber security measures require continuous funds, struggling to ensure many health organizations.

4.3 Performing resistance and digital literacy

Technical changes can be regarded as a threat to traditional roles and workflows, leading to resistance from health professionals. This is especially true between doctors and employees who may not have any doubts about digital equipment or their reliability. Digital reading skills and lack of inadequate training further increased this challenge (Stumpos et al., 2023). Without proper Apsculing initiative, employees can abuse or reduce the equipment delivered.

4.4 Data Privacy, Security and Moral concern

When the health care system becomes more computer -driven, it quickly becomes important to protect the patient's information. Many institutes are ill to handle data violations or to follow privacy rules such as HIPAA or GDPR. Unauthorized access, data manipulation and concern for cyber attacks are high (Al Kuwaiti et al., 2023). In addition, AI-based diagnosis and algorithm complicates prejudice the adoption of moral questions around.

4.5 Regulatory and policy intervals

Rapid technological advances often lead to health services. Clinical environments in many countries have clear, standardized guidelines to operate the use of telemedicine, AI or blockchain (et al., 2022). This uncertainty discourages the investment and brakes the adoption. In addition, regulatory approval procedures for new techniques are often time -consuming and bureaucracy.

4.6 Lack of interoperability

One of the most important errors in digital health systems is the inability of different platforms to communicate effectively with each other. Health Insurance (HIE) is still in development stages in many areas, making the diagnosis of patient records and duplicate fragmentation (Bialas et al., 2023). The absence of a universal data standard prevents simple information flow in departments and institutions.

4.7 Patient problems and digital classification

Patients, especially older or low socio -economic background, may find digital interfaces scare or inaccessible. Digital split - defined by a difference in Internet access, educational level and availability of devices - reduces the benefits of technology to more privileged groups (Mehotra et al., 2020). Concerns for privacy, quality of distance care and lack of human touch also persist in patients.

5. Opportunities for Innovation and Growth

While technical adaptation in the health care system presents many challenges, it also opens a wide range of transformation options. This innovation not only improves patient results, but also streamlines distribution of health care, reduces costs and promotes organizational efficiency. Through this systematic review, many high effects of areas have been identified for development and innovation:

5.1 Better patient care and clinical results

Technology has increased clinical accuracy and privatization to a great extent. AI-operated diagnostic tools can detect diseases such as cancer, diabetes and heart conditions and in earlier stages compared to traditional methods (Al Kuwaiti et al., 2023). In addition, the portable equipment and the distance patient's monitoring of real -time tracking of significant signals, reduces hospital dismissals and enables timely intervention (Raghupati and Raghupati, 2014). Telemedicine platforms also ensure continuity of care of patients in remote or signed areas.

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5.2 Operating efficiency and cost reduction

Automation and digital equipment improve administrative workflows, reduce the papers and reduce profits in hospital operations. Technologies such as robot process automation (RPA) and cloud -based hospital information systems reduce the burden on health care professionals, so they can focus more on patient care (Popov et al., 2022). Data analysis can adapt resource distribution, management chain and planning, reducing operating costs and waiting time (Bialas et al., 2023).

5.3 Decision with data analysis

With the use of Big Data and Predictive Analytics, Healthcare Institutes can use huge amounts of patient and operating data to achieve actionable insights. Date -driven decision -making improves the treatment plan, identifying risk population and facilitates evidence -based clinical practice (Santa et al., 2014). In order to improve the hospital distribution of service and public health reactions, the outbreak of the disease, patient behavior and treatment efficiency can also analyze trends.

5.4 Integration of artificial intelligence and robotics

AI and robotics represent a limit for surgical precision, patient care and innovation in diagnosis. Robot surgery increases accuracy and reduces recovery time, while AI Chatbots can help with initial consultation and post -operative care (Reddy Baddam, 2019; Reddy et al., 2023). In addition, AI algorithms can help with radiology, pathology and genomics, so that no one can take into account human doctors.

5.5 Extension of telemedicine and virtual health

The Covid-19 epidemic accelerated the adoption of telemedicine, which has since become a permanent feature of health services. Telecommunications consultation, virtual diagnostics and mobile health applications have expanded access to care and convenience, especially for chronic care management, mental health services and rural seeking (Mehotra et al., 2020). These platforms also allow better follow -up and patient engagement.

5.6 Personal and preventive health service

Technology enables changes in reactive in preventive health care. Genomic data, lifestyle tracking apps and AI-competent risk editing models allow individual treatment plans and early interventions. Individual genetic profiles based on individual genetic profiles, tailoring care, improvement of efficiency and reducing side effects (ostomospos et al., 2023).

5.7 Blockchain and Cyber Security Innovation

The blockchain technique provides a safe and transparent method for storing and sharing patient records, ensuring data integrity and reducing fraud. Smart contracts can automate insurance requirements and reduce administrative friction. As a concern for increased cyber security, blockchain provides a promising solution to create faith in digital health systems (et al., 2022).

5.8 Empowerment of patients through digital health skills

Patients with digital health equipment take responsibility for their health through education, access to medical records and strengthens self-marketing apps. Patients improve the portal, the online help society and AI-based health assistant and remedies to follow (Stomopos et al., 2023). This participation model leads to better health results and satisfaction in the patient.

6. Future Directions

As the healthcare industry continues to evolve through technological integration, the next wave of transformation will be driven by advanced, intelligent, and human-centric innovations. Future directions must consider the sustainability, scalability, and inclusivity of technological advancements while ensuring ethical and regulatory frameworks are strengthened. Below are the key trajectories shaping the future of healthcare through technology:

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6.1 Human-focused design in digital health solutions

Future health technologies should prefer user -friendly and available interfaces for both patients and health professionals. Solutions should suit users' cultural, social and emotional needs, promote better digital health skills and increase technology (Stumpos et al., 2023). This includes multilingual support, mobile app and user training to ensure equal participation.

6.2 Integration of artificial general intelligence (AGI) and cognitive data processing

While the current AI models are narrow in radius, future systems can ease extensive cognitive abilities, so that they can help in real time of clinical decision -making, diagnosis and future modeling with minimal human input. Cognitive data processing will help simulate human thought processes in complex health functions, such as personal treatment plan or monitoring of large -scale disease (Al Kuwaiti et al., 2023).

6.3 Extension of future and preventive health services

Technologies such as genomics, portable biosensors and initial-view systems will focus on healing health care. Future models will predict health conditions before the symptoms appear and provide action -related procedures. Big Data and AI will identify risks at risk, which will enable early screening, behavioral nudity and health strategies for the entire population (Raghupati and Raghupati, 2014).

6.4 Blockchain for safe and decentralized health records

The decentralized nature of blockchain technology ensures data protection, integrity and openness. You can use blockchain to create a safe safe, tamper-proof electronic health records (EHR), available to patients and suppliers in the Future Healthcare Systems limit. Smart contracts can automate features such as invoicing, insurance and drug approval (et al., 2022).

6.5 Development of interopable ecosystem for digital health

Future health care will require spontaneous communication between equipment, platforms and stakeholders. Interoperability standards must develop to enable different health -IT systems to communicate effectively. Cloud platforms, APIs and federated data models will enable a connected ecosystem where patients, suppliers, laboratories and insurance companies share data -safe and effectively (Popov et al., 2022).

6.6 Sustainable Technology Personio

There is an increasing demand for frugal innovation waves, high influence technologies for rural and submarine areas. Solar cell-operated health monitoring units, offline competition mobile tags and portable diagnostic tools will promote health services access to external areas. Governments and non -state organizations should work together to ensure infrastructure, connection and financing (Balahurovska, 2023).

6.7 Regulation, ethics and policy infrastructure

Future technical adaptation should be directed by strong moral structure and regulatory policy that addresses questions such as the patient's consent, privacy, prejudice in the AI algorithms and fair access. Governments should establish a Fit regulatory model to keep up with technological progress without innovation (Catherine Cressvel and Sheikh, 2013).

6.8 Roll of education and apscilling in digital health

In order to utilize the entire capacity of health technology, capacity building is important. Future strategies should focus on dismissal to health professionals in digital tools, AI -Literacy, interpretation of data and cyber security practice. Educational integration of continuous professional development programs and health information science is necessary (Santa et al., 2014).

6.9 associated with innovation and public private participation

The future of innovation of the health care system lies in collaboration. Cross -sector partnerships between governments, academics, technical companies and health professionals will conduct the co -construction of

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skilled, affordable and impressive technologies. Shared research, open source platforms and innovation hubs will promote a more inclusive and participation digital health flow scenario (Akinvel and Abolsom, 2023).

6.10 Global Health Preparation and Digital Monitoring

Post-pandemic global health regime will depend much on AI-competent surveillance systems, digital dashboards and mobile contact tracking that will be to monitor the spread of disease. Future strategies will use real -time data for rapid control, resource admission and international coordination to prepare the world for future public health emergency conditions (Mehrotra et al., 2020).

7. Conclusion

Technical adaptation in the health care system is no longer optional - it is an important driver for better patient care, operating efficiency and strategic flexibility. This systematic review emphasizes that the health care system, especially multi -specific hospitals, embraces digital changes, continuing to face important challenges, including infrastructure limits, resistance to change, skills interval and moral concerns. However, these obstacles also offer opportunities for innovation, such as AI-operated diagnosis, extension of telemedicine, blockchain-based health records and future analysis for preventive care. The review emphasizes the importance of a patient -centred and inclusive approach when it comes to designing and implementing technical solutions. Equally significant interdisciplinary cooperation, continuous dismissal of health professionals and auxiliary policy structure has the role to ensure that digital equipment increases - not barrier - health distribution. Furthermore, the future of the health service is strong, intermediate and inherent in the creation of intelligent ecosystems that balance innovation with innovation, efficiency with morality and scalp with stability. By addressing the current obstacles and taking advantage of new opportunities, health organizations can unlock transformation ability and determine courses for more responsive, accessible and technically strong health care. This article contributes to the growing knowledge body in digital health and provides practical insight to decision makers, hospital administrators, technology suppliers and researchers in mapping a progressive roadmap for digital development of health services.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
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RESEARCH AND INNOVATION

AI-Driven Workplaces: Opportunities and Challenges for Employee Engagement in Indian Businesses

Vrushali Patade

Abstract
Artificial Intelligence (AI) is transforming Indian workplaces by automating routine tasks and introducing smart technologies in Human Resource (HR) functions. This paper explores the opportunities and challenges AI presents for employee engagement in Indian businesses. Using secondary data from industry reports, academic articles, and case studies, the study highlights how AI tools enhance personalization, real-time feedback, and training, while also creating concerns around job security and emotional disconnect. Recommendations emphasize the need for a human-centric approach to AI adoption to foster engagement in evolving workplaces.

Keywords
Artificial Intelligence, Employee Engagement, Indian Businesses, Workplace Automation, HR Technology, Employee Experience

Background

The rapid digitization of Indian businesses, propelled by the adoption of Artificial Intelligence (AI), is reshaping workplace dynamics. AI applications in HR, such as recruitment chatbots, performance analytics, and learning platforms, have made processes efficient and data-driven. Employee engagement—the emotional commitment and motivation employees have toward their organizations—has become critical for sustaining productivity in this digital transformation era (Gallup, 2020). India's growing IT and service sectors are at the forefront of integrating AI, making the study of its impact on engagement particularly relevant.

Introduction

Artificial Intelligence (AI) is increasingly influencing how Indian businesses manage their workforce. Employee engagement, defined as the psychological investment employees make in

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their work and organizations, has shown to directly impact organizational performance and employee retention (Aon Hewitt, 2018). As AI takes over routine HR tasks, there is both excitement and apprehension regarding its effect on human connections at work. In the Indian context, where cultural nuances and traditional work models coexist with digital transformation, understanding this balance is vital. This paper aims to examine the dual role of AI in presenting opportunities and challenges for employee engagement within Indian businesses by analyzing secondary data from reputable industry and academic sources.

Research Methodology

This paper employs a descriptive research approach based on secondary data. Data sources include:

• Industry reports from NASSCOM, PwC, Deloitte, McKinsey, and Gallup.

• Academic journals and conference papers accessed via databases such as JSTOR and Google Scholar.

• Company case studies published in public domains.

The selection criteria focused on recent (2018-2023), India-specific, and HR-AI related materials.

Opportunities

AI offers several advantages that can positively influence employee engagement:

• Enhanced Recruitment and Onboarding: AI-powered chatbots and automated screening reduce hiring biases and improve candidate experience (Deloitte, 2021).

• Personalized Learning and Development: Machine learning algorithms recommend tailored training programs, increasing employee skills and satisfaction (PwC, 2020).

• Real-Time Feedback and Sentiment Analysis: AI tools gather continuous employee feedback, enabling proactive engagement strategies (Gallup, 2020).

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• Increased Accessibility and Inclusion: AI-enabled platforms provide flexible working arrangements and assist differently-abled employees, broadening participation (NASSCOM, 2022).

These opportunities contribute to creating a responsive and employee-centric workplace that adapts to individual needs and fosters a culture of growth and motivation.

Challenges

Despite the benefits, AI integration raises several challenges related to employee engagement:

• Job Security Concerns: Fear of automation-induced job losses can reduce morale and increase resistance (McKinsey, 2021).

• Emotional Disconnect: Over-reliance on AI may erode human interactions and trust between employees and managers (Aon Hewitt, 2018).

• Algorithmic Bias and Fairness: AI systems may perpetuate biases, negatively impacting fairness and inclusivity (PwC, 2020).

• Technology Adoption Resistance: Employees may feel overwhelmed by constant changes and lack digital skills to engage effectively with AI tools (Deloitte, 2021).

Addressing these challenges is crucial for leveraging AI without compromising employee motivation and workplace harmony.

Case Study / Data Insights

Numerous Indian companies have adopted AI-driven HR solutions with varying impacts on employee engagement:

• Infosys implemented AI-enabled learning platforms offering personalized career development, resulting in improved engagement scores (NASSCOM, 2022).

• Tata Steel integrated AI-powered feedback systems to measure employee sentiment in real-time, enabling timely interventions (Deloitte, 2021).

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• ICICI Bank utilized AI chatbots to streamline onboarding processes, reducing administrative burden and improving new hire satisfaction (PwC, 2020).

Data from surveys by Gallup (2020) and Great Place to Work India (2022) suggest that organizations leveraging AI tools alongside human touchpoints report higher engagement levels compared to those relying solely on traditional methods.

Limitations

This study is based entirely on secondary data sources, which may limit the depth and specificity of insights into AI's impact on employee engagement in Indian businesses. The reliance on publicly available reports and case studies means the research might not capture the latest organizational practices or proprietary data that could offer richer detail. Additionally, the broad focus on multiple industries within India does not allow for an in-depth sector-wise analysis, which may vary significantly in AI adoption and employee engagement outcomes. The paper also does not incorporate primary data such as interviews or surveys with employees and HR professionals, which could provide a more nuanced understanding of employee sentiments and real-time challenges. Finally, rapid advancements in AI technology mean that findings could quickly become outdated without continuous review.

Conclusion and Recommendations

AI is undeniably reshaping Indian workplaces by offering new ways to engage employees through personalized, efficient, and data-driven approaches. However, to harness its full potential, organizations must address concerns of job security, emotional disconnection, and fairness. A balanced strategy that integrates AI tools with empathetic human leadership can foster sustainable employee engagement.

HR leaders should invest in digital literacy training, transparent communication about AI's role, and inclusive AI design to mitigate resistance and bias. Policymakers could encourage ethical AI standards to protect employee interests.

Future research could incorporate primary data and sector-specific analyses to deepen understanding of AI's impact on employee engagement in India.

e-ISSN- 3067-0977

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
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"Making Education More Accessible with AI: Startup Solutions"

Nitin K. Jadhav[1] and Dnyanoba T. Dhage[2]
[1]Dept. of Political Science, MVP Samaj's, K.T.H.M College, Nashik 422002
[2]Dept. of Political Science, MVP Samaj's, K.G.D.M college, Niphad 422303
Corresponding author: jadhavnitin1983@gmail.com[1]; ddnyanesht@gmail.com[2]

Abstract:

Ensuring equitable access to quality education remains a significant challenge worldwide. Both traditional methods struggle to address diverse learners, geographic separation, economic disparities, and differences in prior learning experiences. In this piece, we take a look at the disruptive wave resulting from AI in the EdTech startup space, which is smashing barriers and promoting greater inclusivity and access to education. In this piece, we discuss how AI-EdTech leaves no stone unturned in replacing or shaping a different kind of education system, one that is both potent and more democratic. This article examines how the education technology startup ecosystem is leveraging AI to both disrupt and address problems in more effective and inclusive ways. Conversely, the effects in the strategic areas of Personalised Learning, Intelligent Tutoring systems, and On-Demand support worldwide, facilitated by an AI-generated translator and local dissemination in real-time, are not negligible. Elsewhere, AI is enabling personalised learning, with adaptive interfaces and accessibility features for students with impairments, automating administrative tasks so that teachers can devote more time to differentiated instruction, and predictive analytics to address students at risk before they fall behind. Startups-led innovations, bringing high-quality educational resources and experiences to learners in remote areas, from underprivileged backgrounds, and those with special learning needs, are revolutionising access. The article is a testament to the agility and focus of startups when it comes to identifying precise accessibility gaps and providing tailored, scalable AI-based interventions. By centring the user in design, and through cutting-edge advances in AI, they are not simply incrementally improving the status quo, but redefining who can learn, how they know, and where learning happens, setting a new standard for a more inclusive, equitable future of learning for all.

Keywords: Educational Accessibility**;** AI in Education**;** EdTech Startups**;** Personalised Learning**;** Inclusive Education

e-ISSN- 3067-0977

1. Introduction:

Education is the foundation of human advancement, widely recognised as a human right and essential to individual empowerment, community growth, and the development of national and global economies. It provides people with the knowledge, skills, and opportunities they need to avoid poverty, engage fully in civic life, and contribute to the well-being of their community. Conversely, a focus on education typically leads to improved health, economic stability, and innovation. The ideal of ensuring that all people in all places are provided with access to quality learning to contribute to the increasingly connected, knowledge-driven world we now live in is no longer just an ideal; it is a moral and economic imperative for the world. It is the foundation on which a fairer and more prosperous tomorrow can be constructed. If anything, the picture of education for millions of people across the globe is marked by considerable inequality and daunting obstacles standing in the way of accessing schools. Education opportunities are primarily determined by geographical location, whereby learners in rural or remote communities often experience a shortage of schools, trained teachers, and material resources [1]. Socioeconomic status continues to predict educational achievement, as the expense of schooling, including tuition fees, learning materials, and Information and Communication Technology (ICT), is beyond the reach of many families, resulting in access to only poor-quality schooling. Additionally, traditional schools are not structured to accommodate students' diverse learning needs, including those with special needs and those with unique learning styles, often employing an inflexible, one-size-fits-all approach. Language and cultural issues may also be present, which can prevent effective learning if the material being learned or taught is not presented in the learner's native language or is not presented in culturally compatible formats. In combination, these factors contribute to access inequity, with many facing economic barriers to access [3].

We have made significant progress in recent years in the field of Artificial Intelligence, and these advancements present us with new and unprecedented opportunities to address complex social problems, such as those in the education domain. The cleverness of AI in extracting insights from vast datasets, personalising experiences, automating workflows, and generating customer insights offers potential for addressing the perennial challenges of learning. From adaptive learning systems, which adjust content to meet individual student needs, to natural language processing that enables cross-lingual communication and machine vision systems that facilitate learning for vision-impaired learners, AI promises to be a powerful tool in creating more adaptive, responsive, and inclusive learning environments [4]. This emerging technology has the potential to revolutionise the delivery, experience, and support of education, making it even more accessible to learners who have traditionally been held back! At the forefront in harnessing this disruptive force are inventive Education Technology (EdTech) companies. Freed from the shackles of traditional environments and driven by a burning passion to bridge the never-ending gulf of learning, these agile startups are perfectly poised to build and deploy disruptive AI. They are creating new platforms and tools tailored to promote access, frequently for niche needs or overlooked communities that bigger and more established organisations might not serve. 9 It's not that these startups are adding on AI to established models; instead, they are creating entirely new solutions that are inclusive and personalised. This post will examine how these trailblazing EdTech startups are leveraging AI to overcome barriers and create a future where a quality education is genuinely accessible to all, regardless of their circumstances [5-6].

2. Knowledge of barriers: where traditional education has failed to be accessible

Universal quality education is an increasingly common goal worldwide, but traditional education infrastructures present formidable and long-standing barriers to its widespread attainment for millions of learners globally. These constraints are embedded in the severe hierarchical organisation, production,

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and resourcing of schooling, leading to an access divide that discriminates against the very areas and people who are most vulnerable nationally. It is essential to understand these challenges and the potential of new ideas, particularly those leveraging emerging technologies such as AI, to disrupt and transform. One of the clearest obstacles is geographical and poor infrastructure. In many parts of the world, particularly in far-flung or rural areas, the physical distance to school is often the biggest hindrance to attending school, especially for younger children or those without access to transportation, as the route to school is not safe. And it is not just a shortage of schools; in many cases, there is also a dearth of trained teachers able or prepared to work in these places, resulting in overcrowding or a complete absence of education. The resources they have, such as textbooks, learning materials, and even basic technological tools, can be minimal, adding further challenges for both teachers and students. Furthermore, the absence of electricity and internet connections in several areas makes remote or digital learning possibilities unavailable, reinforcing the disadvantages to which geographically less favoured areas are subjected [7-8].

Another significant challenge to access is linked to socioeconomic conditions. The cost of direct educational expenses, including tuition, examinations, books, and uniforms, could be a significant barrier for families who cannot afford to live in poverty. In addition to those expenses are the indirect costs, including paying for transportation, both wages and meals lost, and the opportunity cost for parents to send their children to school rather than having them perform unpaid or paid work. These economic burdens often result in difficult choices and low rates of persistence among economically disadvantaged students. Even in free education systems, costs related to materials, private tutoring, and access to technology can be a significant barrier to equitable participation and achievement. It is indeed a challenge to meet the diverse learning needs of students in this classical classroom setting. They have varying degrees of prior experience, different learning styles, and varying rates of learning. In addition, classrooms are becoming more diverse and will include students with previously diagnosed disabilities, such as learning disabilities, physical disabilities, and neurodevelopmental disabilities. The one-size-fits-all approach offered by traditional education, in which a standard curriculum is often taught to “the middle” of a class, leaves most students without the individualised support and differentiated instruction needed to succeed truly. Teachers, who typically work under conditions of high teacher-pupil ratios and constrained resources, struggle to personalise instruction, offer individualised assistance, or customise materials for each student. As a result, some students may experience failure or disaffection [9-11].

Educational equity is also impeded by language and cultural differences. For decentralised students (those who are not native to the language of instruction), understanding lessons, participating in discussions, and completing assignments can be pretty challenging. The absence of bilingual teachers or learning resources in multiple languages exacerbates the problem, leaving these students excluded from the mainstream curriculum. Additionally, classes and teaching techniques that are not culturally responsive have the potential to distance students from backgrounds of colour, as the content of learning is not connected to students’ lived experiences and lives, which compromises their satisfaction and learning success. Lastly, the rigidity of conventional educational content and delivery systems raises the barrier to accessibility. The content of textbooks and curricula is often frozen for several years, and is slow to embrace new ideas or respond to the changing needs of society. Instruments for teaching are usually non-interactive, allowing for little instant, personal feedback, and a second explanation, in a second or third language, for example. This is a one-size-fits-all model that assumes every student is ready for the same level of reading and instruction, and that children’s needs are met by this pace, rather than by their progress, roadblocks, or investment in the content. Those learners who do not flourish in this one-size-fits-all model, whether they require additional time to master the material or are prepared to proceed at a faster pace, risk becoming frustrated, uninterested, or disconnected, which can lead to

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poor learning outcomes and limited access to a quality education. Taken together, these deficiencies reflect an urgent need for new approaches that provide greater personalised, flexible, and readily available learning opportunities [12-14].

3. AI-powered solutions: Startups disrupting the learning industry for inclusive learning

As a solution to the traditional education system's deeply rooted barriers, a diverse EdTech start-up ecosystem is emerging that utilises AI technology to create new opportunities for accessible, inclusive learning. These small and agile schemes are well-placed to pinpoint specific pain points in access to education and develop targeted technology-based solutions that can be implemented at scale, even faster and more flexibly than many larger, established providers. AI isn't just a helping hand for these efforts; it's often the underlying technology that powers these startups' ability to provide personalised, adaptive, and globally available educational experiences. Personalised and adaptive learning One of the key uses of AI in advancing accessibility is the creation of personalised and adaptive learning platforms Understand that a one-size-fits-all model doesn't work for every student, and startups are creating platforms that will continuously process AI-driven algorithms to analyse student performance, engagement, and learning patterns as they happen [15-17]. According to this information, the AI will be able to change how material is presented immediately, adjust the rate at which instruction takes place, increase or decrease the difficulty of exercises, or even suggest a different approach to learning by modifying the material used or learning methods. Such a degree of personalisation addresses various learning styles and the pace at which students learn; accordingly, those who need more time to master a concept can do so, even if their progress falls behind that of their peers in a traditional classroom. At the same time, those who learn more rapidly would not be held back. This flexibility enables high-quality learning for more atypical learners, such as students who learn differently or need a more flexible learning environment [17-18].

Startups are also behind one of the other most powerful applications of AI: developing intelligent tutoring systems. These AI tutors are designed to provide students with just-in-time, individualised academic support that emulates a human tutor. Using NLP and ML, these systems can understand students' questions, provide explanations, offer hints, and guide them through problem-solving processes. This is especially valuable for students who lack access to human tutors due to cost, geographical separation, or time constraints. By transcending the limitations of individualised attention in crowded classrooms, intelligent tutors incorporate scalability, providing students with real-time feedback and help at the point of need, ranging from access issues to the perils of students falling behind because they can't get the help needed when they need it. Another area where EdTech startups have made significant strides is in leveraging AI to integrate accessibility features directly into their platforms. There is an understanding that AI can be used for all learners, including those who need support. Supports can be tailored specifically for them, for example, high-quality speech-to-text and text-to-speech tools, which provide students with visual or physical disabilities with better access to digital content. AI-based tools for language translation and localisation are easing language barriers and making learning materials accessible and understandable for both non-native speakers and learners in multilingual environments. Moreover, in the framework of the personalisation of the educational contents to the profile of the user, AI techniques may be used to support the design of adaptive interfaces and to personalise the interface for the purpose to enhance the accessibility to digital learning environments, for a vast population of users including students with cognitive and/or sensory disabilities [18-19].

AI-enabled automated evaluation and feedback systems are transforming the way learners are evaluated and receive feedback. It is a time-consuming activity for teachers, as we have to grade a significant

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number of assignments, and students do not have immediate access to their feedback. Such AI-powered systems can quickly grade a wide range of formats, from multiple-choice questions to essays and coding exercises, and provide detailed feedback for students. This has the further advantage of not only carrying less administrative load for the teacher which gives them more opportunity to engage in the more meaningful conversations, but has the benefit for the student that they can see where they went wrong with their work and work through the correct approach whilst it is still fresh in their minds. Actionable and timely feedback is essential for effective learning, and artificial intelligence (AI)- supported tools are making this feedback accessible to a broader range of learners, enabling them to learn more effectively and in-depth [19].

Start-ups are utilising the key technology of AI-predictive analytics to identify which students might be at risk of faltering or dropping out. By examining trends in student engagement data, performance data, and other predictive indicators, AI algorithms can alert educators to students who are exhibiting early signs of academic struggle. This enables educators and schools to intervene early, providing support, resources, or counselling as necessary, before a student becomes substantially off track. This initiative to help students at the right time, utilising the insights that only AI can provide, becomes another key lever in the fight to retain more students, as well as to maximise the support they receive precisely when they need it, increasing their likelihood of success and continued access to education. Last but not least, AI has entered the realm of content generation and curation, making learning materials more diverse, relevant, and accessible. Generative AI can also help generate initial drafts of lessons, quizzes, or explanations, which teachers can polish and modify. AI algorithms can help select relevant learning resources from external sources, tailored to the learner's learning path and interests, to offer more enriching and diverse learning experiences. Additionally, AI can help transform current content into other reading levels or formats that make it easier for students who would otherwise have limited access to complex information. This ability to produce and customise content on demand addresses the problems of availability of diverse and culturally appropriate learning materials, making educational content more inclusive and engaging for all learners. These diverse AI uses of technology, led by the innovation of EdTech startups, are revolutionising the quest for educational access [20].

4. Conclusion:

In summary, the age-old battle to ensure on-demand access to quality learning, which has long been hindered by geographical, socio-economic, and systemic barriers, is now facing a formidable force in the form of Artificial Intelligence, particularly when applied by disruptive technology startups. In line with what we have analysed so far, the structures and forms of education traditionally have been complex to adjust to the great diversity of needs, situations and ways of learning of students all around the world and many of them are not well served, or even excluded in a potential not fulfilled – from learning what they need to know to reach their maximum of potentialities and ability. However, the scenario is now changing rapidly, with a wave of AI-led solutions being pioneered by nimble startups. Despite its availability, the identified barriers are now being addressed by these initiatives through applications that harness an unprecedented degree of personalisation, by offering adaptive learning pathways that adapt to each individual's pace and style, what they're doing instead: Using intelligent tutoring systems to provide scalable, just-in-time support and effectively emulating the luxury of one-on-one tutelage. They're also integrating valuable accessibility features driven by AI, including real-time translation, speech-to-text, and adaptive interfaces that cater specifically to the needs of learners with disabilities or those who speak other languages. They do not simply accelerate the process by automating assessment and feedback; they also provide students with the feedback and insights they need to improve on a rolling basis. When integrated with predictive analytics that help institutions

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identify and intervene with students who might be at risk before it's too late, and dynamic content creation and curation tools, these innovations are coming together to break down the systemic barriers that have curtailed access to education in the past. The combined might of AI's capabilities and the game-changing potential of EdTech startups is the route to building a vibrant future of learning that is brighter than ever. It's not just about building tools, but also about building bridges, offering 21st-century skills and competencies to today's learners. These ventures are making a meaningful difference. A larger commitment, more investments, and more collaboration in this space is what's sorely needed if we are going to unleash the power of AI and make quality education no longer a luxury of a privileged few but a basic opportunity for children everywhere-as a way to accelerate the speed of global progress and as a means for the world to fulfil its promise.

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e-ISSN- 3067-0977

GLOBAL FRONTIERS
JOURNAL OF MULTIDISCIPLINARY
RESEARCH AND INNOVATION

AI for Climate Change and Sustainability

Samit Shivadekar
samit1@umbc.edu
University Of Maryland Baltimore County, USA.

Abstract

Climate change stands as one of the most significant existential threats of the 21st century, with far-reaching impacts on ecosystems, economies, and the well-being of humanity. Despite the existence of global awareness and policy frameworks, such as the Paris Agreement, efforts for effective mitigation and adaptation are still progressing at a slow and inadequate pace. In this landscape, Artificial Intelligence (AI) has emerged as a transformative technology that holds the potential to tackle climate-related challenges on a large scale. This paper investigates the ways in which AI can aid in climate change mitigation, adaptation, and sustainability across diverse sectors. We start by delving into the scientific foundations and socioeconomic ramifications of climate change to establish a comprehensive understanding of the crisis at hand. Following this, we examine the contributions of AI in various areas, including climate modeling, predictive analytics, early warning systems, agricultural practices, land management, and disaster response mechanisms. Case studies from the real world illustrate successful applications of AI in fields such as renewable energy management, intelligent urban infrastructure, and ecosystem monitoring. Nevertheless, we also critically assess the shortcomings of existing AI systems, with particular emphasis on challenges related to data quality, algorithmic bias, and ethical considerations in deployment. The paper advocates for the advancement of AI systems that are less biased, more inclusive, and incorporate human judgment, ensuring alignment with planetary health objectives and supporting informed decision-making in regions that are particularly vulnerable. By integrating developments in AI and climate science, this research provides a multi-faceted perspective on how intelligent systems can enhance climate resilience and sustainability initiatives. While AI alone is not a panacea, when developed with care and applied ethically, it can be instrumental in fostering a more sustainable future.

Keywords : Artificial Intelligence (AI), climate modeling, intelligent systems, agricultural practices, land management, disaster response mechanisms

e-ISSN- 3067-0977

1. Introduction to AI and Climate Change

Climate change, like the COVID-19 crisis, is one of the biggest global crises humanity has ever faced. An unprecedented increase in global temperature, pollution levels, and destruction of the biodiversity that is the foundation of our Earth's life-support systems is the clearest and most dangerous warning signal that our civilization, as we know it, is simply not sustainable [1]. Yet, despite the repeated awareness, acceptance, and condemnation of climate change on a governmental level with the Paris Agreement, collective action is very slow. After more than 25 years of deliberation about the climate challenge, the situation is exactly the same as it was 30 years ago before the global climate conferences in Rio de Janeiro and Kyoto. Rather than taking the necessary steps to mitigate climate change, the world continues on a path to more and more pollution, and the carbon intensity of the world's economy has been increasing rather than decreasing.

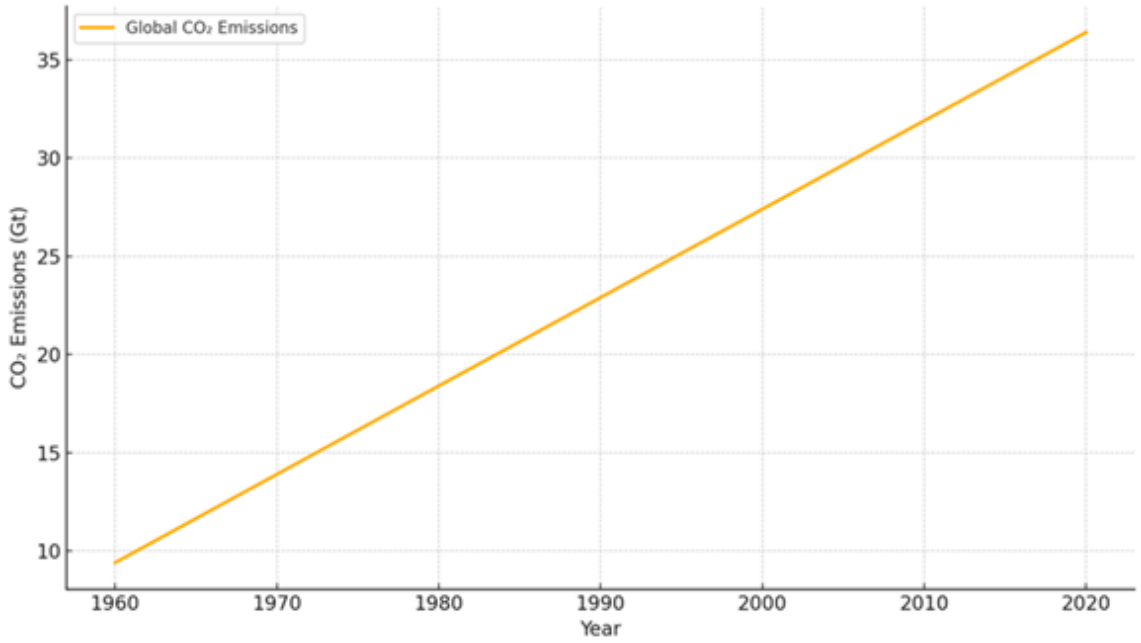

Fig 1 : Global CO_2 Emissions Trend (1960 – 2020)

A large number of technological innovations and steps are desperately needed immediately to give humanity a fighting chance to avert the environmental catastrophe[1]. Such technological innovations must help either to drastically reduce emissions and pollution or to rapidly and massively remove CO2, methane, NOx, and plastic from the atmosphere, oceans, and land. Artificial Intelligence (AI) is currently by far the most rapidly growing technological domain[2]. AI is not a panacea for climate change and will not provide a silver bullet at the touch of a button. Nevertheless, there are indications that it can exert a positive influence on, and steer what little remains of the transition

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towards a sustainable society[1,3]. This implies restricting the development of existing AI applications that can intensify environmental degradation, and at the same time stimulating and prioritizing the development of new AI applications that can help avert climate change[2,3].

2. Understanding Climate Change

To understand climate change, students first learn the basic science behind it. In order to increase understanding of some of the forces behind climate change, students learn about the carbon cycle and atmospheric carbon dioxide trends. The greenhouse effect is the next important physical phenomenon behind climate change, followed by an analysis of different fuel types. The week concludes with an inquiry activity in which students analyze how the fuel type impacts carbon dioxide emissions. The second half of the unit is aimed at deepening students' understanding of climate change. The analysis of climate change policy is a pivotal activity in this section, since policy uses the groundwork set in the first week while also integrating social issues. The unit begins with an exploration of ecosystems using local data, since it highlights how climate change is expected to impact the region around the students[4]. Students investigate how their behaviors and local policies impact the local environment. The unit concludes with an exploration of equity in dealing with climate change[5]. Students learn about the implications of being a developing country in a world where climate change must be dealt with. A Student Choice and Voice activity is included for the final couple of days, allowing the students to work on an idea of their own pertaining to climate change. The curriculum was carefully designed with respect to the science content in order to engage students with climate change in a meaningful way. It was structured to give background knowledge and understanding of scientific phenomena before dealing with deeper issues, allowing students to have enough grounding to be informed about potential solutions and policy, as well as societal issues related to climate change. During the formative and summative assessments involved in the curriculum, it was overwhelmingly evident that climate change is a difficult topic to teach, especially to the target population of students. However, it is possible to engage students while allowing them to have their own input and explore the topic on their own.

2.1. The Science of Climate Change

Climate change threatens the basis of life on Earth. Anthropogenic influences, e.g., via fossil fuel combustion, land-use change, etc., dominated 20th century climate change, and have already affected the environment in ways that a few decades ago would have seemed impossible. The reports explain the current knowledge about climate change, its impacts, and what can be done to reduce

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future change. At the same time, the climate crisis is widely perceived as an unsolved problem; known solutions are not implemented or insufficiently implemented [1]. The information context in the wider society does not enable or support sufficiently effective collective action.

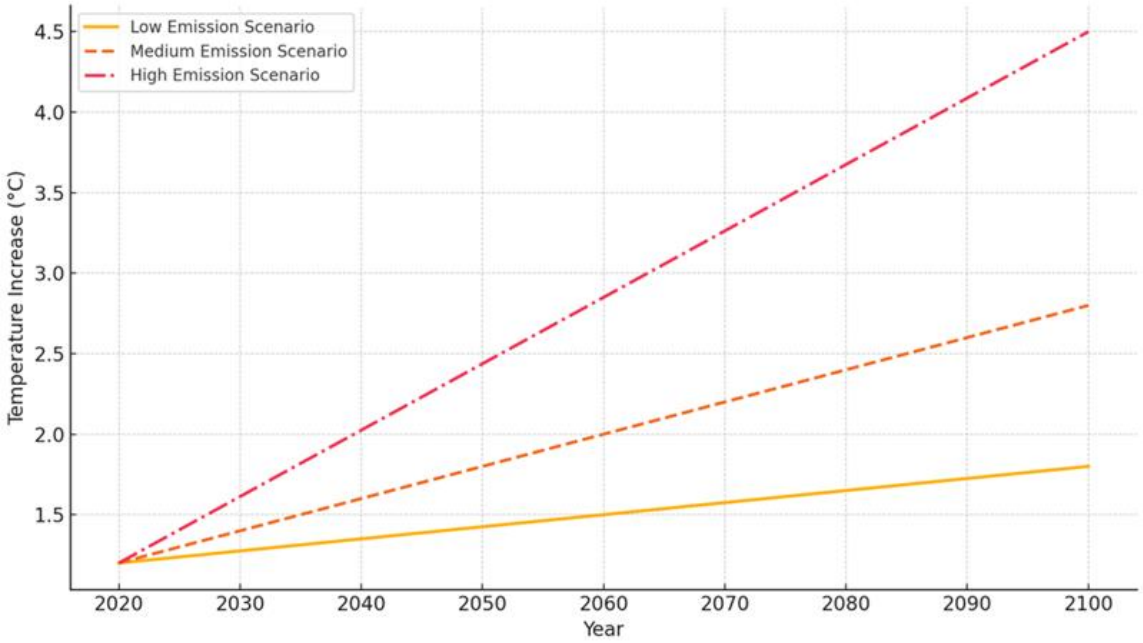

Fig 2 : Projected Global Temperature Increase (2020 – 2100)

Even when the transport, energy, and industrial sectors will be decarbonized and defossilized, ocean acids will still increase. Even when greenhouse gas emissions will be stopped and started to be reversed, the current level of greenhouse gas concentrations will raise temperatures for many years if not centuries. Current emissions levels and atmospheric carbon dioxide concentration levels predict increases in global average temperature that are at least equivalent to a four to five degrees Centigrade increase with the risk of breaking the tipping point of the climate system. It is plausibly expected that most humanity will become vulnerable to destruction (in every high pollution emission scenario by the end of this century) via uninhabitable regions, severe dry spells or flooding episodes in geographies that were reasonable prior to the climate crisis. As the COVID-19 crisis highlights the problem of a relatively strong and coordinated temporary action to solve a serious global problem, a strong coordinated and long-term worldwide action to outsmart the profit incentives trying to preserve an unsustainable situation is arguably even more urgent[4,5].

There are two approaches to which AI technologies can positively influence the transition towards a more sustainable society. The first is to make a more effective stewardship of the environment possible. AI algorithms can improve

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the predictions of climate models and refine those estimates. AI can facilitate the measurement of environmental factors. Ambient devices such as phones or wearables (or specific devices such as CO2, noise, etc., measurement devices) become increasingly cheap and advanced, enabling improved, crowd-sourced, and cheaper measurements of the environment.

2.2. Impact of Climate Change on Ecosystems

Climate change may pose a high risk of change to Earth's ecosystems: shifting climatic boundaries may induce changes in the biogeochemical functioning and structures of ecosystems that render it difficult for endemic plant and animal species to survive in their current habitats. These shifts may be regulated by a complex interplay of ecosystem structure and management potentials [8]. At the same time, the fundamental biogeochemical properties of vegetation, such as initialization carbon content or distribution of maximal carboxylation capacities, are believed to be more resilient to change [7]. Here, changes in the biogeochemical ecosystem state are aggregated as a proxy for the risk of these shifts at different levels of global warming [4]. It uses model simulations in combination with biogeochemical models of the terrestrial carbon cycle to calculate changes in vegetation states and fundamental ecosystem properties related to the biogeochemical coupling of modeled vegetation and climate.

5–19% of the naturally vegetated land surface is projected to be at risk of severe ecosystem change at 2 ◦C of global warming above 1980–2010 levels. At this level, pronounced shifts in biome distribution are projected in boreal North America and Eurasia, while the subtropical and tropical biomes are more resilient to change. For the set of models with a narrow range of projections for climatic change, the extent of regions at risk of severe ecosystem change is projected to rise with 1GMT, approximately doubling between 1GMT = 2 and 3 ◦C, and reaching a median value of 35% of the naturally vegetated land surface for 1GMT = 4 ◦C [4].

The bio geophysical and biogeochemical functioning of recently archived vegetation is projected to be remarkably stable and resilient [7]. Multi-model climate change impact assessment studies in earth system and integrated assessment modelling require a high level of coordination between modelling groups [4,8]. Nonetheless, efforts to assess changes in a major aspect of the climatic systems - ecosystem functioning - at the global scale have been undertaken to date. The modelling of climate change impacts on ecosystem functioning at the global scale requires a high level of coordination between modelling groups. In this study, a first step towards filling this gap is suggested

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by assessing changes in ecosystem states, fundamental biogeochemical properties and the risk of shifts in these properties responsible for changes in the biogeochemical coupling of climate and vegetation based on the assumptions that these properties can be more resilient to change than their dynamical counterparts and that both switching and transmission rates of these changes can be linked to the risk that they happen.

2.3. Socioeconomic Consequences of Climate Change

Climate change has been identified as a fundamental threat to sustainability in the 21st century, because the changing climate has serious implications for, and impacts on, the wellbeing of people and the natural environment [2]. The focus of the climate change problem is shifting from whether climate change is real to understanding the implications of this reality, recognizing that time is running out for society to mitigate the impacts of climate change. In this transition from the "if" to the "so what" of climate change, the timing of climate change, the nature of its impacts, and the vulnerabilities that it creates are becoming more relevant, perceptible and tractable [3]. At the same time, there is an increasing recognition of human responsibility for climate change and the associated obligations to take mitigation and adaptation action, however challenging this may be.

Climate change is also a complex system risk, defined as a risk in which feedbacks, interactions and non-linearities create nuances of system dynamics. It is a slow onset threat that can shift the climate outside of a region's historical envelope, which will not happen uniformly within the climate system. Changes may start in one region while the rest remain stable. Climate change implies changes in average conditions, but changes in extreme weather events can also be of primary concern and are much more difficult to evaluate [4,6]. For example, there is a general increasing trend in the likelihood of extreme weather events from climate models, including floods, droughts, storms and heat waves[9]. These uncertainties in the onset, nature and potential distributions of climate change impacts limit the understandings of processes inducing the risks and harms associated with climate change[6].

3. The Role of AI in Addressing Climate Change

In synthetic biology, model systems can be created that easily change and develop along directed pathways. A model system can exemplify how a rich ecosystem forms from simple building blocks, and discuss the role of evolutionary processes in this formation. Biological life is often viewed as repulsive due to its basic tenacity and expansionary mode. Understanding how living systems form also sheds light on the transition from a vigorous biosphere to a stable planet. While AI systems are present in every corner of life, they are

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modeled on past decision-making systems, making their operation, as well as their potential for human civilization, relatively easy to understand. The question remains whether human civilization can be transferred to a similar information-regulating system with less coherence. This may entail synthesizing the near future with a digitized replication of the current well-structured world. The evolved pattern could then form the basis of a favorable impact on the behavior of existing generations through monitoring and improved decision-making. It is likely that an existential risk threshold would need to be crossed that parallels the industrial revolution of the 1800s [1]. The ongoing global race for bigger and better artificial intelligence (AI) systems is expected to have a profound societal and environmental impact [4]. As witnessed in the past few years, and accelerated by the release of ChatGPT, AI is expected to alter job markets, enable new governance structures or regulatory frameworks, and affect the global consensus for pathways to climate action or mitigation. However, current AI systems and their general diffusion are trained on biased datasets that might destabilize political agencies or legitimate institutions, hence jeopardizing climate change mitigation and adaptation decisions. Thus, the appropriate design of an AI system with a less biased dataset that reflects both the direct and indirect effects on the societies and planetary challenges is a question of paramount importance.

3.1. AI Technologies for Climate Modeling

It is increasingly recognized that climate change and the loss of biodiversity have far-reaching implications for public health, food security, and the economic prospects, especially of the most vulnerable countries and populations [4]. To mitigate or adapt to the impacts of climate change and biodiversity loss, there is a need to conceive and implement an unprecedented level of concerted human action across scales and sectors ranging from individuals to international agreements. However, existing governance and societal welfare systems are often misaligned with these goals due to deep-rooted societal and political inequalities, vested interests in polluting industries, and the epistemic barriers to trust arising from the complexity and long time frames of proposed mitigation and adaptation measures. These issues render projections of the climate crisis and related narratives and knowledge far more uncertain and wildly divergent than in traditional policy arenas. An appropriate design of less biased AI systems that reflect both direct and indirect effects on societies and on related planetary challenges is therefore a question of paramount importance.

Given the massive data on actions and systemic consequences, an AI-augmented epistemic web with human-in-the-loop oversight is proposed, which combines human and machine intelligence for the co-design of less biased AI systems and appreciably lower uncertainties in climate-related governance systems and

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outcomes [2]. Such a less biased AI is co-aligned with an epistemic web on planetary health challenges through relevant on-modeling, timely and adaptive multi-agent training with demonstration-proof backtracking [9]. Such a human-in-the-loop AI is capable of unfoldingly transitioning from the relatively simpler phase of aligning culpable narratives and knowledge with feasible AI, to the far more ambitious phase of direct mitigation and adaptation interventions based on causal knowledge of social tipping elements. The reduction of the violent injustices associated with current AI pretraining datasets is pursued by the cocreation of less biased meta-AI by data-wise egalitarian and epistemically equitable communities [2,3].

3.2. Predictive Analytics and Climate Forecasting

Africa is regarded as the continent with the highest climate risks with high climate extremes and low adaptive capacity. For instance, country representatives at the UN Climate Change Conference have warned about the imminent doom of Madagascar, which has frequently come under the attack of powerful cyclones that cause massive damages on food crops and infrastructure. Consequently, many inhabitants of Madagascar are left homeless, and the cyclone created a ripple effect across the Indian Ocean islands, affecting food supply across the Indian ocean islands, the east coast of Africa, and augmenting fever infections, particularly COVID-19 [5]. Extreme and unpredictable weather events wreak a more significant toll on the vulnerable nation as the socio-economic impact reaches larger portions of the populace. Essentially, predictive and safe weather is imperative to aid farmers' decisions on sowing climate-resilient crops for productivity and sustainability.

A very accurate prediction of the Australian fires that rendered thousands of lives and homes could have curbed it. A forecast about how much rain would cause cyclones in many West African nations as well as where this rainfall would fall, would have helped farmers to start farming by planting early maturing crops. The extent of precipitation and how it would affect the seasons could have informed irrigation and ploughing management. Likewise, a decade ago, a forecast about a time period where an influx of rains would elicit flooding in Kumasi and Accra in Ghana could have informed accurate sand lifting and the construction of better, guided drains [9,10]. Therefore, real-time forecasting products and designing small, easily interpretable analysis components will help enhance communities from forecast to climate resilience [2].

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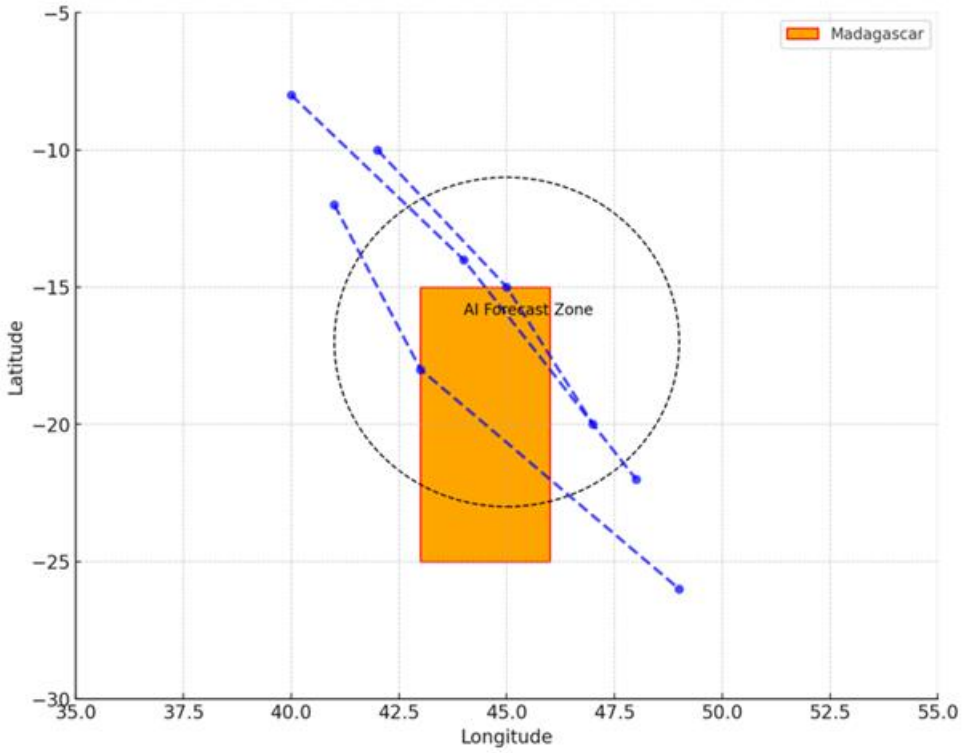

Fig 3 : AI based Cyclone Prediction in Madagascar

Effective early warning includes forecasting techniques offering effective prediction models to derive real-time data on agricultural impacts based on early forecasts of climate. The expected weather variables may augment the full-season weather strategy in developing better seasonal agricultural impact forecasting models, and consequently, deployment of agriculture-output-impact relevant early warnings. It has been noted that considering forecast uncertainty needs to be improved in early warnings. Characteristic of high-dimensionality, sparsity in signal support and time-varying coefficients in structure makes AI a better choice to tackle this challenge [16,17].

4. AI in Agriculture and Land Use

Agricultural production is challenged by a dual threat, directed by climate change and influenced by the anthropogenic emission of greenhouse gases (GHGs), especially on account of the nitrogen-based fertilizer use and farming practices. Changing processes on the earth are related to the large human-related GHG emission from the terrestrial and aquatic environment. Humans alter the natural biophysical and biogeochemical processes on the earth, triggering climate change and variability ubiquitous across space and time. Climate variability threatens agricultural productivity through abnormal departures of climate conditions from those on which agricultural management decisions are developed, jeopardizing food security and livelihood. The dual threat directed by

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climate change and brought about by climate variability creates a new challenge for agriculture. One expectancy of agriculture under climate change is to navigate the impacts of anthropogenic GHGs on climate and food production without infringing its productivity potential. Another expectancy of agriculture under climate variability is to manage the changing climate effectively despite the large uncertainty in climatic predictions. These dual challenges for agriculture underscore a shift in agriculture from a predictable paradigm to a new paradigm governed by the laws of uncertainty [8].

Two competing human-controlled attribution factors dominate to illuminate the inconsistency on such competing arguments on how anthropogenic GHGs affect climate relative with GHGs for energy supplies—and these human-controlled factors cannot account for the volume of the anthropogenic GHGs in the past two decades. GHG-induced climatic variability is likely too important to be neglected in spite of large uncertainties in state-variable adjustments regarding climate cost due to the complexity of the climate system. Agriculture is the second greatest anthropogenic emission source of GHGs on account of land use and land cover change, and also due to Fertilized N, and farm machinery and soil tillage [8,11]. On the other hand, agriculture is the most climate-sensitive economic sector. Based on robust observational evidence, economic modeling, and novel models of climate-emission interactions, it also narrowed the constraints on the role of the net climate system in controlling and managing climate change improvement [4,11].

Agriculture is only accountable for a far smaller proportion of temporally-lagged anthropogenic GHG-induced climatic warmth on account of the legacy of CO2 fertilization—break control and sequential shock on for-going processes in natural and farming systems. Therefore, the challenge of climatic change or variability on agricultural production is brought about not by the static state of climate but by the change of climate and the hydrological regime in tandem with climate change [8,11]. Adaptive, resilient, prediction-based, and smart systems will be introduced to enable agriculture to better navigate productivity constraints on account of GHGs while controlling farming actions with realism [11,12].

4.1. Precision Agriculture Techniques

The autonomous devices commonly used in precision agriculture can be mainly divided into two categories: fully autonomous devices and semi-autonomous devices, such as Unmanned Aerial vehicles (UAVs) and agriculture robots used for detecting plant diseases and weeds. UAVs hold a key place in precision agriculture, as they can gather a vast amount of data on a large-scale farm within a very short period of time. Moreover, aerial images taken from satellites can

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also be used in precision farming for identifying suitable land, plant diseases, predicting weather conditions, and remote sensing applications. Apart from crop condition monitoring and management, livestock management is another important aspect of precision farming, where it can help in monitoring overall health condition and real-time location of animals and improve the productivity, welfare, and reproductive behavior of animals throughout their life cycle. Various intelligent sensors implanted internally and externally on animals and real-time cameras can assist in making smarter decisions regarding underlying conditions and act accordingly in a timely fashion. Despite the slow adoption of precision farming solutions, the wide use of precision farming solutions around the world can be mainly attributed to the power of AI, which is backed by both ML and Deep Learning (DL), the two main pillars of AI. Nonetheless, the availability of high-speed Internet, low-budget sensors, and efficient computational devices has aided the wide dissemination of precision farming solutions at the present time [12].

Agriculture is facing a global crisis due to the depletion of natural resources, population growth, and climate change. Precision agriculture (PA) is a smart and sustainable system that maximizes agricultural yields and minimizes environmental side effects by improving resource utilization. Recently, the 4th industrial revolution has seen the rapid development of big data, cloud computing, drone technology, and the internet of things (IoT). Ideally, PA would involve building cloud-based big data platforms through IoT-based data collection, which would optimize prediction and allow customized prescriptions based on artificial intelligence (AI). This convergence of agriculture and communication technology can help develop eco-friendly farming methods through the automation of agricultural machinery using advanced technology. It can also improve the predictability of crop growth and climatic conditions through sensor and information processing technology. Therefore, PA is expected to be a systematic alternative to the aging rural workforce and help mitigate agriculture-related environmental pollution. An efficient PA system requires novel technologies that can monitor real-time information in a prompt and accurate manner. Developing a systematic diagnostic technique by analyzing the compositions of crop sap and nutrient solution is more important than monitoring physical factors. A wide range of analytical methods such as chemiluminescence, spectrophotometry, fluorescence, and chromatography have been used for monitoring plant growth in agriculture. However, this traditional analysis method is not suitable for on-site monitoring because the pretreatment is complicated and expensive equipment and highly skilled technicians are required [13].

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4.2. Sustainable Land Management Practices

Sustainable land management involves the management of land, water, biodiversity and other resources that meet human requirements while maintaining ecosystem services [7]. In the northern Great Plains (NGP), the combined impacts of land-use and climate variability have placed many soils at the tipping point of sustainability. Climate variability can lead to droughts, floods, and changes in the timing and intensity of the seasons, which in turn affect soil organic carbon (SOC) and nitrogen (N) turnover rates in many regions.

Soil management practices can be sustainable by carefully managing agricultural intensification and climate variability. However, to devise such management practices it is necessary to quantify the sustainability and waves of change in major soils and understand the underlying soil processes. In this context, the NGP provides a unique opportunity to study soil sensitivity to land-use and climate impacts, dual-stable isotopes, and spatially explicit biogeographic modeling [8]. The study objectives were to: calculate land-use changes from 2006 to 2012 and from 2012 to 2014 in South Dakota and Nebraska; assess if land use changes had impacted on soil sustainability; calculate variation in total carbon budget and turnover due to seasonal climate variability, biomass quality and soil properties; and determine effect of fire on the CO2 emissions, soil temperature and soil moisture.

5. Challenges and Limitations of AI in Climate Solutions

AI is expected to have a profound societal and environmental impact. AI systems, however, tend to be trained on biased datasets. The design of such biased AI systems compromises social stability if they ever become widely adopted by political agencies, particularly when the datasets impact climate change mitigation and adaptation decisions. Suppose a synthetic dataset ideally means under-represented geographical regions, economic levels, and social agency. In that case, the question of how to leverage such a dataset to ensure broader adoption and trustworthiness for all decision-makers on a planet level remains and becomes of paramount importance [2].

As AI becomes widely accessible through increased cloud functionality, there is a strong global incentive to develop such less biased systems, especially ones that reflect both direct and indirect effects on societies. It arises in a web of an epistemic and thus trustworthy answer / knowledge sources to increasingly ambitious questions of planetary challenges and cannot be viewed as an isolated system. A definition of such a less biased AI is that it focuses on AI for good, which advances the well-being of all people on earth, enabled through trustworthy information. A human-in-the-loop AI can contribute to such a web by predicting interventions that support climate action and deploying a

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multitude of AI-based tools. Secondly, it can directly enable co-development of mitigation and adaptation through knowledge of social tipping elements and their geographic references. Thirdly, a less biased AI can greatly support climate action by reducing the data injustices associated with AI pre-training datasets.

The climate crisis is unfolding to be equivalent to the COVID-19 crisis. Recently, going back to the Earth after months of human lockdown and observing an unexpected but impressive recovery of the environment was a joyful experience [1]. AI is not a panacea for climate change. Nevertheless, AI can positively influence and guide the transition towards a sustainable society. AI can intervene to continue replenishing the air and seas while avoiding the return to before and leaving no one behind. Therefore, AI saves the planet by applying the AI paradigm to the climate crisis. There are already some examples of productive collaborations between AI researchers and climate experts. Furthermore, preparations are being made for larger actions.

5.1. Data Quality and Availability Issues

The current generation of climate data sets, from monitoring stations to gridded data sets, is far from perfect. Issues such as missing data, drift or instability in the instrument itself, unaccounted quality differences, or environmental conditions affecting it dramatically compromise the quality and availability of the outputs we acquire. Many of these processes are known to alter climate, yet they are hard to ascertain and estimate, leading to potential misinterpretations impacting understanding of climate processes and future policies [6]. Other biases, known as "undetected data quality issues," have been shown to lead to large-scale climate trends that mimic real ones. Examples include missing data caused by the instrument falling into disrepair, new data streams received and/or assimilated that do not fully conform with past data handling routines, relabeling of station IDs or names, and scale changes, among others.

Since climate models are designed using high quality homogenized data, and the impact of undetected data quality issues can rebound on multiple tests incorporating these data sets, it is recommended that climate models be tested on "raw" data sets collected only after a proper account of data quality issues has been taken. Future work should focus on the assessment of data quality issues and the use made of derived climate data sets, combined with the study of state-of-the-art data handling routines specifically designed to deal with multiple types of data quality issues throughout the climate data supply chain. In the longer term, strategies addressing an inclusive better inter-operability between data quality measures and the future open altimeter mission, and improved methods to assess legacy climate data should both be helpful for future archiving of more accessible data.

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5.2. Ethical Considerations in AI Deployment

Before diving into specific issues of ethics and politics of AI relevant to climate change more broadly, there may be the desire to review some of the established boundaries of ethical AI. Computation and analysis carried out by computers are more or less categorical in nature, and it may be prudent to consider ethical AI as operating solely at this broad level with no grey area. Nonetheless, such a view would be problematic, as it would ignore the ethical impact of AI development. The majority of AI climate change articles were considered to have a negligible intention on global warming. Some AI technologies such as robotics, self-driving vehicles, and drones were also ignored in the initial analysis as they are some of the most talked about technologies[3]. Therefore, a collection of AI technologies in climate change reaches a conclusion that over 145 areas of interested AI technologies in climate change, i.e., environmental awareness, remote sensing data, monitoring climate commitments, and so on that continue to evolve[2,9].

There are a few prescriptive frameworks for establishing ethical boundaries in AI development. Many consumers, nations, and corporations have varying boundaries of acceptable application of AI. It is proposed that AI applications that do not promote, protect, and respect fundamental human rights cannot be characterized as ethical [3]. Consistent with the principles articulated by various organizations, it is proposed that the Universal Declaration of Human Rights and the International Covenant on Civil and Political Rights are minimum [2]. Second, if the AI is used in an impactful way (e.g., the AI designs or is used to direct, influence, or otherwise affect human behavior or agency, environmental conditions, opportunities, or risks) then actual or potential harms of that AI must be recognized and minimized [2,9]. Third, statistical practices involve the production of statistical outputs that are powerful and actionable [9].

6. Case Studies of AI in Climate Initiatives

The climate crisis is comparable to the COVID-19 crisis, with evidence emerging that global warming has entered a dangerous phase with ever-increasing consequences. The consequences of climate change are already felt across the globe. The world is on an unstoppable trajectory to civilizational collapse as a consequence of climate change and biodiversity loss [1]. There is a risk of reaching a tipping point, i.e., the severity of the consequences and the speed at which they present themselves, rendering considered action impossible. While awareness, activism, and sustainability initiatives at all levels are becoming ever more intense, the investments in fossil fuels, mining, and agriculture are trillions of dollars annually. Within a decade after the announcement of the Paris Agreement, coal and oil production plans had only amplified. The outcome of the COP26 in Glasgow was very disappointing; coal intends to ramp-up rather than

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decrement; no deadlines have been set for coal; fossil fuel subsidies continue unabated, etc. It is evident that our civilization as we know it is unsustainable.

AI is not a panacea for climate change [1]. However, AI algorithms can positively influence and guide the climate transition towards a sustainable society [2]. AI systems can increase awareness of the consequences of climate change. AI algorithms can even be used to improve the predictions of climate models. Climate models are used to predict the future consequences of climate change based on current conditions. Differences in components of climate models, however, complicate the assessment of consequences. By investigating the assumptions and the underlying physics behind the models, discrepancies in the outputs of currently employed models can be solved. One avenue for study is the historical comparison between the older and newer models. When only the new models are used, climate adaptation planning can be improved [2]. AI systems can better facilitate the measurement of environmental factors. An example of how this can be done is an AI algorithm that quantifies floating plastic waste using video cameras placed on bridges [14]. Deep-learning based object detectors can be trained to detect and classify plastic waste.

6.1. Successful AI Projects in Renewable Energy

Artificial intelligence is currently being implemented globally. The majority of these projects are focused on traffic lights as they control how vehicles move in cities. Traffic lights are often inefficient, leading to longer commute times for both vehicles and public transport. This results in more fuel consumption and greater greenhouse gas emissions [3]. AI can help better manage these traffic lights. AI solutions can learn the entire traffic situation at an intersection in real time. They can then predict the behavior of all users of this intersection as well as the optimal configuration of the lights. This configuration can be communicated to engineers for implementation or directly to the traffic lights. The first road installations generate immediate improvements in traffic flow with up to 30% vehicle speed increases, more than 65% waiting time reductions, a similar fall in fuel consumption, over 70% less pollution, and faster emergency service response times. In China, AI anticipates air pollution thanks to satellite images. Then, AI interprets the data and anticipates where the pollution is going to descend. The city is alerted, leading to the stop of certain polluting traffic. AI also ranks industries according to their pollution rates. AI is currently optimizing the allocation of cleaning resources in cities, as well as the collection of waste.

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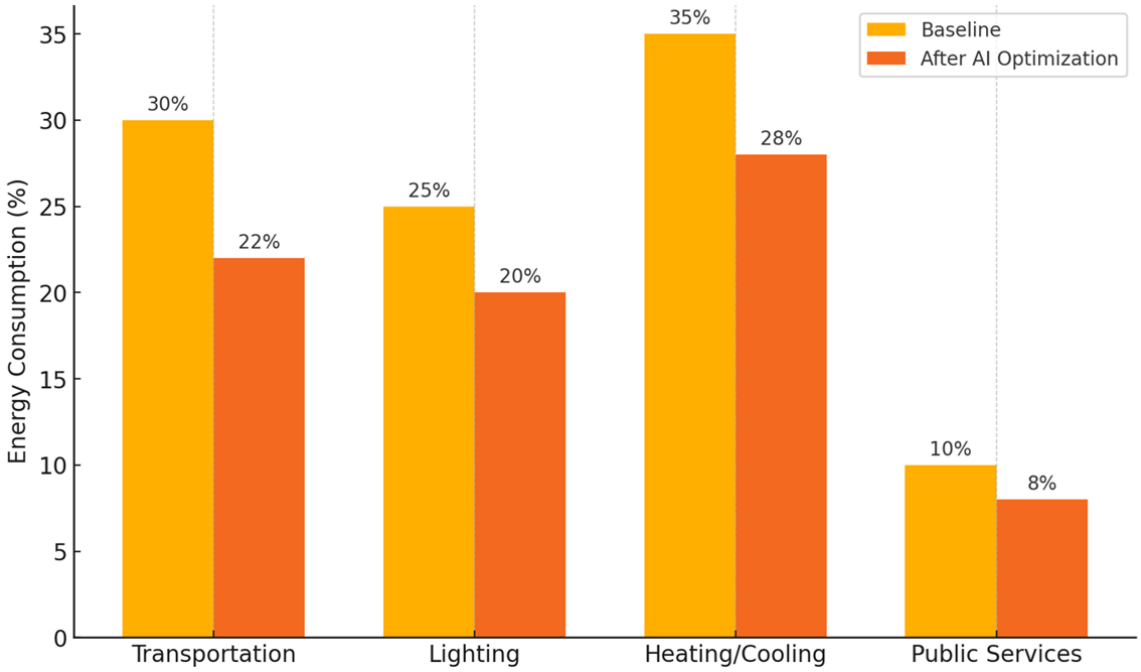

Fig 4 : Energy Optimization by AI in Urban Infrastructure

AI can significantly improve performance, including that of bids. Climate change is still better anticipated by cities' areas than earlier considered. How much energy a city requires is one question crucial to limit expenditure. Also, how to produce this energy is another key question. AI solutions anticipate a city's energy needs day by day and even hour by hour. The AI interprets the meteorological data together with the calendar, and the city's infrastructure. It is able to output recommendations for the corresponding dynamic usage of the several energy resources. Implemented in Nice, the solution combined with already implemented actions has led to over 20% energy consumption reduction [13]. 10% prevention out of 40% projected growth, the output is recommendations hour by hour. This includes the prevention of the heat wave alarm thanks to tree planting recommendations appearing after AI's extensive simulations [9]. AI has helped anticipate by decades a fatal heat peak and then control it. The solution recommends trees according to preference degree and time needed to generate a shade, on green-centrism basis. The city does expect a solution on human-centrism basis. The weight of this project though is much heavier. In the project's family, as well as its sibling actions in cities across the globe, AI is capable to optimize performance, production, bidding and consumption for other renewable energy systems[2].

6.2. AI Innovations in Disaster Response

Every year, thousands of people perish or go missing as a result of natural disasters (ND). Fortunately, there are currently many data-driven approaches

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being developed that automatically extract valuable information from Earth observation (EO) data in order to aid disaster management and relief efforts. Using AI-based algorithms, researchers hope to help in the detection and forecasting of ND and to automatically extract ND footprint information from data streams in the context of damage assessment [9]. This presentation will focus on these two main pillars of current research activity.

Current analytical frameworks reveal that advanced cloud-based artificial intelligence systems are capable of independently identifying natural disasters, thanks to years of meticulous development[9]. Recent advancements suggest that datasets are now effectively utilized to systematically identify instances of wildfires, advancing efforts initiated over a decade ago to improve weather forecasting and tidal evaluations. Continuous enhancements driven by crowdsourced metadata related to natural disasters have notably increased detection accuracy and accelerated response efforts [2].

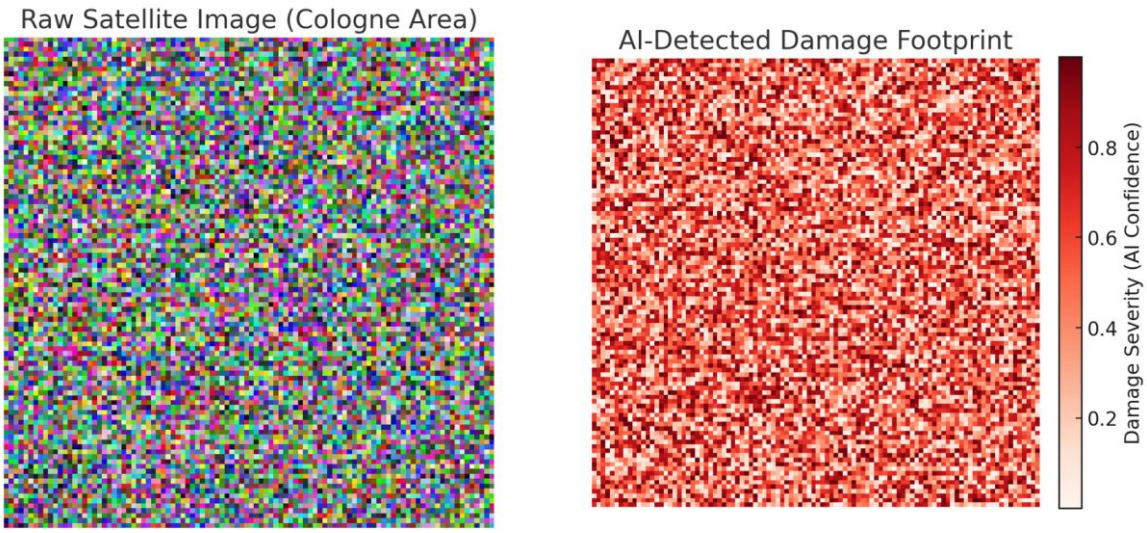

Fig 5 : AI – Augmented Damage Assessment from EO Data (Cologne Example)

The second use case shows the extraction of ND footprint information from data streams using AI-based algorithms. Using a fuzzification approach borrowed from remote sensing land cover studies, the algorithms build per-pixel uncertainty metrics. To demonstrate a proof of concept, the results from optical satellite imagery from the neighborhood of Hohenzollern Bridge in Cologne are shown, with input provided by the satellite Sentinel 2, and output compared to optical drone imagery provided by the Team[15,9]. Examples of land subsidence monitoring during 2014-2022 of a coal extraction region in the eastern part of Germany using an AI-based algorithm are shown. It is demonstrated that state-of-the-art satellite-based InSAR tends to fail for such dynamic processes if the time frame of observation is too large.

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7. Conclusion

The climate crisis is comparable to the COVID-19 crisis. Rising populations together with economic growth – and high rates of consumption in the Western world – constitute a vicious cycle of unsustainable development. A crude comparison of date ranges shows that one could start to worry the same amount about climate and ecological crises as the COVID-weeks of the outbreak of a pandemic; in the year 1900, it was 0.031 °C; in 1970, it rose to 0.9 °C; and, as of July 2021, it now stands at approximately 1.3 °C on the way towards a dreadful 4–4.5 °C in 2100. The increase in atmospheric carbon is an astonishingly unprecedented growth, despite years of forewarnings that have failed to transform. The COVID-19 crisis undoubtedly influences climate in a positive way. Before 2010, to obtain a "safeguarded" outcome was (almost) impossible; however, in 2020, an unprecedented decrease in carbon dioxide emissions was reported, resembling a historical fact. Recently, an astonishing temporal model suggested that on-going gradual developments may be combined with sudden catastrophes; the second would accelerate the third. The aim of this perspective is to polemically argue that – contrary to common beliefs – AI is a powerful tool that can play a decisive role in the (successful) governance of ongoing climatic changes. Such governance falls into the general category of regulation of unforeseen interactions of intelligent agents. AI is not a panacea. It has formidable defects and failures that should be addressed. AI can turn adversarial. These events, however, do not preclude possible advantages of AI. They rather emphasize the need for a fully accepted and personally valued AGI with general moral standards for work, action, and behavior. Even then, AIs with divergent reference systems can attain successes in competition. The successful governance of climate change can give rise to EA-like devastation of the Earth, but this is discussed elsewhere.

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e-ISSN- 3067-0977

CONTACT US

www.mcstemeduversity.us

Mc Stem Eduversity LLC, USA (Registered)
34 N Franklin Ave Ste 687-2084 Pinedale, WY 82941
Email: office@mcstemeduversity.us
D.N. : +1 (561) 448-8539 (WhatsApp)
Call. : +91 9011424678